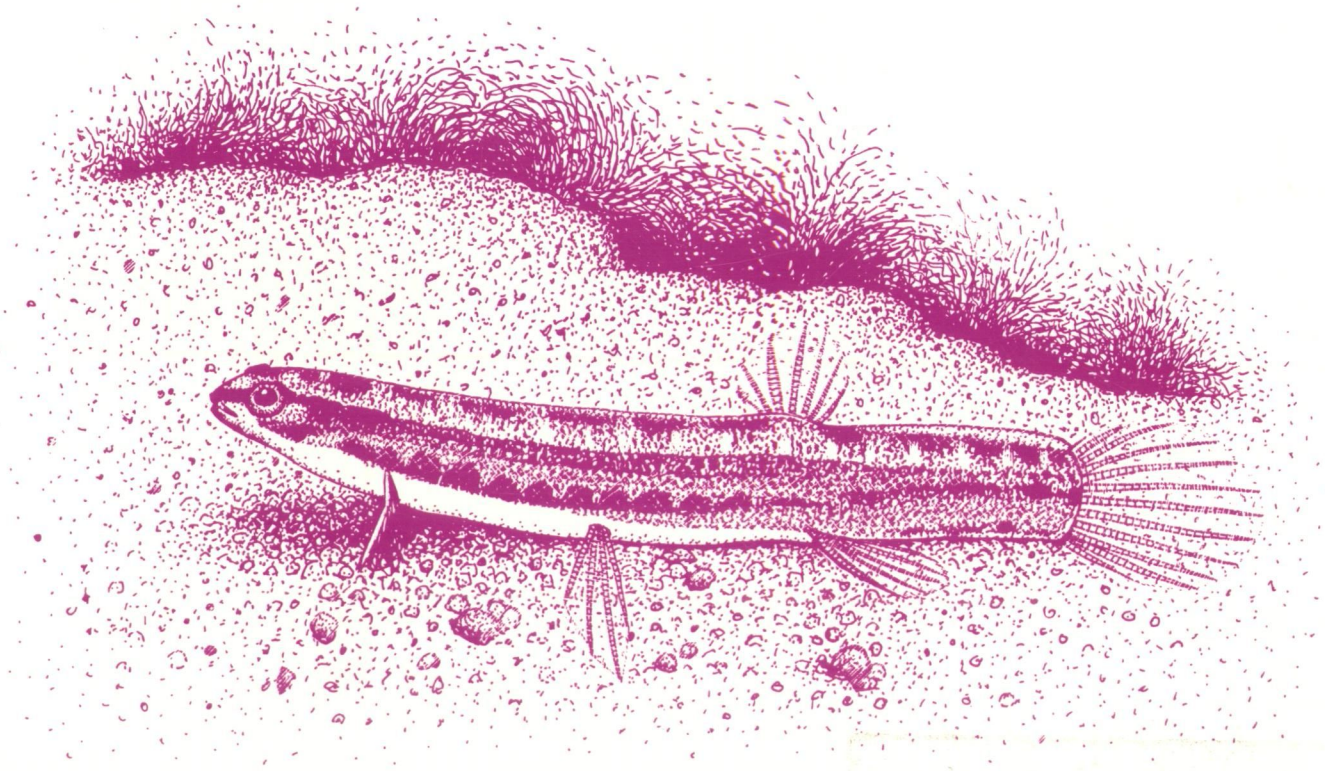
ISBN 0 7307 1218 4
ISSN 0313 122X

Distribution, identification and biology of freshwater fishes in south-western Australia

by

David L. Morgan, Howard S. Gill and Ian C. Potter



Records of the Western Australian Museum
Supplement No. 56

Records
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Printed and published by the Western Australian Museum

ISBN 0 7307 1218 4

Cover: The Western Australian salamanderfish *Lepidogalaxias salamandroides*.
Illustration by Jill Ruse.

DISTRIBUTION, IDENTIFICATION AND BIOLOGY OF FRESHWATER FISHES IN SOUTH-WESTERN AUSTRALIA

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Western Australian Museum
1998

World List Abbreviation:
Rec. West. Aust. Mus. Suppl. No. 56

ISBN 0 7307 1218 4
ISSN 0 313 122X

Printed and published by the Western Australian Museum,
Francis Street, Perth, Western Australia 6000

TABLE OF CONTENTS

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Distribution, identification and biology of freshwater fishes in south-western Australia

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Abstract – A total of 410 sites in the major watersheds in the south-western corner of Australia, bounded by Bunbury in the north-west and just east of Albany in the south-east, were sampled for fish. Sampling of the different sites was carried out using one or more of the following methods, namely seine netting, scoop netting, trapping and electrofishing to catch juvenile and adult fish, and light trapping, scoop netting and haul netting to collect larval fish. The fish caught at each site were identified and the number of each species recorded. These data were then collated, both with those derived from the studies of Christensen (1982) and Jaensch (1992) and with the records of the Western Australian Museum (WAM), to elucidate the distributions of each of the fish species found in freshwater in south-western Australia. The eight species endemic to south-western Australia are *Tandanus bostocki, Lepidogalaxias salamandroides, Galaxias occidentalis, Galaxiella nigrostriata, Galaxiella munda, Bostockia porosa, Edelia vittata* and *Nannatherina balstoni*. The other species found in this region include *Galaxias truttaceus* and *Galaxias maculatus,* which are also represented in south-eastern mainland Australia and Tasmania, the anadromous lamprey *Geotria australis,* and those teleosts which are commonly found in freshwater, but belong to predominantly marine families, i.e. *Leptatherina wallacei, Pseudogobius olorum* and *Afurcagobius suppositus.* Finally, there are those species that have been introduced into the region, i.e. *Oncorhynchus mykiss, Salmo trutta, Gambusia holbrooki* and *Perca fluviatilis.*

The most common and widespread endemic freshwater species in south-western Australia are *G. occidentalis, B. porosa* and *E. vittata,* which are found in the majority of rivers and lakes and many of the pools in the region. Within the sampling region, the freshwater catfish *Tandanus bostocki,* was caught at only two sites during the present study (Alexander Bridge on the Blackwood River and at Lake Smith in the D'Entrecasteaux National Park), and was only recorded from Lake Wilson by Jaensch (1992) and from Pemberton and Nannup in the Western Australian Museum records.

The other four endemic species, namely *L. salamandroides, G. nigrostriata, G. munda* and *N. balstoni,* are effectively restricted to the region bounded by Margaret River in the west and by Albany in the east. However, *G. nigrostriata, G. munda* and *N. balstoni* have disjunct distributions, each having an isolated population near Gingin, which is well to the north of the other populations of these species. Disjunct populations of *G. nigrostriata* and *N. balstoni* have recently been found near Bunbury and Collie, respectively. *Lepidogalaxias salamandroides* and *G. nigrostriata* are generally restricted to the small ephemeral pools in the southern peat flats. Although *N. balstoni* is likewise abundant in the pools of the peat flats, it is also present in very low numbers in some rivers and lakes. *Galaxiella munda* is also found in a number of pools in the peat flats, but is most common in the headwaters of the major rivers of this area.

The two freshwater species, that are also found in south-eastern Australia, namely *G. truttaceus* and *G. maculatus,* were only found in the catchments of the small nature reserve at Two People's Bay. However, G. *maculatus* is known to be most common eastwards of the sampling region, i.e. within the coastal streams and rivers between Albany and Esperance.

Adult *G. australis* were recorded migrating up the Warren, Donnelly and Margaret Rivers during winter and spring. Although the precise locations at which they spawn are unknown, a number of maturing adults were caught in autumn and winter in both isolated pools and the main channel of the headwaters of the Warren River. The larvae (ammocoetes) of *G. australis* were collected from within shallow silty banks in the Capel, Margaret, Donnelly, Warren, Gardner, Shannon, Deep, Kent and Denmark Rivers, while the fully-metamorphosed young adults were typically found in the sandy substrates of these rivers.

Those fish species with marine affinities, that are abundant in freshwater in south-western Australia, namely *L. wallacei*, *P. olorum* and *A. suppositus*, are generally associated with coastal water bodies. However, these species were found considerable distances inland in, for example, the Blackwood River and a number of isolated lakes, such as Lake Jasper in the D'Entrecasteaux National Park.

Gambusia holbrooki, a small introduced species, is extremely common and widespread in south-western Australia. *Perca fluviatilis*, a large introduced species was often locally abundant. These two species are often associated with habitats that have been substantially altered by human activity. For example, they were often common in reservoirs, e.g. Big Brook Dam, in mined areas, e.g. Collie River South Branch and the wetlands of RGC Mineral Sands, and in those systems subject to enrichment through agricultural run-off, e.g. certain areas of the Capel River, Blackwood River, Warren River and Lake Unicup. The two introduced trout species, *O. mykiss* and *S. trutta*, were only found in those systems where stocking had taken place, i.e. predominantly in the streams of the Pemberton area, and they were rarely captured in large numbers.

Habitat alteration, and possibly also the introduction of exotic species, pose the main threats to the highly endemic fish fauna of the south-western corner of Australia. Habitat alteration is likely to occur through those agricultural and forestry practices in the uppermost catchment that cause alterations to inflow, increased salinisation, siltation and eutrophication, and through dam construction, mineral sand exploration and mining, groundwater extraction, the construction of water points for fire fighting and road maintenance. Although three of the endemic species, namely *G. occidentalis*, *B. porosa* and *E. vittata*, are typically represented by large populations in most types of habitat throughout their extensive ranges, and are thus currently under no threat, local populations of these species may be threatened. In contrast, four of the endemic freshwater species *L. salamandroides*, *G. nigrostriata*, *G. munda* and *N. balstoni*, have a very restricted range and are generally represented by small populations in very specific habitats. There is also strong circumstantial evidence that the abundance of the pouched lamprey *G. australis*, has declined in recent years. This decline may reflect the influence of dams, which act as at least partial barriers to the upstream migration of the adults towards their spawning areas and leads to alterations in water flow and thus a decline in the areas of silty substrate in which their larvae (ammocoetes) live. These latter five species are therefore considered potentially vulnerable to the continuing loss or alteration of habitat and, in some cases, also to the introduction of non-native species.

The accounts of the distribution of each species in our study area, together with records of these species to the east and north of our study area, is accompanied by resume's of the taxonomic characters and biology of that species.

INTRODUCTION

The freshwater fishes of Australia and the world

The teleost fishes, which comprise over 24,000 extant species, dominate the vertebrate faunas of marine and freshwater environments (Nelson 1994; Paxton and Eschmeyer 1994). Although freshwater habitats comprise only 0.01% of the world's total aquatic environments, approximately 40% of all fish species are restricted to these habitats (Allen 1982; Nelson 1994; Paxton and Eschmeyer 1994). Based on the presumed habitats of their ancestral stocks, freshwater fish are considered to be represented by two groups. The first group comprises approximately 8,000 species, which are believed to have originated in fresh water and are termed primary freshwater species, whereas the second group of approximately 1,500 species are believed to have been derived from marine species and are referred to as secondary freshwater species (Allen 1982).

Although Australia is considered to have one of the most diverse marine fish faunas, its freshwater fish fauna is depauperate, highly endemic (see Table 1) and lacks many families that are found elsewhere in the world (Lake 1971; Allen 1982, 1989; Merrick and Schmida 1984; Larson and Martin 1990; Paxton and Eschmeyer 1994; McDowall 1996). Thus, while the Australian continental shelf houses more than 4,000 marine species (G. Allen pers. com.), there are less than 200 species resident in the freshwaters of this continent, of which 144 are confined exclusively to freshwater, while the other species exhibit various degrees of diadromy (Allen and Swainston 1988; Allen 1989; Paxton and Eschmeyer 1994). This lack of diversity and richness is emphasised by the fact that elsewhere the freshwater fish fauna is

represented by far greater numbers of species. For example, there are approximately 2,000 species in South America, with some 1,500 species in the Amazon alone, 1,400 in Africa, 600 in China and over 400 in the relatively small country of Thailand (Allen 1982, 1989; Harris 1984; Paxton and Eschmeyer 1994).

The very low diversity of the Australian freshwater fish fauna is related, in part, to both the relative scarcity of rivers and the seasonal nature of inland waters in parts of the continent (Harris 1984; Allen 1989; McDowall 1996). Indeed, it is hardly surprising that freshwater habitats, and thus freshwater fishes, are scarce in a country where annual evaporation exceeds rainfall in over 90% of the continent (Harris 1984). Moreover, the total runoff of the entire continent only marginally exceeds that of the Danube River in Europe (Harris 1984). The high degree of endemism presumably reflects the long period of isolation since the break up of Gondwanaland (Allen 1989, 1991). There is, however, not only a low species diversity of freshwater fish in Australia, but many of the families which dominate freshwater habitats elsewhere in the world are absent or poorly represented in this continent. For example, groups such as the cyprinids, characoids, cyprinodontids, cichlids, anabantoids, channids and nassdids, which dominate the freshwater fish faunas of South America, Asia and Africa, are absent from Australia (Allen 1989, 1991; Larson and Martin 1990).

Australia and New Guinea to the north, which, until approximately 8,000 years ago, were connected by a land bridge, share nearly all of the families, most of the genera, and 33 species of freshwater fishes (Allen 1989, 1991). In contrast, Australia and New Guinea have few freshwater fishes in common with nearby Indonesia, which is characterised by an extremely rich oriental fauna, represented by numerous cypriniform (carps, loaches, etc.) and siluriform (catfishes) fishes (Allen 1982, 1989, 1991; Larson and Martin 1990). The very different fish faunas of these regions presumably reflects their very different geological origins. The Australian and New Guinean land mass began drifting northwards from Antarctica to its present position approximately 50 million years ago, whereas Indonesia is part of the Asian continental plate and was, until 20 million years ago, well separated from Australia (Allen 1991). Furthermore, even during the recent periods of far lower sea levels, the deep oceanic trench between the respective continental plates would have remained a barrier to any exchange of freshwater fishes between these regions (Allen 1982, 1989, 1991; Larson and Martin 1990).

In addition to its low diversity and high degree of endemism, the freshwater fish fauna of Australia is further characterised by an extremely high proportion of secondary species. These include the ariid and plotosid catfishes, atherinids, eleotrids, gobiids and terapontids, which may have spread to Australia from south-eastern Asia and the Indonesian Archipelago as drifting pelagic eggs or larvae, a common method of fish dispersal. These species could then have invaded estuarine habitats in Australia and, after the landlocking of these habitats, become adapted to freshwater conditions. This could explain the restricted distribution of many Australian freshwater fish (Harris 1984; Allen 1989). The primary freshwater fish species include the lungfish *(Neoceratodus forsteri)*, the bony tongues *(Scleropages jardinii* and *S. leichardti)*, the Western Australian salamanderfish *(Lepidogalaxias salamandroides)*, and possibly also the galaxiids, an exclusively southern hemisphere family (Lake 1971; Harris 1984; Merrick and Schmida 1984; Allen 1989, 1991; Larson and Martin 1990).

The factors responsible for the paucity of the Australian freshwater fish fauna includes not only the effects of a long period of isolation, and the presence of deep and/or wide oceanic barriers, but also the generally low, featureless topography and the dry climate to which Australia is exposed (Allen 1989). Since the interior of the continent is particularly dry, it contains little or no permanent water, and, as a consequence, no fish species have been recorded from the Great Sandy, Gibson or Great Victoria Deserts (Allen 1989). The majority of the freshwater fish species found in Australia are distributed throughout the northern and eastern coastal strips, in the drainage systems of the Kimberley-Arnhem Land region and the Great Dividing Range. The presence of substantial rainfall and the range of habitats found in these regions accounts for the relatively greater number of fish species found in this part of the continent (Lake 1971; Allen 1982, 1989, 1991; Harris 1984; Merrick and Schmida 1984).

The major drainage systems of Australia

Although many factors are important in determining the distribution of Australia's freshwater fish fauna, none is probably more important than the drainage patterns of the continent (Figure 1, Table 1). The 11 catchment zones, originally described by Bauer (1955), have proved useful in describing the distribution patterns of Australia's freshwater fish species. However, the number and precise areas occupied by the drainage systems have subsequently been modified by various authors. The following account recognises nine drainage divisions and their associated freshwater fish faunas, based on the studies of Lake (1971), McDowall and Frankenberg (1981), Allen (1982, 1989), Harris (1984), Merrick and Schmida (1984), Eschmeyer

(1990), Fulton (1990), Larson and Martin (1990) and McDowall (1996).

Australia's drainage systems include:

(i) South-western division
(ii) Pilbara division
(iii) Kimberley-Arnhem Land division
(iv) Gulf of Carpentaria division
(v) Eastern Coastal division
(vi) Tasmanian division
(vii) South Australian Gulf division
(viii) Murray-Darling division
(ix) Lake Eyre and adjacent internal divisions

(i) The south-western division (Figure 1). This region, bounded by Geraldton in the north-west and Esperance in the south-east, contains predominantly short coastal rivers, whose characteristics are determined by high winter and low summer rainfall. The region contains ten principal species, comprising one species of the Plotosidae, the sole representative of the Lepidogalaxiidae, five species of the Galaxiidae, the only member of the Percichthyidae in Western Australia and two species of the Nannopercidae. All but two of the galaxiid species are endemic to south-western Australia. The freshwaters of this region also contain the pouched lamprey, which is the sole representative of the family Geotriidae, one endemic species of the Atherinidae and two species of the Gobiidae, one of which is endemic (Table 1).

(ii) The Pilbara division comprises a harsh, dry region, with sparse rainfall and few permanent watercourses (Figure 1), characteristics which are reflected by the presence of only 16 freshwater fish species, of which five are endemic. The region is largely dominated by gudgeons (Eleotridae) and grunters (Terapontidae) (Table 1).

(iii) The Kimberley-Arnhem Land division incorporates the Daly, Victoria, Ord and Fitzroy Rivers (Figure 1). This region is comparatively rich in species (70) and, like the Pilbara, is dominated by eleotrids (10) and terapontids (14). A number of species of the Ariidae (4), Plotosidae (6), Atherinidae (4), Pseudomugilidae (4), Melanotaeniidae (6) and Chandidae (5) are also found in this region. Although many of these species are also found in southern New Guinea, 22 are endemic to this division (Table 1).

(iv) The Gulf of Carpentaria division (Figure 1) is climatically similar to the Kimberley-Arnhem Land division, sharing a number of species with that region and also with southern New Guinea. The dominant species of the region belong to the Ariidae (5), Plotosidae (5), Chandidae (6), Terapontidae (7), Eleotridae (7) and Gobiidae (5). There are only four species endemic to this division (Table 1).

(v) The eastern coastal division can be divided into two subregions, namely that comprising the south-eastern drainage system, which is dominated by high winter rainfall, and the north-eastern drainage system, where rainfall occurs predominantly in summer. The entire division is supplied by the eastward flow of water from the slopes of the Great Dividing Range (Figure 1). A total of 89 species are found in this division, of which 25 are endemic. The region is dominated by species belonging to the Eleotridae (12), Gobiidae (7), Plotosidae (7), Melanotaeniidae (7), Galaxiidae (6), Percichthyidae (6), Terapontidae (5) and Nannopercidae (4) (Table 1).

(vi) The Tasmanian division (Figure 1), which contains 28 species, is dominated by 15 species of galaxiid, ten of which are endemic to the island (Table 1).

(vii) The South Australian Gulf division, which consists of small ephemeral streams originating in the hills to the north and east of Adelaide (Figure 1), is occupied by only nine species, none of which is endemic to this division (Table 1).

(viii) The Murray-Darling division comprises the largest river system in Australia, flowing some 1,900 kilometres (Figure 1). Despite its length, it has the smallest runoff of any large river system in the world. The system contains 32 native species, which include three species of galaxiid, five species of percichthyid, and six species of gudgeon. Only five species are endemic to this region (Table 1).

(ix) The Lake Eyre and adjacent internal divisions encompass much of the interior of the Australian continent (Figure 1) and, although its rivers are believed to have carried large quantities of water during the Pleistocene, water is now generally scarce, a result of the low and erratic rainfall in the region. The 18 native fishes of this division are well adapted to these harsh conditions, congregating in isolated pockets of water or around springs and artesian bores. This division is dominated by four species of plotosid catfish, three species of atherinid, and four species of terapontid (Table 1).

The remainder of the interior of the continent is yet to reveal any living fish species (Allen 1982) and, although of considerable size, its harsh, dry conditions and lack of permanent water suggests that none will be found there (Figure 1).

The fish fauna in the freshwaters of south-western Australia, and the status of biological and ecological research

South-western Australia has a typical Mediterranean climate, with cool wet winters and warm to hot dry summers (Jaensch and Lane 1993). It contains numerous short coastal rivers, lakes and flats, the first of which is thus subjected to large seasonal fluctuations in flow rates (Allen 1989; Jaensch and Lane 1993). Furthermore, water levels in these water bodies, which are high in winter, as

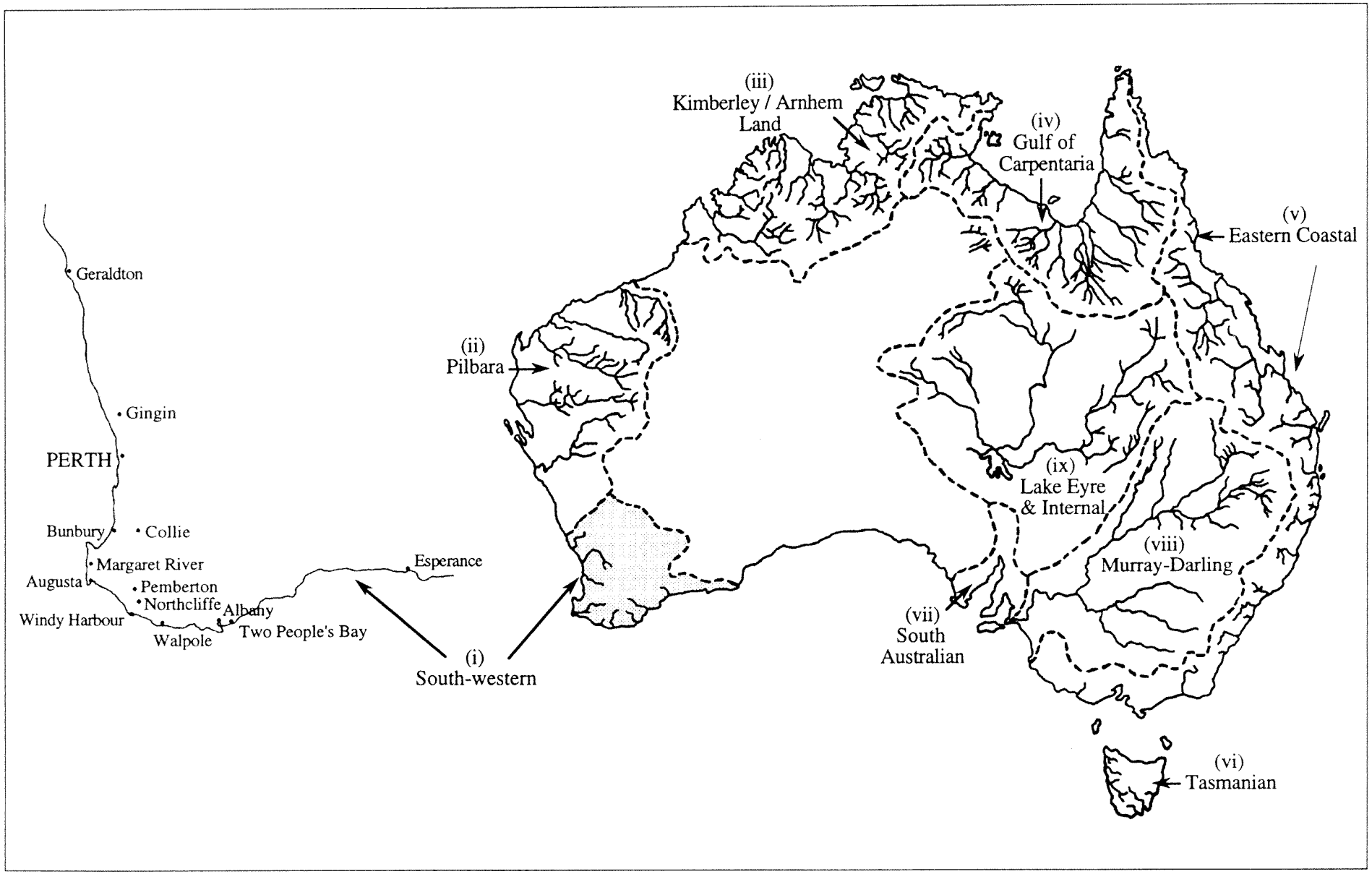


Figure 1 The drainage zones of Australia, modified from Bauer (1955), Lake (1971), Merrick and Schmida (1984) and Allen (1989).

Table 1 The number of fish species in each of those families found in the freshwaters of the major Australian drainage systems, including the total number of species in each family. N.B. Number of endemic species is in parentheses. This information is taken from Lake (1971), McDowall and Frankenberg (1981), Merrick and Schmida (1984), Allen (1989), Eschmeyer (1990), Fulton (1990), Larson and Martin (1990), Nelson (1994) and McDowall (1996). Classification and number of species worldwide follow Eschmeyer (1990) and Nelson (1994), respectively, except for with the Nannopercidae and Percichthyidae which follow references in McDowall (1996).

	NUMBER OF SPECIES		DRAINAGE SYSTEM								
	Australia	World	(i) South-western	(ii) Pilbara	(iii) Kimberley / Arnhem Land	(iv) Gulf of Carpenteria	(v) Eastern Coastal	(vi) Tasmanian	(vii) South Australian Gulf	(viii) Murray-Darling	(ix) Lake Eyre & Internal
CEPHALASPIDOMORPHI (*jawless fishes*)											
Geotriidae (*pouched lamprey*)	1	1	1	–	–	–	1	1	1	1	–
Mordaciidae (*short-headed lampreys*)	2(2)	3	–	–	–	–	2(1)	1	1	1	–
ACTINOPTERYGII (*ray-finned fishes*)											
Osteoglossidae (*bony tongues*)	2(1)	7	–	–	1	1	1(1)	–	–	–	–
Anguillidae (*freshwater eels*)	4	15	–	–	1	–	3	2	–	1	–
Clupeidae (*herrings*)	2(1)	180	–	1	1	1	2(1)	–	–	1	1
Ariidae (*fork–tailed catfishes*)	5	120	–	1	4	5	1	–	–	–	–
Plotosidae (*eel-tailed catfishes*)	12(9)	32	1(1)	1	6	5	7	–	–	1	4(3)
Lepidogalaxiidae (*salamanderfish*)	1(1)	1	1(1)	–	–	–	–	–	–	–	–
Retropinnidae (*southern smelts*)	2(2)	4	–	–	–	–	1	1(1)	1	1	1
Prototroctidae (*southern graylings*)	1(1)	2	–	–	–	–	1	1	–	–	–
Aplochitonidae (*whitebaits*)	1(1)	3	–	–	–	–	–	1(1)	–	–	–
Galaxiidae (*galaxiids or native minnows*)	20(19)	40	5(3)	–	–	–	6	15(10)	3	3(1)	–
Atherinidae (*hardyheads or silversides*)	9(8)	165	1(1)	1(1)	4(2)	3	3	–	–	3	3(3)
Pseudomugilidae (*blue-eyes*)	6(3)	15	–	–	4(1)	2	3(2)	–	–	–	–
Melanotaeniidae (*rainbowfishes*)	13(10)	55	–	1	6(3)	5	7(4)	–	–	1(1)	1
Belonidae (*needlefishes*)	1	32	–	–	1	1	1	–	–	–	–
Hemiramphidae (*halfbeaks*)	1	85	–	1	1	1	1	–	–	–	–
Synbranchidae (*swamp eels*)	3(2)	15	–	1(1)	1	1	1	–	–	–	–
Scorpaenidae (*scorpionfishes*)	1(1)	388	–	–	–	–	1(1)	–	–	–	–
Centropomidae (*giant perches*)	1	22	–	1	1	1	1	–	–	–	–
Chandidae (=Ambassidae) (*glassfishes*)	8(4)	41	–	–	5	6(1)	4(1)	–	–	1	1
Percichthyidae (*freshwater basses & cods*)	8(8)	25	1(1)	–	–	–	6(2)	1	–	5(2)	1
Nannopercidae (*pygmy perches*)	6(6)	6	2(2)	–	–	–	4(3)	1	–	1	–
Gadopsidae (*river blackfishes*)	2(2)	2	–	–	–	–	2	1	–	2	–
Terapontidae (*grunters or tigerfishes*)	22(20)	45	–	3(1)	14(10)	7(1)	5(2)	–	–	2	4(1)
Kuhliidae (*flag-tails*)	1	8	–	–	–	–	1	–	–	–	–
Kurtidae (*nurseryfishes*)	1	2	–	–	1	1	–	–	–	–	–
Apogonidae (*cardinalfishes*)	1	250	–	–	1	1	1	–	–	–	–
Toxotidae (*archerfishes*)	3	6	–	–	3	1	1	–	–	–	–
Mugilidae (*mullets*)	1(1)	100	–	–	–	–	1(1)	–	–	–	–
Bovichtidae (*congollis or bovichtids*)	1(1)	6	–	–	–	–	1	1	1	1	–
Eleotridae (*gudgeons*)	25(19)	150	–	3(2)	10(6)	7	12(3)	1	1	6(1)	1
Gobiidae (*gobies*)	13(6)	1800	2(1)	2	3	5(1)	7(2)	1	1	1	1(1)
Soleidae (*soles*)	3(2)	117	–	–	2	2(1)	–	–	–	–	–
SARCOPTERYGII (*lobe-finned fishes*)											
Ceratodidae (*Australian lungfish*)	1(1)	1	–	–	–	–	1(1)	–	–	–	–
TOTAL	184(131)		14(10)	16(5)	70(22)	56(4)	89(25)	28(12)	9	32(5)	18(8)

a result of the heavy winter rains, decline markedly in summer, when there is little or no rain (Allen 1982).

Geological, palaeoclimatic and palaeobotanical evidence suggests that the biota of the south-western corner of Australia has been separated from other regions of Australia since at least the middle Miocene, i.e. for at least 15 million years (Archer and Fox 1984; Figgis 1993; Trayler *et al.* 1996). This isolation is believed to have led to the speciation of the biota *in situ*, thereby accounting for the high endemicity of the flora and fauna that is characteristic of the region today (Archer and Fox 1984). The unique assemblages of plants and animals in this region would thus alone argue that a high priority should be given to the formulation of management plans for their conservation. This priority is particularly relevant since the increasing human exploitation of the water, timber, agricultural and tourist resources of south-western Australia is having an increasing impact on both the aquatic and terrestrial ecosystems of the region. It should be noted that the flora and fauna of south-western Australia is not only highly endemic, but that its freshwater fauna is far more depauperate than that of south-eastern Australia (Allen 1982, 1989; Bunn and Davies 1990). The last authors concluded that this low diversity can be attributed to a number of factors, including the long isolation of south-western Australia, a long history of aridity, and an extremely low level of primary productivity.

South-western Australia contains only ten species of native freshwater fish, of which eight are endemic to the region (Allen 1982). These ten species, which represent seven genera and five families, comprise one species of the Plotosidae (*Tandanus bostocki*), the sole representative of the Lepidogalaxiidae (*Lepidogalaxias salamandroides*), five species of the Galaxiidae (*Galaxias maculatus, Galaxias truttaceus, Galaxias occidentalis, Galaxiella nigrostriata* and *Galaxiella munda*), one species of the Percichthyidae (*Bostockia porosa*) and two representatives of the Nannopercidae (*Edelia vittata* and *Nannatherina balstoni*).

The biology of the eight species endemic to south-western Australia has been studied in recent years. Information is therefore now available on the life history and ecology of *T. bostocki* (Morrison 1988; Hewitt unpublished honours thesis 1992), *L. salamandroides* (Pusey 1983, 1989, 1990; McDowall and Pusey 1983; Leung 1988; Allen and Berra 1989; Berra and Allen 1989a, 1991, 1995; Berra *et al.* 1989, 1990; Pusey and Stewart 1989; Martin *et al.* 1993), *G. occidentalis* (Pen and Potter 1991a, b), *G. nigrostriata* (Pen *et al.* 1993), *G. munda* (Pen *et al.* 1991), *B. porosa* (Pen and Potter 1990), *E. vittata* (Shipway 1949; Pen and Potter 1991c) and *N. balstoni* (Morgan *et al.* 1995a).

With the exception of the freshwater catfish *T. bostocki*, none of these endemic species typically exceeds 140 mm in total length and five of these species have maximum total lengths of less than 90 mm (Allen 1989; Morgan *et al.* 1995a). Four of these species, namely *L. salamandroides, G. nigrostriata, G. munda* and *N. balstoni*, are typically confined to the high rainfall region in the extreme lower south-western corner of Western Australia. The other four species, namely *T. bostocki, G. occidentalis, B. porosa* and *E. vittata*, are much more widely distributed.

The remaining two freshwater species, *G. maculatus* and *G. truttaceus*, are both widely distributed throughout southern Australia, presumably reflecting the presence of a marine larval stage in the life cycles of the amphidromous forms of these species (McDowall and Frankenberg 1981; McDowall 1988; Allen 1989). While *G. maculatus* occurs in coastal streams and swamps between Denmark and Esperance (Allen 1982; Jaensch 1992), *G. truttaceus* is thought to be the rarest galaxiid in south-western Australia, having been collected only from a small area between Albany and Two People's Bay (Allen 1982), and from the Pallinup and Fitzgerald Rivers (Hodgkin and Clark 1988, 1990). Although the biology of these two galaxiids has been extensively studied in eastern Australia (e.g. Pollard 1971a, b, 1972a, b, 1973, 1974; Chessman and Williams 1975; Humphries 1989, 1990), no comparable investigations have been carried out on these species in south-western Australia.

The sole representative of the monotypic lamprey family Geotriidae, the anadromous species *Geotria australis*, is also found in freshwater in south-western Australia, as are *Leptatherina wallacei, Pseudogobius olorum* and *Afurcagobius suppositus*, which also occur in large numbers in estuaries. Various aspects of the biology of these species have been described (Potter *et al.* 1980, 1983, 1986a, b; Prince *et al.* 1982a, b; Prince and Potter 1983; Potter and Hilliard 1986; Gill and Potter 1993; Gill and Humphries 1995; Gill *et al.* 1996).

Four exotic freshwater species, namely *Gambusia holbrooki, Oncorhynchus mykiss, Salmo trutta* and *Perca fluviatilis*, are also found throughout south-western Australia, the last three species growing to considerably longer lengths than all but one of the endemic species, i.e. *T. bostocki*. The first species was introduced into south-western Australia in an attempt to control mosquito populations, while the last three species were introduced to enhance freshwater fishing in the region (Coy 1979). Although a further two species, namely *Carassius auratus* and *Phalloceros caudimaculatus*, have also been introduced into south-western Australia, they are generally restricted to the Swan Coastal Plain (Morgan unpublished data). Although there is

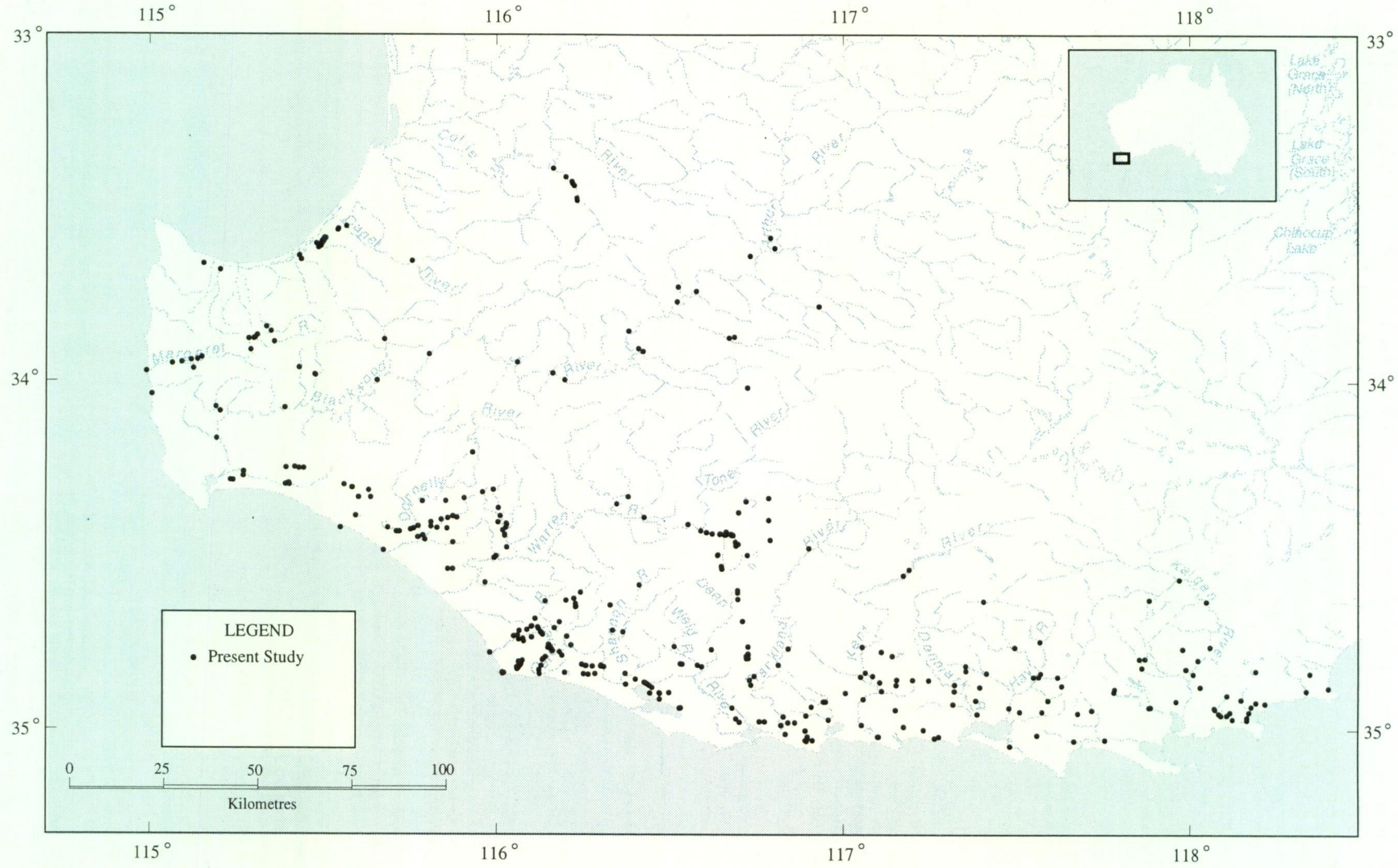


Figure 2 The sites sampled during the present study of the distribution of fish in the south-western corner of Australia.

limited information on the impacts of introduced species in south-western Australia, the deleterious effects caused by the same or comparable species in eastern Australia (e.g. Jackson and Williams 1980; Fletcher 1986; Arthington 1989, 1991; Lloyd 1989; McKay 1989; Hutchinson 1991; Crowl *et al.* 1992; Morgan and Gill 1996), demonstrate that special efforts must be taken to ensure that the introductions of fish do not have similar deleterious effects on the native fauna of south-western Australia.

While some data are available on the distributions of freshwater fish in the south-western corner of Australia (see McDowall and Frankenberg 1981; Allen 1982, 1989; Christensen 1982; Pusey and Edward 1990; Jaensch 1992), they were based on studies that either concentrated on a particular area, water type or species, or employed only one sampling method. We have therefore used a number of different methods aimed at sampling fish at all stages of their life cycles, as well as covering a wide range of habitats throughout south-western Australia. The collation of data from this study with relevant records from the Western Australian Museum (WAM) and those of Christensen (1982) and Jaensch (1992), thus provide a reliable account of the distribution of the freshwater fishes in the south-western corner of Australia between Bunbury in the north-west and Albany in the south-east.

MATERIALS AND METHODS

Study Area

Between 1994 and 1996, 410 sites were sampled in various permanent rivers, lakes and pools, as well as a considerable number of ephemeral creeks and pools, located in the south-western corner of Australia, between Bunbury in the north-west to just east of Albany in the south-east (Figure 2, Table 2).

Sampling Methods

Juvenile and adult fish were sampled using seine nets, scoop nets, traps and an electric fish shocker, while fish larvae were collected using haul nets, scoop nets and larval light traps. The seine net consisted of two 4 m long wings and a 2 m pocket which each had a height of 1.5 m and consisted of 3 mm mesh. The scoop net consisted of 300 mm equilateral triangles of 250, 500 and 1000 µm mesh and the larval haul net comprised a 1 m^2 pocket of 500 µm mesh. The larval light traps, which were constructed of clear perspex and used cyalume sticks as their light source (Kilgore and Morgan 1993), were placed in pools and streams at dusk and retrieved on the following morning. Collapsible fish traps (450 x 250 x 250 mm), consisting of 3 mm woven mesh, and the electric fishshocker and scoop nets were employed in areas where the seine net could not be used. The electric fishshocker, a 400 watt battery powered Smith-Root 12-A model, was also used to establish whether ammocoetes of *Geotria australis* were present in river beds.

Collation of Data

The data collected on the distribution of fish species during this study were collated with the records of the Western Australian Museum (WAM), including those reported by, for example, McDowall and Frankenberg (1981) and Allen (1982, 1989), and with data recorded by Christensen (1982) and Jaensch (1992). Distribution maps were created using Microstation.

The following accounts provide a taxonomic description, the distribution, relative abundance, habitats occupied, biological characteristics and conservation recommendations for each species. N.B. Unless otherwise mentioned, lengths given refer to total length.

Abbreviations Used in Taxonomic Descriptions

D1 – first dorsal fin.
D2 – second dorsal fin.
A – anal fin.
P – pectoral fin.
V – ventral/pelvic fin.
C – caudal fin.
SL – standard length.
TL – total length.

Roman numerals represent the number of spiny fin rays in a fin.

Arabic numerals represent the number of soft fin rays in a fin.

RESULTS AND DISCUSSION

Identification, distribution and biology of the eight endemic freshwater fish species

PLOTOSIDAE

Tandanus bostocki **Whitley, 1944**
Plate 2(a)

Common names

Freshwater cobbler, catfish.

Identification

D1 I, 5–6; D2, C and A contiguous, approximately 150 soft rays; gill rakers on first branchial arch 16–21; sharp serrated spine on D1 and P. D1 and D2 separate. Mouth surrounded by four pairs of barbels. Maximum size *ca* 600 mm TL. Coloration mid-dark brown, grading to whitish on breast. Fins heavily pigmented.

Distribution

Tandanus bostocki is found in the coastal region between the Moore River (Gingin) in the north and the Frankland River (Walpole) on the south coast. This species was captured on only two occasions in the extreme south-western corner of Australia, i.e. at Alexander Bridge on the Blackwood River and at Lake Smith (Table 2). Jaensch (1992) caught *T. bostocki* in Lake Wilson and the WAM has two records for this species in our study area, both from the Pemberton region.

Abundance, habitat and ecology

Although the sampling methods used during this study are not ideally suited for capturing large numbers of *T. bostocki*, our sampling did yield a number of this species in the Serpentine River catchment area (just south-east of Perth). While this species is locally abundant in such regions to the north of our main study area, it is apparently rare or absent in many of the water bodies in our study area. This species has been recorded from lakes and slow-flowing rivers and streams. In Wungong Dam, to the south-east of Perth, the diet of large *T. bostocki* (>250 mm), in all seasons, consists mainly of marron *Cherax tenuimanus*, while terrestrial insects, insect larvae, fish (*Edelia vittata*) and ostracods are also consumed, albeit to a far lesser extent. However, the diet of smaller *T. bostocki* (<250 mm), consisted mainly of insect larvae in winter and spring, ostracods and insect larvae in summer and marron in autumn. *Tandanus bostocki* can live for at least several years. This species is by far the largest of the freshwater fish endemic to south-western Australia and is the only endemic fish species which is targeted by recreational anglers.

Reproduction

In Wungong Dam (near Perth), spawning occurs between November and January, with the mean fecundity being *ca* 5,000.

Threats

Habitat alteration may pose threats to some populations of this species.

Conservation status and actions

Since *T. bostocki* occurs in relatively large numbers in several reservoirs, it does not apparently warrant inclusion in the Australian Society for Fish Biology's list of Australian threatened fishes.

Conservation recommendations

Since little is known about this species in our sampling area, no recommendations can be given for its conservation in this region.

Literature

Morrison (1988); Allen (1989); Hewitt (unpublished honours thesis 1992).

LEPIDOGALAXIIDAE

Lepidogalaxias salamandroides Mees, 1961

Plate 2(b)

Common names

Western Australian or Australian salamanderfish, salamanderfish, Shannon mud minnow, mud minnow.

Identification

D 5–8; A 11–15; P 10–12; V 4; C 12–14; gill rakers on first branchial arch 4–7; vertebrae 43–47; scales absent dorsally and ventrally, thin embedded scales on side, with a mid-lateral line series of about 65; anal fin and surrounding scales modified to form an intromittent organ in males. Maximum size for males and females is *ca* 50 mm TL and *ca* 75 mm TL, respectively. Brown to grey in colour, with a series of dark saddle-like markings dorsally, midlateral series of dark brown blotches forming a pair of longitudinal stripes during the breeding season (most distinct in males), black bar extending from snout through eye and across operculum, ventral surface only lightly pigmented.

Distribution

Our study showed that *L. salamandroides* is now largely restricted to a small area of coastal peat flats between Windy Harbour and Walpole. However, WAM records for 1976 indicate that isolated populations were found in the past as far north as Margaret River and as far east as Albany (Figure 3, Table 3).

Abundance, habitat and ecology

Lepidogalaxias salamandroides was occasionally locally abundant in the ephemeral pools and creeks of the Doggerup, Gardner, Shannon and Scott River watersheds (Table 3). *Lepidogalaxias salamandroides* was never caught in the major channels of rivers or lakes. The sites in which this species were caught were almost always located in the peat flats and adjacent forested areas. The appearance of fish in previously dry pools, shortly after the first rains of autumn, and also their appearance within hours in a pool that had been artificially filled with water, indicate that this species can survive in the moisture that lies below the substrate surface. Unlike *G. nigrostriata*, which was often found in pools that were almost dry, *L. salamandroides* was very rarely captured in such pools, indicating that this species buries itself before the water falls to a very low level. The water

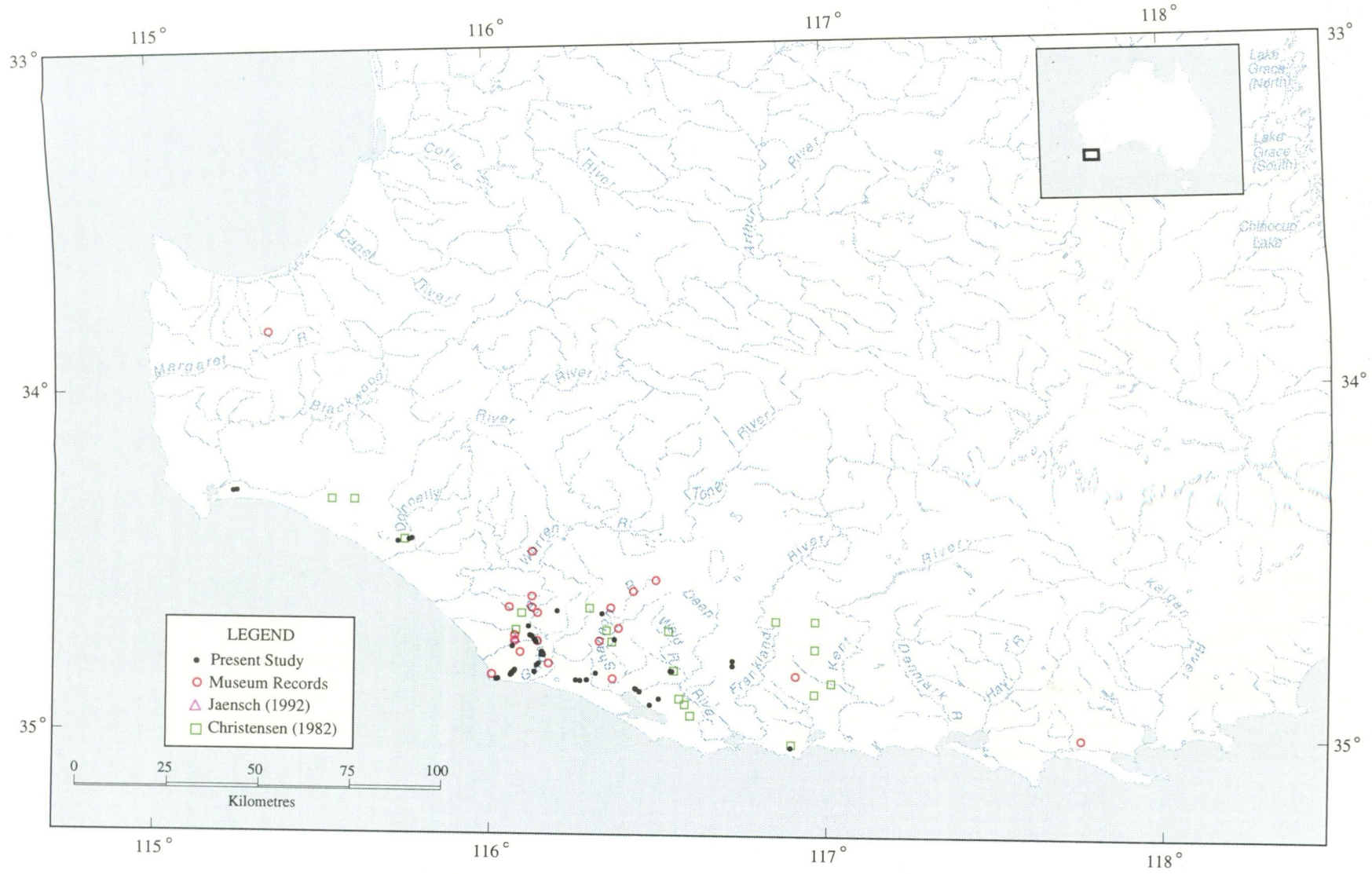
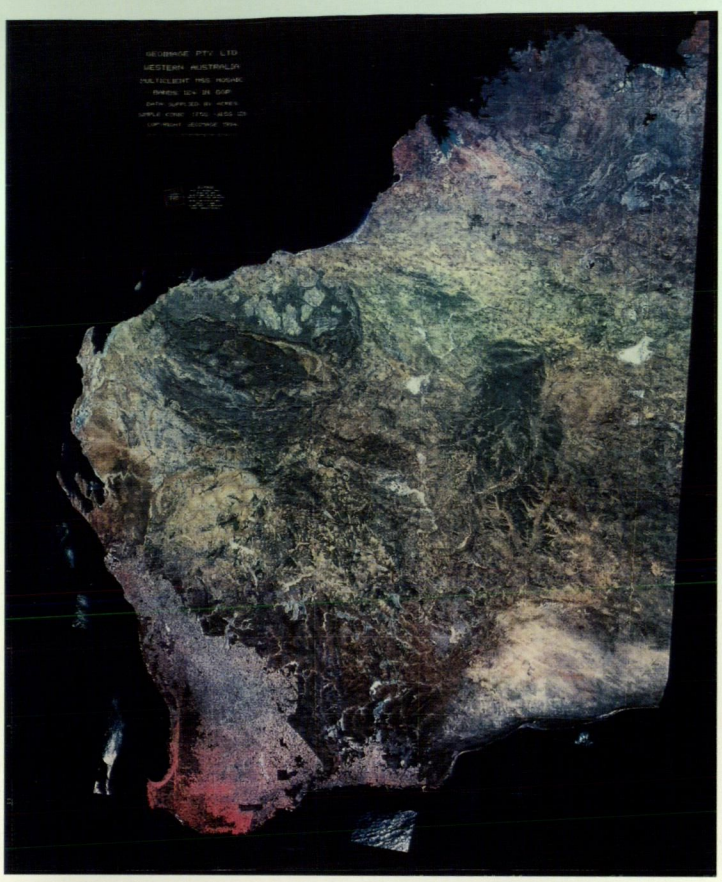
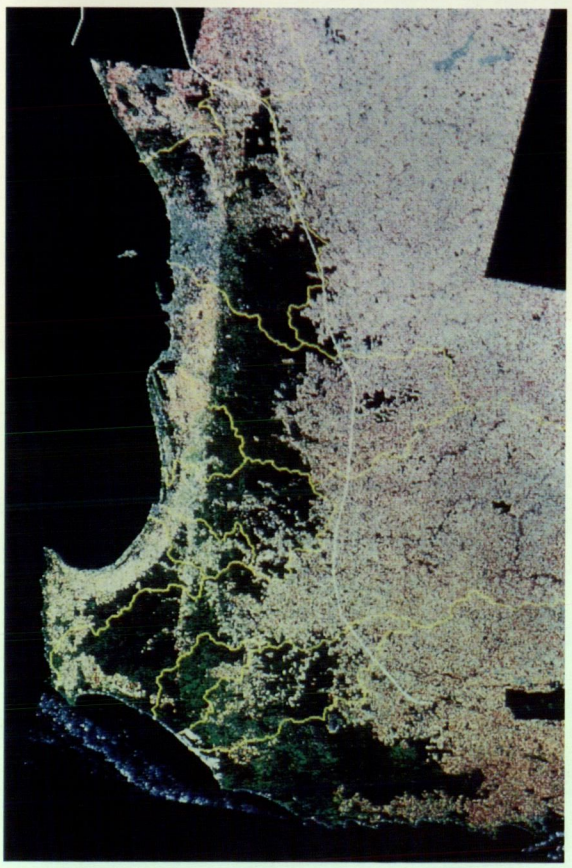


Figure 3 The distribution of *Lepidogalaxias salamandroides* in the south-western corner of Australia.



a



b

Plate 1 (a) A satellite image of Western Australia. Note the extensive cleared land (lighter areas) and also the remnant vegetation (darker areas) in the south-western corner. This image was supplied by GEOIMAGE; (b) A satellite image of the south-western corner of Australia (Moore River to Albany). This image was supplied by the Department of Land Administration.

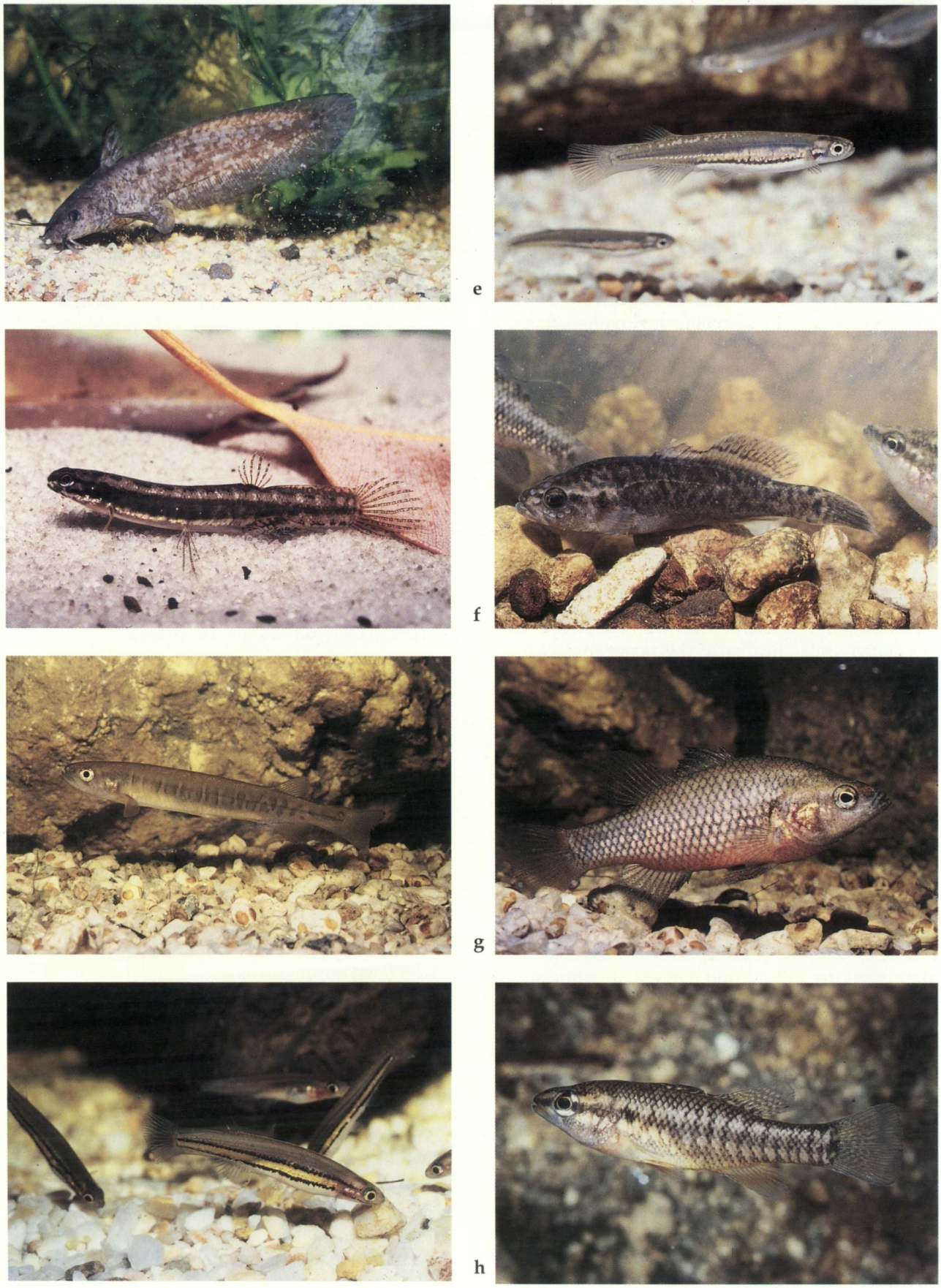


Plate 2 (a) Freshwater catfish (*Tandanus bostocki*); (b) Salamanderfish (*Lepidogalaxias salamadroides*); (c) Western minnow (*Galaxias occidentalis*); (d) Black-stripe minnow (*Galaxiella nigrostriata*); (e) Mud minnow (*Galaxiella munda*); (f) Nightfish (*Bostockia porosa*); (g) Western pygmy perch (*Edelia vittata*); (h) Balston's pygmy perch (*Nannatherina balstoni*). These photographs were taken by Dr G. Allen.

in the shallow isolated pools, in which *L. salamandroides* was typically found, is generally dark and acidic (pH 3.0–6.0) and undergoes marked seasonal fluctuations in temperature (11–35°C). *Lepidogalaxias salamandroides* has several adaptations which are of value in these harsh conditions. For example, the eyes are covered by a secondary eyelid, a character which would presumably protect the eyes when burrowed. This species also has the ability to 'bend its neck'. Since the muscles necessary for controlling eye movements in other teleosts are poorly developed in *L. salamandroides*, this adaptation would presumably help in searching for food. Although the adults of this species were often found close to riparian vegetation, they were also caught in open water. The larvae of this species were typically found feeding in very shallow water (<10 cm). As the larvae increase in size, they gradually move into deeper water. At hatching, larvae measure *ca* 5.5 mm. *Lepidogalaxias salamandroides* is a benthic species, a feature which is reflected in its diet, which comprises mainly dipteran larvae, trichopterans, cladocerans and ostracods.

Reproduction

Fertilisation is internal. The modified anal fin and associated scale sheaths of the males are used to clasp the female and thus facilitate the direct transfer of sperm. The spermatozoa of *L. salamandroides* is considered to be unique among teleosts with internal fertilisation (see Leung 1988). The breeding season extends from July to September.

Threats

Habitat alteration, and possibly also the introduction of exotic species, pose the main threats to *L. salamandroides* and also to the three other species restricted to the peat flat region. Habitat alteration is likely to occur through any alterations to inflow and increased salinisation, siltation and eutrophication that occur through water point construction, road maintenance, mineral sand exploration and mining, groundwater extraction and agricultural and forestry practices in the uppermost catchment. It should be noted that the introduction of both exotic fish species, *Oncorhynchus mykiss, Salmo trutta, Gambusia holbrooki* and *Perca fluviatilis*, and native fish species from eastern Australia, *Macquaria ambigua* and *Bidyanus bidyanus*, has already occurred in the catchments surrounding the peat flats and may pose a serious threat to the small endemic fish of south-western Australia.

Conservation status and actions

Much of the area in which *L. salamandroides* occurs lies in the D'Entrecasteaux National Park and is therefore protected against development. This species is classed as Restricted in the Australian Society for Fish Biology's list of Australian threatened fishes.

Conservation recommendations

The most important action required to conserve *L. salamandroides* is the preservation of the small pools in the peat flats of south-western Australia to which this species is largely restricted. To help ensure that this is achieved, the position of new water points, roads etc. should be appropriately sited. The need for this to occur is illustrated by the fact that many of the roadside pools in which this species aestivates are sometimes mistakenly considered to be devoid of aquatic fauna when they become dry in summer and consequently their substrate is used for 'fill'. The pools themselves are also sometimes filled during routine road maintenance.

Literature

Pusey (1983, 1989, 1990); McDowall and Pusey (1983); Leung (1988); Allen (1989); Allen and Berra (1989); Berra and Allen (1989a, 1991, 1995); Berra *et al.* (1989, 1990); Pusey and Stewart (1989); Martin *et al.* (1993); Gill and Morgan (in press).

GALAXIIDAE

Galaxias occidentalis Ogilby, 1900

Plate 2(c)

Common names

Western minnow, Western galaxias.

Identification

D 10–12; A 11–18 ; P 12–15; V 7; C 16; vertebrae 50–57. A small freshwater fish with a scaleless, very elongate body and long straight gut, reaching about 65–75% of the body length. Lateral canine teeth present in both jaws and enlarged fangs at middle of lower jaw. Dorsal fin is posteriorly placed and originates above or slightly behind the origin of the anal fin; adipose fin is absent. Maximum size *ca* 190 mm TL (G. Sarre pers. com.). Coloration is highly variable (lighter in clear water, almost black in peaty pools), generally olive-green dorso-laterally fading to whitish ventrally. A series of lateral dark bars are often present. Fins lightly pigmented.

Distribution

Galaxias occidentalis was found in the majority of watersheds we sampled, and, together with *Edelia vittata*, is the most common and widespread of the freshwater fishes endemic to the south-western corner of Australia. *Galaxias occidentalis* has a range that extends from about 250 km north of Perth,

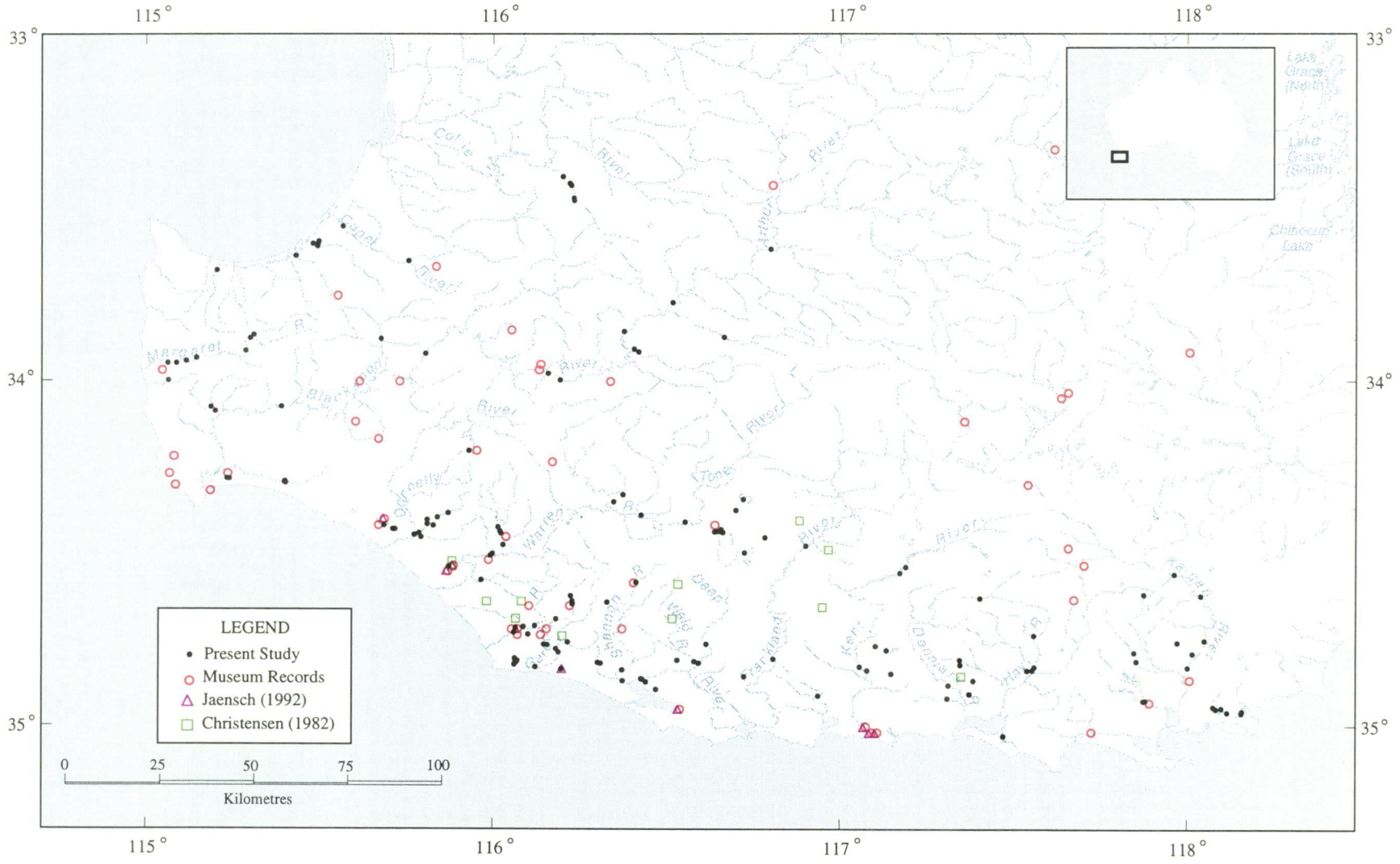


Figure 4 The distribution of *Galaxias occidentalis* in the south-western corner of Australia.

southwards and eastwards to Waychinicup Creek, 80 km east of Albany (Figure 4, Table 4).

Abundance, habitat and ecology

Galaxias occidentalis is abundant in pools, streams, rivers, and lakes throughout most of its range. Furthermore, this species was abundant in water bodies in both karri and jarrah forest (e.g. Donnelly River), the peat flats (e.g. D'Entrecasteaux National Park) and also in farming areas (e.g. Ludlow River, Blackwood River). This species was often seen close to riparian vegetation and in large schools in open water (e.g. Lake Jasper). During the day, terrestrial fauna forms the main component of the diet, although dipteran larvae and pupae, cladocerans and copepods are also important components. However, recent work has shown that this species also feeds at night, when the major food item ingested is the freshwater shrimp *Palaemonetes australis* (E. Fairhurst unpublished data). While many *G. occidentalis* live for two years, older fish have been found.

Reproduction

In the Collie River, south of Perth, males and females of this species attain lengths of approximately 70 and 75 mm at the end of their first year of life, and 90 and 100 mm at the end of their second year, respectively. In the Collie River, fish attain sexual maturity at the end of their first year of life, at which time they move into creeks to spawn. Breeding occurs between early June and late September, with a peak in August. The mean fecundity and mean diameter of mature eggs are 905 and 1.3 mm, respectively.

Threats

Since *G. occidentalis* was common throughout much of its extensive range, and was found in a wide variety of habitats, the survival of this species is unlikely to become threatened. However, habitat alteration and the introduction of exotic species may pose threats to some populations of this species. This view is based on the conclusion that, while *G. occidentalis* was absent or rare in the artificial lakes of the RGC Wetland Centre near Bunbury and the Lake Muir Watershed, which contained large numbers of the introduced species *Gambusia holbrooki*, it was abundant both in the streams of these areas, and in many of those lakes and streams elsewhere in the south-western corner of Australia which did not contain *G. holbrooki*, e.g. Lakes Jasper, Wilson, Smith, Maringup, Doggerup, Samuel; Rivers Shannon, Gardner, Donnelly, Margaret. Moreover, *G. holbrooki* has been observed attacking *G. occidentalis* in the streams of RGC Wetland Centre, and the majority of *G. occidentalis* in these streams had a higher degree of fin damage than those in the nearby Ludlow River, where *G. holbrooki* was far less common. Furthermore, circumstantial evidence from our study suggests that *Perca fluviatilis* and trout species have an effect on *G. occidentalis*, and indeed other endemic fishes, during dry years. For example, during summer, when water levels decline markedly, a number of isolated river pools, in which these large piscivores were present, contained very few native fish, whereas nearby pools, in which these introduced fish were absent, contained large numbers of endemic fishes.

Conservation status and actions

Considering the extensive distribution of *G. occidentalis* and its high abundance in many water bodies, this species does not warrant inclusion on the Australian Society for Fish Biology's list of Australian threatened fishes.

Conservation recommendations

The most important conservation actions are to maintain the natural flow regimes, which is necessary for successful spawning migrations, and to preserve the habitats in which spawning occurs. To ensure this, buffer zones should be maintained in areas used for farming and/or forestry, and the detrimental effects of water usage on stream flow should be minimised. Furthermore, non-endemic species should be introduced only into appropriate water bodies.

Literature

McDowall and Frankenberg (1981); Allen (1989); Pen and Potter (1991a, b); Gill and Neira (1994); Hambleton *et al.* (1996a, b).

Galaxiella nigrostriata (Shipway, 1953)

Plate 2(d)

Common names

Black-stripe minnow.

Identification

D 7–9 (segmented); A 10–15 (segmented); P 11–14; V 5–6; C 12–15; vertebrae 38–43; myomeres 38–42. A small freshwater fish with a scaleless, elongate body and long straight gut, reaching about 60–65% of the body length. Dorsal fin is posteriorly placed and originates anterior to the vertical that passes through the fifth anal ray; adipose fin is absent. The maximum length recorded for males and females was 44 mm and 48 mm TL, respectively. Between June and September, the larvae and adults of this species are characterised by their striking coloration, which consists of two black longitudinal bands separated by a vivid yellow to red stripe. This brightly-coloured lateral stripe gradually disappears after

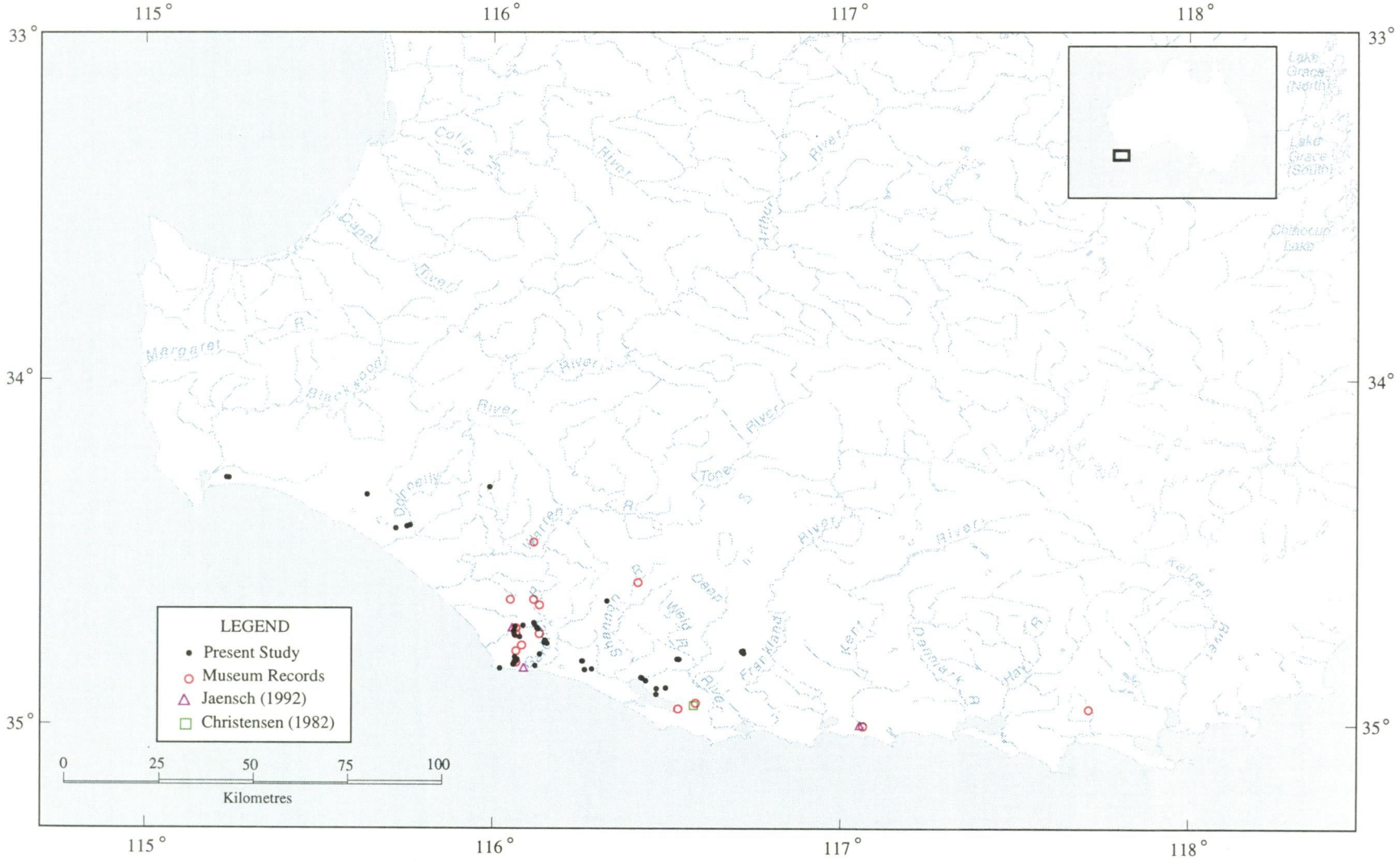


Figure 5 The distribution of *Galaxiella nigrostriata* in the south-western corner of Australia.

September and by December/January most fish have a relatively uniform brown to blackish colour. At hatching, larvae measure *ca* 3.5 mm TL (unpublished data).

Distribution

Galaxiella nigrostriata is restricted to the small area of coastal peat flats found in the south-western corner of Australia that extends from Augusta in the west to Albany in the east, while disjunct populations have recently been discovered in a small pool in Bunbury and in another such pool in the northern part of Perth, *ca* 200 and 400 km to the north, respectively. This discontinuity in distribution probably represents the loss of suitable habitat caused by widespread urban and rural development in this region. From the results of our study, it is evident that the centre of the distribution of *G. nigrostriata* is in the peat flats surrounding Windy Harbour in the D'Entrecasteaux National Park (Figure 5, Table 5).

Abundance, habitat and ecology

Galaxiella nigrostriata is rare throughout most of its distribution, but is occasionally locally abundant in the ephemeral pools of the peat flats within the D'Entrecasteaux National Park (Figure 5, Table 5). Although we never caught *G. nigrostriata* in any of the rivers of south-western Australia, we did find it in very low numbers in Lakes Samuel and Doggerup. The water in the shallow isolated pools in which *G. nigrostriata* is typically found, is generally dark and acidic (pH 3.0–6.0) and exhibits marked seasonal temperature fluctuations (11–35 °C). Since *G. nigrostriata* appear in pools as they begin to contain water, following the first rains of autumn, and as they appear within hours in pools that were artificially filled with water, this species presumably lives in the moist area below the substrate when the pools do not contain water. Although the adults of this species were often caught close to inundated riparian vegetation, they were also found in open water. The smallest larvae of this species typically feed in very shallow water (<10 cm), but then gradually move into deeper water as they increase in size. *Galaxiella nigrostriata* is often found in pools that also contain *Lepidogalaxias salamandroides*, but is rarely abundant in those pools that contained the percicthyid *Bostockia porosa* or the nannopercid *Nannatherina balstoni*. Both of the latter two larger species occasionally ingest *G. nigrostriata*. Calanoid copepods and terrestrial fauna (flying ants and dipterans) are the main prey items ingested in all seasons, while other prey items are important seasonally, e.g. collembolans (winter), dipteran larvae and pupae (summer and autumn) and diatoms (autumn). This species typically lives for about one year.

Reproduction

Males and females reach total lengths of *ca* 33 and 37 mm, respectively, at the end of their first year of life, at which time they attain sexual maturity. This species is a multiple spawner, which breeds between early June and September, with a peak in activity in late June and early July, a period when water temperature and day length are at their minimum.

Threats and conservation recommendations

Since *G. nigrostriata* occurs predominantly in the same water bodies as *L. salamandroides*, which is likewise small, the main threats to this species are the same, i.e. those posed by alterations to the ephemeral pools in which these species live. Thus, it is important that these pools are protected.

Conservation status and actions

Much of the area in which *G. nigrostriata* is found is listed as National Park. This species has been listed as restricted by the Australian Society for Fish Biology.

Literature

McDowall and Frankenberg (1981); Allen (1989); Berra and Allen (1989b); Pen *et al.* (1993); Gill and Neira (1994).

Galaxiella munda McDowall, 1978

Plate 2(e)

Common names

Western mud minnow.

Identification

D 7–10 (segmented); A 9–15 (segmented); P 9–12; V 5–7; C 13–15; vertebrae 38–43; myomeres 41–43. A small freshwater fish with a scaleless, elongate body and long straight gut, reaching about 65–70% of the body length. Dorsal fin is posteriorly placed and originates posterior to the vertical that passes through the fifth anal ray; adipose fin is absent. Maximum size *ca* 58 mm TL. Between June and October, the adults of this species develop two olive-brown longitudinal bands, that are separated by an orange stripe, and a silver belly. The coloured lateral stripe gradually disappears to become a thin silver-white line after October and by January most fish have a relatively uniform light olive-brown colour. Larval *G. munda* are moderately to heavily pigmented. The smallest preflexion larvae recorded was 5.0 mm TL.

Distribution

Galaxiella munda is restricted to the small area in the south-western corner of Australia, that extends

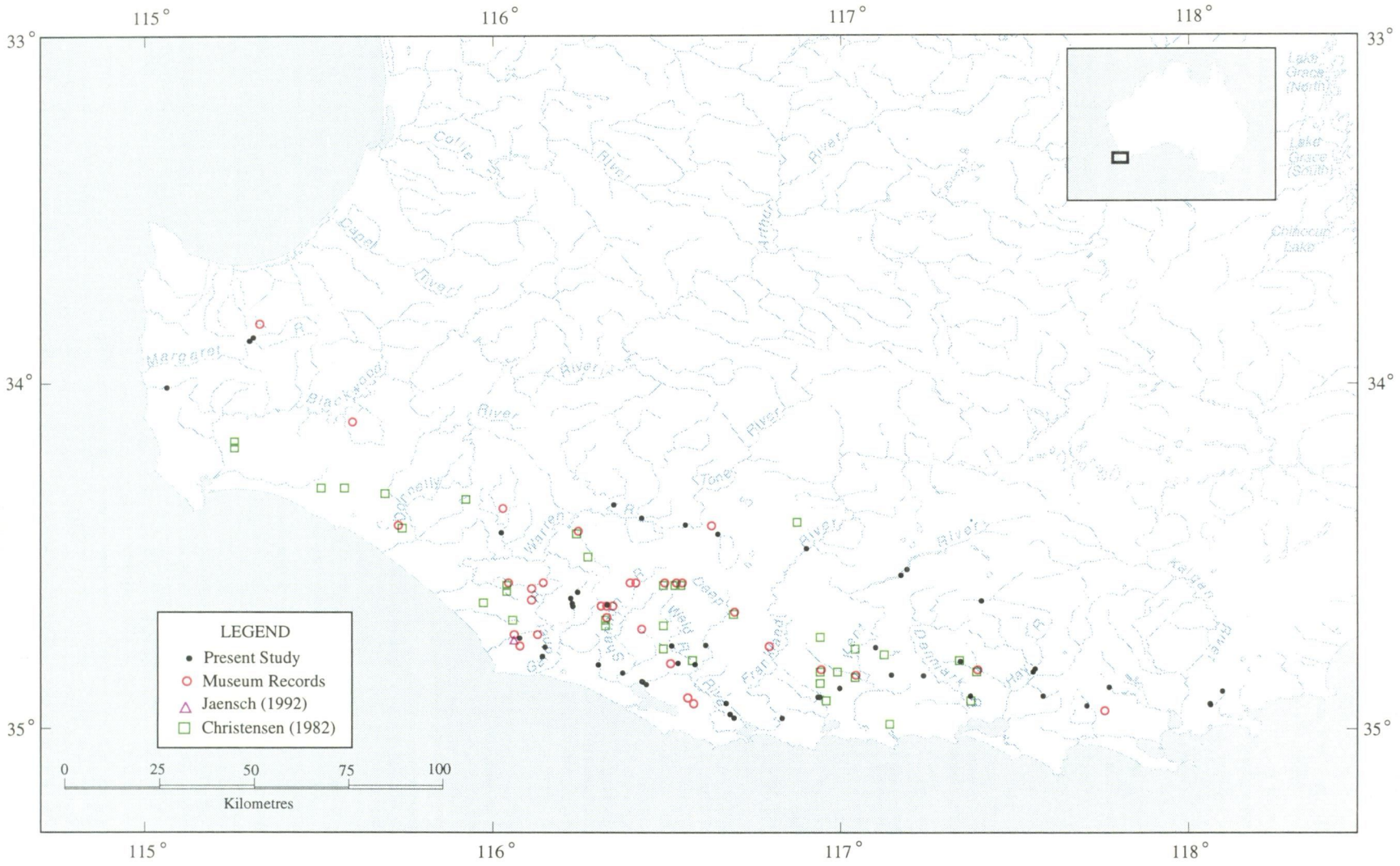


Figure 6 The distribution of *Galaxiella munda* in the south-western corner of Australia.

from Margaret River in the west to Albany in the east, and to an isolated population that is located approximately 100 km north of Perth at Gingin. The discontinuity in the distribution of this species may represent the loss of suitable habitat caused by widespread urban and rural development in the intervening region. During our study, *G. munda* was collected from the watersheds of the Margaret River, Warren River, Lake Muir, Doggerup Creek, Gardner River, Shannon River, Broke Inlet, Deep River, Frankland River, Bow River, Kent River, Denmark River, Hay River, Torbay Inlet, King River and Two People's Bay (Figure 6, Table 6). This species has also been found in the Blackwood and Donnelly River watersheds during other studies (Figure 6, Table 6).

Abundance, habitat and ecology

Although *G. munda* is rare throughout most of its distribution, it is occasionally abundant in the headwaters and tributaries of rivers, and in a number of shallow pools connected to streams. This species is most abundant in creeks and streams of the Gardner River and Shannon River watersheds (Table 5). For example, in Boorara Brook, a tributary of the Gardener River, over one hundred fish were caught in a small pool measuring 3 m by 1 m. Although this species was common in the peat flats and adjacent forested areas, it penetrated further into the forested areas than *N. balstoni*, *G. nigrostriata* and *L. salamandroides*. The water in the pools and streams in which *G. munda* is typically found, is generally dark and acidic (pH 3.0–6.0) and exhibits marked seasonal temperature fluctuations (11–35°C). Adults often live close to riparian vegetation in streams and in the open water of pools. Larvae typically feed in the very shallow water of pools (<10 cm) amongst flooded riparian vegetation. As the larvae increase in size, they gradually move into the deeper water of the pools and then into the streams to which these pools are connected. Terrestrial fauna (dipterans) and dipteran larvae and pupae are the main component of the diet in winter, spring and summer, while cladocerans and copepods are the most important dietary component in autumn. The life cycle of *G. munda* typically lasts for one year.

Reproduction

At the end of their first year of life, males and females reach total lengths of *ca* 43 and 47 mm, respectively, and attain sexual maturity. This species, which is a multiple spawner, breeds between July and October, with spawning activity peaking in late August and early September, when water temperatures and day length have begun to rise.

Threats

Habitat alteration and possibly the introduction of exotic species pose the main threats to *G. munda* and also to the three other species restricted to the peat flat region. Habitat alteration is likely to occur through alterations to inflow, increased salinisation, siltation and eutrophication which occur through dam construction, groundwater extraction and agricultural and forestry practices in the uppermost catchment. The combined effects of habitat alteration, through the construction of dams, and the introductions of *P. fluviatilis*, trout species and *G. holbrooki* may explain the virtual disappearance of *G. munda* from the headwaters of Big Brook. This view is based on the fact that, whereas Pen *et al.* (1991) reported viable populations of this species in these waters, the present study and that of Morgan and Gill (1996) found very few *G. munda* in these streams. It is therefore pertinent that, during several recent dry years, the reservoir immediately above Big Brook Dam was the only upstream section of Big Brook in which water remained during summer and autumn and, during these dry years, the piscivorous *P. fluviatilis* was introduced to the reservoir where it is now well established. Furthermore *G. holbrooki*, *O. mykiss* and *S. trutta* are also found in the headwater streams, both upstream and downstream of the dam (Morgan and Gill 1996).

Conservation status and actions

Galaxiella munda is listed as restricted by the Australian Society for Fish Biology.

Conservation recommendations

The most important action required to conserve this species is to preserve, in the small streams of south-western Australia, the natural flow regimes and suitable habitat for all life cycle stages. To ensure this, buffer zones should be maintained in areas used for both farming and forestry, and further introductions of non-endemic species should be made only into appropriate water bodies.

Literature

McDowall and Frankenberg (1981); Allen (1989); Berra and Allen (1989b); Pen *et al.* (1991); Gill and Neira (1994).

PERCICHTHYIDAE

Bostockia porosa Castelnau, 1873

Plate 2(f)

Common names

Nightfish.

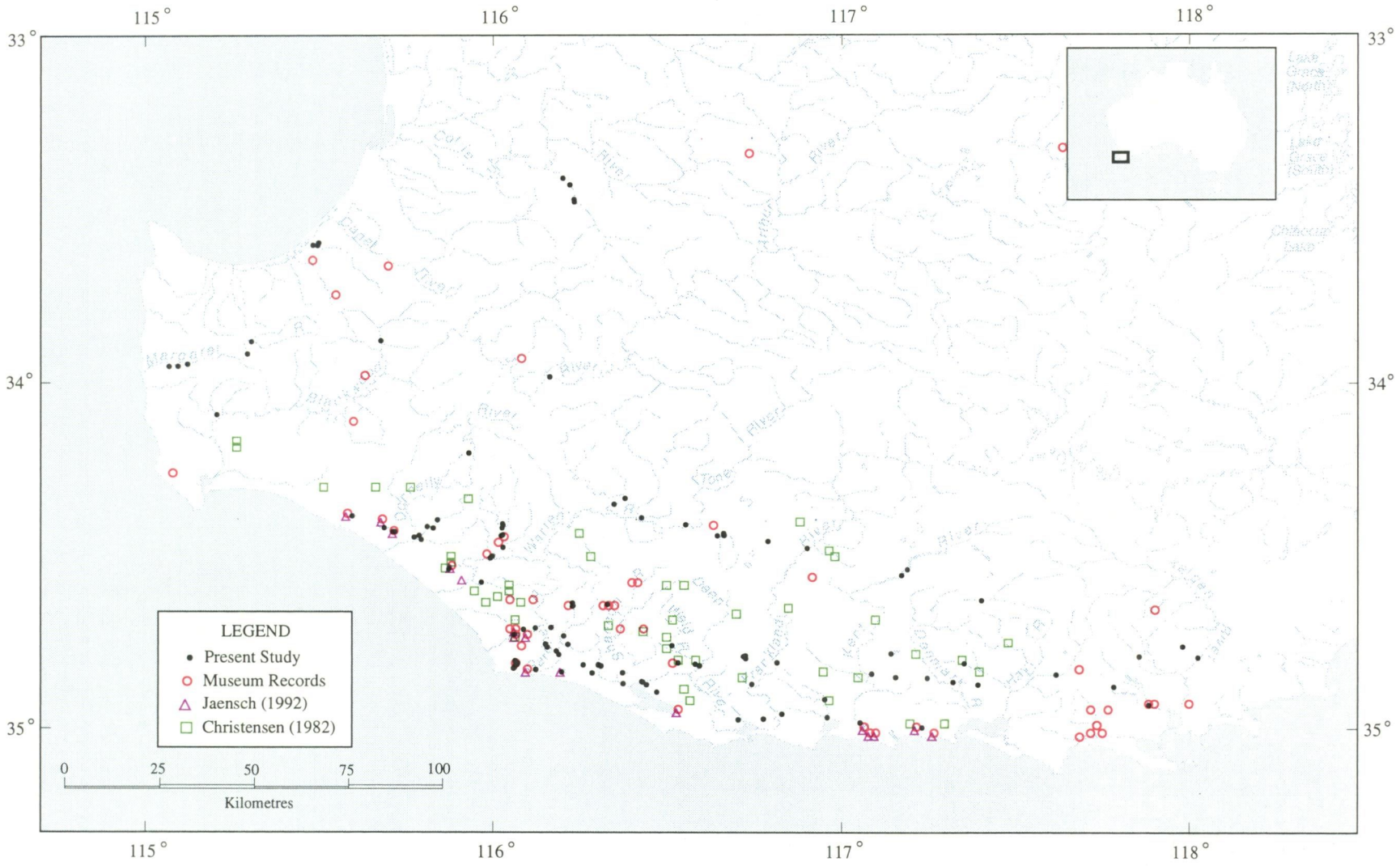


Figure 7 The distribution of *Bostockia porosa* in the south-western corner of Australia.

Identification

D1 VII–VIII; D2 16–17; A III, 11–12; P 13–15; gill rakers on first branchial arch 11–12; tubed lateral-line scales 43–47. Greatest body depth 3.1–3.6 of SL. Deep notch between D1 and D2. Mouth large, extending to middle of eye. A series of large pores are present on the snout and around the eyes. Maximum size *ca* 160 mm TL. Coloration, mottled olive-brown to dark purplish-brown dorso-laterally (occasionally black in peat stained waters), grading to pinkish-white on breast and belly. Fins lightly to moderately pigmented, D1, D2, A and C spotted.

Distribution

Bostockia porosa is one of the most widespread of the freshwater fishes endemic to south-western Australia, with a distribution that extends from Gingin in the north to Albany in the east. This species was found in the majority of watersheds we sampled (Figure 7, Table 7).

Abundance, habitat and ecology

Bostockia porosa is abundant in rivers, streams, lakes and pools throughout most of its range. The juveniles and adults of this species are typically found under ledges, rocks, logs and amongst inundated vegetation. The few small larvae of this species that have been collected were caught either in the relatively deep open water of a pool that was connected to a stream or in the shallow floodwaters of a large pool. While ostracods and dipteran larvae are important dietary items in all seasons and for all size classes, larger prey types, such as odonatan larvae, decapods and gastropods, become increasingly important as this species increases in size. While adult *B. porosa* are active mainly at night, the juveniles feed predominantly during the day (Pen and Potter 1990; Morgan unpublished honours thesis 1993). Although most *B. porosa* belong either to the 0+ and 1+ age classes, this species can live for over six years.

Reproduction

In the Collie River, south of Perth, the males and females of this species both attain lengths of *ca* 56 mm at the end of their first year of life, and reach *ca* 76 and 79 mm at the end of their second year and *ca* 85 and 91 mm by the end of their third year of life, respectively. Most of the males attain sexual maturity at the end of their first year of life, while the majority of females do not attain maturity until the end of their second year. On attaining sexual maturity, fish move into flooded creeks to spawn. Breeding occurs between late August and early September. The mean fecundity and mean diameter of preserved mature eggs are *ca* 600 and 1.5 mm, respectively.

Threats

Since *B. porosa* is common throughout much of its extensive range and is found in a wide variety of habitats, it is unlikely that this species is threatened. However, habitat alteration and the introduction of exotic species may pose threats to some populations. For example, while *B. porosa* was absent/rare in the lakes of the Unicup area, which contained large numbers of the introduced species *Gambusia holbrooki,* it was abundant in the streams of this area and in Lakes Wilson and Smith, which do not contain *G. holbrooki.* Furthermore, in the lakes and streams of the RGC Wetlands Centre near Bunbury, which contain large numbers of *G. holbrooki* and have little cover, *B. porosa* was only abundant in a stream which contained few *G. holbrooki* and had large amounts of cover in the form of aquatic macrophytes and boulders. *Gambusia holbrooki* has been observed attacking *E. vittata* in the RGC system and the majority of native fish, including *B. porosa,* in this system had a high degree of fin damage.

Conservation status and actions

Considering the extensive distribution of *B. porosa,* and its high abundance in some water bodies, this species does not warrant inclusion in the Australian Society for Fish Biology's list of Australian threatened fishes.

Conservation recommendations

The most important conservation actions are to maintain the natural flow regimes, which are necessary for successful spawning migrations, and to preserve suitable habitat for spawning and the areas of riparian vegetation, rocks and submerged logs etc., with which the juveniles and adults of this species are usually associated. To ensure this, buffer zones must be maintained in areas used for farming and/or forestry, while the effects of water usage on stream flow should be minimised. Furthermore, non-endemic species should be introduced only into appropriate water bodies.

Literature

Allen (1989); Pen and Potter (1990); Hambleton *et al.* (1996a, b).

NANNOPERCIDAE

Edelia vittata Castelnau, 1873

Plate 2(g)

Common names

Western pygmy perch, pygmy perch.

Identification

D1 VII–IX; D2 8–9; A III, 6–8; P 11–12; gill rakers

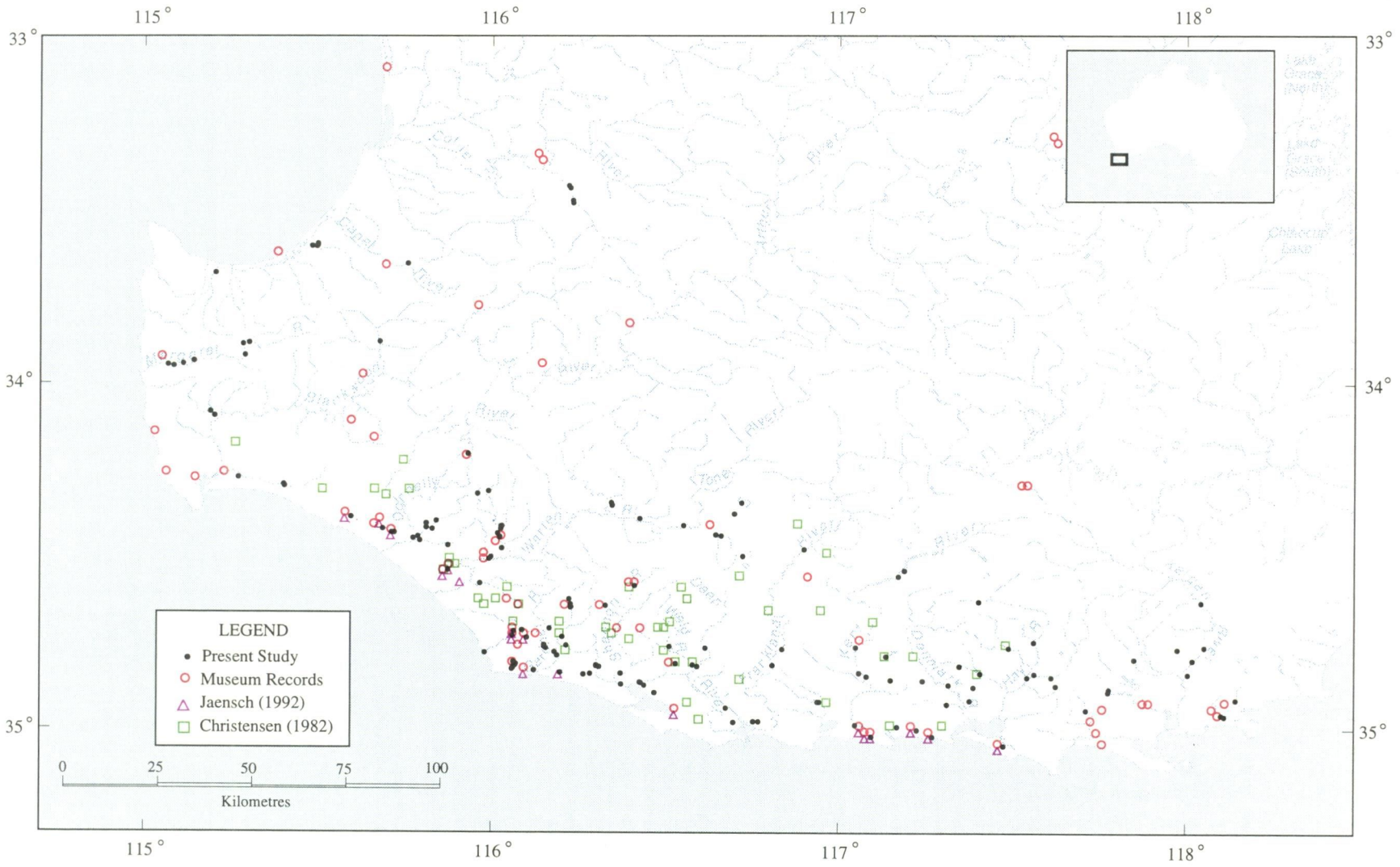


Figure 8 The distribution of *Edelia vittata* in the south-western corner of Australia.

on first branchial arch 11–12; tubed lateral-line scales interspersed with normal scales. Greatest body depth 2.9–3.3 of SL. Deep notch between D1 and D2. Mouth small, not extending to eye. Maximum size *ca* 68 mm TL. Coloration mid-dark brown, grading to white on breast and belly, often with brown mid-lateral stripe bordered by broad yellow-white stripes. Fins lightly to moderately pigmented. During the breeding season, females often become bluish dorsally, while males become darker and the whitish lateral stripes and belly become orange.

Distribution

Edelia vittata, together with *Galaxias occidentalis*, are the most common and widespread of the freshwater fishes endemic to the south-western corner of Australia. The distribution of *E. vittata* extends from the Moore River (Gingin), north of Perth, to the Philips River, east of Albany. During the present study, *E. vittata* was found in the majority of watersheds sampled (Figure 8, Table 8).

Abundance, habitat and ecology

Edelia vittata is widespread and abundant in rivers, streams, lakes and pools. Furthermore, this species was abundant in water bodies in both karri and jarrah forest (e.g. Donnelly River), the peat flats (e.g. D'Entrecasteaux National Park) and farming areas (e.g. Ludlow River). This species was generally associated with riparian vegetation or other forms of cover (submerged macrophytes, algae, snags etc) and was rarely caught in open or deep water. While cladocerans, copepods, ostracods and dipteran larvae are always important dietary items, this species ingests a wide range of small prey types in all seasons. *Edelia vittata* typically does not live for longer than three years.

Reproduction

In the Collie River, south of Perth, the males and females of *E. vittata* attain lengths of *ca* 42 mm and 43 mm at the end of their first year of life and *ca* 51 mm and 53 mm at the end of the second year, respectively. This species attains sexual maturity at the end of their first year of life, at which time it moves into flood waters of the main river and associated creeks to spawn. *Edelia vittata*, which is a multiple spawner, breeds between late July and November with a peak in late September and mid-October. The mean diameter of mature eggs is 0.9 mm.

Threats

Since *E. vittata* is common throughout much of its extensive range, and is found in a wide variety of habitats, it is unlikely that this species is under any threat. However, habitat alteration and the introduction of exotic species may pose threats to some populations. For example, while *E. vittata* was absent or rare in the lakes of the Swan Coastal Plain, which contain large numbers of the introduced species *Gambusia holbrooki*, it was abundant in streams of the lower south-west and in Lakes Wilson, Smith, Maringup etc. (Table 8), which do not contain *G. holbrooki*. Furthermore, the only lake of the RGC Wetlands Centre south of Bunbury in which *E. vittata* was abundant and yet contains large numbers of *G. holbrooki* was one that provided a large amount of cover in the form of aquatic macrophytes and algae. It should also be noted that *G. holbrooki* has been observed attacking pygmy perch in this pool, and that the majority of *E. vittata* in this lake had a higher degree of fin damage than those in the nearby Ludlow River, where *G. holbrooki* was far less common. Its absence from our samples in the upper Blackwood River may be attributable to the high numbers of *G. holbrooki* and/or the high salinity of the catchment.

Conservation status and actions

Considering the extensive distribution and large populations of *E. vittata* found in many water bodies, this species does not apparently warrant inclusion on the Australian Society for Fish Biology's list of Australian threatened fishes.

Conservation recommendations

The most important conservation action is to maintain the natural flow regimes, which are necessary for successful spawning migrations, and to preserve suitable habitat for spawning. Thus, buffer zones must be maintained in areas used for farming and/or forestry, while the effects of water usage on stream flow should be minimised. Furthermore, to maintain local populations, further introductions of non-endemic species should be made only into appropriate water bodies.

Literature

Shipway (1949); Allen (1989); Pen and Potter (1991c); Hambleton *et al.* (1996a, b).

Nannatherina balstoni Regan, 1906

Plate 2(h)

Common names

Balston's pygmy perch or perchlet, King River perchlet.

Identification

D1 VII–VIII; D2 9–11; A III, 8–10; P 12–13; gill rakers on first branchial arch 6–15, very poorly developed; tubed lateral-line scales 2–17, interspersed with normal scales. Greatest body

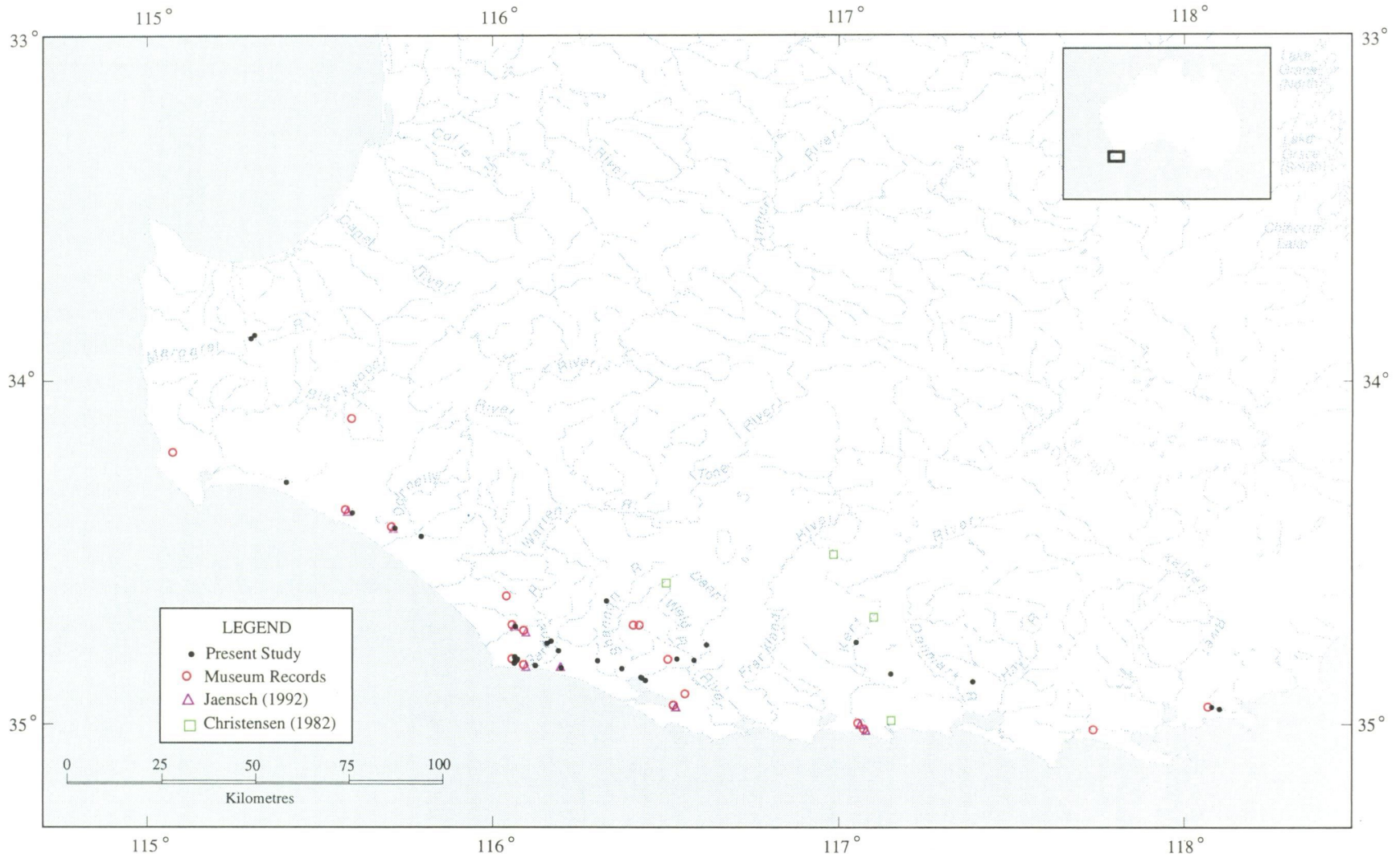


Figure 9 The distribution of *Nannatherina balstoni* in the south-western corner of Australia.

depth 3.4–4.0 of SL. Deep notch between D1 and D2. Mouth relatively large, extending to well under the eye. Maximum size 90 mm TL. Coloration mid-dark brown, grading to whitish on breast and belly, often with darker brown mid-lateral stripe bordered by broad yellow-white blotches or stripes. Fins lightly to moderately pigmented; D2, C and A variegated.

Distribution

Nannatherina balstoni is generally restricted to the small area of coastal peat flats in the south-western corner of Australia that extends from Margaret River in the west to Two People's Bay in the east. However, two populations have recently been found well to the north of this area, i.e. in the Collie River (L. Pen pers. com.) and in the Moore River (near Gingin) (Figure 9, Table 9). The discontinuity in the distribution of this species may represent the loss of suitable habitat caused by widespread urban and rural development in the intervening region. The centre of the present distribution of *N. balstoni* is in the peat flats of the Doggerup, Gardner and Shannon River watersheds (Figure 9, Table 9).

Abundance, habitat and ecology

This species is the rarest of all of the endemic freshwater fishes of south-western Australia. However, *N. balstoni* was moderately abundant in a number of shallow pools and creeks that often dry up in summer, such as those found between Windy Harbour and Walpole. It was captured only in very low numbers in the major rivers (e.g. Margaret, Scott, Donnelly, Shannon, Gardner, Deep, Kent and Denmark Rivers) and lakes in south-western Australia (Lakes Quitjup, Smith, Doggerup, Maringup and Moates). In winter and spring, this species was typically found amongst inundated riparian vegetation, where it presumably feeds and spawns. Although adults were often caught close to this riparian vegetation, they were also caught in open water. The larvae are typically found feeding in very shallow water (<10 cm) amongst flooded riparian vegetation. As the larvae increase in size, they gradually move into deeper water. Larval (<15 mm) and small juvenile (15–25 mm) *N. balstoni* feed predominantly on cladocerans, while terrestrial fauna (arachnids and adults of hymenopterans, coleopterans and dipterans) are the main prey items ingested by *N. balstoni* >25 mm in all seasons. The life cycle typically lasts for one year. The total lengths of the longest male and female were 82 mm and 90 mm, respectively.

Reproduction

When males and females attain sexual maturity, at the end of their first year of life, their mean total lengths are *ca* 60 and 63 mm, respectively. *Nannatherina balstoni* spawns once in the breeding season, which extends from June to September and peaks in mid–July to early August, when water levels are at their maximum. Fecundity ranged from 550 in a 61 mm fish to 1600 in an 82 mm fish.

Threats and conservation recommendations

Same as for *Lepidogalaxias salamandroides*.

Conservation status and actions

Much of the area occupied by *N. balstoni* is in nature reserves, particularly the D'Entrecasteaux and Shannon National Parks. This species has recently been proposed for inclusion in the vulnerable category in the Australian Society for Fish Biology's list of Australian threatened fishes.

Literature

Allen (1989); Morgan *et al.* (1995a).

Identification, distribution and biology of galaxiids found elsewhere in Australia

GALAXIIDAE

***Galaxias truttaceus* Valenciennes, 1846**

Plate 3(a)

Common names

Spotted mountain trout, trout minnow.

Identification

D 11–15; A 14–19; P 13–16; vertebrae 56–62. A small freshwater fish with a scaleless, elongate body. Dorsal fin is posteriorly placed and originates marginally anterior to anal fin origin; adipose fin is absent; tail slightly forked. Eyes moderate to large; jaws with enlarged lateral canine teeth; mouth large, extending to at least front of eye. Maximum size 175 mm SL, common to 100 mm SL. Coloration brown or olive-grey to deep purplish or nearly black, grading to silvery-olive on belly. The trunk is covered in moderately large round blackish spots, each surrounded by a paler halo; a pair of blackish bars on trunk dorsal to basal part of pectoral fin. There is a distinct oblique stripe passing from the eye to the lower preoperculum. All fins are generally brown to orange.

Distribution

Galaxias truttaceus occurs in both south-eastern and south-western Australia. This species is relatively widespread in south-eastern Australia, occurring in coastal streams from Wilson's Promontory westward to the Glenelg River in

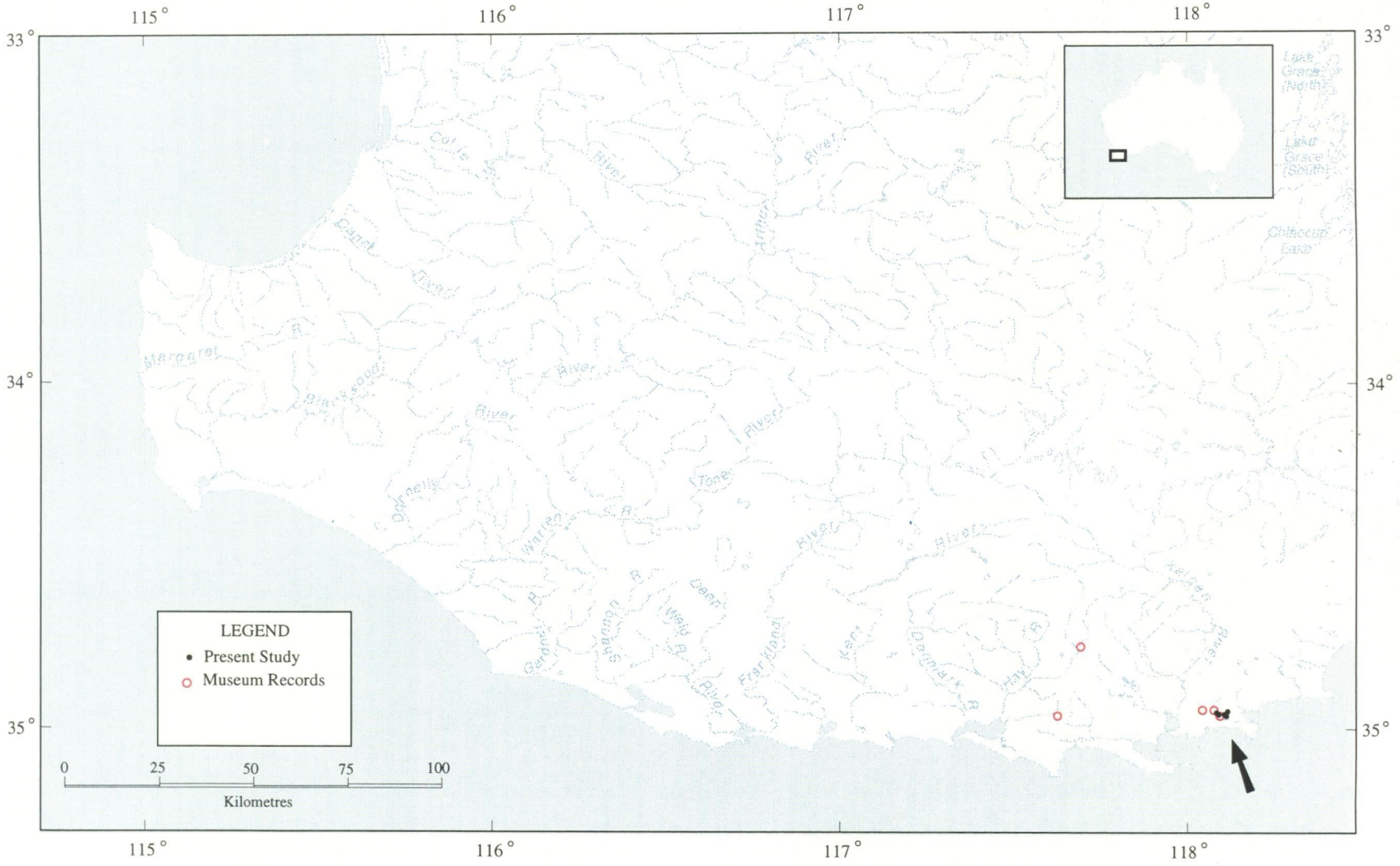


Figure 10 The distribution of *Galaxias truttaceus* in the south-western corner of Australia.

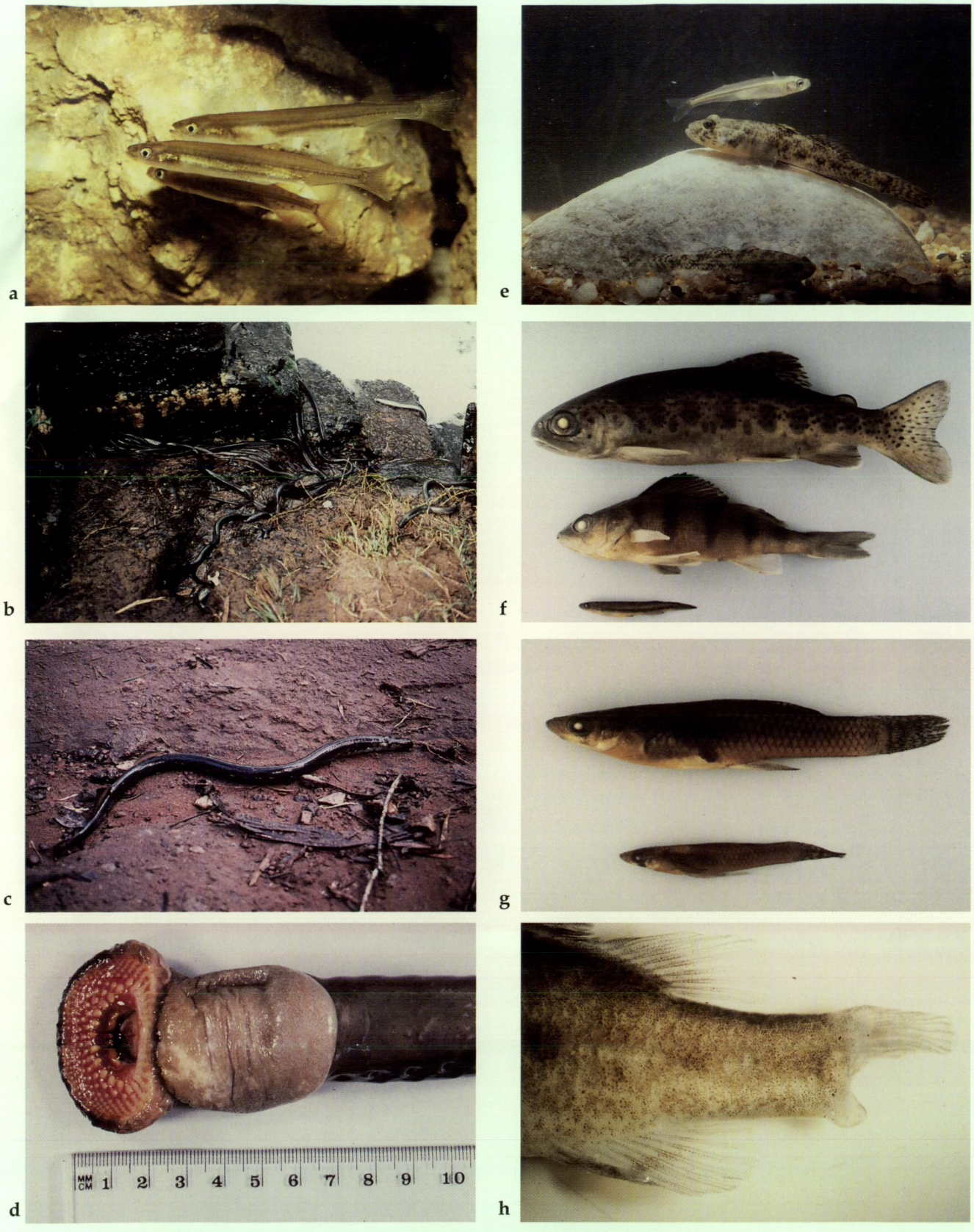


Plate 3 (a) Trout minnow (*Galaxias truttaceus*) (bottom) and Spotted minnow (*Galaxias maculatus*) (top) (Dr G. Allen); (b) Lampreys (*Geotria australis*) circumnavigating the Pemberton Weir on their upstream migration (Dr D. Macey); (c) Adult lamprey (Dr D. Macey); (d) Mature adult lamprey (male), note large gular pouch and oral disc (Dr D. Macey); (e) Western hardyhead (*Leptatherina wallacei*) (top), Swan River goby (*Pseudogobius olorum*) (bottom) and Big headed goby (*Afurcagobius suppositus*) (middle) (S. Visser); (f) From top to bottom, the introduced species, *Oncorhynchus mykiss* (Rainbow trout) and *Perca fluviatilis* (Redfin perch), and the native Mud minnow (*Galaxiella munda*) (S. Visser); (g) Female (top) and male (bottom) mosquitofish (*Gambusia holbrooki*) (S. Visser); (h) The results of fin-nipping attacks by *Gambusia holbrooki* on the caudal fin of *Edelia vittata* (D. Morgan).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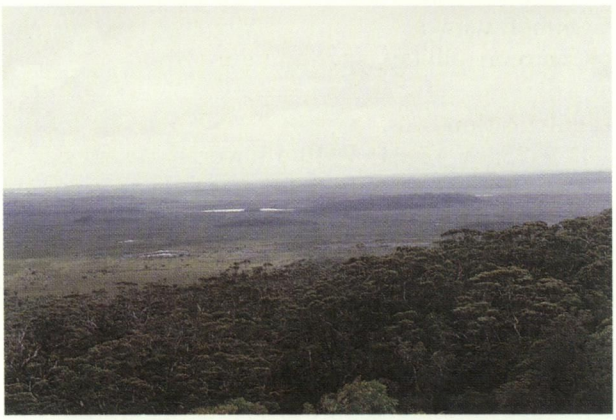
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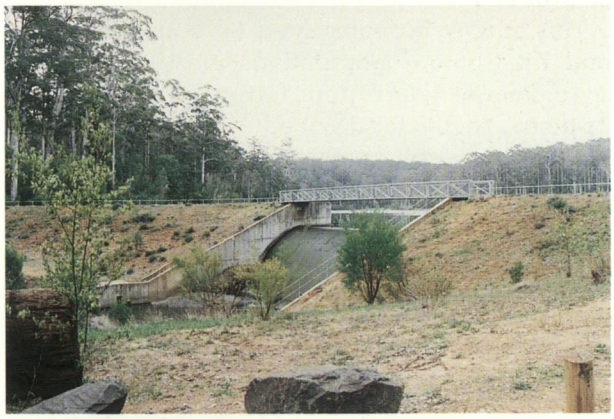
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Plate 4 A pool near Walpole showing contrasting conditions i.e. during (a) winter and (b) summer, which is typical of the habitat in which *L. salamandroides* and *G. nigrostriata* are found; (c) The peat flats of the D'Entrecasteaux National Park (near Northcliffe), the centre of the distributions of *L. salamandroides, G. nigrostriata, G. munda* and *N. balstoni*; (d) A small stream near Pemberton, which is typical of the habitat in which *G. occidentalis, E. vittata, B. porosa* and *G. munda* are found; (e-g) Modified water bodies in south-western Australia, (e) cow trodden stream (Margaret River), (f) salt affected stream (Blackwood River), (g) large dam (Pemberton) and (h) water point created for fire fighting (Pemberton). These photographs were taken by D. Morgan.

Victoria, as well as on King, Flinders and Clarke Islands in Bass Strait, and in coastal streams around the Tasmanian coast and in several lakes in the Central Plateau of Tasmania. In comparison, *G. truttaceus* has a far more restricted distribution and is far rarer in Western Australia. Indeed, *G. truttaceus* is the most restricted freshwater fish in south-western Australia, occurring only within the Albany district. During the present study, this species was found only in the catchments surrounding Moates Lake in Two People's Bay, i.e. the Goodga River and Black Cat Creek (Figure 10, Table 10). WAM records show, however, that this species has been found in streams just to the west of Albany (Figure 10, Table 10).

Abundance, habitat and ecology

This species was found in moderate numbers in the Goodga River, Black Cat Creek and Moates Lake. There have been no ecological or biological studies of this species in Western Australia. However, work has been carried out in south-eastern Australia, where this species inhabits the shore margin of still or slow-flowing waters, where it feeds on aquatic and terrestrial insects.

Reproduction

This species is represented by both landlocked and diadromous populations in Australia. The Two People's Bay population of this species appears to be landlocked. In Tasmania, the diadromous form spawns in late autumn, while the landlocked form spawns in spring. The adults of the diadromous form move downstream into estuaries, where spawning occurs, with the resultant larvae moving into the ocean. Juvenile diadromous *G. truttaceus* return from the ocean in summer, after approximately six months growth. In contrast, the adults of the landlocked form move into tributaries to spawn, with the larvae hatching approximately one month after spawning. The fecundity ranged from over 1,000 eggs in a 72 mm diadromous fish to almost 16,000 in a 142 mm landlocked fish.

Threats

The major threat to *G. truttaceus* in south-western Australia would be any deleterious changes to the habitat in the very restricted region in which this species is found. The highly restricted distribution would also make the survival of this species in south-western Australia susceptible to the introduction of predators. Although *G. truttaceus* is found within the Two People's Bay Nature Reserve and is thus offered some protection, trout have been introduced into this system (A. Danks pers. com.) and *Gambusia holbrooki* and other introduced fish may also be present in dams on private properties within the Goodga River catchment.

Conservation status and actions

Although this species has the most restricted distribution of any of the native freshwater fishes in south-western Australia, it is relatively widespread in south-eastern Australia, including Tasmania.

Conservation recommendations

Precise conservation recommendations for this species require studies to be carried out to determine its precise distribution within the Two People's Bay Nature Reserve and surrounding regions, and whether exotic species, such as trout or *G. holbrooki*, inhabit the same water bodies, and if any nearby dams with introduced fish species are likely to flood the system. It is also crucial that a detailed study of the biology of this species is undertaken in south-western Australia.

Literature

McDowall and Frankenberg (1981); Allen (1989); Humphries (1989, 1990); McDowall (1996).

Galaxias maculatus (Jenyns, 1842)

Plate 3(a)

Common names

Common jollytail, spotted minnow.

Identification

D 9–15; A 13–21; P 10–15; vertebrae 50–62. A small freshwater fish with a scaleless, elongate body. Dorsal fin is posteriorly placed and originates above anal fin origin; adipose fin is absent; tail distinctively forked; caudal peduncle slender. Eyes moderate to large; jaws with lateral canine teeth; mouth slightly oblique, small, extending below anterior eye margin. Maximum size 190 mm TL, common to 100 mm SL. Coloration is translucent olive-grey to amber, with dorsal and dorso-lateral irregular greenish-grey spots, blotches or bands. Coloration paler and pattern indistinct in smaller fish, becoming bolder with growth. Operculum, lower sides and eyes bright silvery. Fins largely unpigmented.

Distribution

Galaxias maculatus, which is represented by both amphidromous and landlocked forms, occurs in both south-eastern and south-western Australia. It is also widely distributed elsewhere throughout the Southern Hemisphere, occurring in New Zealand, Lord Howe Island, the Chatham Islands, Chile, Argentina, Tierra del Fuego and the Falkland Islands. The range of this species in eastern Australia extends coastally along the mainland from southern Queensland to as far west as Port Lincoln in South Australia, and around Tasmania

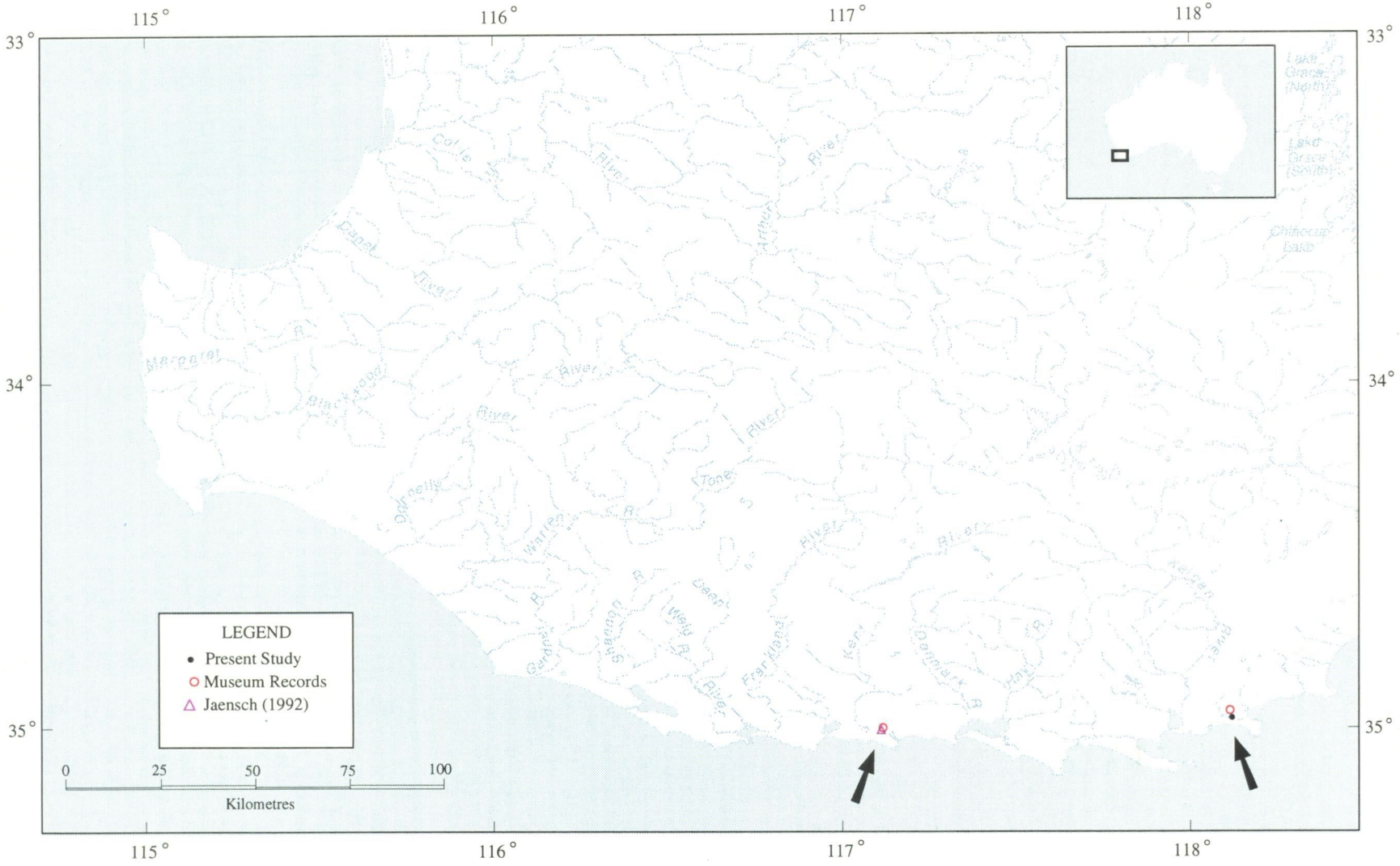

Figure 11 The distribution of *Galaxias maculatus* in the south-western corner of Australia.

and on King and Flinders Islands in Bass Straight. The western range of this species extends from Albany in the west to Esperance in the east (Figure 11, Table 11). This species was only found in the Two People's Bay watershed during our study. WAM records show that *G. maculatus* has also been found in the Kent River Watershed and in one of Boat Harbour Lakes, where it was also found by Jaensch (1992).

Abundance, habitat and ecology

There have been no ecological or biological studies on the Western Australian populations of this species. However, the capture of large numbers of the larvae of this species in lakes and rivers in south-western Australia implies that, at least some of the populations of this species, are landlocked. In south-eastern Australia, where this species inhabits still or slow-flowing coastal water bodies, the diet consists of a wide range of aquatic and terrestrial insects. This species can withstand large variations in salinities, with some populations occurring naturally in hypersaline waters.

Reproduction

In eastern Australia, the adults of the diadromous species migrate downstream to spawn during autumn on spring tides, where they lay their eggs on inundated terrestrial vegetation that has become flooded by the high tide. Over the next two weeks, the eggs develop out of water, with hatching occurring when a second series of tides inundate the eggs. The larvae are swept out to sea and return as juveniles in the spring. In landlocked populations, the adults move into tributaries to spawn, laying their eggs on flooded vegetation. The eggs become stranded when floodwaters recede, but survive and hatch when a second flood reinundates the vegetation two or more weeks later.

Threats

Very little information is available on the biology or ecology of this species in south-western Australia. However, since it is widely distributed and abundant, there is probably no real threat to this species in south-western Australia.

Conservation status and actions

Insufficient data are available on this species in south-western Australia to comment on its conservation status.

Conservation recommendations

In order to formulate conservation recommendations for *G. maculatus*, it will be necessary to determine those water bodies in which it is abundant in south-western Australia and to obtain data on its biology.

Literature

Pollard (1971a, b, 1972a, b, 1973, 1974); Chessman and Williams (1975); McDowall and Frankenberg (1981); Allen (1989); McDowall (1996).

Identification, distribution and biology of the lamprey

GEOTRIIDAE

***Geotria australis* Gray, 1851**

Plate 3(b–d)

Common names

Pouched lamprey.

Identification

Jawless and eel-like. Two dorsal fins and one caudal fin; no paired fins. Seven separate gill openings on each side of the body. Larvae (ammocoetes) brown in colour, blind and toothless, maximum length *ca* 110 mm. At the completion of metamorphosis, the young adults are blue dorsally and silver ventrally. When the fully-grown adults return from the sea, they have the same colour, and possess a prominent dorso-lateral blue-green stripe on each side of the body. As adults move upstream to their spawning grounds, the bright coloration is lost and they become a dull brown/grey. During its upstream migration, the male develops a large ventral pouch behind its suctorial disc. Maximum length *ca* 800 mm TL.

Distribution

Geotria australis is the sole member of the monotypic family Geotriidae and the only representative of the Petromyzontiformes found in south-western Australia. *Geotria australis* is also found in south-eastern Australia (including Tasmania), New Zealand, Chile and Argentina. In Western Australia, it is most abundant in the rivers south of Margaret River, but has been recorded as far north as the Swan River (Perth). During this study, adults were caught in the Margaret, Donnelly and Warren Rivers, and ammocoetes were collected from the Capel, Margaret, Donnelly, Warren, Gardner, Shannon, Deep, Kent and Denmark Rivers (Figures 12, 13, Tables 12, 13). WAM records show that *G. australis* also occurs in the Collie and Blackwood Rivers.

Abundance, habitat and ecology

Ammocoetes were often abundant in the sheltered, slower-flowing areas of river systems, where the substrate is soft and suitable for burrowing. During our study, ammocoetes were abundant in the lower reaches of the Margaret and Gardner Rivers, Lefroy Brook (Warren River) and Fly Brook (Donnelly River), but rare in the

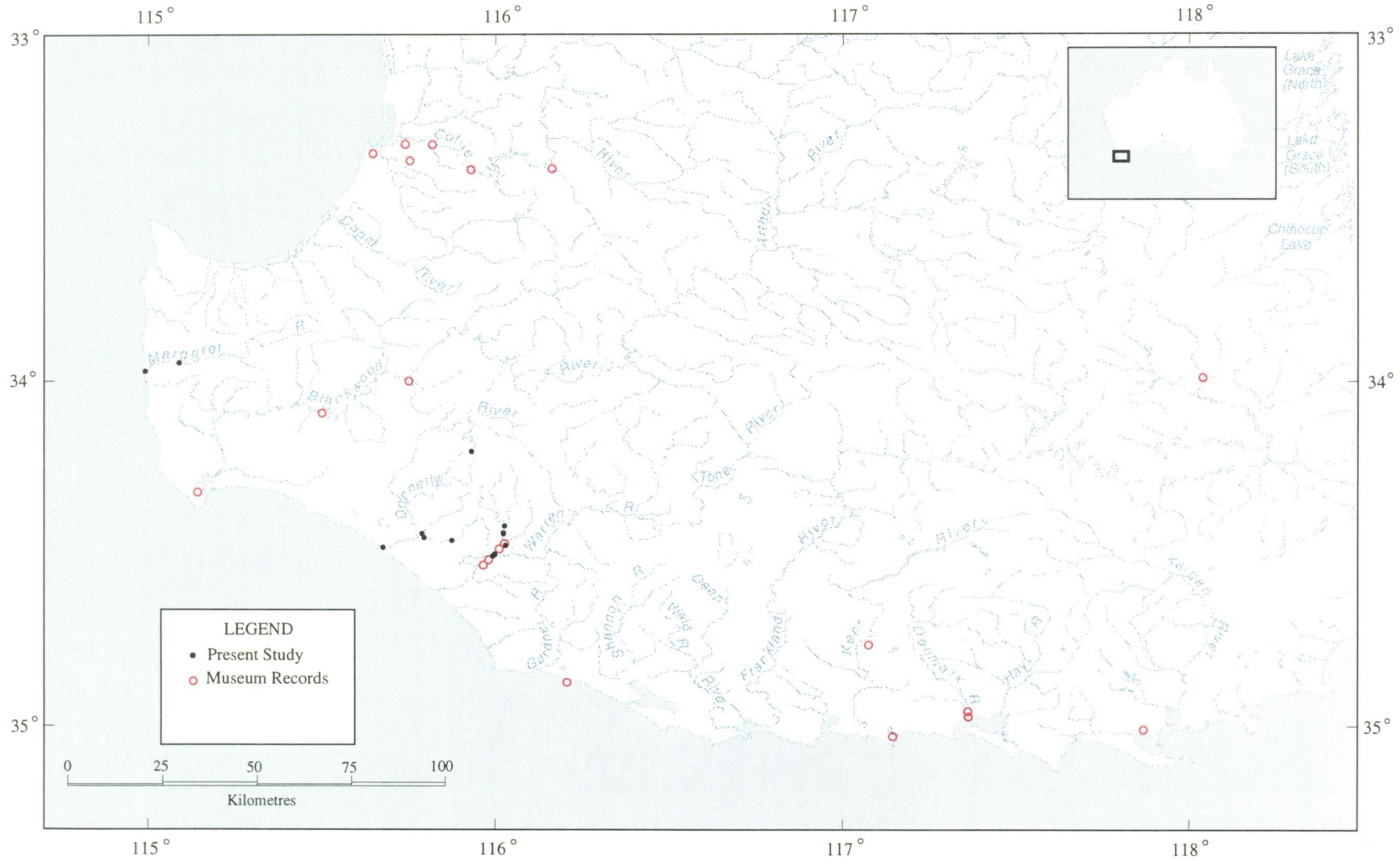

Figure 12 The distribution of *Geotria australis* (adults) in the south-western corner of Australia.

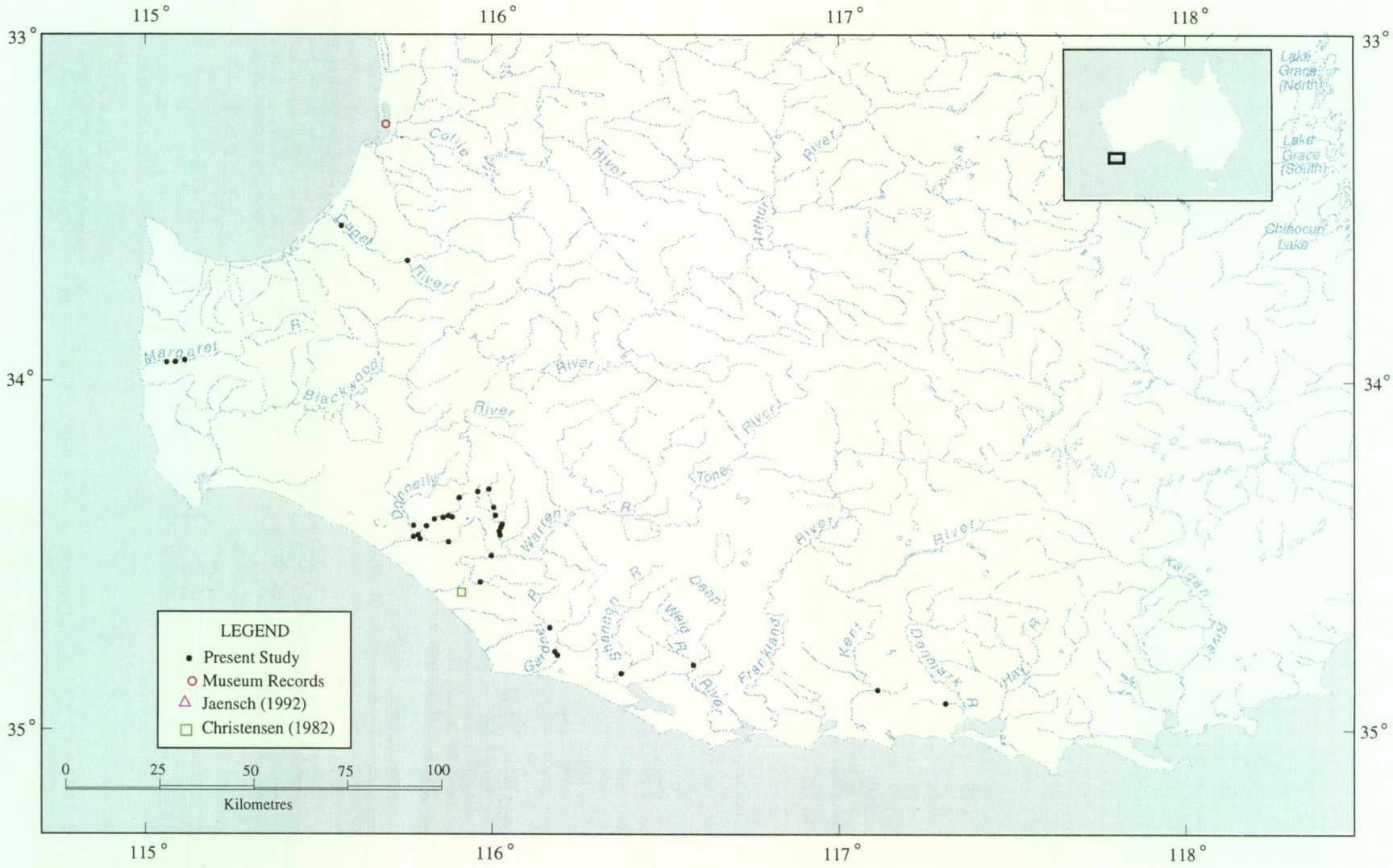

Figure 13 The distribution of *Geotria australis* (ammocoetes) in the south-western corner of Australia.

Capel River. Ammocoetes spend most of their time burrowed in the soft substrate, where they feed on diatoms, detritus and micro-organisms that are drawn into the pharynx on a water current. After $4^1/_4$ years, the ammocoete has reached *ca* 90 mm and starts to metamorphose into a young adult that has prominent eyes and a suctorial disc. Metamorphosis is completed in 5-6 months, after which, in July and August, the young adult, moving predominantly at night, migrates downstream to the sea. During its apparently two year marine trophic phase, where this species is assumed to feed on teleost fish, its length increases from *ca* 90 to 650 mm. The fully-grown adult ceases feeding and re-enters rivers, embarking on an upstream migration, that takes place predominantly at night, and which, after 15–16 months, culminates in spawning and death. The strength of the upstream migration varies greatly between years.

Reproduction

Although no mature adults of *G. australis* have been captured and their precise spawning areas are unknown, the pattern of sexual development of adult lampreys in the laboratory and the time of appearance of small, recently-hatched ammocoetes strongly indicate that spawning takes place in early November. A number of maturing adults were collected from Dombakup Brook (Warren River), the main channel of the Warren River and Lefroy Brook (Warren River), where they were found under rocks and logs and among submerged grass.

Threats

Alterations in the habitat of ammocoetes and adult lampreys pose the main threat to *G. australis*. Habitat alteration is occurring through the construction of dams, groundwater extraction and agricultural and forestry practices in the uppermost catchment. Some of these practises are reducing the areas of silty substrate which provide ideal ammocoete beds. For example, no good ammocoete beds were found in the parts of streams running through cleared agricultural land, where it is believed that agricultural run-off and increased inflow adversely affect the composition of the substrate (D. Macey, pers. comm.). Although adults can move overland and thus around dams, the large dams found in many catchments will still act as partial barriers to the migrating adults, especially on warm dry nights. Such an effect was found in late September 1994, when approximately 5,000 upstream migrants were observed on and below the Lefroy Dam, but none were observed using the fish ladder which was dry at the time and is used by lampreys on wet nights. On the following morning, large numbers of dead lampreys were present at the bottom of the dam.

Conservation status and actions

Considering the extensive distribution of *G. australis*, it does not warrant inclusion on the Australian Society for Fish Biology's list of Australian threatened fishes. However, there is strong circumstantial evidence that the construction of dams has resulted in a reduction in the area of potential ammocoete beds and provides an impediment to the upstream migration of adult lampreys and this had led to a reduction of lamprey numbers.

Conservation recommendations

The most important conservation action is to preserve natural flow regimes and to provide bypasses at dams. This will enable the soft substrate habitats of ammocoetes, where water flow is slow, to be retained and also allow the adult lampreys an unimpeded migration to their upstream spawning areas.

Literature

Potter *et al.* (1980, 1983, 1986a, b); Potter and Hilliard (1986); Allen (1989).

Identification, distribution and biology of the fish with marine affinities

ATHERINIDAE

***Leptatherina wallacei* (Prince, Ivantsoff and Potter, 1981)**

Plate 3(e)

Common names

Swan River hardyhead, western hardyhead.

Identification

D1 V–VIII; D2 I, 8–10; A I, 9–12; P 11–15; gill rakers on lower limb of first branchial arch 14–17. Mouth relatively small, extending to front of eye. A large gap is present between the two dorsal fins. Maximum size *ca* 80 mm TL. Coloration, olive dorsally and silvery laterally and ventrally; a very conspicuous midlateral copper-coloured stripe is often present. Fins pale.

Distribution

The range of this species extends from Moore River (Gingin) in the north to the Pallinup River (east of Albany) in the south-east. During the present study, *L. wallacei* was found in the Abba, Margaret, Blackwood, Scott, Gardner, Shannon, Inlet, Forth, Frankland, Kent and Hay Rivers and in Lakes Jasper, Towerrinning, Saide, Gardner and Angove, and in a number of pools near Windy Harbour and in the Norman's Beach and Cheyne Beach watersheds (Figure 14, Table 14).

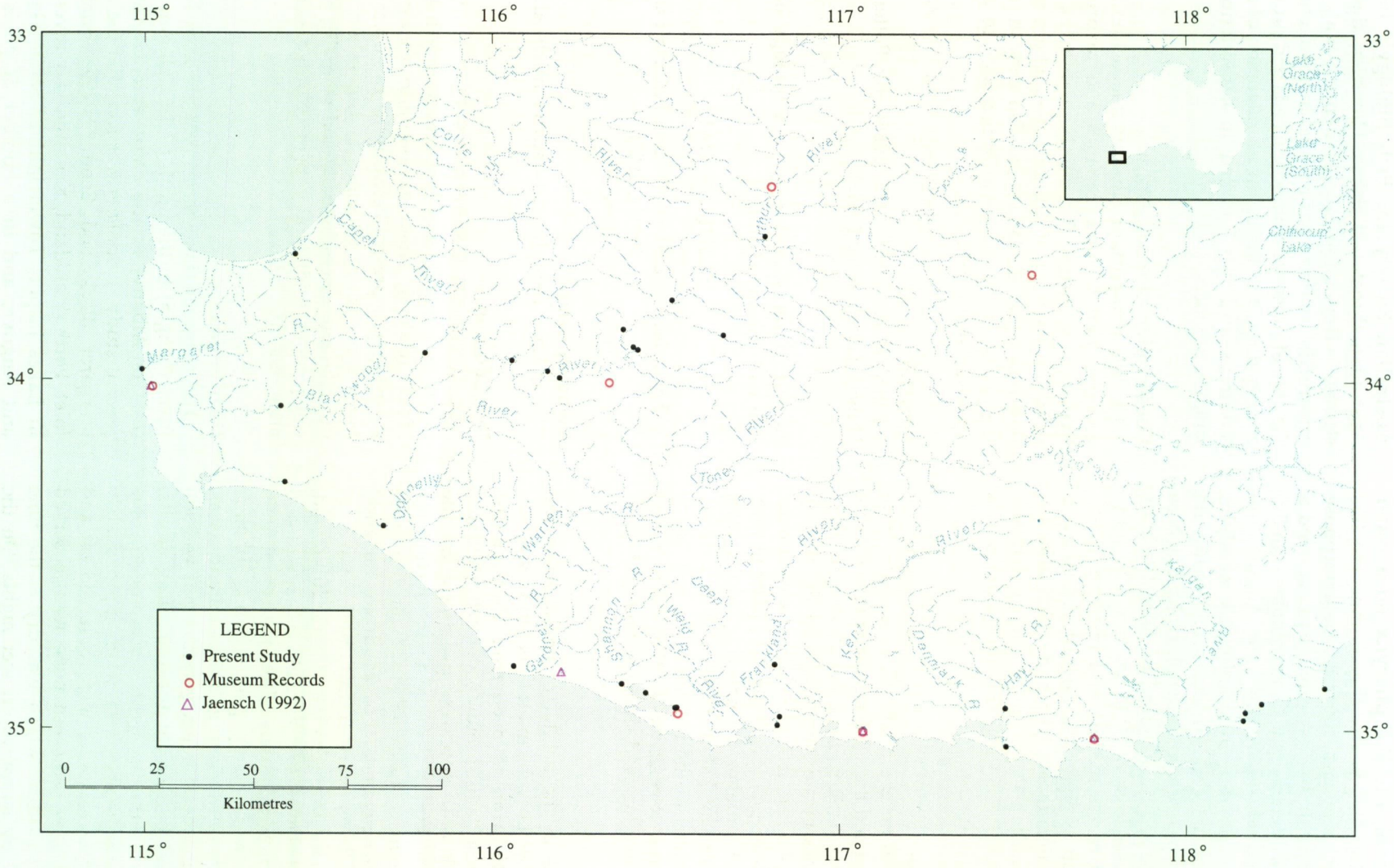

Figure 14 The distribution of *Leptatherina wallacei* in the south-western corner of Australia.

Abundance, habitat and ecology

Leptatherina wallacei is very abundant, often forming large schools in estuaries, rivers, streams and lakes in the coastal areas throughout its range. It has also penetrated considerable distances upstream in the Blackwood River (Figure 14). In the Swan Estuary, planktonic crustaceans, flying insects, polychaetes and unicellular algae are its most important dietary items.

Reproduction

In the Swan Estuary, males and females of this species attain on average lengths of 45 and 55 mm at the end of their first year of life, respectively, at which age they attain sexual maturity. Very few fish survive beyond their first year. This species has a protracted spawning period that peaks in late spring.

Threats

Since *L. wallacei* is abundant throughout much of its extensive range, it is unlikely that this species is threatened.

Conservation status and actions

Considering the extensive distribution of *L. wallacei*, it does not warrant inclusion on the Australian Society for Fish Biology's list of Australian threatened fishes.

Conservation recommendations

Due to its abundance, extensive distribution, and wide range of habitats, no specific conservation recommendations are made.

Literature

Prince *et al.* (1982a, b); Prince and Potter (1983); Allen (1989).

GOBIIDAE

Pseudogobius olorum (Sauvage, 1880)

Plate 3(e)

Common names

Swan River goby, blue spot goby.

Identification

D1 VI; D2 I, 7–9; A I, 7–9; P 15–17; V I, 5 (pelvic fins form distinct disc); gill rakers on first branchial arch 8–9; operculum lightly scaled; cheek naked; cephalic lateral-line system longitudinal; cephalic lateral-lines short. Mouth small and sub-terminal, extending to front of eye. Maximum size *ca* 60 mm TL. Coloration, light brown and pale ventrally. Lateral series of seven to nine dark blotches. Dorsal and caudal fins with a series of brown or black reticulating lines; D1 bearing prominent blue or black spot posteriorly. Pectoral fin transparent. Pelvic and anal fins pale, becoming dark blue to black during the breeding season. Pigmentation varies with site of capture, sex, reproductive status and preservation, and is usually strongest in breeding males which are often almost completely black.

Distribution

Pseudogobius olorum is found in coastal water bodies in south-western Australia, western Victoria and South Australia. The range in south-western Australia extends from Kalbarri in the north to Esperance in the south-east. *Pseudogobius olorum* is generally associated with coastal water bodies throughout the study area, but does penetrate considerable distances inland in certain rivers, e.g. the Blackwood, Warren, Hay and Kalgan Rivers (Figure 15), as well as being found in a number of pools and isolated lakes, e.g. Lakes Jasper, Maringup, Towerrinning, Saide, Powell, Moates, Gardner and Angove (Figure 15, Table 15).

Abundance, habitat and ecology

Pseudogobius olorum is very abundant throughout most of its range, occurring in estuaries, rivers, streams and both freshwater and hypersaline lakes. In the Swan Estuary, algae and mats of bacteria and fungi are the major dietary components in spring, summer and winter, while a considerable amount of animal material is consumed in winter. However, in the freshwater lakes of the Swan Coastal Plain, it feeds predominantly on animal taxa in all seasons. This species can tolerate extreme salinities and temperatures. The life cycle of *P. olorum* typically lasts for less than a year.

Reproduction

In the Swan River Estuary, *P. olorum* spawns in spring and autumn and to a limited extent, in summer. Length-frequency and gonadal data show that the progeny of the spring-spawning group frequently spawn in the following autumn, when they are approximately five months old, and that those of the autumn-spawning group frequently spawn in the following spring, when they are approximately seven months old. Some representatives of these two spawning groups survive through the winter and summer, respectively, to breed in a second season.

Threats

Since *P. olorum* is common and abundant throughout much of its extensive range, it is unlikely to be threatened.

Conservation status and actions

Considering the extensive distribution and

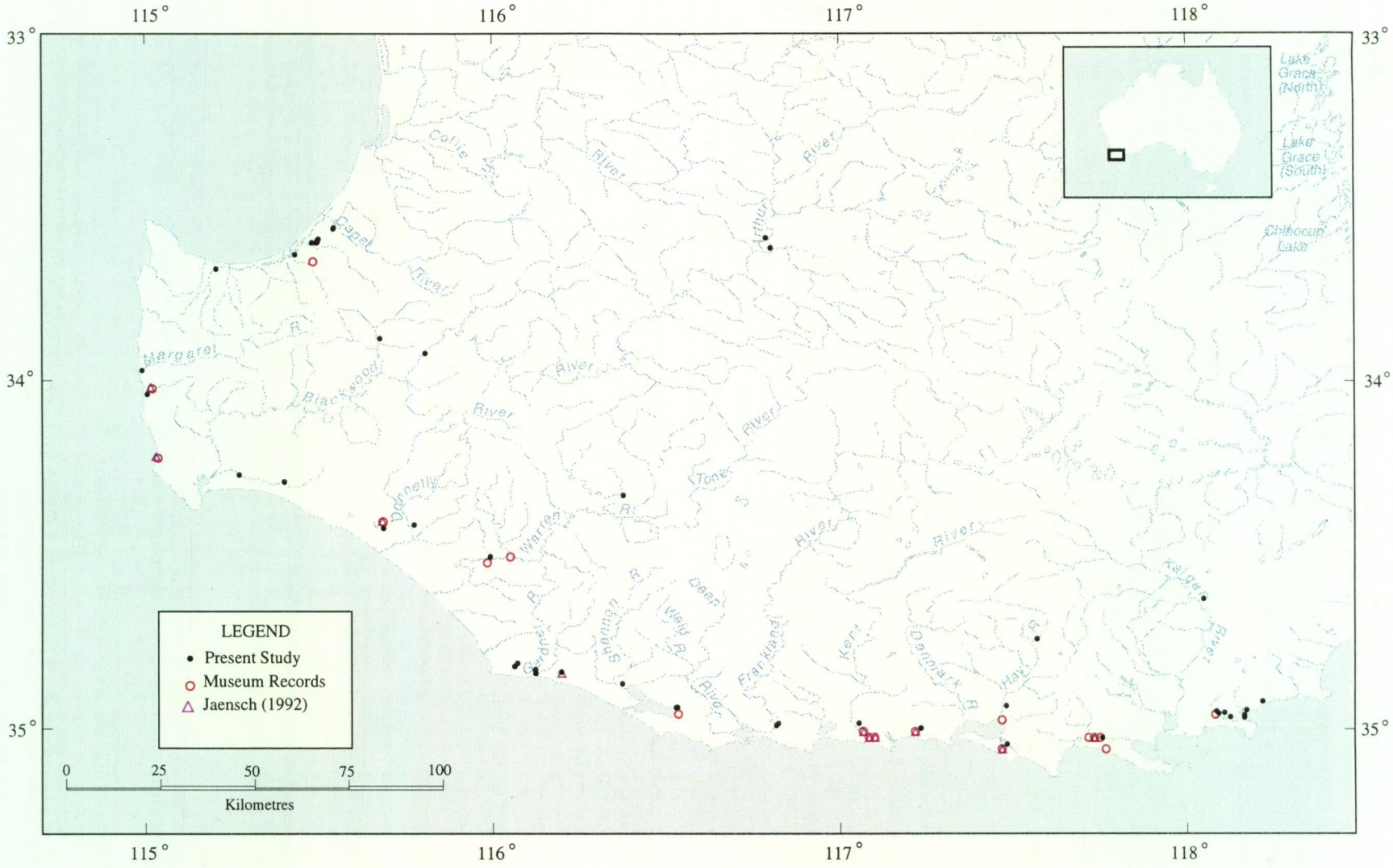

Figure 15 The distribution of *Pseudogobius olorum* in the south-western corner of Australia.

abundance of *P. olorum*, this species does not warrant inclusion on the Australian Society for Fish Biology's list of Australian threatened fishes.

Conservation recommendations

Due to the extensive distribution and tolerance to a wide range of habitats in which this species is often abundant, no specific conservation recommendations are made.

Literature

Halse (1981); Allen (1989); Gill *et al.* (1992, 1996); Fairhurst (1993); Gill and Potter (1993); McDowall (1996).

Afurcagobius suppositus (Sauvage, 1880)

Plate 3(e)

Common names

Big headed goby.

Identification

D1 VI; D2 I, 8; A I, 7; P 15–16; V I, 5 (pelvic fins form distinct disc); gill rakers on first branchial arch 6–11; vertebrae 27; scales in lateral row 30–38; transverse scale count 10–13+1; predorsal scales 0–4; prepelvic area naked; cheek and operculum naked; tongue truncate; cephalic lateral-line system longitudinal; cephalic lateral-line row a1 short. Greatest body depth 5.0–6.5 in SL. Mouth large, extending to rear of eye. Maximum size *ca* 110 mm TL. Coloration, light brown to black dorsally and pale ventrally. Lateral series of six or seven dark blotches. Head usually heavily pigmented. Dorsal and caudal fins with a series of brown or black reticulating lines; D1 bearing prominent dark spot posteriorly. Pectoral fin transparent. Pelvic and anal fins pale, darker during breeding season. Pigmentation varies with site of capture, sex, reproductive status and preservation, and is usually strongest in breeding males.

Distribution

The range extends from Moore River (Gingin) in the north to Esperance in the south-east. Although this species apparently 'prefers' the low salinity regimes in the upper parts of estuaries, it was found in a number of inland waters, e.g. Warren, Scott, Blackwood and Kalgan Rivers, and in reasonable numbers in Lake Jasper (Table 2).

Abundance, habitat and ecology

Afurcagobius suppositus is occasionally locally abundant throughout most of its range and is found in estuaries, rivers, streams and coastal lakes. This species has a strong preference for heavy cover. Hemipterans and dipteran larvae are important dietary components in all seasons, while bivalves, terrestrial insects, ephemopterans, trichopterans and teleosts are important in some seasons. The duration of the life cycle of *A. suppositus* is unknown, but probably lasts for at least two years.

Reproduction

Breeding probably occurs between late spring and early summer and at the end of the first year of life (unpublished data). Males guard a nest under stones or among aquatic macrophytes, where several females have laid their eggs.

Threats

Since *A. suppositus* is common throughout much of its extensive range, it is unlikely to be under any real threat. However, the loss of habitat through urban and agricultural development and agricultural and forestry practices, causing alterations to inflow and the deposition of silt, may pose threats to some populations of this species.

Conservation status and actions

Considering the extensive distribution and abundance of *A. suppositus* in some water bodies, it does not warrant inclusion on the Australian Society for Fish Biology's list of Australian threatened fishes.

Conservation recommendations

The most important conservation actions are the preservation of suitable habitats, and the careful monitoring of any activities that may result in the deposition of silt. While the taxonomy of this species has received much recent attention, little is known about its general biology, a situation which should be addressed before further recommendations can be made.

Literature

Allen (1989); Gill *et al.* (1992); Gill (1993, 1994); Gill and Potter (1993); Young (1994); Gill and Humphries (1995).

Identification, distribution and biology of introduced species

SALMONIDAE

Oncorhynchus mykiss (Walbaum)

Salmo trutta Linnaeus

Plate 3(f)

Common names

Rainbow trout (*O. mykiss*).
Brown trout (*S. trutta*).

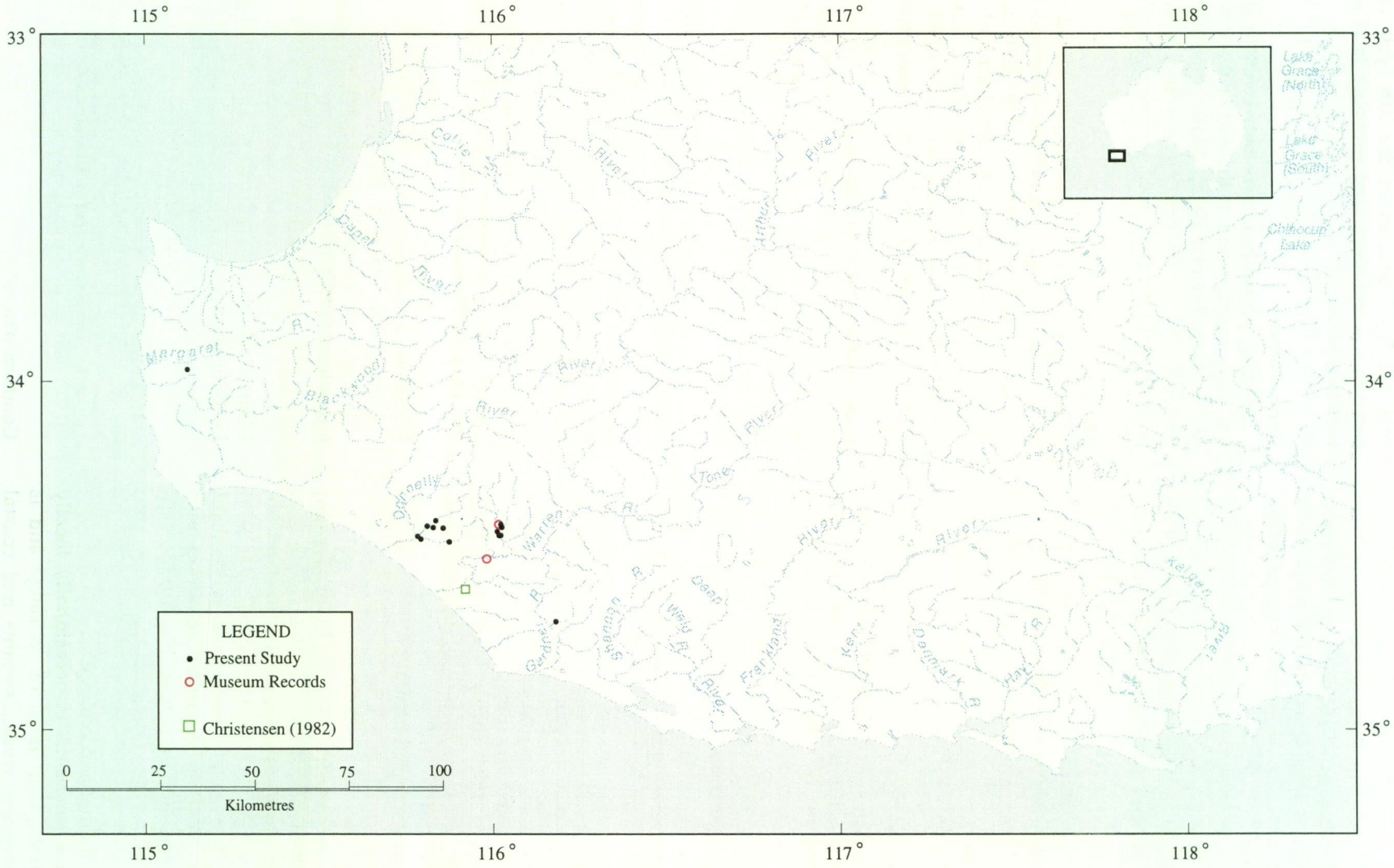

Figure 16 The distribution of *Oncorhynchus mykiss* and *Salmo trutta* in the south-western corner of Australia.

Identification

Trout can be recognised by the presence of an adipose fin between the dorsal and caudal fins. Mouth relatively large, extending to rear of eye. Maximum size *ca* 700 mm TL. Coloration blue-black (*O. mykiss*) to olive (*S. trutta*) dorsally and silver to bronze ventrally, a very obvious midlateral pink stripe is often present in *O. mykiss*. The body and tail are covered by small black spots in *O. mykiss*, whereas large black and red spots, often with white surrounds, are found on the body but not the tail of *S. trutta*.

Distribution

Oncorhynchus mykiss is native to the Pacific coast of North America, whereas *S. trutta* is native to Europe. Both species were introduced into Australia in the 1800s, and are now found in both south-western and south-eastern Australia (including Tasmania). During our study, these two species were found in rivers, streams, lakes and dams in the Margaret, Donnelly, Warren and Gardner River catchments (Figure 16, Table 16). However, particularly *O. mykiss* has been introduced into dams and rivers on a wide scale throughout much of south-western Australia, including Big Brook Dam, Cowan Dam, Drakesbrook Dam, Glen Mervyn Dam, Harvey Weir, Lake Leshenaultia, Logue Brook Dam, Nornalup Dam, Pemberton Swimming Pool, Samson Dam, Stirling Dam, Waroona Dam, King River, Moates Lake, Blackwood River, Brunswick River, Collie Gorge, Dirk Brook, Donnelly River, Harvey River, Hesters Brook, Lefroy Brook, Marrinup Brook, McKnows Brook, Murray River, Samson Brook, Serpentine River, Warren River, Wokalup Brook and Wooroloo/Jane Brook (N. Morrissy pers. comm.). Of the 1,965,500 trout stocked in public waters in south-western Australia between 1985 and 1994, 28 and 70% were released into dams and rivers, respectively (Table 16.1). The majority (98.8%) were stocked as either fry (1,606,000) or yearling (168,800) *O. mykiss*.

Abundance, habitat and ecology

These species are locally abundant in those waters which have been subject to continued stocking and where they form an important recreational fishery. Work in our research group is currently focusing on elucidating the extent to which trout feed on endemic fish species in the rivers of south-western Australia.

Reproduction

Although trout have had some limited breeding success in south-western Australia, trout populations are largely maintained by the stocking of water bodies with hatchery-reared fry and yearlings (Table 16.1).

Threats

Not applicable. However, all of the exotic species present within lower south-western Australia, i.e. *O. mykiss, S. trutta, Perca fluviatilis* and *Gambusia holbrooki*, have been shown to influence, through interference competition and/or predation, the distribution of freshwater fish in Australia and other parts of the world (see for example Tilzey 1976; Cadwallader 1978; Fletcher 1979; Jackson and Williams 1980; Cadwallader and Eden 1982; Meffe 1984; Lloyd *et al.* 1986; Lloyd 1989; Hutchinson 1991; Townsend and Crowl 1991; Crowl *et al.* 1992; Pen and Potter 1992; Morgan *et al.* 1995b; Hambleton *et al.* 1996a, b; Morgan and Gill 1996; Closs and Lake 1996).

Conservation status and actions

Not applicable.

Conservation recommendations

Not applicable.

Literature

Allen (1989); Fulton (1990); McDowall (1996).

POECILIIDAE

Gambusia holbrooki (Girard)

Plate 3(g)

Common names

Gambusia, mosquitofish.

Identification

One soft dorsal fin and moderately deep body. Mouth small. Maximum size is *ca* 35 mm TL for males and *ca* 60 mm TL for females. Coloration, olive-brown dorsally and silver to light bronze laterally and ventrally. Fins lightly pigmented. Mature females with large ventro-lateral blotch. Mature males have elongate anal fin rays, which are modified to form an intromittent organ.

Distribution

Gambusia holbrooki, which is native to the rivers draining into the Gulf of Mexico, was introduced into eastern Australia in the mid-1920s and into south-western Australia in 1934 in an attempt to control mosquitos. This species is now extremely common in Australia, being found in all states and territories, except Tasmania. *Gambusia holbrooki* is widespread in south-western Australia and often occurs in very high numbers. During our study, it was found in the Collie, Capel, Ludlow, Abba, Carbanup, Margaret, Blackwood, Scott, Donnelly, Warren, Gardner, Shannon, Frankland, Lake Muir, Kent, Hay, Torbay Inlet, King and Kalgan River watersheds (Figure 17, Table 17).

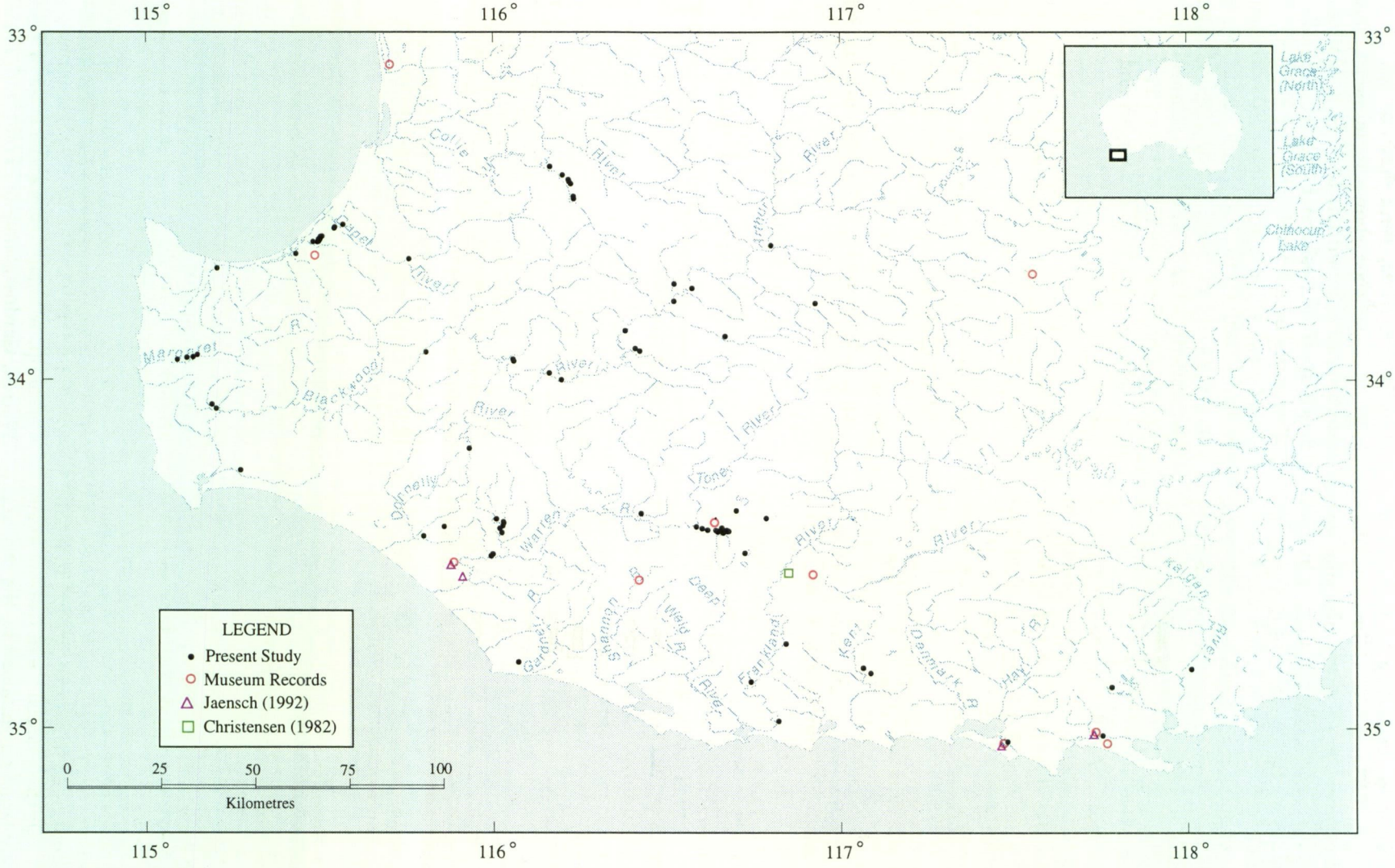

Figure 17 The distribution of *Gambusia holbrooki* in the south-western corner of Australia.

Abundance, habitat and ecology

When present, *G. holbrooki* is typically very abundant. In the Collie River and the wetlands of the Swan Coastal Plain, this species feeds on a wide range of prey types at the water surface and throughout the water column. Pen and Potter (1991d) found no evidence that *G. holbrooki* nipped the fins of other teleosts or exhibited agonistic behaviour towards those species in lotic waters. However, recent work in the RGC Wetlands demonstrated that the majority of native species in that system had extensively damaged caudal fins, which was almost certainly the result of fin nipping by *G. holbrooki* and that this introduced species displays agonostic behaviour towards the native species in this lentic system. Fertilisation is internal, with the female bearing live young and sexual maturity can be reached within a few months. This species is now considered a pest in many areas of the world.

Reproduction

Fertilisation and development occur internally. In the Collie River, *G. holbrooki* breeds when water temperatures exceed 15–16 °C and daylight exceeds 750–780 min. The larger progeny of the spring-recruits breed in late summer and early autumn, while the smaller individuals overwinter and breed in the following spring. The autumn-spawned fish overwinter and breed in the following spring and summer.

Threats

Not applicable for this species in south-western Australia. However, see 'Threats' in the Salmonidae for examples of studies that have implicated *G. holbrooki* with the decline of native fish.

Conservation status and actions

Not applicable.

Conservation recommendations

Not applicable, but, if captured, this species should not be returned to the water body.

Literature

Lloyd *et al.* (1986); Allen (1989); Pen and Potter (1991d); Fairhurst (unpublished honours thesis 1993); Hambleton *et al.* (1996a, b); McDowall (1996).

PERCIDAE

Perca fluviatilis Linnaeus

Plate 3(f)

Common names

Redfin perch, European perch, perch, redfin.

Identification

Spiny first dorsal, soft second dorsal fin and moderately deep body. Mouth relatively large, extending to rear of eye. Maximum size about 500 mm TL. Coloration, olive dorsally and silvery ventrally, a series of vertical bars dorso-laterally. Paired and anal fins orange to red in colour.

Distribution

This species had been introduced into Australia from Europe by at least the 1860s, and is now widespread in south-eastern Australia, including Tasmania and South Australia. We found this species in the Collie, Capel, Margaret, Blackwood, Donnelly and Warren River catchments (Figure 18, Table 18).

Abundance, habitat and ecology

When present, this species is typically abundant. In the Collie River, small *P. fluviatilis* feed predominantly on planktonic crustaceans, while larger fish feed mainly on benthic invertebrates. *Perca fluviatilis* of all sizes feed on endemic teleosts. In Big Brook, *P. fluviatilis* feeds on odonatan larvae, dipteran larvae, trichopterans, copepods, amphipods, decapods and teleosts. This species forms an important recreational fishery in some areas of south-western Australia.

Reproduction

The appearance of large numbers of small (<30 mm) *P. fluviatilis* in the Collie River during November and December, suggest that this species spawns in winter and spring in south-western Australia.

Threats

Not applicable for this species in south-western Australia. However, see 'Threats' in the Salmonidae for examples of studies that have implicated *P. fluviatilis* with the decline of native fish.

Conservation status and actions

Not applicable. However, the Western Australian Fisheries Department requests that, if captured, this species should not be returned to the water.

Conservation recommendations

Not applicable.

Literature

Pen (1990); Pen and Potter (1992); McDowall (1996); Morgan and Gill (1996).

SUMMARY AND RECOMMENDATIONS

Distribution, abundance and habitat requirements

Endemic freshwater fish species

Based on their distribution patterns, abundance

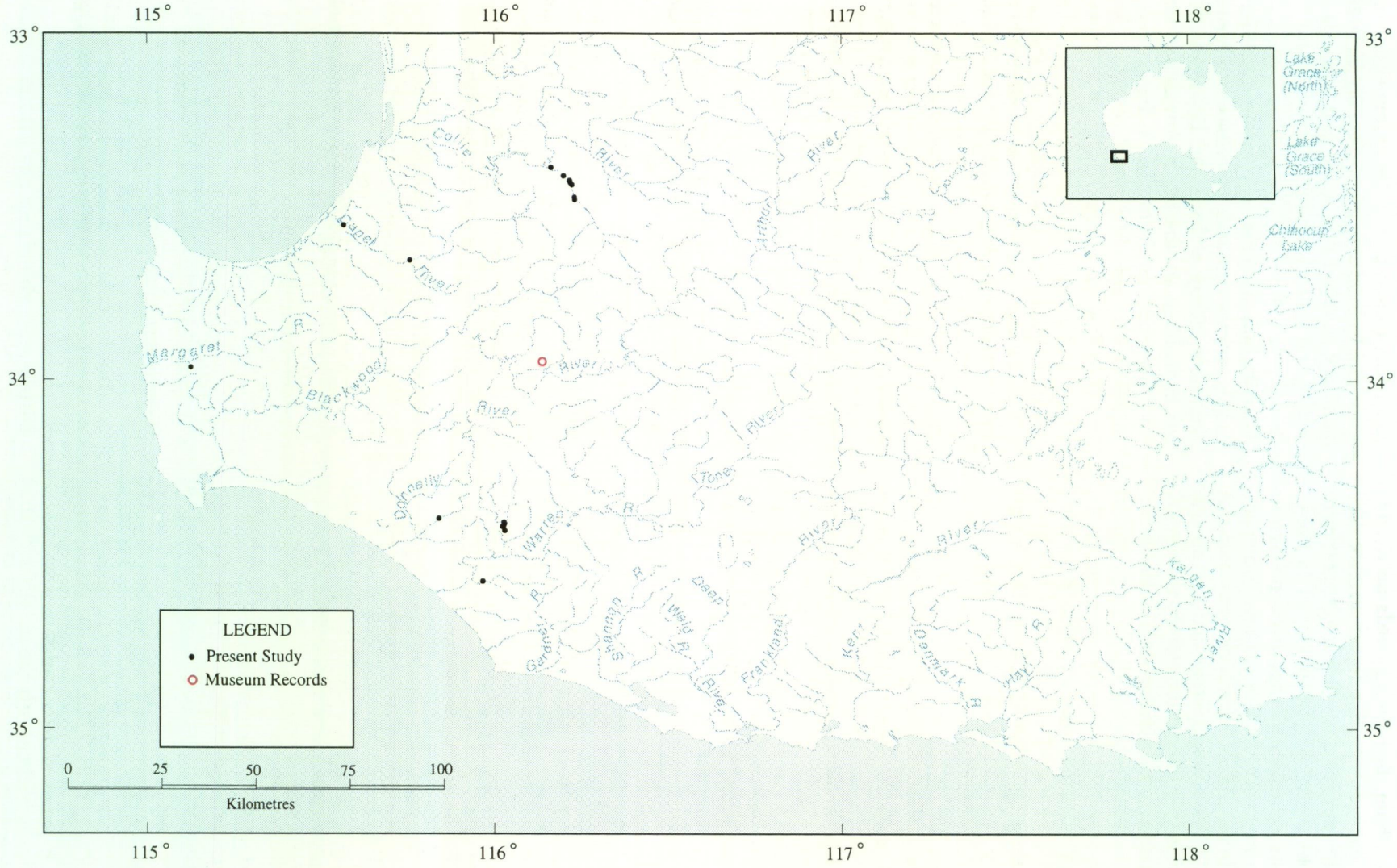

Figure 18 The distribution of *Perca fluviatilis* in the south-western corner of Australia.

and habitat requirements, the seven small freshwater fish species, that are endemic to the south-western corner of Australia, represent two main groups. Three of these species, namely *G. occidentalis, B. porosa* and *E. vittata,* are abundant in rivers, streams, lakes and pools throughout much of the south-western corner of Australia. Furthermore, these three species are common in water bodies within forested areas, the peat flats and agricultural areas. Indeed, the only habitat type in which these species were rare or absent were those water bodies that were devoid of cover, i.e. did not possess riparian vegetation, boulders, submerged snags etc.

The other four small endemic species, namely *L. salamandroides, G. nigrostriata, G. munda* and *N. balstoni,* are essentially restricted to the region bounded by Margaret River in the north-west and Albany in the east. However, there are a small number of disjunct populations of the last three species. Thus, all of these three species are found in a localised region around Gingin, far to the north of their main area of distribution. Furthermore, *N. balstoni* has also been found in the Collie River, while *G. nigrostriata* has been collected near Bunbury. The above four species were found only in certain habitat types where they were sometimes abundant. Thus, *L. salamandroides* and *G. nigrostriata* were almost entirely restricted to the ephemeral pools of the southern peat flats and adjacent forested areas, while *N. balstoni,* which was most common in the pools and small streams of the peat flats, was also occasionally found in the lakes and rivers of the region, albeit in only low numbers. Although *Galaxiella munda* was also found in a number of pools in the peat flats, it was most abundant in the headwaters and streams of the major rivers in the peat flats and adjacent forested areas. The range of this species extends further into the forested areas than those of *L. salamandroides, G. nigrostriata* and *N. balstoni.* None of these four species was ever caught in cleared agricultural areas.

All of the above seven species utilise flooded areas for spawning, either within creeks or amongst the inundated vegetation of pools and lakes (Pen and Potter 1990, 1991a, c; Pen *et al.* 1991, 1993; Morgan *et al.* 1995a, unpublished data). The smallest larvae of *L. salamandroides, G. nigrostriata, G. munda* and *N. balstoni* live in very shallow waters (<10 cm deep), particularly amongst inundated vegetation moving gradually into deeper waters as they increase in size (Gill unpublished data).

The freshwater catfish, *T. bostocki,* was caught at only two sites during the present study (Alexander Bridge on the Blackwood River and at Lake Smith), and has been recorded in our study area at Lake Wilson by Jaensch (1992) and at Pemberton and Nannup by WAM. The studies of Morrison (1988) and Hewitt (unpublished honours thesis 1992) to the north of our study area suggest that this species often inhabits the deeper areas of lakes and slow-flowing rivers and would thus be more susceptible to capture by sunken gill nets and large seine nets than by the methods employed in this study.

Galaxiids that are also found in south-eastern Australia

Although *G. truttaceus* was only captured in the slow-moving streams of the Moates Lake catchment (Goodga River and Black Cat Creek) and in Moates Lake, the WAM records show that it has been found in catchments in the Albany area, and Hodgkin and Clark (1988, 1990) found this species to the east of Albany, in the Pallinup and Fitzgerald Rivers. This species has the most restricted distribution of the freshwater fish species found in south-western Australia. There is essentially no information available on the biology of this species in Western Australia and the same situation pertains with *G. maculatus,* the other species found in both south-western and south-eastern Australia. WAM records show that *G. maculatus* occurs in coastal water bodies between Albany and Esperance. During our study, *G. maculatus* was only found within the Two People's Bay Nature Reserve.

The anadromous lamprey Geotria australis

Adult *G. australis* have been caught migrating up the Warren, Donnelly and Margaret Rivers during winter and spring, with the strength of these upstream migrations varying greatly amongst years (Potter *et al.* 1983). Although the precise locations at which they spawn are unknown, a number of maturing adults have been caught during autumn and winter in the isolated pools and the main channel of the headwaters of the Warren River, where they were found under rocks, logs and amongst submerged bankside grass. Ammocoetes were collected from within the shallow, silty banks in the Capel, Margaret, Donnelly, Warren, Gardner, Shannon, Deep, Kent and Denmark Rivers, while nearly and fully-metamorphosed individuals were typically found burrowed in the sandy substrates of the deeper and faster-flowing waters of these systems. The absence of larval lampreys in our samples from the Blackwood, Frankland, Hay, King and Kalgan Rivers suggests either that ammocoetes are in low numbers, or are present in restricted areas that were not sampled or are no longer present due to the deleterious effects of the higher salinities in these rather degraded systems. Ammocoetes cannot survive in saline water.

Fish species with marine affinities

The estuarine species that were most frequently caught in freshwater in south-western Australia,

namely *L. wallacei, P. olorum* and *A. suppositus,* were generally associated with coastal water bodies. However, these species penetrate some distance into rivers, e.g. the Blackwood River, and they also occur in a number of isolated lakes, e.g. Lake Jasper. Although *L. wallacei* and *P. olorum* were often caught in open water and in large numbers, *A. suppositus* was only found in small numbers in these waters, probably reflecting a preference for areas of dense cover which are difficult to sample (Gill and Humphries 1995). The extensive distribution of *L. wallacei* within the somewhat degraded Blackwood River presumably reflects the presence of higher salinities than would normally occur in this system.

Introduced freshwater fish species

Although the most common and widespread exotic species in the south-western corner of Australia is *G. holbrooki, P. fluviatilis* is also often locally abundant. Both of these species are generally associated with habitats that have been substantially altered by human activity. For example, they were often common in reservoirs (e.g. Big Brook Dam), in water bodies produced by mining (e.g. Collie River South Branch, RGC Wetlands Centre) and in those systems subject to enrichment through agricultural run-off (e.g. certain areas of the Collie River, Capel River, Blackwood River and Lake Unicup). The two trout species, *O. mykiss* and *S. trutta,* were only captured in those systems where regular stocking had taken place, i.e. predominantly in the streams of the Pemberton area. The eastern Australian species *Macquaria ambigua* and *Bidyanus bidyanus* have recently been translocated into farm dams in the major catchments surrounding the peat flats (see Prokop 1994 and papers therein). Although these large piscivorous species have not yet appeared in the natural waterways of the lower south-western corner of Australia, a number of *M. ambigua* were recently captured by gill net in the Swan River, having presumably escaped from farm dams or been irresponsibly deposited into that system (R. Lenanton pers. com.).

Threats and conservation recommendations

Although three of the endemic species, namely *G. occidentalis, B. porosa* and *E. vittata,* were typically represented by large populations in most types of habitat throughout their extensive ranges, and are thus currently under no threat, local populations of these species may be vulnerable to loss of suitable habitat and the introduction of exotic species. For example, recent work in the lakes and pools of the Perth metropolitan area has shown that, while each of these three species are abundant in at least some of the few remaining 'coloured' water bodies of the region, they are absent or greatly reduced in number in the eutrophic water bodies that are common in the region (E. Fairhurst unpublished honours thesis 1993). Furthermore, while these species are absent or rare in those lakes of south-western Australia, which contain large numbers of the introduced species *G. holbrooki,* they are abundant in nearby streams and lakes which do not contain this species. Indeed, the only pools, lakes and streams of the RGC Mineral Sands complex in which the endemic species were abundant, contained large amounts of cover and few *G. holbrooki.* Furthermore, the endemic species in the RGC complex had a higher prevalence of the type of fin damage that is typically produced by *G. holbrooki* than was the case in the nearby Ludlow River, where this feral species was far less common.

In contrast to *G. occidentalis, B. porosa* and *E. vittata,* the other endemic species, namely *L. salamandroides, G. nigrostriata, G. munda* and *N. balstoni,* essentially have a very restricted range and are represented by small populations in specific habitats. These latter species can therefore be considered to be particularly vulnerable to any continuing loss or alteration of habitat and, under certain conditions, the effects of introducing non-native species. Indeed, habitat alteration and possibly predation by introduced fish may explain the recent loss of native fish from the headwaters of Big Brook above Big Brook Dam. Thus, whereas Pen *et al.* (1991) found considerable numbers of endemic fish species in these waters, sampling during the present study and by Morgan and Gill (1996) recorded only a few individuals of endemic fish species. It is therefore pertinent that, during several recent dry years, the reservoir immediately above Big Brook Dam was the only upstream section of Lefroy Brook to retain water during summer and autumn. Furthermore, during these dry years, the piscivorous *P. fluviatilis* was introduced to the reservoir and is now well established in both the reservoir and the headwater streams. It also appears relevant that *O. mykiss, S. trutta* and *G. holbrooki* are also found in these streams (Morgan and Gill 1996).

In the case of both *L. salamandroides* and *G. nigrostriata,* many of the pools in which these species aestivate appear to be mistakenly considered to be devoid of aquatic fauna when they become dry in summer. Their substrate is thus used for 'fill' or the pools themselves are filled during routine road maintenance, which often drastically alters or destroys the pools and thus removes fish habitat. It should also be noted that *G. nigrostriata, G. munda* and *N. balstoni* are each represented by isolated populations well to the north of the southern peat flats. The disjunct distributions of these three species suggest they

once had a continuous range that extended to the northern part of south-western Australia. If that was the case, the contraction of their ranges to essentially the relatively pristine area of the peat flats would probably have occurred through habitat degradation, due to urban and agricultural development. In the context of this view, it is worth noting that almost 80% of the wetlands on the Swan Coastal Plain (Moore River to Vasse River) are believed to have been totally destroyed and that the majority of the remainder has been drastically modified (EPA 1991). Furthermore, in the southern section of the Swan Coastal Plain, between Harvey and Dunsborough, more than 95% of the wetlands have been drained for agricultural purposes (Plate 1) (Fisheries and Wildlife 1978).

Much of the evidence that suggests that introduced species are responsible for the decline of native fish populations in Australia is circumstantial or anecdotal. Evidence collected during the present study suggests that *P. fluviatilis* and trout species may have an effect on native fish during dry years. For example, during summer, when water levels decline markedly, a number of isolated river pools, in which these large piscivores were present, contained very few native fish, while nearby pools, in which these introduced fish were absent, contained large numbers of native fish. In addition, Lloyd *et al.* (1986) state that *G. affinis* (*G. holbrooki*) may be responsible for the loss of populations of endemic species in eastern Australia and cite several references which implicate the introduction of this species as the major cause in the loss of native species in many localities. In addition to the three introduced species caught during the present study, *M. ambigua* and *B. bidyanus* have been translocated from eastern Australia into farm dams within the major catchments surrounding the peat flats. As these large piscivores are adapted to environments similar to those found in Western Australia, their introduction into the few pristine habitats remaining in south-western Australia could further threaten the small endemic species present in these waters.

The two species found in both south-western and south-eastern Australia, *G. truttaceus* and *G. maculatus*, are extremely rare throughout the study area. Indeed, both species were only found in the rather small nature reserve at Two People's Bay, making it extremely difficult to determine the possible threats and/or conservation recommendations for those species.

Although ammocoetes and adults of *G. australis* were often abundant, habitat alteration may pose a threat to this species in some of the rivers in which it is currently found. For example, any changes that lead to a reduction in areas of silty substrate will reduce the habitat available for ammocoetes. In the case of adults, it is critical that impediments to their upstream migration to spawning areas further upriver are kept to a minimum. Thus, dams should be provided with suitable fish ladders to allow the adult lampreys to move with relative ease to waters above the dams. N.B. Dams not only pose a problem for this migratory species but also lead to a reduction in the silty beds in slow-flowing areas that constitute the habitat of ammocoetes.

From the results of this study, it is evident that habitat alteration and possibly also the introduction of exotic species pose the main threats to the highly endemic fish fauna of this region. Habitat alteration will occur through activities such as land clearing, mineral sand exploration and mining, road construction and maintenance, the construction of water points for fire fighting, the construction of dams, groundwater extraction, and those agricultural and forestry practices in the uppermost catchments that cause alterations to inflow, salinisation, siltation and eutrophication (Jaensch and Lane 1993; Trayler *et. al* 1996). The recent excision of land near Lake Jasper, from within the boundaries of the D'Entrecasteaux National Park, for the purpose of mineral sand mining, further demonstrates that, even within National estates, fauna are not afforded total protection (Trayler *et. al* 1996).

From the above, it is thus apparent that the following actions should be taken to ensure that our depauperate but unique freshwater fish fauna is conserved:

The natural flow regimes in rivers should be maintained and the the lentic water bodies in the region should be preserved. Buffer zones should be maintained in areas used for farming and/or forestry and the effects of water usage on stream flow should be minimised, while the positions of new water points, roads etc. in the peat flats should be carefully selected.

Every effort should be made to ensure that, in the future, non-endemic species are introduced only into water bodies that are artificial and not connected to natural systems.

ACKNOWLEDGEMENTS

Financial support for this study was provided by the Water and Rivers Commission (W.A), Fisheries Department (W.A.), National Fishcare, Natural Heritage Trust, RGC Ltd, and Murdoch University. Funding was also received from Fishcare W.A. for the publication of this report. Thanks are extended to Lynn, Claire and Emma Gill, Steven Head, Murray Stevenson, Simon Visser, Dean Campbell-Smith, Paul Wright and Simon Hambleton for their invaluable help in the field. Thanks are also due to John Jackway and Luke Bouwman (C.A.L.M.) for their much needed support whilst we were in

Pemberton and Walpole, respectively, and to Dr Gerry Allen and Sue Morrison from the Western Australian Museum for providing distributional records, Gerry Allen also provided most of the species photographs. Thanks to Dr Noel Morrissy from the Western Australian Fisheries Department for kindly providing data on the stocking of trout. Many thanks to Dr Luke Pen from the Water and Rivers Commission for initiating the project and for his help throughout. Finally we would like to thank Kerryn Prosser for her time and help in producing the final distribution maps.

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Manuscript received 30 May 1997; accepted 24 March 1998.

Table 2 Those sites sampled for freshwater fish in the lower south-western corner of Australia and the species present at each site. N.B. *Tb* refers to *Tandanus bostocki*, and similarly, *Ls - Lepidogalaxias salamandroides, Go - Galaxias occidentalis, Gn - Galaxiella nigrostriata, Gm - Galaxiella munda, Bp - Bostockia porosa, Ev - Edelia vittata, Nb - Nannatherina balstoni, Gt - Galaxias truttaceus, Gma - Galaxias maculatus, Ga*(Ad) - Adult *Geotria australis, Ga*(am) - ammocoete *Geotria australis, Lw - Leptatherina wallacei, Po - Pseudogobius olorum, As - Afurcagobius suppositus,* Trout sp. - *Oncorhynchus mykiss* and *Salmo trutta, Gh - Gambusia holbrooki* and *Pf - Perca fluviatilis.*

Site Number	General Location	Latitude (S)	Longitude (E)	*Tb*	*Ls*	*Go*	*Gn*	*Gm*	*Bp*	*Ev*	*Nb*	*Gt*	*Gma*	*Ga*(Ad)	*Ga*(am)	*Lw*	*Po*	*As*	Trout sp.	*Gh*	*Pf*
	COLLIE RIVER WATERSHED																				
1.1	Collie River-Schultz's Weir	33°23.19'	116°09.78'																	x	x
1.2	" " " -Collieburn Pool	33°24.66'	116°11.97'			x			x											x	x
1.3	" " " -Townsend's Pool	33°25.45'	116°13.00'																	x	x
1.4	" " " -Cox's Pool	33°25.80'	116°13.13'			x			x	x										x	x
1.5	" " " -Round Pool	33°26.16'	116°13.40'			x				x										x	x
1.6	" " " -Western Collieries	33°28.34'	116°13.86'			x			x	x										x	x
1.7	" " " -Davies' Pool	33°28.75'	116°13.90'			x			x	x										x	x
	CAPEL WATERSHED																				
2.1	Capel River-under railway bridge	33°33.18'	115°34.01'			x									x					x	x
2.2	Capel River-south	33°39.16'	115°45.43'			x				x					x					x	x
	ABBA/LUDLOW DRAINAGE																				
3.1	Lake 9-RGC	33°33.66'	115°32.62'														x			x	
3.2	Lake 10	33°33.74'	115°32.58'														x			x	
3.3	Lake 11	33°33.82'	115°32.54'														x			x	
3.4	Swamphen Lake	33°35.27'	115°30.39'																	x	
3.5	Island Lake	33°35.28'	115°30.38'																		
3.6	Peninsula Lake	33°35.30'	115°30.35'																	x	
3.7	Paperbark Lake	33°35.31'	115°30.20'																		
3.8	Wet Woodland	33°35.21'	115°30.20'																		
3.9	Crinea Creek	33°35.28'	115°30.15'																	x	
3.10	Cadjeput Pool	33°35.50'	115°30.10'																	x	
3.11	Taylor's Lake	33°35.70'	115°30.05'																	x	
3.12	Boulder Lake	33°35.80'	115°30.02'																	x	
3.13	Tigersnake Lake	33°35.60'	115°30.00'														x			x	
3.14	Priessiana Pool	33°35.75'	115°29.90'																	x	
3.15	Plover Lakes	33°36.00'	115°29.80'							x							x			x	
3.16	Pobblebonk Swamp	33°36.15'	115°29.80'														x			x	
3.17	Gravel Pool	33°36.20'	115°29.70'			x											x			x	
3.18	Stream south of above	33°36.25'	115°29.65'			x			x	x							x			x	
3.19	Ludlow Swamp	33°35.80'	115°29.80'			x			x	x							x			x	
3.20	Ludlow River-Bridge on Bypass	33°36.20'	115°28.82'			x			x	x							x			x	
3.21	Ludlow River-on RGC	33°36.64'	115°29.59'			x															
3.22	Ludlow River-Bussell Hwy	33°36.92'	115°29.17'																		
3.23	Abba River-Bussell Hwy	33°38.95'	115°26.20'																		
3.24	Abba River-Bridge on Bypass	33°38.30'	115°25.91'			x										x	x			x	
3.25	Carbanup River	33°40.78'	115°12.19'			x				x							x			x	
3.26	Station Gully Drain-Quindalup Rd	33°39.72'	115°09.30'																		

3.27	Brake Creek-Molloy Rd(off Sabina)	33°50.59'	115°20.19'																		
	MARGARET RIVER WATERSHED																				
4.1	Margaret River-Great North Rd(Rapids)	33°52.60'	115°18.01'		x		x	x	x	x											
4.2	Margaret R-1.3km from Cane Break Rd	33°51.99'	115°18.64'		x		x			x											
4.3	Margaret R-Molloy Rd(North Branch)	33°51.36'	115°20.98'																		
4.4	Margaret River-Molloy Rd (Main R)	33°53.18'	115°21.55'																		
4.5	Margaret River-1st Weir	33°56.92'	115°03.83'		x			x	x				x	x					x		
4.6	Margaret R-Mouth	33°58.24'	114°59.38'												x	x					
4.7	Margaret R-2nd Weir	33°56.89'	115°05.35'		x			x	x				x	x					x		
4.8	Margaret R-Margaret R Rd	33°56.53'	115°06.98'		x			x	x					x					x		
4.9	Margaret R-Margaret R Rd	33°56.42'	115°08.07'																x		
4.10	Margaret R-Margaret R Rd	33°56.03'	115°08.82'		x				x										x		
4.11	Margaret R-Margaret R Rd	33°54.77'	115°17.31'		x			x	x												
4.12	Margaret R-Cranebreak Picnic Area	33°52.84'	115°16.97'						x												
4.13	Margaret R-small stream behind Leeuwin Estate	33°59.95'	115°03.92'		x		x														
4.14	Margaret R-Ten Mile Brook Dam	33°57.98'	115°07.38'															x		x	
4.15	Calgardup Brook, mouth-Redgate Rd	34°02.40'	115°00.16'													x					
	BLACKWOOD RIVER WATERSHED																				
5.1	Track off Great West Rd	33°57.60'	115°25.84'																		
5.2	Another track off above	33°58.80'	115°28.55'																		
5.3	Rosa Brook	33°58.86'	115°28.68'																		
5.4	Blackwood R-north of Nannup	33°55.27'	115°48.35'		x										x	x			x		
5.5	Blackwood R-Sues Bridge	34°04.54'	115°23.42'		x										x	x	x				
5.6	Blackwood R-Alexander Bridge	34°09.86'	115°11.53'	x												x					
5.7	St John Brook (Blackwood River)	33°52.70'	115°40.59'		x			x	x							x					
5.8	Blackwood R-Walter Willis Rd	34°56.84'	116°03.38'												x				x		
5.9	Blackwood R-Tweed Rd	33°58.72'	116°09.54'					x							x				x		
5.10	Blackwood R	33°59.89'	116°11.63'		x										x				x		
5.11	Blackwood R-Aegers Bridge Rd	33°54.95'	116°25.17'		x										x				x		
5.12	Blackwood R-Terry Rd	33°54.47'	116°24.38'		x										x				x		
5.13	Blackwood R-Terry Rd	33°51.43'	116°22.66'		x										x				x		
5.14	Blackwood R-Arthur River Rd	33°44.57'	116°34.34'																x		
5.15	Blackwood R-Gibb Rd	33°43.84'	116°31.23'																x		
5.16	Blackwood R-Condinup Crossing Rd	33°46.35'	116°31.07'		x										x				x		
5.17	Blackwood R-Arthur River Rd	33°38.49'	116°43.68'																		
5.18	Towerrinning Lake	33°35.37'	116°47.17'												x	x					
5.19	Arthur R-Moodiarup Rd	33°37.13'	116°47.96'		x											x			x		
5.20	Balgarup R	33°47.18'	116°55.63'																x		
5.21	Lower Bridgetown Rd	33°52.41'	116°40.97'																		
5.22	Blackwood R-Kulikup Rd &																				

Table 2 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)	*Tb*	*Ls*	*Go*	*Gn*	*Gm*	*Bp*	*Ev*	*Nb*	*Gt*	*Gma*	*Ga*(Ad)	*Ga*(am)	*Lw*	*Po*	*As*	Trout sp.	*Gh*	*Pf*
	Lower Bridgetown	33°52.39'	116°39.88'			x										x				x	
5.23	Chapman Brook	34°04.61'	115°11.31'			x				x										x	
5.24	Chapman Brook	34°05.33'	115°12.04'			x			x	x										x	
	SCOTT RIVER WATERSHED																				
6.1	Scott River-Brennan Bridge	34°15.58'	115°16.23'																	x	
6.2	Scott R-Bridge on Milyeannup Rd (1)	34°17.56'	115°24.02'			x				x							x				
6.3	Scott R- " " " " (2)	34°17.70'	115°24.10'			x				x						x	x	x			
6.4	Scott R- " " " " (3)	34°17.80'	115°24.15'			x				x	x						x	x			
6.5	Pool 200m south of above	34°17.68'	115°23.87'			x															
6.6	Pool 500m south of above	34°17.76'	115°23.50'																		
6.7	Pool on Scott R Rd-power pole43	34°17.05'	115°13.96'		x	x	x														
6.8	Pool (1) on Govenor Broome Rd	34°14.94'	115°26.60'																		
6.9	Pool (2) " " " "	34°14.94'	115°25.80'																		
6.10	Pool (3) " " " "	34°14.77'	115°25.10'																		
6.11	Pool (4) " " " "	34°14.88'	115°23.56'																		
6.12	Pool (1) on Fouracres Rd	34°18.28'	115°35.05'																		
6.13	Pool (2) " " "	34°18.32'	115°35.00'																		
6.14	Pool (3) " " "	34°17.80'	115°33.60'																		
6.15	Pool on Scott R Rd-power pole 38	34°17.08'	115°14.40'		x	x	x														
6.16	" " " -power pole 10	34°16.33'	115°16.17'							x							x				
	LAKE QUITJUP WATERSHED																				
7.1	Lake Quitjup	34°23.17'	115°35.66'						x	x	x										
7.2	Bolghinup Lake	34°25.22'	115°33.00'																		
7.3	Pool (1) on Black Point Rd	34°19.98'	115°36.16'																		
7.4	Pool (2) " " " "	34°18.77'	115°37.89'																		
7.5	Pool at end of Black Point Rd	34°20.00'	115°38.25'				x														
	LAKE JASPER WATERSHED																				
8.1	Lake Jasper	34°25.22'	115°41.19'			x			x	x						x	x	x			
	DONNELLY RIVER WATERSHED																				
9.1	Lake Wilson	34°25.86'	115°42.68'			x			x	x											
9.2	Lake Smith	34°25.89'	115°43.05'	x		x			x	x	x										
9.3	Swamp adjacent to Lake Smith	34°25.89'	115°43.20'		x		x			x											
9.4	Pool (1) on Scott Rd	34°25.50'	115°45.16'		x		x														
9.5	Pool (2) " "	34°25.35'	115°45.67'		x		x														
9.6	Donnelly River Mouth	34°29.11'	115°40.42'											x							
9.7	Donnelly River-Boat Ramp	34°26.84'	115°46.38'			x			x	x					x						
9.8	Donnelly River-Bridge on Scott Rd	34°24.93'	115°46.46'												x		x				
9.9	Donnelly River-One Tree Bridge	34°12.19'	115°55.82'			x			x	x				x						x	
9.10	Fly Brook-Charlie Rd	34°27.24'	115°47.61'			x			x	x	x			x	x				x	x	

9.11	Fly Brook-Fly Brook Rd	34°27.76'	115°52.45'					x		x	x				x			
9.12	Carey Brook-Bridge on Cleave Rd	34°26.54'	115°47.25'		x		x	x		x	x				x			
9.13	Carey Brook-Bridge on Vasse Hwy	34°25.01'	115°48.65'		x		x	x			x				x			
9.14	Beedelup Brook-Karri Valley	34°25.35'	115°51.41'												x	x		
9.15	Beedelup Brook-Opposite Tobruk Rd	34°25.27'	115°49.68'		x		x	x							x			
9.16	Carey Brook-Staircase Rd	34°23.81'	115°50.39'		x		x	x			x				x		x	
9.17	Carey Brook-Steep Rd	34°23.56'	115°51.58'								x							
9.18	Carey Brook-Stirling Track and Pile Rd	34°23.24'	115°52.45'		x						x							
9.19	Carey Brook- " " " and Beedelup Rd	34°23.49'	115°53.10'								x							
9.20	Carey Brook-Thornhill & Seven Day Rds	34°20.11'	115°54.37'								x							
9.21	Carey Brook-Sandy Hill Rd	34°24.27'	115°48.65'		x			x										
9.22	Water sign-200m past Boot Rd (on 7day)	34°20.68'	115°47.13'															
9.23	Water sign on Seven Day Rd	34°20.60'	115°51.20'															
	WARREN RIVER WATERSHED																	
10.1	Warren R-Dombakup Brk-Plantation Rd	34°34.66'	115°57.98'		x		x	x		x	x						x	
10.2	Yeagerup Lake	34°32.35'	115°52.39'		x		x	x										
10.3	Neanup Swamp-Pool at Yeagerup Dunes	34°32.35'	115°51.55'															
10.4	Warren River-Bridge on Pemb/North Rd	34°30.42'	115°59.54'		x		x	x		x		x	x			x		
10.5	Warren River-King Trout Farm	34°30.10'	115°59.85'		x		x	x		x	x					x		
10.6	Lefroy Brook-The Cascades	34°28.60'	116°01.71'		x		x	x		x								
10.7	Lefroy Brook-Downstream of trout hatch	34°26.60'	116°01.36'		x		x	x		x	x				x			
10.8	Lefroy Dam-Immediately downstream	34°26.41'	116°01.36'		x		x	x		x					x		x	
10.9	Lefroy Dam-Immediately upstream	34°26.35'	116°01.35'												x			
10.10	Middle Weir-Lefroy Brook	34°25.65'	116°01.00'		x			x			x				x		x	
10.11	Lefroy Brook-Broken Bridge	34°25.19'	116°01.53'			x	x	x		x	x				x		x	
10.12	Big Brook Dam-Under downstream bridge	34°24.73'	116°01.71'				x	x			x						x	
10.13	Big Brook Dam-Pool at bottom of dam	34°24.68'	116°01.71'														x	
10.14	Big Brook Dam-Actual	34°24.49'	116°01.64'				x	x							x		x	
10.15	Bridge Upstream of Big Brook Dam	34°24.26'	116°00.22'														x	
10.16	Bridge south of Jn of 4 & 5 Mile Brooks	34°23.22'	116°00.58'								x							
10.17	Four Mile Brook-Channybearup Rd	34°21.84'	116°00.26'								x							
10.18	" " " " -Seven Day Rd	34°18.65'	115°59.39'			x		x			x							
10.19	Channybearup Brook-Seven Day Rd	34°19.11'	115°57.52'					x			x							

Table 2 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)	*Tb*	*Ls*	*Go*	*Gn*	*Gm*	*Bp*	*Ev*	*Nb*	*Gt*	*Gma*	*Ga*(Ad)	*Ga*(am)	*Lw*	*Po*	*As*	Trout sp.	*Gh*	*Pf*
10.20	Wilgarup River-Bridge on Cormint Rd	34°21.11'	116°20.73'			x		x	x	x											
10.21	Peerup River-Bridge on Muirs Hwy	34°23.41'	116°25.52'			x		x	x	x										x	
10.22	Tone River-Bridge on Muirs Hwy	34°24.65'	116°33.10'			x		x	x	x											
10.23	Unicup Lake	34°20.65'	116°43.13'			x				x											
10.24	Kulunilup Lake	34°20.08'	116°47.06'																		
10.25	Tone River-Two Mile	34°26.24'	116°36.96'																	x	
10.26	Tone River-Two Mile	34°26.00'	116°36.00'																	x	
10.27	Tone River-Wingarup Gully	34°25.68'	116°35.00'																	x	
10.28	Wilgarup River-Muirs Hwy	34°19.86'	116°22.45'			x			x	x							x	x			
	LAKE MUIR WATERSHED																				
11.1	Lake Muir	34°26.41'	116°39.58'			x				x										x	
11.2	Noobijup lake	34°23.89'	116°47.06'																		
11.3	Byenup Lagoon	34°29.95'	116°43.36'			x				x										x	
11.4	Lake at Jn of Lake Unicup & Pindicup Rds	34°22.57'	116°41.87'			x				x										x	
11.5	Cowerup Swamp (Surrounding Pools)	34°26.22'	116°38.68'			x		x		x											
11.6	Stream of Lake Muir	34°27.30'	116°47.00'			x			x												
11.7	Red Lake	34°26.30'	116°38.33'			x			x											x	
11.8	Drain fom Red Lake	34°26.25'	116°39.47'			x			x											x	
11.9	Red Lake	34°26.20'	116°39.40'			x			x											x	
11.10	Red Lake	34°25.90'	116°39.40'			x			x											x	
11.11	Drain-connect Red Lake/Lake Muir/Cowerup Sw	34°26.35'	116°39.07'																	x	
11.12	Lake Muir-Hanekamp Rd	34°28.30'	116°41.10'																		
11.13	Lake Muir- " "	34°27.68'	116°41.00'																		
11.14	Pool adjacent to Lake Muir-Hanekamp Rd	34°27.89'	116°41.10'																		
11.15	Pool adjacent to Lake Muir-Hanekamp Rd	34°27.97'	116°41.16'																		
11.16	Pool adjacent to Lake Muir-Hanekamp Rd	34°28.10'	116°41.29'																		
11.17	Pool adjacent to Lake Muir-Hanekamp Rd	34°28.03'	116°41.49'																		
11.18	Stream adjacent to Lake Muir-Muirs Hwy	34°26.41'	116°41.50'																	x	
11.19	Stream adjacent to Lake Muir-Muirs Hwy	34°26.49'	116°41.58'																	x	
11.20	Pool adjacent to Lake Muir-																				

	Muirs Hwy	34°26.46'	116°40.32'											x
11.21	Pool adjacent to Lake Muir-													
	Muirs Hwy	34°26.46'	116°40.29'											x
11.22	Pool adjacent to Lake Muir-													
	Muirs Hwy	34°26.30'	116°40.20'											x
11.23	Pool adjacent to Lake Muir-													
	Thomson Rd	34°29.85'	116°38.00'											
11.24	Pool adjacent to Lake Muir-													
	Thomson Rd	34°29.95'	116°37.90'											
11.25	Pool adjacent to Lake Muir-													
	Thomson Rd	34°31.84'	116°38.60'											
11.26	Pool adjacent to Lake Muir-													
	Thomson Rd	34°32.16'	116°38.65'											
	DOGGERUP CREEK WATERSHED													
12.1	Doggerup Creek-Mouth	34°46.75'	115°58.82'						x					
12.2	Lake Doggerup	34°42.99'	116°03.88'		x	x			x	x				
12.3	Lake Samuel	34°43.77'	116°03.58'		x	x		x	x					
12.4	Pool on Malimup Rd (Summertime													
	Track)	34°43.90'	116°02.92'											
12.5	Dam on McGeachin's Property	34°42.82'	116°05.22'		x	x		x	x					
12.6	Pool (1) on Windy Harbour Rd	34°42.17'	116°06.05'											
12.7	Pool (1)-Doggerup Creek Track	34°44.79'	116°04.65'			x								
12.8	Pool (2)- " " " " "	34°44.32'	116°04.53'				x							
12.9	Pool (3)- " " " " "	34°44.46'	116°03.78'	x		x								
12.10	Pool (2) on Windy Harbour Rd	34°42.25'	116°05.98'											
12.11	Pool (3) on Windy Harbour Rd	34°48.13'	116°04.46'											
	GARDNER RIVER WATERSHED													
13.1	Gardner River Mouth	34°50.43'	116°07.40'									x		
13.2	Blackwater-Pool 1	34°49.82'	116°07.29'		x	x		x	x	x		x		
13.3	Blackwater-Pool 2	34°49.82'	116°07.34'		x			x	x	x		x		
13.4	Large Swamp on Salmon Beach Rd	34°50.32'	116°00.97'	x										
13.5	Pool oppostie 13.4	34°50.16'	116°00.90'											
13.6	Pool adjacent 13.5	34°50.20'	116°01.05'											
13.7	Pool at southern end of Windy													
	Harbour Rd	34°50.24'	116°01.22'	x		x								
13.8	Pool 100m south of 13.9	34°49.60'	116°03.50'	x		x		x	x					
13.9	Pool 200m south of 13.10	34°49.40'	116°03.70'	x	x	x		x	x	x				
13.10	Swamp west of 13.11	34°49.25'	116°03.44'											
13.11	Small Lake west of 13.12	34°49.25'	116°03.66'	x										
13.12	Pool opposite 13.13	34°49.23'	116°03.72'	x	x	x		x	x	x	x	x		
13.13	Pool 450m south of 13.14	34°49.17'	116°03.82'	x	x	x		x	x	x				
13.14	Pool 50m south of 13.15	34°48.98'	116°04.05'	x	x	x		x	x	x				
13.15	Narrow stream on Windy Harbour Rd	34°48.88'	116°04.12'	x	x	x		x	x	x				
13.16	Pool on Windy Harbour Rd	34°48.70'	116°04.20'	x	x	x		x	x	x		x		x
13.17	Meandering Stream-off Windy													

Table 2 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)	*Tb*	*Ls*	*Go*	*Gn*	*Gm*	*Bp*	*Ev*	*Nb*	*Gt*	*Gma*	*Ga*(Ad)	*Ga*(am)	*Lw*	*Po*	*As*	Trout sp.	*Gh*	*Pf*
	Harbour Rd	34°48.41'	116°03.77'			x			x	x	x										
13.18	Summer pool at western end of 13.17	34°48.29'	116°03.75'			x	x		x	x	x										
13.19	Small Lake 200m north of 13.17	34°48.47'	116°03.86'				x		x	x											
13.20	Pool on Windy Hr Rd-400m N of Chesapeake Rd	34°40.88'	116°06.64'		x																
13.21	1st pool on Chesapeake Rd	34°42.36'	116°07.06'		x		x		x												
13.22	Pool near Lake Florence entrance	34°42.63'	116°07.19'		x	x	x														
13.23	43.1km from east end of Chesapeake Rd	34°43.18'	116°07.59'		x		x														
13.24	42.6km " " " " " "	34°43.37'	116°07.82'		x		x														
13.25	42.4km " " " " " "	34°43.43'	116°07.85'		x																
13.26	42.3km " " " " " "	34°43.50'	116°07.88'		x																
13.27	42.2km " " " " " "	34°43.55'	116°07.92'		x																
13.28	42.1km " " " " " "	34°43.60'	116°07.95'		x																
13.29	Pool 38.2km " " " " "	34°45.40'	116°09.02'		x		x		x	x											
13.30	Pool opposite 13.29	34°45.38'	116°09.00'		x		x														
13.31	Lake Florence	34°44.12'	116°06.06'			x				x											
13.32	1st pool on Lower Gardner River Rd	34°45.64'	116°09.03'		x	x	x			x	x										
13.33	Pool 37.6km from east end of Chesapeake Rd	34°45.66'	116°09.18'		x		x														
13.34	Large pool on Chesapeake Rd	34°45.92'	116°09.36'		x	x	x		x	x	x										
13.35	Pool 500m south of 13.34	34°46.13'	116°09.48'																		
13.36	Pool 35.8km from east end of Chesapeake	34°46.46'	116°09.67'																		
13.37	Gardner River-South of bridge	34°47.21'	116°11.32'			x			x	x	x				x						
13.38	Gardner River-Bridge	34°46.62'	116°10.87'			x			x	x					x						
13.39	Buldania Creek-Gardner River Rd	34°45.46'	116°12.87'			x			x	x											
13.40	Una Brook- " " " "	34°43.95'	116°12.14'						x	x											
13.41	Gardner River-Laws Track	34°42.49'	116°09.96'						x	x					x						
13.42	Boorara Brook-Bettink's	34°41.46'	116°10.85'			x													x		
13.43	" " " -Muirillup Rd	34°38.84'	116°13.60'			x			x	x											
13.44	" " " -Daubney's (1)	34°38.78'	116°13.69'			x		x	x	x											
13.45	" " " - " " (2)	34°38.33'	116°13.63'			x		x	x	x											
13.46	" " " - " " (3)	34°37.42'	116°13.37'			x		x		x											
13.47	" " " -Jane Block	34°36.35'	116°14.53'					x													
13.48	Lake Maringup	34°50.22'	116°11.81'			x			x	x	x						x				
13.49	Gravel Pool on Moore's Hut Track	34°50.45'	116°15.05'		x																
13.50	Pool on Moore's Hut Track	34°50.54'	116°15.84'		x		x			x											
13.51	Pool 4.9km west of Deeside/Chspke Jn	34°49.00'	116°15.51'				x		x												
13.52	Pool 50m west of 13.51	34°49.00'	116°15.45'																		
13.53	Pool 50m west of 13.52	34°49.00'	116°15.38'				x														
13.54	Pool on Chspke Rd(43.2km from east end)	34°43.25'	116°07.64'				x														

13.55	Pool on Chspke Rd(21.6km from west end	34°48.76'	116°14.72'												
13.56	Small Lake on Lower Gardner River Rd	34°48.99'	116°07.70'	x											
13.57	Pool on " " " " " "	34°47.98'	116°07.90'												
13.58	Pool on " " " " " "	34°47.90'	116°08.02'												
13.59	Pool on " " " " " "	34°47.82'	116°08.09'	x		x									
13.60	Pool on " " " " " "	34°47.48'	116°08.46'	x			x								
13.61	Pool on " " " " " "	34°45.88'	116°08.90'	x			x								
13.62	Swamp east Gardner R-Taylor Property	34°37.93'	116°11.84'	x											
13.63	Northcliffe Weir	34°38.08'	116°08.23'				x	x	x						
	SHANNON RIVER WATERSHED														
14.1	Pool on Moore's Hut Track	34°50.40'	116°17.03'	x		x		x	x						
14.2	Pool " " " " "	34°49.11'	116°16.55'												
14.3	Pool on Chesapeake Rd-9.6km west Broke	34°51.32'	116°24.01'												
14.4	Shannon River-Bridge on Cheaspeake Rd	34°50.36'	116°22.27'		x		x	x	x	x		x			
14.5	" " " -Springbreak Rd	34°52.23'	116°22.37'		x			x	x				x	x	
14.6	Upper Shannon R-NE of Dam	34°35.05'	116°24.69'		x				x						
14.7	Pool on Chesapeake Rd-19.4km west Broke	34°49.20'	116°18.57'	x	x			x	x						
14.8	Pool at Jn of Deeside & Chesapeake Rds	34°49.07'	116°17.99'												
14.9	Chesapeake Brook (1)-20.05km W Broke	34°49.07'	116°18.09'		x			x	x						
14.10	" " " " (2)-" " "	34°48.96'	116°18.08'					x	x	x					
14.11	" " " " (3)-" " "	34°48.90'	116°18.07'				x		x						
14.12	Pool on Chesapeake Rd-20.2km "	34°49.09'	116°18.06'												
14.13	Pool on Deeside Coast Rd	34°42.92'	116°20.05'												
14.14	Pools at Jn of Deeside Coast & Preston Rds	34°38.52'	116°19.63'	x	x	x	x	x	x	x					
14.15	Shannon River-Nelson Rd	34°43.19'	116°21.88'												
	BROKE INLET WATERSHED														
15.1	Forth River	34°51.85'	116°25.55'	x	x	x	x	x	x	x					
15.2	Small stream 6.6km west of Broke Inlet Rd	34°51.94'	116°25.72'	x	x	x	x	x	x	x					
15.3	Pool 6.0km west of Broke Inlet Rd	34°52.12'	116°26.00'												
15.4	Pool/small stream 5.2km west of Broke Inlet Rd	34°52.40'	116°26.37'	x	x	x	x	x	x	x					
15.5	Pool on Chesapeake Rd 4.2km west of Broke Inlet Rd	34°52.77'	116°26.85'												
15.6	Small stream on Chesapeake Rd 1.6km west of Broke Inlet Rd	34°53.68'	116°28.14'		x			x	x						
15.7	Pool on Chesapeake Rd 1.3km west of Broke Inlet Rd	34°53.76'	116°28.23'			x									

Table 2 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)	*Tb*	*Ls*	*Go*	*Gn*	*Gm*	*Bp*	*Ev*	*Nb*	*Gt*	*Gma*	*Ga*(Ad)	*Ga*(am)	*Lw*	*Po*	*As*	Trout sp.	*Gh*	*Pf*
15.8	Pool on Broke Inlet Rd 1.9km N Chesapeake Rd	34°53.62'	116°29.78'		x		x														
15.9	Pool on Broke Inlet Rd 1.6km S Chesapeake Rd	34°54.75'	116°28.18'		x		x														
15.10	Inlet River-1km upstream of mouth	34°56.28'	116°31.84'													x	x				
15.11	Inlet River-near mouth	34°56.31'	116°31.60'													x	x				
15.12	Small stream running into Broke Inlet	34°53.75'	116°26.48'													x	x	x			
	DEEP RIVER WATERSHED																				
16.1	Deep River-Bridge on Beardmore Rd	34°49.14'	116°35.52'			x			x	x											
16.2	Weld River- " " " " "	34°48.89'	116°34.75'			x		x	x	x	x				x						
16.3	Weld river-Wye Rd	34°45.65'	116°30.75'					x	x	x											
16.4	Jn Beardmore & South West Hwy	34°48.66'	116°31.82'		x	x	x	x	x	x	x										
16.5	Small pools along Beardmore Rd	34°48.67'	116°32.12'		x		x														
16.6	Pool on Thomson Rd	34°36.00'	116°41.41'																		
16.7	Pool on Thomson Rd	34°36.41'	116°41.40'																		
16.8	Pool on Thomson Rd	34°37.46'	116°41.45'																		
16.9	Pool on Thomson Rd	34°41.30'	116°42.26'																		
16.10	Pool on Thomson Rd	34°46.57'	116°42.97'		x		x														
16.11	Pool on Thomson Rd	34°46.73'	116°43.07'																		
16.12	Pool on Thomson Rd	34°47.73'	116°42.91'																		
16.13	Deep River-Peakway Rd	34°45.99'	116°36.97'			x		x		x	x										
16.14	Collier Creek-Cemetary Rd	34°58.40'	116°45.27'							x											
16.15	Collier Creek-Gully Rd	34°58.40'	116°46.13'						x	x											
16.16	Felix Brook-Angrove Rd	34°58.48'	116°41.82'					x	x	x											
16.17	Felix Brook-Angrove Rd	34°57.91'	116°41.16'					x													
16.18	Jn of Walpole River/Samuel Brook	34°56.06'	116°40.48'					x		x											
	FRANKLAND RIVER WATERSHED																				
17.1	Frankland River-Muirs Bridge	34°28.73'	116°54.00'			x		x	x	x											
17.2	Pool on Thomson Rd	34°45.70'	116°43.17'				x														
17.3	Pool on Thomson Rd	34°46.89'	116°43.17'																		
17.4	Pool on Thomson Rd	34°47.03'	116°43.20'																		
17.5	Pool on Thomson Rd	34°47.22'	116°43.12'				x		x												
17.6	Pool on Thomson Rd	34°47.32'	116°42.84'																		
17.7	Pool on Thomson Rd	34°47.49'	116°42.97'		x		x														
17.8	Pool on Thomson Rd	34°47.65'	116°43.20'				x		x												
17.9	Pool on Thomson Rd	34°47.32'	116°42.84'				x		x												
17.10	Wedding Brook	34°50.78'	116°44.25'				x		x												
17.11	Elsie Brook	34°51.46'	116°43.43'			x	x		x												
17.12	Frankland River-Elsie Brook Rd	34°52.33'	116°44.14'						x											x	
17.13	Frankland River-Caldyanup Crossing	34°48.62'	116°48.57'			x			x	x						x					

17.14	Frankland River-Mitchell Rd	34°45.80'	116°50.24'					x					x
17.15	Frankland River-Sappers Bridge	34°57.55'	116°49.40'				x				x		
17.16	Boxhall Creek-Boxhall Rd	34°58.55'	116°50.15'			x							
17.17	Boxhall Creek-East Flat Rd	34°58.53'	116°51.39'										
17.18	Frankland River-Monastery Rd	34°59.06'	116°48.93'								x	x	x
17.19	Swamp-Blue Holes Rd	35°00.53'	116°49.72'										
17.20	Pool-Station Rd	34°59.96'	116°53.16'										
	KWOKALUP CREEK WATERSHED												
18.1	Kwokalup Creek-Nut Rd	35°00.98'	116°53.51'										
18.2	Kwokalup Creek-Nut Rd	35°01.17'	116°53.49'										
18.3	Small lake on farm-Ficifolia Rd	35°01.62'	116°54.44'										
18.4	Small lake-Ficifolia Rd	35°01.74'	116°53.32'	x									
	BOW RIVER WATERSHED												
19.1	Creek on Hazelvale Rd	34°57.37'	116°53.30'										
19.2	Pool on Trent Rd	34°55.88'	116°54.22'										
19.3	Stream on Middle Rd	34°54.96'	116°56.34'		x	x		x					
19.4	Creek on Gum Link Rd	34°54.93'	116°56.69'			x	x	x					
19.5	Creek on Gum Link Rd	34°53.44'	117°00.09'			x							
19.6	Small pool-Ficifolia Rd	35°01.60'	116°53.15'										
19.7	Bow River-South Coast Hwy	34°58.07'	116°57.20'				x						
	KENT RIVER WATERSHED												
20.1	Kent River-Pools on Muirs Hwy	34°33.41'	117°10.29'		x	x	x	x					
20.2	Camballup Pool	34°32.38'	117°11.33'		x	x	x	x					
20.3	Nile Creek-Break Rd	34°50.61'	117°02.75'										
20.4	Kent River-Break Rd	34°49.95'	117°03.56'		x			x					x
20.5	Falls of Forth-Kent River	34°50.52'	117°04.84'		x		x	x					x
20.6	Millars Basin-Kent River	34°45.48'	117°03.01'					x	x				
20.7	Kent River-Kent River Siding Rd	34°59.01'	117°02.81'				x	x				x	
20.8	Kent River-Parker Rd	34°54.56'	117°03.16'										
20.9	Creek-Kordabup Rd	34°52.05'	117°08.85'										
20.10	Styx River-Fernley Rd	34°53.10'	117°06.33'							x			
20.11	Creek-fernley Rd	34°51.57'	117°06.07'										
20.12	Styx River-Break Rd	34°51.10'	117°08.99'		x	x	x	x	x				
20.13	Pool-Break Rd	34°51.18'	117°11.75'										
20.14	Boat Harbour Lake-Boat Harbour Rd	35°00.97'	117°05.67'					x					
20.15	Boat Harbour Lake-Boat Harbour Rd	35°00.97'	117°05.84'										
	KORDABUP RIVER WATERSHED												
21.1	Kordabup River-Kordabup Rd	34°59.25'	117°10.13'					x					
21.2	Creek-Kordabup Rd	34°56.40'	117°08.74'										
	LAKE WILLIAMS NP WATERSHED												
22.1	Small creek near Lake Williams	35°01.25'	117°15.49'										
22.2	Lake Williams	35°00.96'	117°16.20'					x					
22.3	Lake on William Bay Rd	34°59.80'	117°13.56'				x	x				x	

Table 2 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)	*Tb*	*Ls*	*Go*	*Gn*	*Gm*	*Bp*	*Ev*	*Nb*	*Gt*	*Gma*	*Ga*(Ad)	*Ga*(am)	*Lw*	*Po*	*As*	Trout sp.	*Gh*	*Pf*
	DENMARK RIVER WATERSHED																				
23.1	Flats-Romance Rd	34°46.32'	117°06.31'			x		x													
23.2	Creek-Break Rd	34°51.26'	117°14.52'					x	x	x											
23.3	Scotsdale Brook-Mt Lindsay Rd	34°55.38'	117°18.74'			x				x					x						
23.4	Creek of Denmark River	34°53.09'	117°18.90'			x															
23.5	Denmark River-Nutcracker Rd	34°51.96'	117°18.95'						x	x											
23.6	Water point-Watershed Rd	34°47.04'	117°08.19'			x			x	x											
23.7	Quickip River-Denmark Mt Barker Rd	34°52.38'	117°23.25'			x			x	x	x										
23.8	Quickip River-Denmark Mt Barker Rd	34°54.73'	117°22.62'			x		x		x											
23.9	Denmark River-Denmark Mt Barker Rd	34°57.04'	117°22.84'																		
	HAY RIVER WATERSHED																				
24.1	Hay River-Pools on Muirs Hwy	34°37.81'	117°24.15'			x		x	x	x											
24.2	Lake Saide	35°02.58'	117°28.50'			x				x						x	x			x	
24.3	Cuppup Creek-Stanley Rd	35°00.75'	117°33.20'																		
24.4	Sleeman River-Hunwick Rd	34°56.62'	117°34.05'																		
24.5	Sleeman River-Sleeman Rd	34°56.62'	117°30.20'																		
24.6	Hay River-Keith Rd	34°56.00'	117°28.40'													x	x				
24.7	Hay River-Redmond West Rd	34°54.71'	117°35.16'					x													
24.8	Hay River-Verne Rd	34°52.12'	117°37.52'							x											
24.9	Blue Gum Creek-Healy Rd	34°50.63'	117°36.75'						x	x											
24.10	Blue Gum Creek-Redmond Hay Rd	34°50.57'	117°33.45'			x		x													
24.11	Hay River-Redmond Hay River Rd	34°50.61'	117°32.57'			x				x											
24.12	Blue Gum Creek-The Pass Rd	34°50.01'	117°33.86'			x		x		x											
24.13	Hay River-Spencer Rd	34°44.54'	117°33.73'			x				x							x				
24.14	Sheepwash Creek-Denmark Mt Barker	34°45.54'	117°29.36'							x											
24.15	Mitchell River-Stan Rd	34°49.54'	117°20.92'			x															
24.16	Mitchell River-Stan Rd	34°48.70'	117°20.87'			x		x	x	x											
24.17	Mitchell River-Denmark Mt Barker Rd	34°50.00'	117°24.45'							x											
	TORBAY INLET WATERSHED																				
25.1	Unndiup Creek-Lower Denmark Rd	35°01.67'	117°39.60'																		
25.2	Marbelup Brook-Hunwick Rd	34°56.91'	117°40.23'																		
25.3	Marbelup Brook-Marbelup North Rd	34°56.42'	117°42.70'					x		x											
25.4	Lake Powell	35°01.67'	117°39.60'														x			x	
	KING RIVER WATERSHED																				
26.1	Mill Brook-Warren Rd	34°55.85'	117°52.96'			x															
26.2	King River-Warren Rd	34°55.95'	117°52.70'			x			x												
26.3	King River-Millbrook Rd	34°52.74'	117°46.70'						x	x											
26.4	King River-Albany Hwy	34°53.24'	117°46.56'					x		x										x	

	KALGAN RIVER WATERSHED																	
27.1	Johnston Creek-South Coast Hwy	34°54.86'	117°57.42'															
27.2	Creek of Kalgan River-Deep Creek Rd	34°52.29'	118°01.63'															
27.3	Stream of Kalgan River-Deep Creek Rd	34°50.12'	118°00.36'		x			x										x
27.4	Kalgan River-Takalarup Rd	34°37.60'	118°02.62'		x			x								x		
27.5	Chergugup Creek/Kalgan River	34°33.81'	117°58.00'		x													
27.6	Gaalgegup Creek-Knight Rd	34°37.39'	117°52.72'		x													
27.7	Napier Creek-Elliot Rd	34°49.01'	117°51.48'		x													
27.8	Napier Creek-Jackson Rd	34°47.48'	117°51.08'		x		x	x										
27.9	Yallingup Brook-Jackson Rd	34°47.48'	117°52.00'															
27.10	Takenup Creek-Bennett Rd	34°45.79'	117°58.55'		x		x	x										
27.11	Takenup Creek-Takenup Rd	34°47.68'	118°01.17'		x		x	x										
27.12	Kalgan River-Oyama Rd	34°45.40'	118°03.27'		x			x									x	
27.13	Creek of Kalgan River-Takenup Rd	34°49.29'	117°59.07'															
	TWO PEOPLE'S BAY WATERSHED																	
28.1	Gardner Lake-Drain	34°57.63'	118°09.63'		x											x		
28.2	Goodga River-Two People's Bay Rd	34°57.21'	118°05.14'		x				x	x						x		
28.3	Goodga River-Track along River	34°56.96'	118°04.79'		x					x						x		
28.4	Goodga River-Creek of	34°56.19'	118°04.07'			x												
28.5	Goodga River-Dempster Rd	34°55.98'	118°04.07'			x												
28.6	Lake Pleasant View	34°49.58'	118°11.20'															
28.7	Angove River-Small stream of	34°55.75'	118°10.43'															
28.8	Gardner Lake	34°58.04'	118°09.65'		x										x	x		
28.9	Moates Lake	34°57.92'	118°07.20'		x			x		x	x					x		
28.10	Black Cat Creek-Mouth	34°57.17'	118°06.20'		x			x	x	x						x		
28.11	Black Cat Creek-Firebreak track	34°56.72'	118°06.70'							x								
28.12	Goodga River-Creek of	34°53.82'	118°06.17'			x												
28.13	Angove Lake	34°56.70'	118°10.01'												x	x		
28.14	Angove River-Moyles Rd	34°54.56'	118°08.72'					x										
	KING CREEK WATERSHED																	
29.1	King Creek-Bettys Beach Rd	34°55.00'	118°11.25'															
	NORMANS BEACH WATERSHED																	
30.1	Estuary/stream-Norman's Beach Rd	34°55.17'	118°12.81'												x	x		
	WAYCHINICUP RIVER WATERSHED																	
31.1	Waychinicup River-Cheyne Beach Rd	34°50.00'	118°20.60'															
31.2	Waychinicup River-Waychinicup Rd	34°53.00'	118°20.00'															
	CHEYNE BEACH WATERSHED																	
32.1	Small lake-Cheyne Beach Rd	34°52.50'	118°23.80'												x			

Table 3 The sites at which *Lepidogalaxias salamandroides* was captured during the present study, together with those recorded in the collections at the Western Australian Museum, and by Jaensch (1992) and Christensen (1982).

Site Number	General Location	Latitude (S)	Longitude (E)
	SCOTT RIVER WATERSHED		
6.7	Pool on Scott R Rd-power pole 43	34°17.05'	115°13.96'
6.15	Pool on Scott R Rd-power pole 38	34°17.08'	115°14.40'
	DONNELLY RIVER WATERSHED		
9.3	Swamp adjacent to Lake Smith	34°25.89'	115°43.20'
9.4	Pool (1) on Scott Rd	34°25.50'	115°45.16'
9.5	Pool (2) " "	34°25.35'	115°45.67'
	DOGGERUP CREEK WATERSHED		
12.9	Pool (3)-Doggerup Creek Track	34°44.46'	116°03.78'
	GARDNER RIVER WATERSHED		
13.4	Large Swamp on Salmon Beach Rd	34°50.32'	116°00.97'
13.7	Pool at southern end of Windy Harbour Rd	34°50.24'	116°01.22'
13.8	Pool 100m south of 13.9	34°49.60'	116°03.50'
13.9	Pool 200m south of 13.10	34°49.40'	116°03.70'
13.11	Small Lake west of 13.12	34°49.25'	116°03.66'
13.12	Pool opposite 13.13	34°49.23'	116°03.72'
13.13	Pool 450m south of 13.14	34°49.17'	116°03.82'
13.14	Pool 50m south of 13.15	34°48.98'	116°04.05'
13.15	Narrow stream on Windy Harbour Rd	34°48.88'	116°04.12'
13.16	Pool on Windy Harbour Rd	34°48.70'	116°04.20'
13.20	Pool on Windy Hr Rd-400m N of Chspke	34°40.88'	116°06.64'
13.21	1st pool on Chesapeake Rd	34°42.36'	116°07.06'
13.22	Pool near Lake Florence entrance	34°42.63'	116°07.19'
13.23	43.1km from east end of Chesapeake Rd	34°43.18'	116°07.59'
13.24	42.6km " " " " " " "	34°43.37'	116°07.82'
13.25	42.4km " " " " " " "	34°43.43'	116°07.85'
13.26	42.3km " " " " " " "	34°43.50'	116°07.88'
13.27	42.2km " " " " " " "	34°43.55'	116°07.92'
13.28	42.1km " " " " " " "	34°43.60'	116°07.95'
13.29	Pool 38.2km " " " " " "	34°45.40'	116°09.02'
13.30	Pool opposite 13.29	34°45.38'	116°09.00'
13.32	1st pool on Lower Gardner River Rd	34°45.64'	116°09.03'
13.33	Pool 37.6km from east end of Chesapeake	34°45.66'	116°09.18'
13.34	Large pool on Chesapeake Rd	34°45.92'	116°09.36'
13.49	Gravel Pool on Moore's Hut Track	34°50.45'	116°15.05'
13.50	Pool on Moore's Hut Track	34°50.54'	116°15.84'
13.56	Small Lake on Lower Gardner River Rd	34°48.99'	116°07.70'
13.59	Pool on " " " " " " "	34°47.82'	116°08.09'
13.60	Pool on " " " " " " "	34°47.48'	116°08.46'
13.61	Pool on " " " " " " "	34°45.88'	116°08.90'
13.62	Swamp east Gardner R-Taylor Property	34°37.93'	116°11.84'
	SHANNON RIVER WATERSHED		
14.1	Pool on Moore's Hut Track	34°50.40'	116°17.03'
14.7	Pool on Chesapeake Rd-19.4km west Broke	34°49.20'	116°18.57'
14.14	Pools at Jn of Deeside Coast & Preston Rds	34°38.52'	116°19.63'
14.15	Shannon River-Nelson Rd	34o43.19'	116o21.88'
	BROKE INLET WATERSHED		
15.1	Forth River	34°51.85'	116°25.55'
15.2	Small stream 6.6km west of Broke Inlet Rd	34°51.94'	116°25.72'
15.4	Pool/small stream 5.2km " " "	34°52.40'	116°26.37'
15.8	Pool on Broke Inlet Rd 1.9km N Chspke Rd	34°53.62'	116°29.78'
15.9	Pool " " " " 1.6km S " "	34°54.75'	116°28.18'

Table 3 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
	DEEP RIVER WATERSHED		
16.4	Jn Beardmore & South West Hwy	34°48.66'	116°31.82'
16.5	Small pools along Beardmore Rd	34°48.67'	116°32.12'
16.10	Pool on Thomson Rd	34°46.57'	116°42.97'
	FRANKLAND RIVER WATERSHED		
17.7	Pool on Thomson Rd	34°47.49'	116°42.97'
	KWOKALUP CREEK WATERSHED		
18.4	Small lake-Ficifolia Rd	35°01.74'	116°53.32'
	MUSEUM RECORDS		
1	Northcliffe 1988	34°38'	116°07'
2	1959	34°33'	116°29'
3	1961	34°51'	116°21'
4	1961	34°42'	116°22'
5	Northcliffe 1961	34°36'	116°07'
6	1964	34°35'	116°25'
7	Windy Harbour 1962	34°50'	116°00'
8	Albany 1976	35°01'	117°45'
9	Cane Brake Creek 1976	33°50'	115°20'
10	Northcliffe 1982	34°38'	116°21'
11	Walpole 1975	34°50'	116°54'
12	Northcliffe 1986	34°44'	116°08'
13	" " "	34°39'	116°08'
14	" " "	34°48'	116°10'
15		34°38'	116°03'
16	Doggerup Creek 1986	34°44'	116°04'
17	Lake Samuel 1985	34°43'	116°04'
18	Northcliffe 1986	34°44'	116°19'
19	" " "	34°46'	116°05'
20	" " "	34°39'	116°08'
21	" " 1988	34°28'	116°07'
	R. JAENSCH (1992)		
12	Lake Doggerup	34°43'	116°04'
	P. CHRISTENSEN (1982)		
4	Nelson Rd	34°43'	116°21'
5	" "	34°41'	116°31'
15	Deeside Coast Rd	34°41'	116°20'
18	South West Hwy	34°56'	116°35'
21	" " " "	34°54'	116°34'
22	" " " "	34°53'	116°33'
23		34°48'	116°32'
34	East Brook-Boorara Rd	34°37'	116°17'
48	Richardson Rd	34°38'	116°05'
64	Meerup River-Gurnsey Rd	34°41'	116°04'
74	Pneumonia Rd	34°25'	115°44'
79	Boronia Rd	34°39'	116°50'
82	Middle Rd	34°52'	116°57'
89	Fouracres Rd	34°18'	115°35'
90	" " "	34°18'	115°31'
99	Nornalup Rd	34°39'	116°57'
100	" " "	34°44'	116°57'
101	" " "	34°44'	116°57'
103		34°50'	117°00'
108	South West Hwy	35°01'	116°53'

Table 4 The sites at which *Galaxias occidentalis* was captured during the present study, together with those recorded in the collections at the Western Australian Museum, and by Jaensch (1992) and Christensen (1982).

Site Number	General Location	Latitude (S)	Longitude (E)
	COLLIE RIVER WATERSHED		
1.2	Collie River-Collieburn Pool	33°24.66'	116°11.97'
1.4	" " " -Cox's Pool	33°25.80'	116°13.13'
1.5	" " " -Round Pool	33°26.16'	116°13.40'
1.6	" " " -Western Collieries	33°28.34'	116°13.86'
1.7	" " " -Davies' Pool	33°28.75'	116°13.90'
	CAPEL WATERSHED		
2.1	Capel River-under railway bridge	33°33.18'	115°34.01'
2.2	Capel River-south	33°39.16'	115°45.43'
	ABBA/LUDLOW DRAINAGE		
3.17	Gravel Pool	33°36.20'	115°29.70'
3.18	Stream south of above	33°36.25'	115°29.65'
3.19	Ludlow Swamp	33°35.80'	115°29.80'
3.20	Ludlow River-Bridge on Bypass	33°36.20'	115°28.82'
3.21	Ludlow River-on RGC	33°36.64'	115°29.59'
3.24	Abba River-Bridge on Bypass	33°38.30'	115°25.91'
3.25	Carbanup River	33°40.78'	115°12.19'
	MARGARET RIVER WATERSHED		
4.1	Margaret River-Great North Rd(Rapids)	33°52.60'	115°18.01'
4.2	Margaret R-1.3km from Cane Break Rd	33°51.99'	115°18.64'
4.5	Margaret River-1st Weir	33°56.92'	115°03.83'
4.7	Margaret R-2nd Weir	33°56.89'	115°05.35'
4.8	Margaret R-Margaret R Rd	33°56.53'	115°06.98'
4.10	Margaret R-Margaret R Rd	33°56.03'	115°08.82'
4.11	Margaret R-Margaret R Rd	33°54.77'	115°17.31'
4.13	Margaret R-small stream behind Leeuwin Estate	33°59.95'	115°03.92'
	BLACKWOOD RIVER WATERSHED		
5.4	Blackwood R-north of Nannup	33°55.27'	115°48.35'
5.5	Blackwood R-Sues Bridge	34°04.54'	115°23.42'
5.7	St John Brook (Blackwood River)	33°52.70'	115°40.59'
5.9	Blackwood R-Tweed Rd	33°58.72'	116°09.54'
5.10	Blackwood R	33°59.89'	116°11.63'
5.11	Blackwood R-Aegers Bridge Rd	33°54.95'	116°25.17'
5.12	Blackwood R-Terry Rd	33°54.47'	116°24.38'
5.13	Blackwood R-Terry Rd	33°51.43'	116°22.66'
5.16	Blackwood R-Condinup Crossing Rd	33°46.35'	116°31.07'
5.17	Blackwood R-Arthur River Rd	33°38.49'	116°43.68'
5.19	Arthur R-Moodiarup Rd	33°37.13'	116°47.96'
5.22	Blackwood R-Kulikup Rd & Lower Bridgetown	33°52.39'	116°39.88'
5.23	Chapman Brook	34°04.61'	115°11.31'
5.24	Chapman Brook	34°05.33'	115°12.04'
	SCOTT RIVER WATERSHED		
6.2	Scott R-Bridge on Milyeannup Rd (1)	34°17.56'	115°24.02'
6.3	Scott R- " " " " (2)	34°17.70'	115°24.10'
6.4	Scott R- " " " " (3)	34°17.80'	115°24.15'
6.5	Pool 200m south of above	34°17.68'	115°23.87'
6.7	Pool on Scott R Rd-power pole43	34°17.05'	115°13.96'
6.15	Pool on Scott R Rd-power pole 38	34°17.08'	115°14.40'
	LAKE JASPER WATERSHED		
8.1	Lake Jasper	34°25.22'	115°41.19'
	DONNELLY RIVER WATERSHED		
9.1	Lake Wilson	34°25.86'	115°42.68'
9.2	Lake Smith	34°25.89'	115°43.05'
9.7	Donnelly River-Boat Ramp	34°26.84'	115°46.38'
9.9	Donnelly River-One Tree Bridge	34°12.19'	115°55.82'
9.10	Fly Brook-Charlie Rd	34°27.24'	115°47.61'

Table 4 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
9.12	Carey Brook-Bridge on Cleave Rd	34°26.54'	115°47.25'
9.13	Carey Brook-Bridge on Vasse Hwy	34°25.01'	115°48.65'
9.15	Beedelup Brook-Opposite Tobruk Rd	34°25.27'	115°49.68'
9.16	Carey Brook-Staircase Rd	34°23.81'	115°50.39'
9.18	Carey Brook-Stirling Track and Pile Rd	34°23.24'	115°52.45'
9.21	Carey Brook-Sandy Hill Rd	34°24.27'	115°48.65'
	WARREN RIVER WATERSHED		
10.1	Warren R-Dombakup Brk-Plantation Rd	34°34.66'	115°57.98'
10.2	Yeagerup Lake	34°32.35'	115°52.39'
10.4	Warren River-Bridge on Pemb/North Rd	34°30.42'	115°59.54'
10.5	Warren River-King Trout Farm	34°30.10'	115°59.85'
10.6	Lefroy Brook-The Cascades	34°28.60'	116°01.71'
10.7	Lefroy Brook-Downstream of trout hatch	34°26.60'	116°01.36'
10.8	Lefroy Dam-Immediately downstream	34°26.41'	116°01.36'
10.10	Middle Weir-Lefroy Brook	34°25.65'	116°01.00'
10.20	Wilgarup River-Bridge on Cormint Rd	34°21.11'	116°20.73'
10.21	Peerup River-Bridge on Muirs Hwy	34°23.41'	116°25.52'
10.22	Tone River-Bridge on Muirs Hwy	34°24.65'	116°33.10'
10.23	Unicup Lake	34°20.65'	116°43.13'
10.28	Wilgarup River-Muirs Hwy	34°19.86'	116°22.45'
	LAKE MUIR WATERSHED		
11.1	Lake Muir	34°26.41'	116°39.58'
11.3	Byenup Lagoon	34°29.95'	116°43.36'
11.4	Lake at Jn of Lake Unicup & Pindicup Rds	34°22.57'	116°41.87'
11.5	Cowerup Swamp (Surrounding Pools)	34°26.22'	116°38.68'
11.6	Stream of Lake Muir	34°27.30'	116°47.00'
11.7	Red Lake	34°26.30'	116°38.33'
11.8	Drain fom Red Lake	34°26.25'	116°39.47'
11.9	Red Lake	34°26.20'	116°39.40'
11.10	Red Lake	34°25.90'	116°39.40'
	DOGGERUP CREEK WATERSHED		
12.2	Lake Doggerup	34°42.99'	116°03.88'
12.3	Lake Samuel	34°43.77'	116°03.58'
12.5	Dam on McGeachin's Property	34°42.82'	116°05.22'
	GARDNER RIVER WATERSHED		
13.2	Blackwater-Pool 1	34°49.82'	116°07.29'
13.3	Blackwater-Pool 2	34°49.82'	116°07.34'
13.9	Pool 200m south of 13.10	34°49.40'	116°03.70'
13.12	Pool opposite 13.13	34°49.23'	116°03.72'
13.13	Pool 450m south of 13.14	34°49.17'	116°03.82'
13.14	Pool 50m south of 13.15	34°48.98'	116°04.05'
13.15	Narrow stream on Windy Harbour Rd	34°48.88'	116°04.12'
13.16	Pool on Windy Harbour Rd	34°48.70'	116°04.20'
13.17	Meandering Stream-off Windy Harbour Rd	34°48.41'	116°03.77'
13.18	Summer pool at western end of 13.17	34°48.29'	116°03.75'
13.22	Pool near Lake Florence entrance	34°42.63'	116°07.19'
13.31	Lake Florence	34°44.12'	116°06.06'
13.32	1st pool on Lower Gardner River Rd	34°45.64'	116°09.03'
13.34	Large pool on Chesapeake Rd	34°45.92'	116°09.36'
13.37	Gardner River-South of bridge	34°47.21'	116°11.32'
13.38	Gardner River-Bridge	34°46.62'	116°10.87'
13.39	Buldania Creek-Gardner River Rd	34°45.46'	116°12.87'
13.42	Boorara Brook-Bettink's	34°41.46'	116°10.85'
13.43	" " " -Muirillup Rd	34°38.84'	116°13.60'
13.44	" " " -Daubney's (1)	34°38.78'	116°13.69'
13.45	" " " - " " (2)	34°38.33'	116°13.63'
13.46	" " " - " " (3)	34°37.42'	116°13.37'
13.48	Lake Maringup	34°50.22'	116°11.81'

Table 4 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
	SHANNON RIVER WATERSHED		
14.4	Shannon River-Bridge on Cheaspeake Rd	34°50.36'	116°22.27'
14.5	" " " -Springbreak Rd	34°52.23'	116°22.37'
14.6	Upper Shannon R-NE of Dam	34°35.05'	116°24.69'
14.7	Pool on Chesapeake Rd-19.4km west Broke	34°49.20'	116°18.57'
14.9	Chesapeake Brook (1)-20.05km W Broke	34°49.07'	116°18.09'
14.14	Pools at Jn of Deeside Coast & Preston Rds	34°38.52'	116°19.63'
	BROKE INLET WATERSHED		
15.1	Forth River	34°51.85'	116°25.55'
15.2	Small stream 6.6km west of Broke Inlet Rd	34°51.94'	116°25.72'
15.4	Pool/small stream 5.2km " " "	34°52.40'	116°26.37'
15.6	Small stream on Chesapeake Rd 1.6km "	34°53.68'	116°28.14'
	DEEP RIVER WATERSHED		
16.1	Deep River-Bridge on Beardmore Rd	34°49.14'	116°35.52'
16.2	Weld River- " " " " "	34°48.89'	116°34.75'
16.4	Jn Beardmore & South West Hwy	34°48.66'	116°31.82'
16.13	Deep River-Peakway Rd	34°45.99'	116°36.97'
	FRANKLAND RIVER WATERSHED		
17.1	Frankland River-Muirs Bridge	34°28.73'	116°54.00'
17.11	Elsie Brook	34°51.46'	116°43.43'
17.13	Frankland River-Caldyanup Crossing	34°48.62'	116°48.57'
	BOW RIVER WATERSHED		
19.3	Stream on Middle Rd	34°54.96'	116°56.34'
	KENT RIVER WATERSHED		
20.1	Kent River-Pools on Muirs Hwy	34°33.41'	117°10.29'
20.2	Camballup Pool	34°32.38'	117°11.33'
20.4	Kent River-Break Rd	34°49.95'	117°03.56'
20.5	Falls of Forth-Kent River	34°50.52'	117°04.84'
20.12	Styx River-Break Rd	34°51.10'	117°08.99'
	DENMARK RIVER WATERSHED		
23.1	Flats-Romance Rd	34°46.32'	117°06.31'
23.3	Scotsdale Brook-Mt Lindsay Rd	34°55.38'	117°18.74'
23.4	Creek of Denmark River	34°53.09'	117°18.90'
23.6	Water point-Watershed Rd	34°47.04'	117°08.19'
23.7	Quickip River-Denmark Mt Barker Rd	34°52.38'	117°23.25'
23.8	Quickip River-Denmark Mt Barker Rd	34°54.73'	117°22.62'
	HAY RIVER WATERSHED		
24.1	Hay River-Pools on Muirs Hwy	34°37.81'	117°24.15'
24.2	Lake Saide	35°02.58'	117°28.50'
24.10	Blue Gum Creek-Redmond Hay Rd	34°50.57'	117°33.45'
24.11	Hay River-Redmond Hay River Rd	34°50.61'	117°32.57'
24.12	Blue Gum Creek-The Pass Rd	34°50.01'	117°33.86'
24.13	Hay River-Spencer Rd	34°44.54'	117°33.73'
24.15	Mitchell River-Stan Rd	34°49.54'	117°20.92'
24.16	Mitchell River-Stan Rd	34°48.70'	117°20.87'
	KING RIVER WATERSHED		
26.1	Mill Brook-Warren Rd	34°55.85'	117°52.96'
26.2	King River-Warren Rd	34°55.95'	117°52.70'
	KALGAN RIVER WATERSHED		
27.3	Stream of Kalgan River-Deep Creek Rd	34°50.12'	118°00.36'
27.4	Kalgan River-Takalarup Rd	34°37.60'	118°02.62'
27.5	Chergugup Creek/Kalgan River	34°33.81'	117°58.00'
27.6	Gaalgegup Creek-Knight Rd	34°37.39'	117°52.72'
27.7	Napier Creek-Elliot Rd	34°49.01'	117°51.48'
27.8	Napier Creek-Jackson Rd	34°47.48'	117°51.08'
27.10	Takenup Creek-Bennett Rd	34°45.79'	117°58.55'

Table 4 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
27.11	Takenup Creek-Takenup Rd	34°47.68'	118°01.17'
27.12	Kalgan River-Oyama Rd	34°45.40'	118°03.27'
	TWO PEOPLE'S BAY WATERSHED		
28.1	Gardner Lake-Drain	34°57.63'	118°09.63'
28.2	Goodga River-Two People's Bay Rd	34°57.21'	118°05.14'
28.3	Goodga River-Track along River	34°56.96'	118°04.79'
28.8	Gardner Lake	34°58.04'	118°09.65'
28.9	Moates Lake	34°57.92'	118°07.20'
28.10	Black Cat Creek-Mouth	34°57.17'	118°06.20'
	MUSEUM RECORDS (Go)		
1	Manjimup	34°14'	116°10'
2	Tambellup	34°02'	117°39'
3	Karridale 1931	34°18'	115°05'
4	Pemberton 1936	34°27'	116°02'
5	1937	34°07'	117°21'
6	1944	34°25'	115°40'
7	1944	34°19'	115°11'
8	Bridgetown 1946	33°57'	116°08'
9	Gnowangerup 1947	33°55'	118°00'
10	Tambellup 1947	34°02'	117°39'
11	Dumbleyung 1947	33°19'	117°38'
12	Mount Barker	34°38'	117°40'
13		34°18'	117°32'
14		33°26'	116°48'
15	Bridgetown 1954	33°57'	116°09'
16	1955	34°31'	117°43'
17	Deepdene 1957	34°16'	115°04'
18	Karridale 1959	34°12'	115°06'
19	Nannup 1961	33°59'	115°45'
20	Margaret River Area 1961	33°57'	115°04'
21	Greenbushes 1964	33°51'	116°03'
22	1962	34°16'	115°14'
23	Kendenup 1965	34°29'	117°39'
24	Nannup 1974	33°59'	115°38'
25	Pemberton 1974	34°27'	116°02'
26	Albany 1976	35°01'	117°43'
27	1976	34°10'	115°40'
28	Mayanup 1979	34°00'	116°20'
29	1981	34°56'	117°53'
30	1981	34°52'	118°00'
31	Warren River 1981	34°25'	116°38'
32	Capel River 1978	33°40'	115°50'
33	Ludlow 1982	33°45'	115°33'
34	Northcliffe 1986-Gardner River	34°39'	116°13'
35	" " " " " "	34°39'	116°06'
36	" " " " " "	34°44'	116°08'
37	" " " " -Warren River	34°31'	115°59'
38	Blackwood River 1986	34°07'	115°36'
39	Donnelly River 1986	34°12'	115°57'
40	Doggerup Creek 1986	34°44'	116°04'
41	Lake Samuel 1986	34°43'	116°04'
42	" " " "	34°43'	116°03'
43	Shannon River 1986	34°43'	116°22'
44	" " " "	34°35'	116°24'
45	Doggerup Lake 1986	34°44'	116°04'
46	1988	34°43'	116°09'
47	Denmark 1992	35°00'	117°04'
48	" " "	35°01'	117°05'
49	" " "	35°01'	117°06'

Table 4 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
50	Broke Inlet 1992	34°57'	116°32'
51	Manjimup 1992	34°33'	115°52'
52	" " "	34°32'	115°53'
53	Nannup 1992	34°24'	115°41'
	R. JAENSCH (Go)		
6	Lake Jasper	34°24'	115°41'
9	Yeagerup Lake	34°32'	115°53'
11	Un-named Lake (near 9)	34°33'	115°52'
12	Doggerup Lake	34°43'	116°04'
16	Maringup Lake	34°50'	116°12'
17	Lake East of Broke Inlet	34°57'	116°32'
19	Owingup Swamp	35°00'	117°04'
20	Boat Harbour Lake 1	35°01'	117°05'
22	" " " " 3	35°01'	117°06'
	P. CHRISTENSEN (Go)		
26	Weld R-Soth West Hwy	34°41'	116°31'
31	Una Brook-Gardener River Rd	34°44'	116°12'
40	Lake Yeagerup	34°32'	115°53'
41	Lake Rd	34°31'	115°53'
47	Richardson Rd	34°38'	115°59'
48	" " "	34°38'	116°05'
54	Bevan Rd	34°35'	116°32'
56	Tone River-Muir Hwy	34°24'	116°53'
64	Meerup River-Gurnsey Rd	34°41'	116°04'
99	Nornalup Rd	34°39'	116°57'
111	Muir Hwy	34°29'	116°58'
118	Stan Rd	34°51'	117°21'

Table 5 The sites at which *Galaxiella nigrostriata* was captured during the present study, together with those recorded in the collections at the Western Australian Museum, and by Jaensch (1992) and Christensen (1982).

Site Number	General Location	Latitude (S)	Longitude (E)
	SCOTT RIVER WATERSHED		
6.7	Pool on Scott R Rd - power pole 43	34°17.05'	115°13.96'
6.15	Pool on Scott R Rd - power pole 38	34°17.08'	115°14.40'
	LAKE QUITJUP WATERSHED		
7.5	Pool at end of Black Point Rd	34°20.00'	115°38.25'
	DONNELLY RIVER WATERSHED		
9.3	Swamp adjacent to Lake Smith	34°25.89'	115°43.20'
9.4	Pool (1) on Scott Rd	34°25.50'	115°45.16'
9.5	Pool (2) " "	34°25.35'	115°45.67'
	WARREN RIVER WATERSHED		
10.18	Four Mile Brook-Seven Day Rd	34°18.65'	115°59.39'
	DOGGERUP CREEK WATERSHED		
12.2	Lake Doggerup	34°42.99'	116°03.88'
12.3	Lake Samuel	34°43.77'	116°03.58'
12.5	Dam on McGeachin's Property	34°42.82'	116°05.22'
12.7	Pool (1)-Doggerup Creek Track	34°44.79'	116°04.65'
12.9	Pool (3)- " " " " "	34°44.46'	116°03.78'
	GARDNER RIVER WATERSHED		
13.2	Blackwater-Pool 1	34°49.82'	116°07.29'
13.7	Pool at southern end of Windy Harbour Rd	34°50.24'	116°01.22'
13.8	Pool 100m south of 13.9	34°49.60'	116°03.50'
13.9	Pool 200m south of 13.10	34°49.40'	116°03.70'
13.12	Pool opposite 13.13	34°49.23'	116°03.72'
13.13	Pool 450m south of 13.14	34°49.17'	116°03.82'
13.14	Pool 50m south of 13.15	34°48.98'	116°04.05'
13.15	Narrow stream on Windy Harbour Rd	34°48.88'	116°04.12'
13.16	Pool on Windy Harbour Rd	34°48.70'	116°04.20'
13.18	Summer pool at western end of 13.17	34°48.29'	116°03.75'
13.19	Small Lake 200m north of 13.17	34°48.47'	116°03.86'
13.21	1st pool on Chesapeake Rd	34°42.36'	116°07.06'
13.22	Pool near Lake Florence entrance	34°42.63'	116°07.19'
13.23	43.1km from east end of Chesapeake Rd	34°43.18'	116°07.59'
13.24	42.6km " " " " " " "	34°43.37'	116°07.82'
13.29	Pool 38.2km " " " " " "	34°45.40'	116°09.02'
13.30	Pool opposite 13.29	34°45.38'	116°09.00'
13.32	1st pool on Lower Gardner River Rd	34°45.64'	116°09.03'
13.33	Pool 37.6km from east end of Chesapeake	34°45.66'	116°09.18'
13.34	Large pool on Chesapeake Rd	34°45.92'	116°09.36'
13.50	Pool on Moore's Hut Track	34°50.54'	116°15.84'
13.51	Pool 4.9km west of Deeside/Chspke Jn	34°49.00'	116°15.51'
13.53	Pool 50m west of 13.52	34°49.00'	116°15.38'
13.54	Pool on Chspke Rd(43.2km from east end)	34°43.25'	116°07.64'
13.59	Pool on Lower Gardner River Rd	34°47.82'	116°08.09'
	SHANNON RIVER WATERSHED		
14.1	Pool on Moore's Hut Track	34°50.40'	116°17.03'
14.14	Pools at Jn of Deeside Coast & Preston Rds	34°38.52'	116°19.63'
	BROKE INLET WATERSHED		
15.1	Forth River	34°51.85'	116°25.55'
15.2	Small stream 6.6km west of Broke Inlet Rd	34°51.94'	116°25.72'
15.4	Pool/small stream 5.2km " " "	34°52.40'	116°26.37'
15.7	Pool on Chesapeake Rd 1.3km " " "	34°53.76'	116°28.23'
15.8	Pool on Broke Inlet Rd 1.9km N Chspke Rd	34°53.62'	116°29.78'
15.9	Pool " " " " 1.6km S " "	34°54.75'	116°28.18'
	DEEP RIVER WATERSHED		
16.4	Jn Beardmore & South West Hwy	34°48.66'	116°31.82'
16.5	Small pools along Beardmore Rd	34°48.67'	116°32.12'
16.10	Pool on Thomson Rd	34°46.57'	116°42.97'

Table 5 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
	FRANKLAND RIVER WATERSHED		
17.2	Pool on Thomson Rd	34°45.70'	116°43.17'
17.5	Pool on Thomson Rd	34°47.22'	116°43.12'
17.6	Pool on Thomson Rd	34°47.32'	116°42.84'
17.7	Pool on Thomson Rd	34°47.49'	116°42.97'
17.8	Pool on Thomson Rd	34°47.65'	116°43.20'
	MUSEUM RECORDS		
1	1964	34°35'	116°25'
2	North Rd 1964	34°35'	116°25'
3	Albany 1976	34°57'	117°43'
4	Gardner River 1977	34°46'	116°05'
5	" " " 1982	34°47'	116°04'
6	" " " "	34°38'	116°07'
7	" " " 1986	34°44'	116°08'
8	" " " "	34°39'	116°08'
9	Warren River 1986	34°38'	116°03'
10	Lake Samuel 1985	34°43'	116°04'
11	Northcliffe 1986	34°46'	116°05'
12	Mt Chudalup 1986	34°49'	116°04'
13	Lake Doggerup 1986	34°44'	116°04'
14	Crystal Springs 1977	34°56'	116°35'
15	Gardner River 1988	34°28'	116°07'
16	Denmark 1992	35°00'	117°04'
17	Broke Inlet	34°57'	116°32'
	R. JAENSCH (1992)		
12	Lake Doggerup	34°43'	116°04'
15	Gardner River Lake	34°50'	116°06'
19	Owingup Swamp	35°00'	117°04'
	P. CHRISTENSEN (1982)		
18	South West Hwy	34°56'	116°35'
19	" " " "	34°56'	116°35'

Table 6 The sites at which *Galaxiella munda* was captured during the present study, together with those recorded in the collections at the Western Australian Museum, and by Jaensch (1992) and Christensen (1982).

Site Number	General Location	Latitude (S)	Longitude (E)
	MARGARET RIVER WATERSHED		
4.1	Margaret River-Great North Rd(Rapids)	33°52.60'	115°18.01'
4.2	Margaret R-1.3km from Cane Break Rd	33°51.99'	115°18.64'
4.13	Margaret R-small stream behind Leeuwin Estate	33°59.95'	115°03.92'
	WARREN RIVER WATERSHED		
10.11	Lefroy Brook-Broken Bridge	34°25.19'	116°01.53'
10.20	Wilgarup River-Bridge on Cormint Rd	34°21.11'	116°20.73'
10.21	Peerup River-Bridge on Muirs Hwy	34°23.41'	116°25.52'
10.22	Tone River-Bridge on Muirs Hwy	34°24.65'	116°33.10'
	LAKE MUIR WATERSHED		
11.5	Cowerup Swamp (Surrounding Pools)	34°26.22'	116°38.68'
	DOGGERUP CREEK WATERSHED		
12.8	Pool (2)-Doggerup Creek Track	34°44.32'	116°04.53'
	GARDNER RIVER WATERSHED		
13.44	Boorara Brook-Daubney's (1)	34°38.78'	116°13.69'
13.45	" " " - " " (2)	34°38.33'	116°13.63'
13.46	" " " - " " (3)	34°37.42'	116°13.37'
13.47	" " " -Jane Block	34°36.35'	116°14.53'
13.60	Pool on Lower Gardner River Rd	34°47.48'	116°08.46'
13.61	Pool on " " " " " " "	34°45.88'	116°08.90'
	SHANNON RIVER WATERSHED		
14.4	Shannon River-Bridge on Cheaspeake Rd	34°50.36'	116°22.27'
14.11	Chesapeake Brook (3)-20.05km W Broke	34°48.90'	116°18.07'
14.14	Pools at Jn of Deeside Coast & Preston Rds	34°38.52'	116°19.63'
	BROKE INLET WATERSHED		
15.1	Forth River	34°51.85'	116°25.55'
15.2	Small stream 6.6km west of Broke Inlet Rd	34°51.94'	116°25.72'
15.4	Pool/small stream 5.2km " " "	34°52.40'	116°26.37'
	DEEP RIVER WATERSHED		
16.2	Weld River-Bridge on Beardmore Rd	34°48.89'	116°34.75'
16.3	Weld river-Wye Rd	34°45.65'	116°30.75'
16.4	Jn Beardmore & South West Hwy	34°48.66'	116°31.82'
16.13	Deep River-Peakway Rd	34°45.99'	116°36.97'
16.16	Felix Brook-Angrove Rd	34°58.48'	116°41.82'
16.17	Felix Brook-Angrove Rd	34°57.91'	116°41.16'
16.18	Jn of Walpole River/Samuel Brook	34°56.06'	116°40.48'
	FRANKLAND RIVER WATERSHED		
17.1	Frankland River-Muirs Bridge	34°28.73'	116°54.00'
17.16	Boxhall Creek-Boxhall Rd	34°58.55'	116°50.15'
	BOW RIVER WATERSHED		
19.3	Stream on Middle Rd	34°54.96'	116°56.34'
19.4	Creek on Gum Link Rd	34°54.93'	116°56.69'
19.5	Creek on Gum Link Rd	34°53.44'	117°00.09'
	KENT RIVER WATERSHED		
20.1	Kent River-Pools on Muirs Hwy	34°33.41'	117°10.29'
20.2	Camballup Pool	34°32.38'	117°11.33'
20.12	Styx River-Break Rd	34°51.10'	117°08.99'
	DENMARK RIVER WATERSHED		
23.1	Flats-Romance Rd	34°46.32'	117°06.31'
23.2	Creek-Break Rd	34°51.26'	117°14.52'
23.8	Quickip River-Denmark Mt Barker Rd	34°54.73'	117°22.62'
	HAY RIVER WATERSHED		
24.1	Hay River-Pools on Muirs Hwy	34°37.81'	117°24.15'
24.7	Hay River-Redmond West Rd	34°54.71′	117°35.16'
24.10	Blue Gum Creek-Redmond Hay Rd	34°50.57′	117°33.45'
24.12	Blue Gum Creek-The Pass Rd	34°50.01′	117°33.86'

Table 6 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
24.16	Mitchell River-Stan Rd	34°48.70'	117°20.87'
	TORBAY INLET WATERSHED		
25.3	Marbelup Brook-Marbelup North Rd	34°56.42′	117°42.70'
	KING RIVER WATERSHED		
26.4	King River-Albany Hwy	34°53.24'	117°46.56'
	TWO PEOPLE'S BAY WATERSHED		
28.4	Goodga River-Creek of	34°56.19'	118°04.07'
28.5	Goodga River-Dempster Rd	34°55.98'	118°04.07'
28.12	Goodga River-Creek of	34°53.82'	118°06.17'
	MUSEUM RECORDS		
1	Northcliffe1960	34°36'	116°07'
2	1962	34°40'	115°14'
3	Fish Creek Pool1964	34°35'	116°25'
4	1961	34°35'	116°24'
5	Pemberton1958	34°22'	116°02'
6	Mount Chudalup1977	34°46'	116°05'
7	Walpole 1977	34°46'	116°48'
8	Cane Break Creek1976	33°50'	115°20'
9	Warren1981	34°25'	116°38'
10	Jeffrey Rd1981	34°39'	116°21'
11	Shannon1982	34°39'	116°20'
12	Gardner R1982	34°38'	116°07'
13	Gardner R1986	34°44'	116°08'
14	Blackwood R1986	34°07'	115°36'
15	Doggerup Creek1986	34°44'	116°04'
16	Shannon R-Nelson Rd1986	34°43'	116°26'
17	Shannon R1986	34°39'	116°19'
18	Weld River1986	34°49'	116°31'
19	Inlet River1986	34°55'	116°34'
20	Lake Powell1986	34°57'	117°46'
21	Quinnup1978	34°26'	116°15'
22	Northcliffe1978	34°40'	116°42'
23	" " " "	34°35'	116°32'
24	Shannon1977	34°41'	116°20'
25	Crystal Springs1977	34°56'	116°35'
26	Shannon1978	34°35'	116°30'
27	" " "	34°35'	116°33'
28	Denmark1978	34°50'	117°24'
29	Northcliffe1978	34°35'	116°03'
30	" " " "	34°25'	115°44'
31	Mt Frankland1978	34°50'	116°57'
32	Nile Creek1978	34°51'	117°03'
33	Northcliffe1978	34°35'	116°09'
34	Gardner River1988	34°38'	116°07'
	R. JAENSCH (1992)		
13	Lake Samuel	34°44'	116°04'
	P. CHRISTENSEN (1982)		
6	Nelson Rd	34°42'	116°30'
14	Deeside Coast Rd	34°42'	116°20'
15	" " " "	34°41'	116°20'
24	South West Hwy	34°46'	116°30'
28	Quininup Brook-Cripple Rd	34°30'	116°17'
29	Wheatley Coast Rd	34°26'	116°15'
47	Richardson Rd	34°38'	115°59'
49	Thompson Rd	34°40'	116°42'
53	Deep River-Bevan Rd	34°35'	116°33'
54	Bevan Rd	34°35'	116°32'
55	" "	34°35'	116°30'
56	Tone River-Muir Hwy	34°24'	116°53'

Table 6 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
61	Mitchell River-Denbarker Rd	34°50'	117°24'
62	Denbarker Rd	34°55'	117°23'
64	Meerup River-Gurnsey Rd	34°41'	116°04'
67	Rifle Range Rd	34°36'	116°03'
68	" " "	34°35'	116°03'
74	Pnuemonia Rd	34°25'	115°45'
77	Deep River-Beardmore Rd	34°48'	116°35'
81	Middle Rd	34°50'	116°57'
82	" "	34°52'	116°57'
83	Bow River-Middle Rd	34°55'	116°58'
84	Break Rd	34°51'	117°03'
86	Stewart Rd	34°19'	115°42'
88	Fouracres Rd	34°18'	115°35'
89	" " "	34°18'	115°35'
90	" " "	34°18'	115°31'
92	Scott Rd	34°11'	115°16'
93	" "	34°10'	115°16'
100	Nornalup Rd	34°44'	116°57'
102	Kent River-Basin Rd	34°46'	117°03'
103	Nornalup Rd	34°50'	117°00'
105	Kordabup Rd/South West Hwy	34°59'	117°09'
114	Kockelup Rd	34°47'	117°08'
117	Stan Rd	34°48'	117°21'
119	Court Rd	34°20'	115°56'

Table 7 The sites at which *Bostockia porosa* was captured during the present study, together with those recorded in the collections at the Western Australian Museum, and by Jaensch (1992) and Christensen (1982).

Site Number	General Location	Latitude (S)	Longitude (E)
	COLLIE RIVER WATERSHED		
1.2	Collie River-Collieburn Pool	33°24.66'	116°11.97'
1.4	" " " -Cox's Pool	33°25.80'	116°13.13'
1.6	" " " -Western Collieries	33°28.34'	116°13.86'
1.7	" " " -Davies' Pool	33°28.75'	116°13.90'
	ABBA/LUDLOW DRAINAGE		
3.18	Stream south of 3.17	33°36.25'	115°29.65'
3.19	Ludlow Swamp	33°35.80'	115°29.80'
3.20	Ludlow River-Bridge on Bypass	33°36.20'	115°28.82'
	MARGARET RIVER WATERSHED		
4.1	Margaret River- Great North Rd(Rapids)	33°52.60'	115°18.01'
4.5	Margaret River-1st Weir	33°56.92'	115°03.83'
4.7	Margaret R-2nd Weir	33°56.89'	115°05.35'
4.8	Margaret R- Margaret R Rd	33°56.53'	115°06.98'
4.11	Margaret R- Margaret R Rd	33°54.77'	115°17.31'
	BLACKWOOD RIVER WATERSHED		
5.7	St John Brook (Blackwood River)	33°52.70'	115°40.59'
5.9	Blackwood R-Tweed Rd	33°58.72'	116°09.54'
5.24	Chapman Brook	34°05.33'	115°12.04'
	LAKE QUITJUP WATERSHED		
7.1	Lake Quitjup	34°23.17'	115°35.66'
	LAKE JASPER WATERSHED		
8.1	Lake Jasper	34°25.22'	115°41.19'
	DONNELLY RIVER WATERSHED		
9.1	Lake Wilson	34°25.86'	115°42.68'
9.2	Lake Smith	34°25.89'	115°43.05'
9.7	Donnelly River-Boat Ramp	34°26.84'	115°46.38'
9.9	Donnelly River-One Tree Bridge	34°12.19'	115°55.82'
9.10	Fly Brook-Charlie Rd	34°27.24'	115°47.61'
9.12	Carey Brook-Bridge on Cleave Rd	34°26.54'	115°47.25'
9.13	Carey Brook-Bridge on Vasse Hwy	34°25.01'	115°48.65'
9.15	Beedelup Brook-Opposite Tobruk Rd	34°25.27'	115°49.68'
9.16	Carey Brook-Staircase Rd	34°23.81'	115°50.39'
	WARREN RIVER WATERSHED		
10.1	Warren R-Dombakup Brk-Plantation Rd	34°34.66'	115°57.98'
10.2	Yeagerup Lake	34°32.35'	115°52.39'
10.4	Warren River-Bridge on Pemb/North Rd	34°30.42'	115°59.54'
10.5	Warren River-King Trout Farm	34°30.10'	115°59.85'
10.6	Lefroy Brook-The Cascades	34°28.60'	116°01.71'
10.7	Lefroy Brook-Downstream of trout hatch	34°26.60'	116°01.36'
10.8	Lefroy Dam-Immediately downstream	34°26.41'	116°01.36'
10.11	Lefroy Brook-Broken Bridge	34°25.19'	116°01.53'
10.12	Big Brook Dam-Under downstream bridge	34°24.73'	116°01.71'
10.14	Big Brook Dam-Actual	34°24.49'	116°01.64'
10.20	Wilgarup River-Bridge on Cormint Rd	34°21.11'	116°20.73'
10.21	Peerup River-Bridge on Muirs Hwy	34°23.41'	116°25.52'
10.22	Tone River-Bridge on Muirs Hwy	34°24.65'	116°33.10'
10.28	Wilgarup River-Muirs Hwy	34°19.86'	116°22.45'
	LAKE MUIR WATERSHED		
11.6	Stream of Lake Muir	34°27.30'	116°47.00'
11.7	Red Lake	34°26.30'	116°38.33'
11.8	Drain from Red Lake	34°26.25'	116°39.47'
11.9	Red Lake	34°26.20'	116°39.40'
11.10	Red Lake	34°25.90'	116°39.40'
	DOGGERUP CREEK WATERSHED		
12.3	Lake Samuel	34°43.77'	116°03.58'
12.5	Dam on McGeachin's Property	34°42.82'	116°05.22'

Table 7 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
	GARDNER RIVER WATERSHED		
13.2	Blackwater-Pool 1	34°49.82'	116°07.29'
13.3	Blackwater-Pool 2	34°49.82'	116°07.34'
13.8	Pool 100m south of 13.9	34°49.60'	116°03.50'
13.9	Pool 200m south of 13.10	34°49.40'	116°03.70'
13.12	Pool opposite 13.13	34°49.23'	116°03.72'
13.13	Pool 450m south of 13.14	34°49.17'	116°03.82'
13.14	Pool 50m south of 13.15	34°48.98'	116°04.05'
13.15	Narrow stream on Windy Harbour Rd	34°48.88'	116°04.12'
13.16	Pool on Windy Harbour Rd	34°48.70'	116°04.20'
13.17	Meandering Stream-off Windy Harbour Rd	34°48.41'	116°03.77'
13.18	Summer pool at western end of 13.17	34°48.29'	116°03.75'
13.19	Small Lake 200m north of 13.17	34°48.47'	116°03.86'
13.21	1st pool on Chesapeake	34°42.36'	116°07.06'
13.29	Pool 38.2km from east end of Chesapeake	34°45.40'	116°09.02'
13.34	Large pool on Chesapeake Rd	34°45.92'	116°09.36'
13.37	Gardner River-South of bridge	34°47.21'	116°11.32'
13.38	Gardner River-Bridge	34°46.62'	116°10.87'
13.39	Buldania Creek-Gardner River Rd	34°45.46'	116°12.87'
13.40	Una Brook- " " " "	34°43.95'	116°12.14'
13.41	Gardner River-Laws Track	34°42.49'	116°09.96'
13.43	Boorara Brook-Muirillup Rd	34°38.84'	116°13.60'
13.44	" " " -Daubney's (1)	34°38.78'	116°13.69'
13.45	" " " - " " (2)	34°38.33'	116°13.63'
13.48	Lake Maringup	34°50.22'	116°11.81'
13.51	Pool 4.9km west of Deeside/Chspke Jn	34°49.00'	116°15.51'
	SHANNON RIVER WATERSHED		
14.1	Pool on Moore's Hut Track	34°50.40'	116°17.03'
14.4	Shannon River-Bridge on Cheaspeake Rd	34°50.36'	116°22.27'
14.5	" " " -Springbreak Rd	34°52.23'	116°22.37'
14.7	Pool on Chesapeake Rd-19.4km west Broke	34°49.20'	116°18.57'
14.9	Chesapeake Brook (1)-20.05km W Broke	34°49.07'	116°18.09'
14.10	" " " " (2)- " " " "	34°48.96'	116°18.08'
14.14	Pools at Jn of Deeside Coast & Preston Rds	34°38.52'	116°19.63'
	BROKE INLET WATERSHED		
15.1	Forth River	34°51.85'	116°25.55'
15.2	Small stream 6.6km west of Broke Inlet Rd	34°51.94'	116°25.72'
15.4	Pool/small stream 5.2km " " "	34°52.40'	116°26.37'
15.6	Small stream on Chesapeake Rd 1.6km "	34°53.68'	116°28.14'
	DEEP RIVER WATERSHED		
16.1	Deep River-Bridge on Beardmore Rd	34°49.14'	116°35.52'
16.2	Weld River- " " " " "	34°48.89'	116°34.75'
16.3	Weld river-Wye Rd	34°45.65'	116°30.75'
16.4	Jn Beardmore & South West Hwy	34°48.66'	116°31.82'
16.15	Collier Creek-Gully Rd	34°58.40'	116°46.13'
16.16	Felix Brook-Angrove Rd	34°58.48'	116°41.82'
	FRANKLAND RIVER WATERSHED		
17.1	Frankland River-Muirs Bridge	34°28.73'	116°54.00'
17.5	Pool on Thomson Rd	34°47.22'	116°43.12'
17.8	Pool on Thomson Rd	34°47.65'	116°43.20'
17.9	Pool on Thomson Rd	34°47.32'	116°42.84'
17.12	Frankland River-Elsie Brook Rd	34°52.33'	116°44.14'
17.13	Frankland River-Caldyanup Crossing	34°48.62'	116°48.57'
17.15	Frankland River-Sappers Bridge	34°57.55'	116°49.40'
	BOW RIVER WATERSHED		
19.4	Creek on Gum Link Rd	34°54.93'	116°56.69'
19.7	Bow River-South Coast Hwy	34°58.07'	116°57.20'
	KENT RIVER WATERSHED		
20.1	Kent River-Pools on Muirs Hwy	34°33.41'	117°10.29'
20.2	Camballup Pool	34°32.38'	117°11.33'

Table 7 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
20.5	Falls of Forth-Kent River	34°50.52'	117°04.84'
20.7	Kent River-Kent River Siding Rd	34°59.01'	117°02.81'
20.12	Styx River-Break Rd	34°51.10'	117°08.99'
	LAKE WILLIAMS NP WATERSHED		
22.3	Lake on William Bay Rd	34°59.80'	117°13.56'
	DENMARK RIVER WATERSHED		
23.2	Creek-Break Rd	34°51.26'	117°14.52'
23.5	Denmark River-Nutcracker Rd	34°51.96'	117°18.95'
23.6	Water point-Watershed Rd	34°47.04'	117°08.19'
23.7	Quickip River-Denmark Mt Barker Rd	34°52.38'	117°23.25'
	HAY RIVER WATERSHED		
24.1	Hay River-Pools on Muirs Hwy	34°37.81'	117°24.15'
24.9	Blue Gum Creek-Healy Rd	34°50.63'	117°36.75'
24.16	Mitchell River-Stan Rd	34°48.70'	117°20.87'
	KING RIVER WATERSHED		
26.2	King River-Warren Rd	34°55.95'	117°52.70'
26.3	King River-Millbrook Rd	34°52.74'	117°46.70'
	KALGAN RIVER WATERSHED		
27.8	Napier Creek-Jackson Rd	34°47.48'	117°51.08'
27.10	Takenup Creek-Bennett Rd	34°45.79'	117°58.55'
27.11	Takenup Creek-Takenup Rd	34°47.68'	118°01.17'
	MUSEUM RECORDS		
1	Albany 1916	34°56'	117°54'
2	1935	34°30'	115°59'
3	Pemberton 1937	34°27'	116°02'
4	Bridgetown 1947	33°56'	116°05'
5	Dumbleyung 1947	33°19'	117°38'
6	Grasmere 1947	35°01'	117°45'
7	1948	34°59'	117°44'
8	1951	34°50'	117°41'
9	1953	34°39'	117°54'
10		34°56'	118°00'
11	Fish Creek Pool 1964	34°35'	116°25'
12	Shannon River Dam 1959	34°35'	116°24'
13	Albany 1964	35°01'	117°41'
14	Pemberton 1964	34°28'	116°01'
15	Boranup 1959	34°16'	115°05'
16	Busselton	33°39'	115°29'
17	Nannup 1974	33°59'	115°38'
18	Albany 1976	35°01'	117°45'
19	" " "	34°57'	117°43'
20	" " "	35°01'	117°43'
21	1981	34°56'	117°53'
22	1981	34°25'	116°38'
23	Jeffrey Rd 1981	34°39'	116°21'
24	Shannon 1982	34°39'	116°20'
25	Ludlow 1982	33°45'	115°33'
26	Northcliffe 1986	34°39'	116°13'
27	" " " "	34°38'	116°03'
28	Nannup 1986	34°07'	115°36'
29	Lake Samuel 1985	34°43'	116°04'
30	" " " 1986	34°43'	116°03'
31	Northcliffe1986	34°43'	116°22'
32	Shannon River-Nelson Rd 1986	34°43'	116°26'
33	Northcliffe 1986	34°39'	116°19'
34	" " " "	34°46'	116°05'
35	Mt Chudalup 1986	34°49'	116°04'
36	1986	34°35'	116°24'
37	Weld River 1986	34°49'	116°31'

Table 7 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
38	Elleker 1986	34°57'	117°46'
39	Lake Doggerup 1986	34°44'	116°04'
40	1978	33°40'	115°42'
41	Northcliffe 1988	34°38'	116°07'
42	Albany 1992	35°01'	117°16'
43	Denmark 1992	35°00'	117°13'
44	" " "	35°00'	117°04'
45	" " "	35°01'	117°05'
46	" " "	35°01'	117°06'
47	Broke Inlet 1992	34°57'	116°32'
48	Manjimup 1992	34°50'	116°06'
49	" " " "	34°44'	116°06'
50	" " " "	34°34'	116°55'
51	" " " "	34°32'	115°53'
52	" " " "	34°26'	115°43'
53	Nannup 1992	34°24'	115°41'
54	" " "	34°23'	115°35'
55	Darkin	34°20'	116°44'
	R. JAENSCH (1992)		
5	Lake Quitjup	34°23'	115°35'
6	Lake Jasper	34°24'	115°41'
7	Lake Wilson	34°26'	115°43'
8	Lake Smith	34°26'	115°43'
9	Yeagerup Lake	34°32'	115°53'
A4	Warren River Oxbow	34°34'	115°55'
12	Doggerup Lake	34°43'	116°04'
13	Lake Samuel	34°44'	116°04'
14	Lake Florence	34°44'	116°06'
15	Gardner River Lake	34°50'	116°06'
16	Maringup Lake	34°50'	116°12'
17	Lake East of Broke Inlet	34°57'	116°32'
19	Owingup Swamp	35°00'	117°04'
20	Boat Harbour Lake 1	35°01'	117°05'
22	" " " " 3	35°01'	117°06'
23	Reserve 12046 Lake	35°00'	117°13'
24	Lake Williams	35°01'	117°16'
	P. CHRISTENSEN (1982)		
5	Nelson Rd	34°41'	116°31'
8	Off " "	34°43'	116°26'
14	Deeside Coast Rd	34°42'	116°20'
20	Inlet River-South West Hwy	34°55'	116°34'
22	South West Hwy	34°53'	116°33'
23	" " " "	34°48'	116°32'
24	" " " "	34°46'	116°30'
25	" " " "	34°44'	116°30'
28	Quininup Brook-Cripple Rd	34°30'	116°17'
29	Wheatley Coast Rd	34°26'	116°15'
39	Lake Yeagerup	34°32'	115°52'
41	Lake Rd	34°31'	115°53'
42	Ritters Rd	34°30'	115°53'
45	Richardson Rd	34°36'	115°57'
47	" " "	34°38'	115°59'
48	" " "	34°38'	116°05'
49	Thompson Rd	34°40'	116°42'
51	Elsie Brook-Thompson Rd	34°51'	116°43'
53	Deep River-Bevan Rd	34°35'	116°33'
55	Bevan Rd	34°35'	116°30'
56	Tone River-Muir Hwy	34°24'	116°53'
59	Denbarker Rd	34°45'	117°29'
61	Mitchell River-Denbarker Rd	34°50'	117°24'
63	Summertime Track	34°44'	116°04'

Table 7 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
64	Meerup River-Gurnsey Rd	34°41'	116°04'
65	Rifle Range Rd	34°37'	116°01'
67	" " "	34°36'	116°03'
68	" " "	34°35'	116°03'
70	Vasse Hwy	34°18'	115°46'
77	Deep River-Beardmore Rd	34°48'	116°35'
80	Boronia Rd	34°39'	116°51'
81	Middle Rd	34°50'	116°57'
83	Bow River-Middle Rd	34°55'	116°58'
84	Break Rd	34°51'	117°03'
87	Black Pt Rd	34°18'	115°40'
90	Fouracres Rd	34°18'	115°31'
92	Scott Rd	34°11'	115°16'
93	" "	34°10'	115°16'
106	South West Hwy	34°59'	117°12'
107	" " " "	34°59'	117°18'
111	Muir Hwy	34°29'	116°58'
112	" "	34°30'	116°59'
113	Kent River-Bevan Rd	34°41'	117°06'
115	Denmark River-Kockelup Rd	34°47'	117°13'
117	Stan Rd	34°48'	117°21'
119	Court Rd	34°20'	115°56'

Table 8 The sites at which *Edelia vittata* was captured during the present study, together with those recorded in the collections at the Western Australian Museum, and by Jaensch (1992) and Christensen (1982).

Site Number	General Location	Latitude (S)	Longitude (E)
	COLLIE RIVER WATERSHED		
1.4	Collie River-Cox's Pool	33°25.80'	116°13.13'
1.5	" " " -Round Pool	33°26.16'	116°13.40'
1.6	" " " -Western Collieries	33°28.34'	116°13.86'
1.7	" " " -Davies' Pool	33°28.75'	116°13.90'
	CAPEL WATERSHED		
2.2	Capel River-south	33°39.16'	115°45.43'
	ABBA/LUDLOW DRAINAGE		
3.15	Plover Lakes	33°36.00'	115°29.80'
3.18	Stream south of above	33°36.25'	115°29.65'
3.19	Ludlow Swamp	33°35.80'	115°29.80'
3.20	Ludlow River-Bridge on Bypass	33°36.20'	115°28.82'
3.25	Carbanup River	33°40.78'	115°12.19'
	MARGARET RIVER WATERSHED		
4.1	Margaret River-Great North Rd(Rapids)	33°52.60'	115°18.01'
4.5	Margaret River-1st Weir	33°56.92'	115°03.83'
4.7	Margaret R-2nd Weir	33°56.89'	115°05.35'
4.8	Margaret R-Margaret R Rd	33°56.53'	115°06.98'
4.10	Margaret R-Margaret R Rd	33°56.03'	115°08.82'
4.11	Margaret R-Margaret R Rd	33°54.77'	115°17.31'
4.12	Margaret R-Cranebreak Picnic Area	33°52.84'	115°16.97'
	BLACKWOOD RIVER WATERSHED		
5.7	St John Brook (Blackwood River)	33°52.70'	115°40.59'
5.23	Chapman Brook	34°04.61'	115°11.31'
5.24	Chapman Brook	34°05.33'	115°12.04'
	SCOTT RIVER WATERSHED		
6.2	Scott R-Bridge on Milyeannup Rd (1)	34°17.56'	115°24.02'
6.3	Scott R- " " " " (2)	34°17.70'	115°24.10'
6.4	Scott R- " " " " (3)	34°17.80'	115°24.15'
6.16	Pool on Scott River Rd - power pole 10	34°16.33'	115°16.17'
	LAKE QUITJUP WATERSHED		
7.1	Lake Quitjup	34°23.17'	115°35.66'
	LAKE JASPER WATERSHED		
8.1	Lake Jasper	34°25.22'	115°41.19'
	DONNELLY RIVER WATERSHED		
9.1	Lake Wilson	34°25.86'	115°42.68'
9.2	Lake Smith	34°25.89'	115°43.05'
9.3	Swamp adjacent to Lake Smith	34°25.89'	115°43.20'
9.7	Donnelly River-Boat Ramp	34°26.84'	115°46.38'
9.9	Donnelly River-One Tree Bridge	34°12.19'	115°55.82'
9.10	Fly Brook-Charlie Rd	34°27.24'	115°47.61'
9.11	Fly Brook-Fly Brook Rd	34°27.76'	115°52.45'
9.12	Carey Brook-Bridge on Cleave Rd	34°26.54'	115°47.25'
9.13	Carey Brook-Bridge on Vasse Hwy	34°25.01'	115°48.65'
9.15	Beedelup Brook-Opposite Tobruk Rd	34°25.27'	115°49.68'
9.16	Carey Brook-Staircase Rd	34°23.81'	115°50.39'
9.21	Carey Brook-Sandy Hill Rd	34°24.27'	115°48.65'
	WARREN RIVER WATERSHED		
10.1	Warren R-Dombakup Brk-Plantation Rd	34°34.66'	115°57.98'
10.2	Yeagerup Lake	34°32.35'	115°52.39'
10.4	Warren River-Bridge on Pemb/North Rd	34°30.42'	115°59.54'
10.5	Warren River-King Trout Farm	34°30.10'	115°59.85'
10.6	Lefroy Brook-The Cascades	34°28.60'	116°01.71'
10.7	Lefroy Brook-Downstream of trout hatch	34°26.60'	116°01.36'
10.8	Lefroy Dam-Immediately downstream	34°26.41'	116°01.36'
10.10	Middle Weir-Lefroy Brook	34°25.65'	116°01.00'
10.11	Lefroy Brook-Broken Bridge	34°25.19'	116°01.53'
10.12	Big Brook Dam-Under downstream bridge	34°24.73'	116°01.71'

Table 8 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
10.14	Big Brook Dam-Actual	34°24.49'	116°01.64'
10.18	Four Mile Brook -Seven Day Rd	34°18.65'	115°59.39'
10.19	Channybearup Brook-Seven Day Rd	34°19.11'	115°57.52'
10.20	Wilgarup River-Bridge on Cormint Rd	34°21.11'	116°20.73'
10.21	Peerup River-Bridge on Muirs Hwy	34°23.41'	116°25.52'
10.22	Tone River-Bridge on Muirs Hwy	34°24.65'	116°33.10'
10.23	Unicup Lake	34°20.65'	116°43.13'
10.28	Wilgarup River-Muirs Hwy	34°19.86'	116°22.45'
	LAKE MUIR WATERSHED		
11.1	Lake Muir	34°26.41'	116°39.58'
11.3	Byenup Lagoon	34°29.95'	116°43.36'
11.4	Lake at Jn of Lake Unicup & Pindicup Rds	34°22.57'	116°41.87'
11.5	Cowerup Swamp (Surrounding Pools)	34°26.22'	116°38.68'
	DOGGERUP CREEK WATERSHED		
12.1	Doggerup Creek-Mouth	34°46.75'	115°58.82'
12.2	Lake Doggerup	34°42.99'	116°03.88'
12.3	Lake Samuel	34°43.77'	116°03.58'
12.5	Dam on McGeachin's Property	34°42.82'	116°05.22'
	GARDNER RIVER WATERSHED		
13.2	Blackwater-Pool 1	34°49.82'	116°07.29'
13.3	Blackwater-Pool 2	34°49.82'	116°07.34'
13.8	Pool 100m south of 13.9	34°49.60'	116°03.50'
13.9	Pool 200m south of 13.10	34°49.40'	116°03.70'
13.12	Pool opposite 13.13	34°49.23'	116°03.72'
13.13	Pool 450m south of 13.14	34°49.17'	116°03.82'
13.14	Pool 50m south of 13.15	34°48.98'	116°04.05'
13.15	Narrow stream on Windy Harbour Rd	34°48.88'	116°04.12'
13.16	Pool on Windy Harbour Rd	34°48.70'	116°04.20'
13.17	Meandering Stream-off Windy Harbour Rd	34°48.41'	116°03.77'
13.18	Summer pool at western end of 13.17	34°48.29'	116°03.75'
13.19	Small Lake 200m north of 13.17	34°48.47'	116°03.86'
13.29	Pool 38.2km from east end of Chesapeake	34°45.40'	116°09.02'
13.31	Lake Florence	34°44.12'	116°06.06'
13.32	1st pool on Lower Gardner River Rd	34°45.64'	116°09.03'
13.34	Large pool on Chesapeake Rd	34°45.92'	116°09.36'
13.37	Gardner River-South of bridge	34°47.21'	116°11.32'
13.38	Gardner River-Bridge	34°46.62'	116°10.87'
13.39	Buldania Creek-Gardner River Rd	34°45.46'	116°12.87'
13.40	Una Brook- " " " "	34°43.95'	116°12.14'
13.41	Gardner River-Laws Track	34°42.49'	116°09.96'
13.43	Boorara Brook-Muirillup Rd	34°38.84'	116°13.60'
13.44	" " " -Daubney's (1)	34°38.78'	116°13.69'
13.45	" " " - " " (2)	34°38.33'	116°13.63'
13.46	" " " - " " (3)	34°37.42'	116°13.37'
13.48	Lake Maringup	34°50.22'	116°11.81'
13.50	Pool on Moore's Hut Track	34°50.54'	116°15.84'
	SHANNON RIVER WATERSHED		
14.1	Pool on Moore's Hut Track	34°50.40'	116°17.03'
14.4	Shannon River-Bridge on Cheaspeake Rd	34°50.36'	116°22.27'
14.5	" " " -Springbreak Rd	34°52.23'	116°22.37'
14.6	Upper Shannon R-NE of Dam	34°35.05'	116°24.69'
14.7	Pool on Chesapeake Rd-19.4km west Broke	34°49.20'	116°18.57'
14.9	Chesapeake Brook (1)-20.05km W Broke	34°49.07'	116°18.09'
14.10	" " " " (2)- " " " "	34°48.96'	116°18.08'
14.11	" " " " (3)- " " " "	34°48.90'	116°18.07'
14.14	Pools at Jn of Deeside Coast & Preston Rds	34°38.52'	116°19.63'
	BROKE INLET WATERSHED		
15.1	Forth River	34°51.85'	116°25.55'
15.2	Small stream 6.6km west of Broke Inlet Rd	34°51.94'	116°25.72'
15.4	Pool/small stream 5.2km " " "	34°52.40'	116°26.37'
15.6	Small stream on Chesapeake Rd 1.6km "	34°53.68'	116°28.14'

Table 8 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
	DEEP RIVER WATERSHED		
16.1	Deep River-Bridge on Beardmore Rd	34°49.14'	116°35.52'
16.2	Weld River- " " " " "	34°48.89'	116°34.75'
16.3	Weld river-Wye Rd	34°45.65'	116°30.75'
16.4	Jn Beardmore & South West Hwy	34°48.66'	116°31.82'
16.13	Deep River-Peakway Rd	34°45.99'	116°36.97'
16.14	Collier Creek-Cemetary Rd	34°58.40'	116°45.27'
16.15	Collier Creek-Gully Rd	34°58.40'	116°46.13'
16.16	Felix Brook-Angrove Rd	34°58.48'	116°41.82'
16.18	Jn of Walpole River/Samuel Brook	34°56.06'	116°40.48'
	FRANKLAND RIVER WATERSHED		
17.1	Frankland River-Muirs Bridge	34°28.73'	116°54.00'
17.13	Frankland River-Caldyanup Crossing	34°48.62'	116°48.57'
17.14	Frankland River-Mitchell Rd	34°45.80'	116°50.24'
	BOW RIVER WATERSHED		
19.3	Stream on Middle Rd	34°54.96'	116°56.34'
19.4	Creek on Gum Link Rd	34°54.93'	116°56.69'
	KENT RIVER WATERSHED		
20.1	Kent River-Pools on Muirs Hwy	34°33.41'	117°10.29'
20.2	Camballup Pool	34°32.38'	117°11.33'
20.4	Kent River-Break Rd	34°49.95'	117°03.56'
20.5	Falls of Forth-Kent River	34°50.52'	117°04.84'
20.6	Millars Basin-Kent River	34°45.48'	117°03.01'
20.7	Kent River-Kent River Siding Rd	34°59.01'	117°02.81'
20.12	Styx River-Break Rd	34°51.10'	117°08.99'
20.14	Boat Harbour Lake-Boat Harbour Rd	35°00.97'	117°05.67'
	KORDABUP RIVER WATERSHED		
21.1	Kordabup River-Kordabup Rd	34°59.25'	117°10.13'
	LAKE WILLIAMS NP WATERSHED		
22.2	Lake Williams	35°00.96'	117°16.20'
22.3	Lake on William Bay Rd	34°59.80'	117°13.56'
	DENMARK RIVER WATERSHED		
23.2	Creek-Break Rd	34°51.26'	117°14.52'
23.3	Scotsdale Brook-Mt Lindsay Rd	34°55.38'	117°18.74'
23.5	Denmark River-Nutcracker Rd	34°51.96'	117°18.95'
23.6	Water point-Watershed Rd	34°47.04'	117°08.19'
23.7	Quickip River-Denmark Mt Barker Rd	34°52.38'	117°23.25'
23.8	Quickip River-Denmark Mt Barker Rd	34°54.73'	117°22.62'
	HAY RIVER WATERSHED		
24.1	Hay River-Pools on Muirs Hwy	34°37.81'	117°24.15'
24.2	Lake Saide	35°02.58'	117°28.50'
24.8	Hay River-Verne Rd	34°52.12'	117°37.52'
24.9	Blue Gum Creek-Healy Rd	34°50.63'	117°36.75'
24.11	Hay River-Redmond Hay River Rd	34°50.61'	117°32.57'
24.12	Blue Gum Creek-The Pass Rd	34°50.01'	117°33.86'
24.13	Hay River-Spencer Rd	34°44.54'	117°33.73'
24.14	Sheepwash Creek-Denmark Mt Barker	34°45.54'	117°29.36'
24.16	Mitchell River-Stan Rd	34°48.70'	117°20.87'
24.17	Mitchell River-Denmark Mt Barker Rd	34°50.00'	117°24.45'
	TORBAY INLET WATERSHED		
25.3	Marbelup Brook-Marbelup North Rd	34°56.42'	117°42.70'
	KING RIVER WATERSHED		
26.3	King River-Millbrook Rd	34°52.74'	117°46.70'
26.4	King River-Albany Hwy	34°53.24'	117°46.56'
	KALGAN RIVER WATERSHED		
27.3	Stream of Kalgan River-Deep Creek Rd	34°50.12'	118°00.36'
27.4	Kalgan River-Takalarup Rd	34°37.60'	118°02.62'
27.8	Napier Creek-Jackson Rd	34°47.48'	117°51.08'

Table 8 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
27.10	Takenup Creek-Bennett Rd	34°45.79'	117°58.55'
27.11	Takenup Creek-Takenup Rd	34°47.68'	118°01.17'
27.12	Kalgan River-Oyama Rd	34°45.40'	118°03.27'
	TWO PEOPLE'S BAY WATERSHED		
28.9	Moates Lake	34°57.92'	118°07.20'
28.10	Black Cat Creek-Mouth	34°57.17'	118°06.20'
28.14	Angove River-Moyles Rd	34°54.56'	118°08.72'
	MUSEUM RECORDS		
1	Busselton 1912	33°39'	115°24'
2	Albany 1916	34°56'	117°54'
3	Pemberton 1935	34°30'	115°59'
4	Pemberton 1936	34°27'	116°02'
5	1944	34°25'	115°40'
6	1945	33°50'	116°24'
7	1945	34°45'	117°04'
8	Grasmere 1947	35°01'	117°45'
9	Dumbleyung 1947	33°19'	117°38'
10	1947	34°18'	117°32'
11	1948	34°59'	117°44'
12	Cranbrook 1949	34°18'	117°33'
13	1950	33°47'	115°58'
14	1957	34°16'	115°04'
15	Bridgetown 1958	33°57'	116°09'
16	1961	33°22'	116°09'
17	Pemberton 1964	34°28'	116°01'
18	Fish Creek Pool 1964	34°35'	116°25'
19	Shannon River Dam 1959	34°35'	116°24'
20	Margaret River Area 1961	33°57'	115°04'
21	1961	33°22'	116°09'
22	1961	33°06'	115°42'
23	1962	34°16'	115°14'
24	1963	34°59'	117°44'
25	1967	34°57'	118°08'
26	Nannup 1974	33°59'	115°38'
27	Hardy Inlet 1975	34°17'	115°09'
28	Albany 1976	35°01'	117°45'
29	Albany 1976	34°57'	118°05'
30	1976	34°10'	115°40'
31	1981	34°56'	117°53'
32	1981	34°25'	116°38'
33	Northcliffe 1986	34°39'	116°13'
34	Northcliffe 1986	34°44'	116°08'
35	Northcliffe 1986	34°39'	116°05'
36	Northcliffe 1986	34°38'	116°03'
37	Northcliffe 1986	34°31'	115°59'
38	Blackwood River 1986	34°07'	115°36'
39	Donnelly River 1986	34°13'	115°56'
40	Doggerup Creek 1986	34°44'	116°04'
41	Lake Samuel 1986	34°43'	116°04'
42	Shannon River 1986	34°43'	116°22'
43	Shannon River 1986	34°43'	116°26'
44	Shannon River 1986	34°39'	116°19'
45	Northcliffe 1986	34°46'	116°05'
46	Mt Chudalup 1986	34°49'	116°04'
47	1986	34°35'	116°24'
48	Weld River 1986	34°49'	116°31'
49	Elleker-Lake Powell 1986	35°03'	117°46'
50	" " " " "	34°57'	117°46'
51	Albany 1986	34°58'	118°06'
52	1978	33°40'	115°42'
53	Boranup 1965	34°09'	115°02'
54	Albany 1992	35°03'	117°28'

Table 8 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
55	Albany 1992	35°01'	117°16'
56	Denmark 1992	35°00'	117°13'
57	" " "	35°00'	117°04'
58	" " "	35°01'	117°05'
59	" " "	35°01'	117°06'
60	Broke Inlet 1992	34°57'	116°32'
61	Manjimup 1992	34°50'	116°06'
62	" " " "	34°44'	116°06'
63	" " " "	34°44'	116°04'
64	" " " "	34°43'	116°04'
65	" " " "	34°34'	116°55'
66	" " " "	34°33'	115°52'
67	" " " "	34°32'	115°53'
68	" " " "	34°26'	115°43'
69	Nannup 1992	34°24'	115°41'
70	" " "	34°23'	115°35'
	R. JAENSCH (1992)		
5	Lake Quitjup	34°23'	115°35'
6	Lake Jasper	34°24'	115°41'
7	Lake Wilson	34°26'	115°43'
8	Lake Smith	34°26'	115°43'
9	Yeagerup Lake	34°32'	115°53'
11	Un-named Lake(near 9)	34°33'	115°52'
A4	Warren River Oxbow	34°34'	115°55'
12	Doggerup Lake	34°43'	116°04'
13	Lake Samuel	34°44'	116°04'
14	Lake Florence	34°44'	116°06'
15	Gardner River Lake	34°50'	116°06'
16	Maringup Lake	34°50'	116°12'
17	Lake East of Broke Inlet	34°57'	116°32'
19	Owingup Swamp	35°00'	117°04'
20	Boat Harbour Lake 1	35°01'	117°05'
22	" " " " 3	35°01'	117°06'
23	Reserve 12046 Lake	35°00'	117°13'
24	Lake Williams	35°01'	117°16'
25	Lake Saide	35°03'	117°28'
	P. CHRISTENSEN (1982)		
1	Ant Pool	34°44'	116°24'
4	Nelson Rd	34°43'	116°21'
5	" "	34°41'	116°31'
6	" "	34°42'	116°30'
7	Off "	34°42'	116°29'
14	Deeside Coast Rd	34°42'	116°20'
17	South West Hwy	34°58'	116°36'
20	Inlet River	34°55'	116°34'
23	South West Hwy	34°48'	116°32'
24	" " " "	34°46'	116°30'
27	Shannon River	34°35'	116°24'
30	Gardner River Rd	34°43'	116°12'
32	Buldania Creek	34°46'	116°13'
33	Boorara Brook	34°41'	116°12'
38	Barker Rd	34°31'	115°54'
39	Lake Yeagerup	34°32'	115°52'
41	Lake Rd	34°31'	115°53'
42	Ritters Rd	34°30'	115°53'
46	Off Richardson Rd	34°37'	115°58'
47	Richardson Rd	34°38'	115°59'
48	Richardson Rd	34°38'	116°05'
51	Elsie Brook-Thompson Rd	34°51'	116°43'
53	Deep River-Bevan Rd	34°35'	116°33'
56	Tone River-Muirs Hwy	34°24'	116°53'
59	Denbarker Rd	34°45'	117°29'

Table 8 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
61	Mitchell River	34°50'	117°24'
64	Meerup River	34°41'	116°04'
65	Rifle Range Rd	34°37'	116°01'
66	" " "	34°37'	116°01'
68	" " "	34°35'	116°03'
69	Barlee Brook	34°13'	115°45'
70	Vasse Hwy	34°18'	115°46'
76	Weld River-Beardmore Rd	34°37'	116°34'
77	Deep River- " " "	34°48'	116°35'
78	Frankland River-Caldyanning Rd	34°39'	116°48'
83	Bow River-Middle Rd	34°55'	116°58'
85	Barlee Brook-Stewart Rd	34°19'	115°42'
86	Stewart Rd	34°19'	115°42'
87	Black Pt Rd	34°18'	115°40'
90	Fouracres Rd	34°18'	115°31'
93	Scott Rd	34°10'	115°16'
96	Myalgelup Rd	34°33'	116°43'
99	Nornalup Rd	34°39'	116°57'
105	Kordabup Rd	34°59'	117°09'
107	South West Hwy	34°59'	117°18'
111	Muirs Hwy	34°29'	116°58'
113	Kent River-Bevan Rd	34°41'	117°06'
114	Kockelup Rd	34°47'	117°08'
115	Denmark river-Kockelup Rd	34°47'	117°13'

Table 9 The sites at which *Nannatherina balstoni* was captured during the present study, together with those recorded in the collections at the Western Australian Museum, and by Jaensch (1992) and Christensen (1982).

Site Number	General Location	Latitude (S)	Longitude (E)
	MARGARET RIVER WATERSHED		
4.1	Margaret River-Great North Rd(Rapids)	33°52.60'	115°18.01'
4:2	Margaret R-1.3km from Cane Break Rd	33°51.99'	115°18.64'
	SCOTT RIVER WATERSHED		
6.4	Scott R-Bridge on Milyeannup Rd (3)	34°17.80'	115°24.15'
	LAKE QUITJUP WATERSHED		
7.1	Lake Quitjup	34°23.17'	115°35.66'
	DONNELLY RIVER WATERSHED		
9.2	Lake Smith	34°25.89'	115°43.05'
9.10	Fly Brook-Charlie Rd	34°27.24'	115°47.61'
	DOGGERUP CREEK WATERSHED		
12.2	Lake Doggerup	34°42.99'	116°03.88'
	GARDNER RIVER WATERSHED		
13.2	Blackwater-Pool 1	34°49.82'	116°07.29'
13.3	Blackwater-Pool 2	34°49.82'	116°07.34'
13.9	Pool 200m south of 13.10	34°49.40'	116°03.70'
13.12	Pool opposite 13.13	34°49.23'	116°03.72'
13.13	Pool 450m south of 13.14	34°49.17'	116°03.82'
13.14	Pool 50m south of 13.15	34°48.98'	116°04.05'
13.15	Narrow stream on Windy Harbour Rd	34°48.88'	116°04.12'
13.16	Pool on Windy Harbour Rd	34°48.70'	116°04.20'
13.17	Meandering Stream-off Windy Harbour Rd	34°48.41'	116°03.77'
13.18	Summer pool at western end of 13.17	34°48.29'	116°03.75'
13.32	1st pool on Lower Gardner River Rd	34°45.64'	116°09.03'
13.34	Large pool on Chesapeake Rd	34°45.92'	116°09.36'
13.37	Gardner River-South of bridge	34°47.21'	116°11.32'
13.48	Lake Maringup	34°50.22'	116°11.81'
	SHANNON RIVER WATERSHED		
14.4	Shannon River-Bridge on Cheaspeake Rd	34°50.36'	116°22.27'
14.10	Chespeake Brook (2)- 20.05km W Broke Inlet Rd	34°48.96'	116°18.08'
14.14	Pools at Jn of Deeside Coast & Preston Rds	34°38.52'	116°19.63'
	BROKE INLET WATERSHED		
15.1	Forth River	34°51.85'	116°25.55'
15.2	Small stream 6.6km west of Broke Inlet Rd	34°51.94'	116°25.72'
15.4	Pool/small stream 5.2km " " "	34°52.40'	116°26.37'
	DEEP RIVER WATERSHED		
16.2	Weld River- Bridge on Beardmore Rd	34°48.89'	116°34.75'
16.4	Jn Beardmore & South West Hwy	34°48.66'	116°31.82'
16.13	Deep River-Peakway Rd	34°45.99'	116°36.97'
	KENT RIVER WATERSHED		
20.6	Millars Basin-Kent River	34°45.48'	117°03.01'
20.12	Styx River-Break Rd	34°51.10'	117°08.99'
	DENMARK RIVER WATERSHED		
23.7	Quickip River-Denmark Mt Barker Rd	34°52.38'	117°23.25'
	TWO PEOPLE'S BAY WATERSHED		
28.2	Goodga River-Two People's Bay Rd	34°57.21'	118°05.14'
28.10	Black Cat Creek-Mouth	34°57.17'	118°06.20'
	MUSEUM RECORDS		
1	Grasmere 1947	35°01'	117°45'
2	1962	34°13'	115°05'
3	Albany 1976	34°57'	118°05'
4	Northcliffe 1981	34°43'	116°25'
5	Northcliffe 1986-Warren River	34°38'	116°03'
6	Nannup 1986-Blackwood River	34°07'	115°36'
7	Nelson Rd 1986-Shannon River	34°43'	116°26'
8	Mt Chudalup 1986	34°49'	116°04'

Table 9 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
9	Walpole 1986-Weld River	34°49'	116°31'
10	Walpole1986-Inlet River	34°55'	116°34'
11	Denmark 1992	35°00'	117°04'
12	" " " "	35°01'	117°05'
13	Broke Inlet 1992	34°57'	116°32'
14	Manjimup 1992	34°50'	116°06'
15	" " " "	34°44'	116°06'
16	" " " "	34°43'	116°04'
17	" " " "	34°26'	115°43'
18	Nannup 1992	34°23'	115°35'
	R. JAENSCH (1992)		
5	Quitjup Lake	34°23'	115°35'
8	Lake Smith	34°26'	115°43'
12	Doggerup Lake	34°43'	116°04'
14	Lake Florence	34°44'	116°06'
15	Gardner River Lake	34°50'	116°06'
16	Maringup Lake	34°50'	116°12'
17	Lake East of Broke Inlet	34°57'	116°32'
19	Owingup Swamp	35°00'	117°04'
20	Boat Harbour Lake 1	35°01'	117°05'
	P. CHRISTENSEN (1982)		
55	Bevan Rd	34°35'	116°30'
105	Kordabup Rd/South West Hwy	34°59'	117°09'
112	Muir Hwy	34°30'	116°59'
113	Kent R-Bevan Rd	34°41'	117°06'

Table 10 The sites at which *Galaxias truttaceus* was captured during the present study, together with those recorded in the collections at the Western Australian Museum.

Site Number	General Location	Latitude (S)	Longitude (E)
	TWO PEOPLE'S BAY WATERSHED		
28.2	Goodga River-Two People's Bay Rd	34°57.21'	118°05.14'
28.3	Goodga River-Track along River	34°56.96'	118°04.79'
28.9	Moates Lake	34°57.92'	118°07.20'
28.10	Black Cat Creek-Mouth	34°57.17'	118°06.20'
28.11	Black Cat Creek-Firebreak track	34°56.72'	118°06.70'
	MUSEUM RECORDS		
1	Nannarup 1943	34°46'	117°42'
2	Albany 1976	34°57'	118°05'
3	Albany 1980	34°57'	118°03'
4	Albany 1986	34°58'	118°06'
5	Board Rd 1990	34°58'	117°38'

Table 11 The sites at which *Galaxias maculatus* was captured during the present study, together with those recorded in the collections at the Western Australian Museum and by Jaensch (1992).

Site Number	General Location	Latitude (S)	Longitude (E)
	TWO PEOPLE'S BAY WATERSHED		
28.9	Moates Lake	34°57.92'	118°07.20'
	MUSEUM RECORDS		
2	Albany 1986	34°58'	118°06'
1	Boat Harbour Lake 1992	34°58'	117°06'
	R. JAENSCH (1992)		
22	Boat Harbour Lake 3	34°58'	117°06'

Table 12 Those sites at which adults of *Geotria australis* were captured during the present study, together with those recorded in the collections at the Western Australian Museum.

Site Number	General Location	Latitude (S)	Longitude (E)
	MARGARET RIVER WATERSHED		
4.5	Margaret R-1st Weir	33°56.92'	115°03.83'
4.7	Margaret R-2nd Weir	33°56.89'	115°05.35'
	DONNELLY RIVER WATERSHED		
9.6	Donnelly River Mouth	34°29.11'	115°40.42'
9.9	Donnelly River-One Tree Bridge	34°12.19'	115°55.82'
9.10	Fly Brook-Charlie Rd	34°27.24'	115°47.61'
9.11	Fly Brook-Fly Brook Rd	34°27.76'	115°52.45'
9.12	Carey Brook-Bridge on Cleave Rd	34°26.54'	115°47.25'
	WARREN RIVER WATERSHED		
10.4	Warren River-Bridge on Pemb/North Rd	34°30.42'	115°59.54'
10.5	Warren River-King Trout Farm	34°30.10'	115°59.85'
10.6	Lefroy Brook-The Cascades	34°28.60'	116°01.71'
10.7	Lefroy Brook-Downstream of trout hatchery	34°26.60'	116°01.36'
10.8	Lefroy Dam-Immediately downstream	34°26.41'	116°01.36'
10.11	Lefroy Brook-Broken Bridge	34°25.19'	116°01.53'
	MUSEUM RECORDS		
1	Collie 1912	33°22'	116°09'
2	Collie 1916	33°18'	115°44'
3	Harvey	33°23'	115°55'
4	Pemberton	34°27'	116°02'
5	Dardanup 1951	33°21'	115°45'
6	Roelands 1936	33°18'	115°49'
7	Bunbury	33°20'	115°38'
8	1939	33°59'	118°02'
9	1939	34°30'	115°59'
10	Nannup 1941	33°59'	115°45'
11	1945	34°45'	117°04'
12	1945	34°05'	115°30'
13	Hardy Inlet 1949	34°17'	115°09'
14	Denmark 1951	34°57'	117°21'
15	Pemberton 1961	34°28'	116°01'
16	Denmark 1968	34°58'	117°21'
17	Parry Inlet 1972	35°01'	117°09'
18	Pemberton 1974	34°31'	115°58'
19	Gardner River 1982	34°52'	116°12'
20	Albany 1982	35°00'	117°52'

Table 13 The sites at which ammocoetes of *Geotria australis* were captured during the present study, together with those recorded in the collections at the Western Australian Museum, and by Christensen (1982).

Site Number	General Location	Latitude (S)	Longitude (E)
	CAPEL WATERSHED		
2.1	Capel River-under railway bridge	33°33.18'	115°34.01'
2.2	Capel River-south	33°39.16'	115°45.43'
	MARGARET RIVER WATERSHED		
4.5	Margaret R-1st Weir	33°56.92'	115°03.83'
4.7	Margaret R-2nd Weir	33°56.89'	115°05.35'
4.8	Margaret R-Margaret R Rd	33°56.53'	115°06.98'
	DONNELLY RIVER WATERSHED		
9.7	Donnelly River-Boat Ramp	34°26.84'	115°46.38'
9.8	Donnelly River-Bridge on Scott Rd	34°24.93'	115°46.46'
9.10	Fly Brook-Charlie Rd	34°27.24'	115°47.61'
9.11	Fly Brook-Fly Brook Rd	34°27.76'	115°52.45'
9.12	Carey Brook-Bridge on Cleave Rd	34°26.54'	115°47.25'
9.13	Carey Brook-Bridge on Vasse Hwy	34°25.01'	115°48.65'
9.16	Carey Brook-Staircase Rd	34°23.81'	115°50.39'
9.17	Carey Brook-Steep Rd	34°23.56'	115°51.58'
9.18	Carey Brook-Stirling Track and Pile Rd	34°23.24'	115°52.45'
9.19	Carey Brook- " " " and Beedelup Rd	34°23.49'	115°53.10'
9.20	Carey Brook-Thornhill & Seven Day Rds	34°20.11'	115°54.37'
	WARREN RIVER WATERSHED		
10.1	Warren R-Dombakup Brk-Plantation Rd	34°34.66'	115°57.98'
10.5	Warren River-King Trout Farm	34°30.10'	115°59.85'
10.7	Lefroy Brook-Downstream of trout hatch	34°26.60'	116°01.36'
10.10	Middle Weir-Lefroy Brook	34°25.65'	116°01.00'
10.11	Lefroy Brook-Broken Bridge	34°25.19'	116°01.53'
10.12	Big Brook Dam-Under downstream bridge	34°24.73'	116°01.71'
10.16	Bridge south of Jn of 4 & 5 Mile Brooks	34°23.22'	116°00.58'
10.17	Four Mile Brook-Channybearup Rd	34°21.84'	116°00.26'
10.18	" " " " -Seven Day Rd	34°18.65'	115°59.39'
10.19	Channybearup Brook-Seven Day Rd	34°19.11'	115°57.52'
	GARDNER RIVER WATERSHED		
13.37	Gardner River-South of bridge	34°47.21'	116°11.32'
13.38	Gardner River-Bridge	34°46.62'	116°10.87'
13.41	Gardner River-Laws Track	34°42.49'	116°09.96'
	SHANNON RIVER WATERSHED		
14.4	Shannon River-Bridge on Cheaspeake Rd	34°50.36'	116°22.27'
	DEEP RIVER WATERSHED		
16.2	Weld River-Bridge on Beardmore Rd	34°48.89'	116°34.75'
	KENT RIVER WATERSHED		
20.10	Styx River-Fernley Rd	34°53.10'	117°06.33'
	DENMARK RIVER WATERSHED		
23.3	Scotsdale Brook-Mt Lindsay Rd	34°55.38'	117°18.74'
	P. CHRISTENSEN (1982)		
43	Warren River-Lewin Rd	34°36'	115°55'

Table 14 The sites at which *Leptatherina wallacei* was captured during the present study, together with those recorded in the collections at the Western Australian Museum, and by Jaensch (1992).

Site Number	General Location	Latitude (S)	Longitude (E)
	ABBA/LUDLOW DRAINAGE		
3.24	Abba River-Bridge on Bypass	33°38.30'	115°25.91'
	MARGARET RIVER WATERSHED		
4.6	Margaret R-Mouth	33°58.24'	114°59.38'
	BLACKWOOD RIVER WATERSHED		
5.4	Blackwood R-north of Nannup	33°55.27'	115°48.35'
5.5	Blackwood R-Sues Bridge	34°04.54'	115°23.42'
5.8	Blackwood R-Walter Willis Rd	34°56.84'	116°03.38'
5.9	Blackwood R-Tweed Rd	33°58.72'	116°09.54'
5.10	Blackwood R	33°59.89'	116°11.63'
5.11	Blackwood R-Aegers Bridge Rd	33°54.95'	116°25.17'
5.12	Blackwood R-Terry Rd	33°54.47'	116°24.38'
5.13	Blackwood R-Terry Rd	33°51.43'	116°22.66'
5.16	Blackwood R-Condinup Crossing Rd	33°46.35'	116°31.07'
5.18	Towerrinning Lake	33°35.37'	116°47.17'
5.22	Blackwood R-Kulikup Rd & Lower Bridgetown	33°52.39'	116°39.88'
	SCOTT RIVER WATERSHED		
6.3	Scott R- Bridge on Milyeannup Rd (2)	34°17.70'	115°24.10'
	LAKE JASPER WATERSHED		
8.1	Lake Jasper	34°25.22'	115°41.19'
	GARDNER RIVER WATERSHED		
13.12	Pool opposite 13.13	34°49.23'	116°03.72'
	SHANNON RIVER WATERSHED		
14.5	Shannon River-Springbreak Rd	34°52.23'	116°22.37'
	BROKE INLET WATERSHED		
15.10	Inlet River-≈1km upstream of mouth	34°56.28'	116°31.84'
15.11	Inlet River-near mouth	34°56.31'	116°31.60'
15.12	Small stream running into Broke Inlet	34°53.75'	116°26.48'
	FRANKLAND RIVER WATERSHED		
17.13	Frankland River-Caldyanup Crossing	34°48.62'	116°48.57'
17.15	Frankland River-Sappers Bridge	34°57.55'	116°49.40'
17.18	Frankland River-Monastery Rd	34°59.06'	116°48.93'
	HAY RIVER WATERSHED		
24.2	Lake Saide	35°02.58'	117°28.50'
24.6	Hay River-Keith Rd	34°56.00'	117°28.40'
	TWO PEOPLE'S BAY WATERSHED		
28.8	Gardner Lake	34°58.04'	118°09.65'
28.13	Angove Lake	34°56.70'	118°10.01'
	NORMANS BEACH WATERSHED		
30.1	Estuary/stream-Norman's Beach Rd	34°55.17'	118°12.81'
	CHEYNE BEACH WATERSHED		
32.1	Small lake-Cheyne Beach Rd	34°52.50'	118°23.80'
	MUSEUM RECORDS		
1		33°26'	116°48'
2	Kukerin 1964	33°09'	118°01'
3	Katanning 1964	33°41'	117°33'
4	Mayanup 1979	34°00'	116°20'
5	Albany 1992	35°01'	117°44'
6	Denmark 1992	35°00'	117°04'
7	Manjimup 1992	34°57'	116°32'
8	Augusta/Margaret River 1992	34°01'	115°01'
	R. JAENSCH (1992)		
3	Devil's Pool	34°01'	115°01'
16	Lake Maringup	34°50'	116°12'
19	Owingup Swamp	35°00'	117°04'
27	Lake Powell	35°01'	117°44'

Table 15 The sites at which *Psuedogobius olorum* was captured during the present study, together with those recorded in the collections at the Western Australian Museum, and by Jaensch (1992).

Site Number	General Location	Latitude (S)	Longitude (E)
	ABBA/LUDLOW DRAINAGE		
3.1	Lake 9-RGC	33°33.66'	115°32.62'
3.2	Lake 10	33°33.74'	115°32.58'
3.3	Lake 11	33°33.82'	115°32.54'
3.13	Tigersnake Lake	33°35.60'	115°30.00'
3.15	Plover Lakes	33°36.00'	115°29.80'
3.16	Pobblebonk Swamp	33°36.15'	115°29.80'
3.17	Gravel Pool	33°36.20'	115°29.70'
3.18	Stream south of above	33°36.25'	115°29.65'
3.19	Ludlow Swamp	33°35.80'	115°29.80'
3.20	Ludlow River-Bridge on Bypass	33°36.20'	115°28.82'
3.24	Abba River-Bridge on Bypass	33°38.30'	115°25.91'
3.25	Carbanup River	33°40.78'	115°12.19'
	MARGARET RIVER WATERSHED		
4.6	Margaret R-Mouth	33°58.24'	114°59.38'
4.15	Calgardup Brook, mouth-Redgate Rd	34°02.40'	115°00.16'
	BLACKWOOD RIVER WATERSHED		
5.4	Blackwood R-north of Nannup	33°55.27'	115°48.35'
5.5	Blackwood R-Sues Bridge	34°04.54'	115°23.42'
5.7	St John Brook (Blackwood River)	33°52.70'	115°40.59'
5.18	Towerrinning Lake	33°35.37'	116°47.17'
5.19	Arthur R-Moodiarup Rd	33°37.13'	116°47.96'
	SCOTT RIVER WATERSHED		
6.2	Scott R-Bridge on Milyeannup Rd (1)	34°17.56'	115°24.02'
6.3	Scott R- " " " " (2)	34°17.70'	115°24.10'
6.4	Scott R- " " " " (3)	34°17.80'	115°24.15'
6.16	Pool on Scott River Rd-power pole 10	34°16.33'	115°16.17'
	LAKE JASPER WATERSHED		
8.1	Lake Jasper	34°25.22'	115°41.19'
	DONNELLY RIVER WATERSHED		
9.8	Donnelly River-Bridge on Scott Rd	34°24.93'	115°46.46'
	WARREN RIVER WATERSHED		
10.4	Warren River-Bridge on Pemb/North Rd	34°30.42'	115°59.54'
10.28	Wilgarup River-Muirs Hwy	34°19.86'	116°22.45'
	GARDNER RIVER WATERSHED		
13.1	Gardner River Mouth	34°50.43'	116°07.40'
13.2	Blackwater-Pool 1	34°49.82'	116°07.29'
13.3	Blackwater-Pool 2	34°49.82'	116°07.34'
13.12	Pool opposite 13.13	34°49.23'	116°03.72'
13.16	Pool on Windy Harbour Rd	34°48.70'	116°04.20'
13.48	Lake Maringup	34°50.22'	116°11.81'
	SHANNON RIVER WATERSHED		
14.5	Shannon River-Springbreak Rd	34°52.23'	116°22.37'
	BROKE INLET WATERSHED		
15.10	Inlet River-≈1km upstream of mouth	34°56.28'	116°31.84'
15.11	Inlet River-near mouth	34°56.31'	116°31.60'
15.12	Small stream running into Broke Inlet	34°53.75'	116°26.48'
	FRANKLAND RIVER WATERSHED		
17.18	Frankland River-Monastery Rd	34°59.06'	116°48.93'
	KENT RIVER WATERSHED		
20.7	Kent River-Kent River Siding Rd	34°59.01'	117°02.81'
	LAKE WILLIAMS NP WATERSHED		
22.3	Lake on William Bay Rd	34°59.80'	117°13.56'
	HAY RIVER WATERSHED		
24.2	Lake Saide	35°02.58'	117°28.50'

Table 15 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
24.6	Hay River-Keith Rd	34°56.00'	117°28.40'
24.13	Hay River-Spencer Rd	34°44.54'	117°33.73'
	TORBAY INLET WATERSHED		
25.4	Lake Powell	35°01.67'	117°39.60'
	KALGAN RIVER WATERSHED		
27.4	Kalgan River-Takalarup Rd	34°37.60'	118°02.62'
	TWO PEOPLE'S BAY WATERSHED		
28.1	Gardner Lake-Drain	34°57.63'	118°09.63'
28.2	Goodga River-Two People's Bay Rd	34°57.21'	118°05.14'
28.3	Goodga River-Track along River	34°56.96'	118°04.79'
28.8	Gardner Lake	34°58.04'	118°09.65'
28.9	Moates Lake	34°57.92'	118°07.20'
28.10	Black Cat Creek-Mouth	34°57.17'	118°06.20'
28.13	Angove Lake	34°56.70'	118°10.01'
	NORMANS BEACH WATERSHED		
30.1	Estuary/stream-Norman's Beach Rd	34°55.17'	118°12.81'
	MUSEUM RECORDS		
1	1964	34°58'	117°28'
2	1959	34°30'	116°03'
3	Busselton 1972	33°39'	115°29'
4	Albany 1976	35°01'	117°45'
5	" " "	35°01'	117°43'
6	" " "	34°57'	118°05'
7	Northcliffe 1986	34°31'	115°59'
8	Lake Powell 1986	35°03'	117°46'
9	Albany 1992	35°01'	117°44'
10	" " "	35°03'	117°28'
11	Denmark 1992	35°00'	117°13'
12	" " "	35°00'	117°04'
13	" " "	35°01'	117°05'
14	" " "	35°01'	117°06'
15	Manjimup 1992	34°57'	116°32'
16	Nannup 1992	34°24'	115°41'
17	Augusta/Margaret River 1992	34°13'	115°02'
18	" " " " " "	34°01'	115°01'
	R. JAENSCH (1992)		
3	Devil's Pool	34°01'	115°01'
4	Lake Davies	34°13'	115°02'
6	Lake Jasper	34°24'	115°41'
16	Lake Maringup	34°50'	116°12'
19	Owingup Swamp	35°00'	117°04'
20	Boat Harbour Lake 1	35°01'	117°05'
22	" " " " 3	35°01'	117°06'
23	Reserve 12046 Lake	35°00'	117°13'
25	Lake Saide	35°03'	117°28'
27	Lake Powell	35°01'	117°44'

Table 16 The sites at which the trout, *Onchorhynchus mykiss* and *Salmo trutta*, were captured during the present study, together with those recorded in the collections at the Western Australian Museum, and by Christensen (1982).

Site Number	General Location	Latitude (S)	Longitude (E)
	MARGARET RIVER WATERSHED		
3.14	Margaret R-Ten Mile Brook Dam	33°57.98′	115°07.38'
	DONNELLY RIVER WATERSHED		
9.10	Fly Brook-Charlie Rd	34°27.24'	115°47.61'
9.11	Fly Brook-Fly Brook Rd	34°27.76'	115°52.45'
9.13	Carey Brook-Bridge on Vasse Hwy	34°25.01'	115°48.65'
9.14	Beedelup Brook-Karri Valley	34°25.35'	115°51.41'
9.12	Carey Brook-Bridge on Cleave Rd	34°26.54'	115°47.25'
9.15	Beedelup Brook-Opposite Tobruk Rd	34°25.27'	115°49.68'
9.16	Carey Brook-Staircase Rd	34°23.81'	115°50.39'
	WARREN RIVER WATERSHED		
10.7	Lefroy Brook-Downstream of trout hatch	34°26.60'	116°01.36'
10.8	Lefroy Dam-Immediately downstream	34°26.41'	116°01.36'
10.9	Lefroy Dam- " " upstream	34°26.35'	116°01.35'
10.10	Middle Weir-Lefroy Brook	34°25.65'	116°01.00'
10.11	Lefroy Brook-Broken Bridge	34°25.19'	116°01.53'
10.14	Big Brook Dam-Actual	34°24.49'	116°01.64'
	GARDNER RIVER WATERSHED		
13.42	Boorara Brook-Bettink's	34°41.46'	116°10.85'
	MUSEUM RECORDS		
1	Pemberton1986	34°25'	116°01'
2	Northcliffe1986	34°31'	115°59'
	P. CHRISTENSEN (1982)		
43	Lewin Rd	34°36'	115°55'

Table 16.1 The total numbers of trout, *Oncorhynchus mykiss* and *Salmo trutta*, stocked into public waters in the south-west of Australia between 1985 and 1994. N.B. * refers to trout released in vibert boxes by the Western Australian Trout Fishing Association (Tasmanian stock). This information was provided by the Fisheries Department of Western Australia.

Waterbody	Stock	Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Total number of trout stocked in rivers in the south-west of Australia	*O. mykiss*	Ova							28 000			
		Fry	209 000	3 000	63 000		83 000	174 000	112 000	160 000	228 000	225 000
		Yearlings	22 000	6 800	1 000	4 000	4 000	2 000	1 400	3 000	13 000	17 000
		X-brood			2 700						600	
	S. trutta	Ova										
		Fry							*9 000			
		Yearlings			1 700							
		X-brood										
Total number of trout stocked in dams in the south-west of Australia	*O. mykiss*	Ova						25 000		60 000		
		Fry	47 000		38 000		25 000	50 000	20 000	40 000	50 000	60 000
		Yearlings	9 400	12 000	9 200	6 800	6 800	11 000	9 200	5 000	12 000	11 000
		X-brood							500	800	1 800	1 300
	S. trutta	Ova							*35 000			
		Fry							*10 000			
		Yearlings			500							
		X-brood										
Total number of trout stocked in public waters in the south-west of Australia	*O. mykiss*	Ova						25 000	28 000	60 000		
		Fry	256 000	3 000	101 000		108 000	224 000	132 000	200 000	278 000	285 000
		Yearlings	31 400	18 800	10 200	10 800	10 800	13 000	10 600	8 000	25 000	28 000
		X-brood			2 700				500	800	2 400	1 300
	S. trutta	Ova	*35 000						*35 000			
		Fry							*19 000			
		Yearlings			2 200							
		X-brood										

Table 17 The sites at which *Gambusia holbrooki* was captured during the present study, together with those recorded in the collections at the Western Australian Museum, and by Jaensch (1992) and Christensen (1982).

Site Number	General Location	Latitude (S)	Longitude (E)
	COLLIE RIVER WATERSHED		
1.1	Collie River-Schultz's Weir	33°23.19'	116°09.78'
1.2	" " " -Collieburn Pool	33°24.66'	116°11.97'
1.3	" " " -Townsend's Pool	33°25.45'	116°13.00'
1.4	" " " -Cox's Pool	33°25.80'	116°13.13'
1.5	" " " -Round Pool	33°26.16'	116°13.40'
1.6	" " " -Western Collieries	33°28.34'	116°13.86'
1.7	" " " -Davies' Pool	33°28.75'	116°13.90'
	CAPEL WATERSHED		
2.1	Capel River-under railway bridge	33°33.18'	115°34.01'
2.2	Capel River-south	33°39.16'	115°45.43'
	ABBA/LUDLOW DRAINAGE		
3.1	Lake 9-RGC	33°33.66'	115°32.62'
3.2	Lake 10	33°33.74'	115°32.58'
3.3	Lake 11	33°33.82'	115°32.54'
3.4	Swamphen Lake	33°35.27'	115°30.39'
3.6	Peninsula Lake	33°35.30'	115°30.35'
3.9	Crinea Creek	33°35.28'	115°30.15'
3.10	Cadjeput Pool	33°35.50'	115°30.10'
3.11	Taylor's Lake	33°35.70'	115°30.05'
3.12	Boulder Lake	33°35.80'	115°30.02'
3.13	Tigersnake Lake	33°35.60'	115°30.00'
3.14	Priessiana Pool	33°35.75'	115°29.90'
3.15	Plover Lakes	33°36.00'	115°29.80'
3.16	Pobblebonk Swamp	33°36.15'	115°29.80'
3.17	Gravel Pool	33°36.20'	115°29.70'
3.18	Stream south of above	33°36.25'	115°29.65'
3.19	Ludlow Swamp	33°35.80'	115°29.80'
3.20	Ludlow River-Bridge on Bypass	33°36.20'	115°28.82'
3.24	Abba River-Bridge on Bypass	33°38.30'	115°25.91'
3.25	Carbanup River	33°40.78'	115°12.19'
	MAGARET RIVER WATERSHED		
4.5	Margaret River-1st Weir	33°56.92'	115°03.83'
4.7	Margaret R-2nd Weir	33°56.89'	115°05.35'
4.8	Margaret R-Margaret R Rd	33°56.53'	115°06.98'
4.9	Margaret R-Margaret R Rd	33°56.42'	115°08.07'
4.10	Margaret R-Margaret R Rd	33°56.03'	115°08.82'
	BLACKWOOD RIVER WATERSHED		
5.4	Blackwood R-north of Nannup	33°55.27'	115°48.35'
5.8	Blackwood R-Walter Willis Rd	34°56.84'	116°03.38'
5.9	Blackwood R-Tweed Rd	33°58.72'	116°09.54'
5.10	Blackwood R	33°59.89'	116°11.63'
5.11	Blackwood R-Aegers Bridge Rd	33°54.95'	116°25.17'
5.12	Blackwood R-Terry Rd	33°54.47'	116°24.38'
5.13	Blackwood R-Terry Rd	33°51.43'	116°22.66'
5.14	Blackwood R-Arthur River Rd	33°44.57'	116°34.34'
5.15	Blackwood R-Gibb Rd	33°43.84'	116°31.23'
5.16	Blackwood R-Condinup Crossing Rd	33°46.35'	116°31.07'
5.19	Arthur R-Moodiarup Rd	33°37.13'	116°47.96'
5.20	Balgarup R	33°47.18'	116°55.63'
5.22	Blackwood R-Kulikup Rd & Lower Bridgetown	33°52.39'	116°39.88'
5.23	Chapman Brook	34°04.61'	115°11.31'
5.24	Chapman Brook	34°05.33'	115°12.04'
	SCOTT RIVER WATERSHED		
6.1	Scott River-Brennan Bridge	34°15.58'	115°16.23'
	DONNELLY RIVER WATERSHED		
9.9	Donnelly River-One Tree Bridge	34°12.19'	115°55.82'
9.10	Fly Brook-Charlie Rd	34°27.24'	115°47.61'
9.14	Beedelup Brook-Karri Valley	34°25.35'	115°51.41'
	WARREN RIVER WATERSHED		
10.4	Warren River-Bridge on Pemb/North Rd	34°30.42'	115°59.54'
10.5	Warren River-King Trout Farm	34°30.10'	115°59.85'
10.8	Lefroy Dam-Immediately downstream	34°26.41'	116°01.36'
10.9	Lefroy Dam- " " upstream	34°26.35'	116°01.35'

Table 17 (cont.)

Site Number	General Location	Latitude (S)	Longitude (E)
10.10	Middle Weir-Lefroy Brook	34°25.65'	116°01.00'
10.11	Lefroy Brook-Broken Bridge	34°25.19'	116°01.53'
10.12	Big Brook Dam-Under downstream bridge	34°24.73'	116°01.71'
10.13	Big Brook Dam-Pool at bottom of dam	34°24.68'	116°01.71'
10.14	Big Brook Dam-Actual	34°24.49'	116°01.64'
10.15	Bridge Upstream of Big Brook Dam	34°24.26'	116°00.22'
10.21	Peerup River-Bridge on Muirs Hwy	34°23.41'	116°25.52'
10.25	Tone River-Two Mile	34°26.24'	116°36.96'
10.26	Tone River-Two Mile	34°26.00'	116°36.00'
10.27	Tone River-Wingarup Gully	34°25.68'	116°35.00'
	LAKE MUIR WATERSHED		
11.1	Lake Muir	34°26.41'	116°39.58'
11.2	Noobijup lake	34°23.89'	116°47.06'
11.3	Byenup Lagoon	34°29.95'	116°43.36'
11.4	Lake at Jn of Lake Unicup & Pindicup Rds	34°22.57'	116°41.87'
11.5	Cowerup Swamp (Surrounding Pools)	34°26.22'	116°38.68'
11.7	Red Lake	34°26.30'	116°38.33'
11.8	Drain fom Red Lake	34°26.25'	116°39.47'
11.9	Red Lake	34°26.20'	116°39.40'
11.10	Red Lake	34°25.90'	116°39.40'
11.11	Drain-connect Red Lake/Lake Muir/Cowerup Sw	34°26.35'	116°39.07'
11.18	Stream adjacent toLake Muir-Muirs Hwy	34°26.41'	116°41.50'
11.19	Stream adjacent toLake Muir- " "	34°26.49'	116°41.58'
11.20	Pool adjacent toLake Muir- " "	34°26.46'	116°40.32'
11.21	Pool adjacent toLake Muir- " "	34°26.46'	116°40.29'
11.22	Pool adjacent toLake Muir- " "	34°26.30'	116°40.20'
	GARDNER RIVER WATERSHED		
13.16	Pool on Windy Harbour Rd	34°48.70'	116°04.20'
	FRANKLAND RIVER WATERSHED		
17.12	Frankland River-Elsie Brook Rd	34°52.33'	116°44.14'
17.14	Frankland River-Mitchell Rd	34°45.80'	116°50.24'
17.18	Frankland River-Monastery Rd	34°59.06'	116°48.93'
	KENT RIVER WATERSHED		
20.4	Kent River-Break Rd	34°49.95'	117°03.56'
20.5	Falls of Forth-Kent River	34°50.52'	117°04.84'
	HAY RIVER WATERSHED		
24.2	Lake Saide	35°02.58'	117°28.50'
	TORBAY INLET WATERSHED		
25.4	Lake Powell	35°01.67'	117°39.60'
	KING RIVER WATERSHED		
26.4	King River-Albany Hwy	34°53.24'	117°46.56'
	KALGAN RIVER WATERSHED		
27.3	Stream of Kalgan River-Deep Creek Rd	34°50.12'	118°00.36'
	MUSEUM RECORDS		
1	1964	34°35'	116°25'
2	1961	33°06'	115°42'
3	Katanning 1971	33°42'	117°33'
4	Busselton 1972	33°39'	115°29'
5	1981	34°25'	116°38'
6	Lake Powell 1986	35°03'	117°46'
7	Albany 1992	35°01'	117°44'
8	" " "	35°03'	117°28'
9	Manjimup 1992	34°34'	116°55'
10	" " "	34°32'	115°53'
	R. JAENSCH (1992)		
9	Lake Yeagerup	34°32'	115°53'
A4	Warren River Oxbow	34°34'	115°55'
25	Lake Saide	35°03'	117°28'
27	Lake Powell	35°01'	117°44'
	P. CHRISTENSEN (1982)		
97	Frankland River-Myalgelup	34°33'	116°51'

Table 18 The sites at which *Perca fluviatilis* was captured during the present study, together with those recorded in the collections at the Western Australian Museum.

Site Number	General Location	Latitude (S)	Longitude (E)
	COLLIE RIVER WATERSHED		
1.1	Collie River-Schultz's Weir	33°23.19'	116°09.78'
1.2	" " " -Collieburn Pool	33°24.66'	116°11.97'
1.3	" " " -Townsend's Pool	33°25.45'	116°13.00'
1.4	" " " -Cox's Pool	33°25.80'	116°13.13'
1.5	" " " -Round Pool	33°26.16'	116°13.40'
1.6	" " " -Western Collieries	33°28.34'	116°13.86'
1.7	" " " -Davies' Pool	33°28.75'	116°13.90'
	CAPEL WATERSHED		
2.1	Capel River-under railway bridge	33°33.18'	115°34.01'
2.2	Capel River-south	33°39.16'	115°45.43'
	MARGARET RIVER WATERSHED		
4.14	Margaret R-Ten Mile Brook Dam	33°57.98'	115°07.38'
	DONNELLY RIVER WATERSHED		
9.16	Carey Brook-Staircase Rd	34°23.81'	115°50.39'
	WARREN RIVER WATERSHED		
10.1	Warren R-Dombakup Brk-Plantation Rd	34°34.66'	115°57.98'
10.8	Lefroy Dam-Immediately downstream	34°26.41'	116°01.36'
10.10	Middle Weir-Lefroy Brook	34°25.65'	116°01.00'
10.11	Lefroy Brook-Broken Bridge	34°25.19'	116°01.53'
10.12	Big Brook Dam-Under downstream bridge	34°24.73'	116°01.71'
10.14	Big Brook Dam-Actual	34°24.49'	116°01.64'
	MUSEUM RECORDS		
1	Bridgetown 1937	33°57'	116°08'

Guide to Authors

Subject Matter:

Reviews, observations and results of research into all branches of natural science and human studies will be considered for publication. However, emphasis is placed on studies pertaining to Western Australia. Longer papers will be considered for publication as a Supplement to the *Records of the Western Australian Museum*. Short communications should not normally exceed three typed pages and this category of paper is intended to accommodate observations, results or new records of *significance*, that otherwise might not get into the literature, or for which there is a particular urgency for publication. All material must be original and not have been published elsewhere.

Presentation:

Authors are advised to follow the layout and style in the most recent issue of the *Records of the Western Australian Museum* including headings, tables, illustrations and references.

The title should be concise, informative and contain key words necessary for retrieval by modern searching techniques. An abridged title (not exceeding 50 letter spaces) should be included for use as a running head.

An abstract must be given in full length papers but not short communications, summarizing the scope of the work and principal findings. It should normally not exceed 2% of the paper and should be suitable for reprinting in reference periodicals.

The International System of units should be used.

Numbers should be spelled out from one to nine in descriptive text; figures used for 10 or more. For associated groups, figures should be used consistently, e.g. 5 to 10, not five to 10.

Spelling should follow the *Concise Oxford Dictionary*.

Systematic papers must conform with the International Codes of Botanical and Zoological Nomenclature and, as far as possible, with their recommendations.

Synonymies should be given in the short form (taxon, author, date, page) and the full reference cited at the end of the paper. All citations, including those associated with scientific names, must be included in the references.

Manuscripts:

The original and two copies of manuscripts and figures should be submitted to the Editors, c/- Publications Department, Western Australian Museum, Francis Street, Perth, Western Australia 6000. They must be in double-spaced typescript on A4 sheets. All margins should be at least 30 mm wide. Tables plus heading and legends to illustrations should be typed on separate pages. The desired position for insertion of tables and illustrations in the text should be indicated in pencil. Tables should be numbered consecutively, have headings which make them understandable without reference to the text, and be referred to in the text.

High quality illustrations are required to size (16.8 cm x 25.2 cm) or no larger than 32 cm x 40 cm with sans serif lettering suitable for reduction to size. Photographs must be good quality black and white prints, not exceeding 16.8 cm x 25.2 cm. Scale must be indicated on illustrations. All maps, line drawings, photographs and graphs, should be numbered in sequence and referred to as Figure/s in the text and captions. Each must have a brief, fully explanatory caption. On acceptance a computer disk containing all corrections should be sent with amended manuscript. The disk should be marked with program (e.g. Word, WordPerfect, etc).

In papers dealing with historical subjects references may be cited as footnotes. In all other papers references must be cited in the text by author and date and all must be listed alphabetically at the end of the paper. The names of journals are to be given in full.

Processing:

Papers and short communications are reviewed by at least two referees and acceptance or rejection is then decided by the editors.

The senior author is sent one set of page proofs which must be returned promptly.