Fish fauna of the Donnelly River, Western Australia

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Summary

This report provides an overview of the fishes of the Donnelly River that is based on collections made during June 2006 and from historical data. The Donnelly River, including Lake Jasper, Lake Wilson and Lake Smith, is one of the few catchments in south-western Australia that is inhabited by all of the region’s endemic freshwater fishes. The relative high diversity of freshwater fishes is likely to have been fostered by the diversity of aquatic habitats offered within the catchment. For example, species such as the Salamanderfish and Black-stripe Minnow are restricted to ephemeral pools and floodplain environments and within the Donnelly catchment are confined to the wetlands and pools on Scott Rd and around Lake Smith. Lake Smith is also the only known location within the catchment of the rare Balston’s Pygmy Perch and, together with Lake Wilson is the only known habitat in the catchment with the large Freshwater Cobbler. The Western Minnow, Western Pygmy Perch and Nightfish are relatively common and widespread through the catchment, occurring in most habitat types including the lakes. The rare Mud Minnow is restricted to headwater streams and is very uncommon in the system, possibly as a consequence of predation by exotic species. Three introduced fishes are known from the Donnelly River, the Eastern Mosquitofish, Redfin Perch and Rainbow Trout, the latter being the most widespread, presumably as a consequence of the long term stocking of the species into the catchment. For example, over 500,000 Rainbow Trout were stocked into the system between 1999 and 2004, however there is limited information on the impacts of the species on the ecology of the river. There have been only limited surveys of the estuary of the Donnelly River, and only a small number of species have been recorded there. It is recommended that further seasonal surveys are conducted within the estuary to determine the species composition. The Donnelly River also supports extremely important breeding and nursery grounds for the primitive Pouched Lamprey. Good water quality and habitats (uncleared, high organic content and shade) in some of the major tributaries provide the ammocoetes (larvae) with important nursery areas. The Donnelly River and its catchment is an important refuge for a number of fishes that are unique to Western Australia, while it is also important to many people for recreational purposes and possesses many sites that are of cultural and archaeological importance.
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Background

The catchment of the Donnelly River is comparatively small; covering an area of approximately 1600 km$^2$, with the headwaters arising between Bridgetown and Manjimup some 60 km inland before flowing south-west where they meet the Southern Ocean (Hodgkin and Clarke 1989). Situated in the high rainfall belt in the south-western corner of Western Australia, the catchment is largely uncleared (80-90%) and dominated by impressive Karri (Eucalyptus diversicolor) and Jarrah (Eucalyptus marginata) forests (Hodgkin and Clarke 1989, Pen 1999). Although in south-western Australia there are some 20 river systems that are larger than the Donnelly River, it is sixth in terms of mean annual flow (310000 ML). Within the Donnelly River catchment are the near pristine wetlands of Lake Jasper, Lake Wilson and Lake Smith. Parts of the lower Donnelly River, Barlee Brook and much of Lake Jasper are of important cultural and archaeological significance and many of these sites are Registered Aboriginal Heritage Sites (Dortch & Godfrey 1990, Goode 2003, Goode & Irvine 2006).

There have been several studies relating to the fish fauna of the Donnelly River. The distributions of freshwater fishes inhabiting the Donnelly River and the adjacent lakes were documented by Morgan et al. (1998), and include data from the collections in the Western Australian Museum and from those made by Christensen (1982) and from Jaensch (1992) in Lakes Jasper, Wilson and Smith. Hodgkin and Clarke (1989) provide a list of the fish species found within the Donnelly River Estuary and also provide information on the catchment characteristics and physical features. Hoddell (2003) examined the phylogeny (i.e. evolutionary relationships) of the Western Hardyhead (Leptatherina wallacei) and the Swan River Goby (Pseudogobius olorum) in the lower estuary and Lake Jasper and compared these to populations elsewhere in south-western Australia. Since the mid 1970s Professor Ian Potter and his staff and students in the Centre for Fish and Fisheries Research at Murdoch University have been extremely active in the study of the Pouched Lamprey (Geotria australis), with much of the work (almost 100 scientific publications) involving lampreys from the Donnelly River, many of which have been collected by the senior author with site captures of adults and ammocoetes (larvae) presented in Morgan et al. (1998). The Donnelly River is also regularly stocked with trout and information regarding such stockings was obtained from the Department of Fisheries Western Australia while there is some information on the diets of trout from the Donnelly River in Morgan et al. (2004). By collating relevant information in the above studies and through additional sampling in the lower Donnelly River, this report provides an overview of the fishes in the Donnelly River.

Adult Pouched Lamprey (Geotria australis)
Methodology

Collections of fish in the Donnelly River

As mentioned in the Background, a number of studies provide information regarding specific aspects of the fishes of the Donnelly River. Utilising GPS co-ordinates and species occurrences in Christensen (1982) (11 sites), Jaensch (1992) (3 sites), Morgan et al. (1998) (24 sites) and Hoddell (2003) (3 sites), together with five sites sampled during June 2006, we have generated a series of species maps using MapInfo (MapInfo Corporation 1998) (see Figure 1). Information regarding species in the estuary was collated from Hodgkin and Clarke (1989), Hoddell (2003), Brearley (2005) and from samples obtained during June 2006 (this study).

Sampling during June 2006 included four sites within the estuary (tidal influence) and one site on Carey Brook (Figure 1). Sampling methods included monofilament gill nets, fine mesh (3 mm) seine nets, and both boat deployed (240v) and backpack (12v) electrofishers. At the time of sampling the river mouth was open and the river was tidally influenced to at least Boat Landing Road.

![Figure 1](image-url)  
**Figure 1** Sites sampled for fish in June 2006 and during relevant past studies; each of which was used to provide species distributions throughout the catchment.
In the following synopsis of the fish fauna of the Donnelly River we have grouped species into a number of conventionally used life history categories, i.e. species have been conveniently grouped if they are strictly freshwater species, are estuarine teleosts or whether they are introduced fishes. A further category has been included to account for the anadromous Pouched Lamprey, which belongs to a primitive group of fishes known as the Agnatha.

Native Freshwater Fishes of the Donnelly River

The south-west of Western Australia (otherwise known as the Southwest Coast Drainage Division) has the highest proportion (80%) of endemic fishes in the country. Of the 10 native freshwater fishes that are naturally found within the south-west, eight are found nowhere else. The Donnelly River catchment (including Lakes Jasper, Wilson and Smith) is one of the few systems in the south-west that provides refuge for all of the south-west’s endemic fishes. As such, it is extremely important to the State’s biodiversity and houses the enigmatic Salamanderfish (*Lepidogalaxias salamandroides*), the Freshwater Cobbler (*Tandanus bostocki*), the Western Minnow (*Galaxias occidentalis*), the Black-stripe Minnow (*Galaxiella nigrostriata*), the Mud Minnow (*Galaxiella munda*), the Western Pygmy Perch (*Edelia vittata*), Balston’s Pygmy Perch (*Nannatherina balstoni*) and the Nightfish (*Bostockia porosa*). A synopsis of each of these species follows:

**Salamanderfish (*Lepidogalaxias salamandroides*)**

*Photo: D. Morgan*

**Distribution in the Donnelly River catchment:** The Salamanderfish has a very restricted distribution, occurring in pools from Augusta to just east of Walpole (Morgan *et al.* 1998). The Salamanderfish is seldom found in the main channel, or even a major tributary, of any river system and the Donnelly is no exception. Within the Donnelly catchment the Salamanderfish has been captured from: the swamps surrounding Lake Smith, in pools along Scott Rd and on a large flat on Pneumonia Rd (Figure 2).
species is characteristically found in tannin stained, acidic, ephemeral pools in heath land associated with the peat flats (Christensen 1982, Morgan et al. 1998).

**Life history and general remarks:** Although the Salamanderfish is of small size (generally <80 mm total length (TL)) and very restricted in distribution, it has created much interest amongst biologists not only because it is the sole member of the Lepidogalaxiidae, but because it possesses a number of unusual characteristics. For example, not only does it aestivate when the pools in which it inhabits dry up (Pusey 1989) but it can bend its head at right angles to the body (Berra and Allen 1989); has an anal fin which, in the adult male, becomes greatly modified to facilitate sperm transfer to the female (Pusey and Stewart 1989); has an unusual sequence of fin development (Gill and Morgan 1999); and an atypical sperm morphology (Leung 1988). This species survives aestivation by inter alia secreting a mucous sheath over its entire body, which thereby protects it from desiccation, and by possessing mechanisms that enable it to minimise the accumulation of urea (Pusey 1989). The ability to burrow is facilitated by a robust wedge-shaped skull, a flexible vertebral column and reduced ribs (Berra and Allen 1989). Salamanderfish are multiple spawners that breed between winter and early spring and although some may attain maturity in their first year of life, most mature in their second (Morgan et al. 2000). Salamanderfish live for a maximum of only four to five years (Morgan et al. 2000).
Freshwater Cobbler (*Tandanus bostocki*)

**Photo:** M. Allen

**Distribution in the Donnelly River catchment:** The Freshwater Cobbler has a relatively sporadic and unusual distribution within south-western Australia and the same may be said within the Donnelly catchment, where it is only known from Lake Smith and Lake Wilson (Figure 3) (Jaensch 1992, Morgan *et al.* 1998). The species is characteristically found in large waterbodies such as the main channel of rivers and/or dams.

**Life history and general remarks:** Attaining almost 500 mm TL, this is the largest of the region’s freshwater fishes. Breeding occurs in late spring and early summer and the diet is dominated by freshwater crayfish, mussels and small teleosts.

**Figure 3** Distribution of Freshwater Cobbler within the Donnelly River catchment.
Western Minnow (*Galaxias occidentalis*)

Distribution in the Donnelly River catchment: The Western Minnow is the most widespread and abundant of south-western Australia’s endemic freshwater fishes and is known from the Arrowsmith River in the north to the Waychinnicup River in the south-east. They are found in larger rivers, small streams, lakes and floodwaters and have a diet that consists largely of terrestrial insects. The Western Minnow is widespread throughout the Donnelly River and is very abundant in Lakes Jasper, Wilson and Smith where they often form large schools (Figure 4).

Life history and general remarks: Major migratory periods include late winter and spring to spawn and late spring for new recruits. Rarely exceeding 150 mm TL, the species is considerably tolerant of salt and is still found in the upper reaches of salt-affected systems, such as the Blackwood River. Considerable coloration differences exist between populations in Lake Jasper compared to Lake Wilson and Smith; presumably as a response to the tannin coloured waters of the latter lakes. The Lake Jasper population is infected with an introduced cestode (tapeworm), *Ligula intestinalis*.

![Distribution of the Western Minnow within the Donnelly River catchment.](Figure 4)
**Mud Minnow (Galaxiella munda)**

**Distribution in the Donnelly River catchment:** The Mud Minnow is one of the rarest of the south-west’s endemic fishes and it has only been reported in the Donnelly River catchment in three localities by Christensen (1982) (Figure 5). An isolated population of the species is found in the Moore River catchment near Gingin, the next nearest population being in the upper headwaters of Margaret River (Morgan *et al.* 1998).

**Life history and general remarks:** Mud Minnows have an extended breeding period (July-October), are multiple spawners and die in the next few months after spawning, i.e. they only live for just over a year, and rarely exceed 60 mm TL (Pen *et al.* 1991). The small size, surface feeding and preference for headwater streams has seen it disappear from a number of systems, presumably as a result of predation by introduced fishes such as Redfin Perch, trout and Eastern Mosquitofish (Morgan *et al.* 1998, 2002).

![Figure 5](image)  
**Figure 5**  Distribution of the Mud Minnow within the Donnelly River catchment.
Black-stripe Minnow (Galaxiella nigrostriata)

**Distribution in the Donnelly River catchment:** The Black-stripe Minnow is very restricted in geographical distribution and also in the habitat types that it occupies. Along with the Salamanderfish, it is generally restricted to ephemeral pools along the south coast between Augusta and Walpole although disjunct populations have been recorded (Morgan et al. 1998, Morgan & Gill 2000). Within the Donnelly River catchment it is restricted to a number of pools/floodwaters along Scott Road (Figure 6).

**Life history and general remarks:** The waters in which it lives are generally tannin stained and acidic (pH 3-6). Their appearance in pools that were artificially filled with water suggests that they are capable of aestivation (Morgan et al. 1998). The Black-stripe Minnow has a diet that consists largely of terrestrial insects as adults and aquatic invertebrates as larvae (Gill & Morgan 2003) and it generally only lives for just over a year (Pen et al. 1993).

![Distribution of the Black-stripe Minnow within the Donnelly River catchment.](image)

*Figure 6*  Distribution of the Black-stripe Minnow within the Donnelly River catchment.
Western Pygmy Perch (*Edelia vittata*)

**Distribution in the Donnelly River catchment:** The Western Pygmy Perch is widespread and relatively common in a number of habitats throughout the Donnelly River catchment (Figure 7). It is particularly abundant in Lake Smith and Lake Wilson. The species is widespread throughout south-western Australia, from the Arrowsmith River in the north to the Angove River in the south-east.

**Life history and general remarks:** Its absence from the main channel of some of the region’s larger salt-affected rivers suggests a relatively low tolerance to dissolved salts. They are also susceptible to *Gambusia* attack. They are multiple spawners during spring and live for up to five years (Pen & Potter 1991).

![Distribution of the Western Pygmy Perch within the Donnelly River catchment.](image)
Balston’s Pygmy Perch (*Nannatherina balstoni*)

**Distribution in the Donnelly River catchment:** Balston’s Pygmy Perch is extremely rare, and within the Donnelly River catchment is only known from Lake Smith, with one individual found in Fly Brook (Figure 7) (Morgan *et al.* 1998). Specimens of the species from Moore River are housed in the Western Australian Museum and Pen (1999) reports one individual from the Collie River. Their range has been severely fragmented by development and they are now found from the upper reaches of Margaret River east to the Angove River.

**Life history and general remarks:** Balston’s Pygmy Perch breed in their first year of life and the diet is dominated by terrestrial insects. They are not long lived and are rarely found in large numbers (Morgan *et al.* 1995).

![Figure 8](image)

*Figure 8* Distribution of the Balston’s Pygmy Perch within the Donnelly River catchment.
Nightfish (Bostockia porosa)

Distribution in the Donnelly River catchment: The Nightfish is found throughout the catchment including in the Lakes Jasper, Wilson and Smith (Figure 9). It is comparatively widespread throughout south-western Australia from the Hill River to the Kalgan River.

Life history and general remarks: A nocturnal species, the Nightfish requires complex habitat and is thus rarely found in areas devoid of instream structure. Nightfish attain a maximum of 150 mm TL, with most males reaching maturity in their first year and females delaying maturation until their second year (Pen & Potter 1990). Nightfish live for up to six years.

Figure 9 Distribution of the Nightfish within the Donnelly River catchment.
Estuarine Fishes in the Donnelly River

Hodgkin and Clarke (1989) report a number of marine/estuarine fishes from the Donnelly River estuary including: Black Bream (*Acanthopagrus butcheri*), Yelloweye Mullet (*Aldrichetta forsteri*), Sea Mullet (*Mugil cephalus*), Silverfish (*Atherinosoma presbyteroides*), Hardyhead (listed as Atherinid sp. but is presumably the Western Hardyhead (*Leptatherina wallacei*)), South West Goby (*Afurcagobius suppositus*) and Blue Spot or Swan River Goby (*Pseudogobius olorum*). Brearley (2005) adds that other species, including Tarwhine (*Rhabdosargus sarba*), Cobbler (presumably *Cnidoglanis macrocephalus*), Australian Herring (*Arripis georgianus*) and flathead sp. are also caught by recreational anglers in the river. Our sampling in June 2006 in the estuary captured the majority of these species including Black Bream, Tarwhine, Australian Herring, Sea Mullet, Yelloweye Mullet, Western Hardyhead, Swan River Goby and South West Goby. At the time of sampling the mouth of the river was open, and the salinity of the bottom (at Hut 20) was 21.1 ppt while the surface salinity was 1.0 ppt. The salinity at Boat Landing Rd boat ramp was still ~18 ppt on the bottom but was fresh on the surface. While the majority of the above species are not found beyond the lower estuary or limit of tidal influence, the Western Hardyhead, Swan River Goby and South West Goby are recorded upstream into freshwaters in many of the south-west’s river and within the Donnelly catchment they are each very abundant within Lake Jasper (Morgan *et al.* 1998). During recent sampling we also captured the South West Goby in Carey Brook and the Swan River Goby was previously captured a considerable distance up the main channel of the Donnelly River (see Morgan *et al.* 1998).

![Figure 10](image.jpg)

**Figure 10** Some of the fish species found within the Donnelly River estuary.

**Introduced Fishes**

Prior to 2005 a total of 10 species of introduced freshwater fish were recorded from Western Australia (Morgan *et al.* 2004), with a further two introduced fish species being captured in south-western Australia in the last two years. The Donnelly River catchment has records of Eastern Mosquitofish (*Gambusia holbrooki*) and Redfin Perch (*Perca fluviatilis*) from a few locations (see Morgan *et al.* 1998) while Rainbow Trout
(Oncorhynchus mykiss) are fairly prolific within the catchment, presumably as a result of a long term stocking programme in the system (Figure 11). For example, approximately 500,000 Rainbow Trout fry were stocked by the Department of Fisheries Western Australia into the Donnelly River between 1999 and 2004, and this figure includes approximately 70,000 fry into both Carey Brook and Barlee Brook. This represents about 20% of all of the Rainbow Trout fry stocked into Western Australian waters. A further 20,500 yearling Rainbow Trout were also stocked during this period, representing ~13% of all yearling Rainbow Trout stocked. Although they are stocked into the freshwaters of the main channel and main tributaries of the system, Rainbow Trout are apparently commonly captured at the mouth of the river at certain times of the year and were reported from the mouth of the river by Hodgkin & Clarke (1989). The impact of stocking a large predatory fish such as Rainbow Trout within the Donnelly River has not been assessed. An examination of the stomachs of 20 small Rainbow Trout (<310 mm TL, mean TL = 152 mm) in Carey Brook captured in May 1996 revealed that they preyed on a variety of fauna, but the stomachs were dominated by terrestrial fauna (insects) (35% by volume), freshwater crayfish (13%), dipteran larvae (11%), dipteran pupae (12%) and fish/larval lampreys (4%). The proportion of different prey eaten will no doubt change when considering larger trout (see Tay 2005). The impact of trout stocking in this system needs to be assessed in both the freshwaters and the estuary. The impacts of the other feral species that are found in the system are summarised in Morgan et al. (2004), while information on Redfin Perch and Eastern Mosquitofish in WA can also be found in Morgan et al. (2002) and Gill et al. (1999), respectively.

Figure 11  The published records of Rainbow Trout within the Donnelly River catchment.
Lampreys in the Donnelly River

The Pouched Lamprey (*Geotria australis*) belongs to the Petromyzontiformes, which are one of the only two surviving groups of the jawless (agnathan) stage in vertebrate evolution (Hardisty 1982). The absence of jaws and paired fins separates the agnathans from the cartilaginous (sharks and rays) and bony (teleosts) fishes. While there are 38 species of extant lampreys, the Pouched Lamprey is the sole member of the Geotriidae and one of only four species of Southern Hemisphere lampreys (Potter 1980). The species is known from south-western and south-eastern Australia, Tasmania, New Zealand and south-western and south-eastern South America (Potter 1996) and in WA it is found in most of the river systems from the Murray River south to approximately the Waychinnicup River east of Albany (Morgan *et al.* 1998). After four or so years, the microphagous larva (ammocoete) undergoes a radical metamorphosis into an adult, which possesses eyes, one or two prominent dorsal fins and a tooth-bearing suckorial disc (Potter *et al.* 1980, Potter & Hilliard 1986). The adult of the species is parasitic and is thought to feed on the flesh of teleost fishes (Gill *et al.* 2003).

Much of the work on the species in south-western Australia has been undertaken by Professor Ian Potter and his colleagues at Murdoch University who have worked on the species since 1976, with almost 100 scientific articles published on various aspects of the species including, for example: biology, habitats, development, morphology, relationship to other lampreys and physiology. The life-cycle is complex, with the worm–like larval stage (ammocoete) living in ‘burrows’ below the substrate where they feed on diatoms, detritus and micro-organisms. In south-western Australia at approximately four years of age (and at approximately 90 mm TL) the ammocoete undergoes metamorphosis (Figure 12) with the resultant downstream migrant leaving the river during winter. It is thought that there is a one to two year marine trophic phase, where it presumably feeds on fish and their length increases to approximately 500-700 mm TL. The adult then ceases feeding, re-enters rivers and embarks on an upstream migration (moving predominantly at night) during winter and spring. After spending approximately 15-16 months in the river, when they survive off accumulated fat reserves, the adults spawn and die. During this 15-16 month period in the river the adults mature and the males develop a large gular pouch (hence the name pouched lamprey) (Figure 12). An enlargement of the oral disc also occurs during this maturation period.

The sites that ammocoetes were found buried in within the Donnelly River (Figure 13) were characterised by a high degree of shade and a high abundance of organic material on the substrate, factors that are known to influence larval densities (Potter *et al.* 1986). The metamorphosed juveniles (downstream migrants) however are most often associated with (buried in) sandy substrates that occur in well-oxygenated waters. At the site sampled on Carey Brook during this study, a total of 92 downstream migrants were captured, at an approximate density of 0.31 m^-2^, while only 11 ammocoetes were captured.

*Fish fauna of the Donnelly River*
The strength of the upstream migration is variable from year to year, and due to their nocturnal migration being in winter they are seldom seen. The larvae are particularly vulnerable to habitat modification and rely on well oxygenated non-saline waters that are characterised by shade and organic matter. There is substantial evidence that lampreys are declining in numbers, particularly as a result of loss of suitable habitat for the larvae, and this is evident within south-western Australian rivers such as the Blackwood where salinisation and land clearing are causing loss of larval beds.

Figure 12  The life-cycle of the Pouched Lamprey includes an upstream migration phase from the sea to a river, the adults mature over the next year with males developing a gular pouch and enlarged oral disc; larvae (ammocoetes) remain buried in freshwater tributaries for over four years then metamorphose into a small juvenile and head back to sea during winter. Photographs: D. Morgan, I. Potter & L. Brooker

Figure 13  The locations of the Pouched Lamprey within the Donnelly River catchment. The site at the mouth and the upper river represents adults caught by colleagues at Murdoch University. Most other sites indicate ammocoete (larval) beds.
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