wheatbelt natural resource management

Australian Government

Department of Environment and Conservation

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Aquatic invertebrates and waterbirds of wetlands in the Avon region

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By Susan Jones, Cara Francis, Anna Leung and Adrian Pinder

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Common names and scientific names of waterbirds used in this booklet are consistent with the most up to date CSIRO/Australian Museum avian taxonomic list available at the time of printing (Christidis and Boles, 2008).

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Foreword

More than 23,000 wetlands of various types and sizes have been mapped in the Avon region during the past few years. These were highly valued by the original inhabitants of the region as well as early European settlers. Aside from being places of great beauty and an integral part of south-west ecosystems, they were also sources of food and provided water for stock. Some early naturalists found an incredible diversity of life and reported fascinating adaptations to the pulse of the seasons. Barbara York Main, then of Yorkrakine, recorded her discoveries in *'Between Wodjil and Tor'* published in 1967. Others, like Professor Dakin and overseas scientists represented by Folk Linder, named some of the unique aquatic species.

In recent years, scientists from the Department of Environment and Conservation, assisted by university academics, consultants and museum workers have been investigating the region's aquatic biodiversity more comprehensively. The scientific world is still coming to terms with the huge diversity of more than 1,000 species of aquatic invertebrates in the Wheatbelt. Many of these species are not known from anywhere else in the world and this is especially true of the naturally saline playas and ephemeral freshwater wetlands (including pools on granite outcrops). This means the south-west of Western Australia is a biodiversity hot spot for many groups of aquatic animals, just as it is for flowering plants.

Wetlands are intriguing ecosystems where the interplay of geomorphology, hydrology, water chemistry and biology can often be more easily observed than elsewhere. Basic to these observations is the ability to recognise the conspicuous animal and plant components. For plants and birds this is usually possible with the wealth of books available, but often impossible for invertebrates, partially due to a dearth of books, but also to a lack of exposure to invertebrates in our education.

The diversity of waterbirds and especially invertebrates gives us important clues to the functioning of a wetland, so besides being a pleasurable pastime, their identification is one of basic importance to wetland studies. All of us can be involved, whether it be by identifying a few animals in a degraded wetland, or doing a seasonal study or life history investigation on healthier wetlands such as freshwater swamps, farm dams, naturally saline lakes or rock pools on granite outcrops. Many changes are occurring and, of particular concern, is the spread of the alien brine shrimp, *Artemia* spp., into lakes formerly the preserve of our native brine shrimps, *Parartemia* spp.

It is well recognised that wetlands in the Avon region are continuing to decline due to salinisation, acidification and weed invasion, and a changing climate will have consequences for these wetlands that are as yet hard to predict. This book fills a basic need for amateurs and, yes professionals too, in the study and greater appreciation of our wetlands and their unique animals. Invertebrates are categorised and many are illustrated, making it less daunting to become familiar with the huge array of invertebrate life. The notes on each group provide an insight into their diverse and fascinating biology. The inclusion of waterbirds, with notes on their ecology, add to the usefulness of the book, if for no other reason than saving on trouser pockets to carry other references into the field. While the book is written for the Avon catchment, it will be useful across the rest of the Wheatbelt and Goldfields, and even to some degree beyond the State. Just the wonderful images of invertebrates are a joy to behold.

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Australian Museum

Brian has been at the forefront of research into Australian wetlands and their invertebrates for over 40 years. Saline lakes have been a particular interest and, more recently, fairy, brine and clam shrimps of the arid-zone. The Australian Society of Limnologists (scientists who study inland waters) awarded Brian the prestigious Jolly Medal in 2002 for his works on lakes all over Australia.

The Avon Natural Resource Management region straddles one of the world's biodiversity hotspots and is widely acknowledged for its diverse and endemic flora. However, there is far less knowledge or recognition of the unique and diverse fauna inhabiting the region's wetlands. This book explores the surprising diversity of aquatic invertebrates and waterbirds living in wetlands of the Avon region.

The Avon region is located in the south-west of Western Australia. It encompasses an area that is nearly 12 million hectares or around twice the size of Tasmania. Within that area it is estimated that wetlands and granite outcrops occupy nearly 750,000 hectares, or just over six per cent of the surface area of the region. The region has the largest expanse of salt lake chains found in Australia (and probably the world) and many of the invertebrates found in these wetlands are endemic because they have evolved to cope with salinity and temporary presence of water in isolation from other regions, and have therefore diversified over time. The wetlands supporting these communities continue to be threatened by a range of impacts, including weed invasion, altered hydrology, nutrient enrichment, salinisation and acidification.

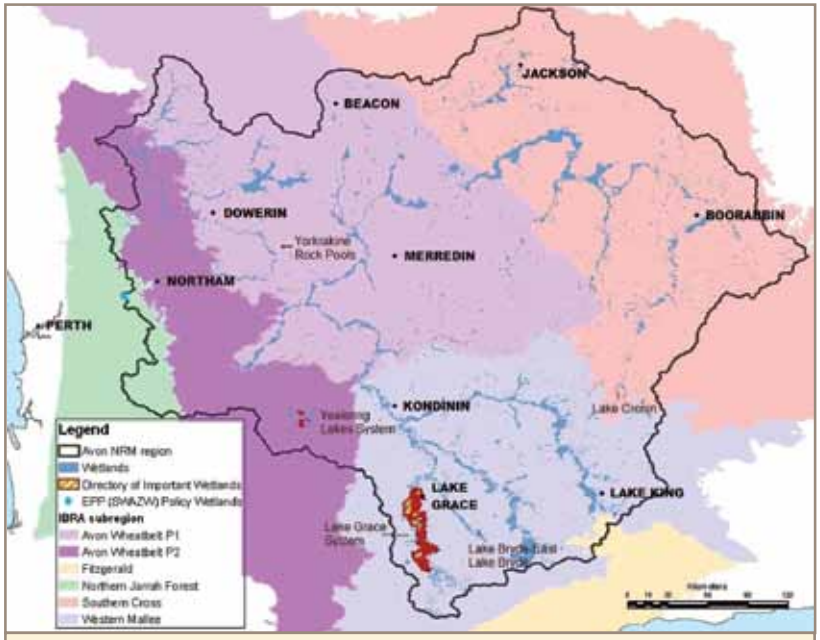


Figure 1: Location of the Avon Natural Resource Management region showing the extent of wetlands, IBRA subregions and the location of nationally significant wetlands.

The term wetland refers to any area of land that is either permanently or temporarily inundated, or waterlogged, where the presence of water influences the biota and ecological processes occurring. In the Avon region, this includes lakes, swamps, marshes, granite outcrop pools, claypans, dams, creeks, rivers and floodplains.

History of the region

The Avon region was originally populated by the Nyoongar people, comprising multiple dialect groups from different parts of the region. Wetlands are an important part of Aboriginal culture as communities regularly congregated around watering holes. Granite outcrops are particularly significant as they often have deep rock holes (gnammas) that fill with water and were used for water supply. The gnammas were either covered with stone slabs to prevent evaporation and contamination of the water, or filled with sticks or branches to enable animals to climb out.

European settlers first arrived in the region in the 1830s and the area of land cleared for agriculture continued to expand until the 1970s to' 80s. This has resulted in significant changes to the landscape and quality of wetland environments, including salinisation and altered hydrology.

Climate

The Avon region has a typically Mediterranean to semi-arid climate. This creates hot summers and cooler winters, with most rainfall occurring in winter, except for rare low pressure systems that can bring extensive rains in summer. Average annual rainfall ranges from 250 to 300 millimetres in the east to 500 to 600 millimetres in the west. Average annual evaporation rates range from around 2,400 millimetres in the north-east of the region to 1,600 millimetres in the south-west. The combination of low and variable rainfall and high evaporation rates in the eastern parts creates very unpredictable and temporary water availability.

Regions within the Avon

The Interim Biogeographic Regionalisation for Australia (IBRA) divides Australia into 85 regions based on climate, geology, landform and flora and fauna communities. There are five main IBRA subregions in the Avon (shown in Figure 1 on page 8), which are: Northern Jarrah Forest, Avon-Wheatbelt 1 and 2, Western Mallee and Southern Cross. A very small area of the Fitzgerald IBRA subregion also reaches into the Avon region but this is not discussed further.

Northern Jarrah Forest subregion

The Northern Jarrah Forest subregion is in the 'zone of rejuvenated drainage' and only covers the very western boundary of the Avon region on the eastern slopes of the Darling Range. The underlying soils are Archaean granite and metamorphic rocks capped by an extensive lateritic duricrust, broken by occasional granite hills. Vegetation in this part is dominated by jarrah-marri forest. Wetlands in this subregion are mostly isolated freshwater swamps and lakes, or waterways flowing into the Avon River, some of which have become saline.

Avon Wheatbelt 1 subregion

This subregion constitutes the western part of the 'zone of ancient drainage'. It is flat with ancient river systems that have filled in and now form a series of braided channels that connect thousands of naturally saline wetlands. The confluence of four river systems occurs in this region: the Salt, Yilgarn, Lockhart and Mortlock rivers. These now only function as waterways in years of high rainfall, when they may feed into the Yenyenning lakes and then into the Avon River. Most wetlands in this region are naturally saline. Freshwater wetlands such as granite rock pools, claypans, swamps and lakes occur, but many of these are becoming salinised. Vegetation consists of a mosaic of scrub and woodlands.

Avon Wheatbelt 2 subregion

This subregion is in the 'zone of rejuvenated drainage' (west of the Meckering Line – a geological fault line that separates the 'zone of rejuvenated drainage' from the 'zone of ancient drainage') and has gently rolling hills and abrupt granite breakaways. Wetlands in this region generally consist of waterways that flow in most years and isolated swamps, granite rock pools and lakes that either remain fresh or have salinised. Vegetation includes woodlands of wandoo, York gum and salmon gum with jam, *Casuarina*, and some areas of heath.

Western Mallee subregion

The Western Mallee subregion constitutes the southern part of the 'zone of ancient drainage' and is formed by clays and silts that are underlain by kankar, exposed granite (granite outcrops), sandplains and laterite pavements. Three major naturally saline systems drain northwards to converge into the Lockhart River, which only flows in years of very high rainfall. Temporary freshwater swamps and claypans can still be found in this region, perched above the saline groundwater on clay soils. Vegetation mostly consists of mallee woodlands that vary with soil type.

Unseasonable rains in January 2006 transformed the lakes north of Lakelands Nature Reserve into a river. Photo – Lance Mudgway/DEC Narrogin

Southern Cross subregion

The Southern Cross subregion is mostly east of the clearing line and constitutes the eastern part of the 'zone of ancient drainage'. Gently undulating yellow and gravelly sandplains are underlain by granite, intersected in parts by parallel bands of greenstone. Large numbers of granite outcrops rise out of the landscape throughout the region. Some of the largest salt lakes in the south-west occur as part of extensive salt lake chains such as Lake Deborah East and West, which very rarely overflow downstream. Isolated freshwater swamps and claypans are also present in the region. Due to the semi-arid climate, the large salt lakes are frequently dry for years at a time, but then hold water for considerable periods after especially heavy rainfall events. Vegetation mostly consists of *Eucalyptus* woodlands around salt lakes and in valleys, and *Acacia* thickets and scrub-heaths on sandplains.

Types of wetlands in the region

Wetlands are described by a combination of geomorphological, hydrological and chemical characteristics. These factors largely determine the combination of plants and animals that are supported at each wetland. Even though every wetland is slightly different, they can be grouped into broad categories.

Freshwater wetlands

Most freshwater wetlands in the Avon are seasonally or temporarily inundated, often only containing water after winter rains or unseasonal storm events in summer. They support a large number of plants, invertebrates and other wetland-associated fauna such as birds, frogs, fish and turtles. There are four types of wetlands that commonly occur in the Avon: swamps, lakes, claypans and granite outcrop pools.

Yate swamp located south of Pingrup. Photo – Wetlands group/DEC Science Division

Swamps

Swamps are heavily vegetated across the bed and usually have relatively shallow water. They have highly diverse vegetation communities, particularly aquatic plants and fringing communities of annual herbs. Some have trees such as yate (*Eucalyptus occidentalis*) or swamp sheoak (*Casuarina obesa*) across their bed, while others are dominated by sedges.

Lakes

Freshwater lakes are now much less common in the Avon than they used to be, and are restricted to the western part of the region. These are generally deep (more than one metre), sometimes permanent wetlands with emergent vegetation that is largely restricted to the fringe. They are particularly important for native fish and their avian predators, such as cormorants and darters.

Open freshwater lake located near Bejoording. Photo – Wetlands group/ DEC Science Division

Small, shallow freshwater claypan located between salt lakes near Dambouring Lake. Photo – Wetlands group/DEC Science Division

Claypans

Freshwater claypans are shallow, turbid wetlands with clay sediments that isolate the surface water from saline groundwater. The high turbidity of these wetlands protects aquatic invertebrates and tadpoles from predation by waterbirds. For this reason these claypans are particularly important for larger tadpoles and invertebrates such as clam shrimp, fairy shrimp and shield shrimp.

Granite outcrop pools

Pools located on granite outcrops are also known as gnammas. These are usually small, shallow waterbodies that are inundated for short periods of time after rainfall, though a few are deeper and virtually permanent. They provide a refuge for some freshwater plants and animals in a landscape otherwise affected by salinisation. The invertebrate faunas

Pools on Dunn Rock, a granite outcrop south of Lake King. Photo – Wetlands group/DEC Science Division

of these pools are unique as they have adapted to the unpredictable and temporary inundation periods with short life cycles. Larger crustaceans such as fairy shrimps, shield shrimps and clam shrimps are often present in these wetlands.

Natural salt lakes

Natural salt lakes form the largest proportion of wetlands in the Avon region. Salinity can vary from less than that of seawater to more than 10 times that of seawater (greater than 300 grams per litre), with salinity increasing as the wetland dries out. Depending on their shape, size and location, these wetlands can hold water for anywhere between a few weeks to more than a year after filling. Salt lakes have similar ionic composition to seawater because the salts are derived from rainfall over hundreds of thousands of years.

Wetlands in the region

Natural salt lakes are often characterised by the presence of dunes, or lunettes, on the downwind side of the wetland. These may become a series of dunes that eventually divide the wetland. The dunes are composed of various soils, such as gypsum, sand or clay and have distinct vegetation communities. Gypsum is often a significant component of dunes and is mined in some parts of Western Australia.

Naturally saline wetlands often appear to be coloured when viewed from the air. This is either the result of acidity (orange-brown), very high salinity (white), increased depth (darker blue) or the presence of submerged macrophytes (darker blue-green) or algae (green to pink). When present, the alga *Dunaliella salina* makes lakes appear pink due to the high concentrations of β-carotene in its cells.

A typical chain of natural salt lakes that occur along the paths of ancient in-filled river systems. Often these lakes are different colours when viewed from the air. Photo – Wetlands group/DEC Science Division

Shrubs and trees that grow in association with naturally saline wetlands are predominantly restricted to above the water line and are characterised by the presence of a low-lying shrub commonly known as samphire. Other plants encountered on the dunes of naturally saline wetlands include species of *Atriplex, Melaleuca* and *Acacia* and include many endemic and restricted species. The vegetation surrounding the wetland is often distributed according to soil characteristics, such as texture, salinity, pH and gypsum content. Submerged plants occurring in these wetlands are usually from the genera *Ruppia* or *Lepilaena*.

The invertebrate communities of these wetlands are more diverse than might be expected, including many species that only occur in south-western Australia. This fauna is able to cope with the very high salinities and has adapted to the often long, dry periods through the production of drought -resistant eggs. These may last in the soil for many years and still successfully hatch when the wetland is refilled. Crustaceans make up the bulk of the invertebrate diversity in these wetlands and many are endemic to the Avon. Waterbirds usually visit naturally saline wetlands to feed on submerged macrophytes or aquatic invertebrates.

Lepilaena cylindrocarpa – a common submerged plant occurring in salt lakes. It often forms thick stands across the bed of shallow wetlands and provides food and habitat for invertebrates and food for waterbirds. Photo – Wetlands group/ DEC Science Division

Seasonal, shallow natural salt lake on King Rocks Road, east of Hyden. Photo – Wetlands group/DEC Science Division

Large, deep natural salt lake in Lake Magenta Nature Reserve. Photo – Wetlands group/DEC Science Division

Floodplains and waterways

Throughout most of the Avon region there are long braided channels that follow the paths of ancient in-filled river systems. These channels, or palaeodrainage flats, usually contain a series of salt lake chains that are connected by floodplains and in some cases can be kilometres wide. There are four main drainage systems that feed into the Swan-Avon River through the Yenyenning Lakes, these are: the Salt, Yilgarn, Lockhart and Mortlock rivers.

The gradient of waterways increases towards the western parts of the region. West of the Meckering Line, a geological fault line that separates the 'zone of rejuvenated drainage' from the 'zone of ancient drainage' in Western Australia, the channels become more defined and flow increases. The gradient of the palaeodrainage flats in the eastern parts of the region is so low that the rivers only flow as a connected system after the most extreme rainfall events. It has been suggested that flow within the region's rivers is among the most unpredictable in the world.

Large flood events occurred in the Avon in 1926, 1930, 1945-6, 1958, 1963-4, 1974, 2000 and 2006. The flood event in 2000 was the first time the Lockhart sub-catchment had significantly flowed in summer for 40 years. Flood events in the

Wetlands in the region

Flooding along the Newdegate to Pingrup Road that occurred in January 2006. Photo – Natalie Nicholson/DEC Katanning

Section of the Avon River between Northam and York. Photo – Avon Catchment Council, Northam

Avon also usually coincide with high levels of salinity, nutrients and sediments in the Swan River. This can lead to other problems such as fish kills and algal blooms.

Waterways in the Avon can be either naturally saline or freshwater depending on their position in the landscape. Freshwater systems are more likely to occur west of the Meckering Line or at the head of a catchment, but many have salinised over time. Large, naturally saline channel systems are present throughout the region and form the bulk of the waterways in the Avon.

Significant wetlands in the region

The *Directory of Important Wetlands* is a register of wetlands that are considered to be of national significance. There are five systems

Salinised channel that feeds into the Lockhart River. Photo – Wetlands group/DEC Science Division

or groups of wetlands in the Avon region that are identified under this register (also shown in Figure1). These are:

- Lake Bryde and East Lake Bryde – listed because they have the only known occurrence of the threatened ecological community, 'Unwooded freshwater wetlands of the southern Wheatbelt of Western Australia, dominated by *Muehlenbeckia horrida* subsp. *abdita* and *Tecticornia verrucosa* across the lake floor'. These wetlands have also been identified as having diverse waterbird and aquatic invertebrate populations.
- Lake Cronin – listed because it is the best example of a *Melaleuca*-dominated freshwater lake-marsh in the region.
- Lake Grace System – listed because these wetlands are a good example of a series of large, naturally saline lakes in the region.
- Yealering Lakes System – listed because these wetlands are an example of a suite of salinised, part-wooded lakes, exhibiting varied hydrological features.
- Yorkrakine Rock Pools – listed because they are a good example of the granite outcrop pools that occur patchily but broadly across inland south-western Australia, providing 'islands' of freshwater habitat in a region dominated by salinised wetlands.

Lake Bryde is one of five groups of wetlands in the Avon region identified under the Directory of Important Wetlands. Photo – Natalie Nicholson/DEC Katanning

Protection of wetlands

The *Environmental Protection (South West Agricultural Zone Wetlands) Policy* was developed in 1998 under Part III of the *Environmental Protection Act 1986*. The primary purpose of this policy is to "prevent the further degradation of valuable wetlands and to promote the rehabilitation of wetlands in the South West Agricultural Zone of Western Australia". Of the two wetlands that are listed under this policy, one occurs in the Avon region. This wetland is Koojedda Swamp near Northam, which was listed because of its recreational, Aboriginal, flora, fauna and ecosystem service values. This policy is currently under review by the Environmental Protection Authority.

Threats to wetlands in the region

Wetlands in the Avon region face many threats to their biodiversity and ecosystem processes. The most significant of these threats is dryland salinisation, caused by the rise of saline groundwater following the replacement of deep-rooted native vegetation with shallow-rooted annual agricultural crops. This process poses two main problems for wetlands in the region: an increase in salinity and prolonged inundation. Salinisation can affect both naturally saline and freshwater systems.

Freshwater wetlands are the most severely affected by salinisation because their plant and animal communities are not adapted to saline conditions. The number of aquatic invertebrate species declines significantly once the salinity rises above about four grams per litre. Salinisation also affects waterbird communities as the young of many species require water with a low salinity for drinking.

Naturally saline wetlands can also be affected by salinisation. Salinities that are consistently very high can result in the loss of submerged vegetation and some invertebrate species in salt lakes, although, where waterlogging has prevented seasonal drying, the maximum salinity may be lower than it would have been. Prolonged inundation and increased wetland extent can also cause the death of surrounding vegetation and interrupt the life cycles of invertebrate fauna adapted to a drying-out phase. With the loss of invertebrates and vegetation comes the disappearance of waterbird communities that use these resources for feeding and breeding. The impact of salinisation on naturally saline systems is often overlooked.

Freshwater wetlands affected by salinisation are often characterised by the death of vegetation across the bed of the wetland. Photo – Wetlands group/DEC Science Division

The disposal of agricultural drainage water via drains also has consequences for wetlands. Some of the saline drainage water is re-used, but the vast majority is discharged into natural water bodies. Often wetlands are seen as ideal for this purpose since they function as natural evaporation basins and are agriculturally unproductive. The disposal of drainage water frequently changes both the water quality (particularly salinity and pH) and the hydrology of the receiving wetland.

The vegetation surrounding naturally saline wetlands affected by salinisation is often in poor or declining condition. The destruction moves further up the bank as salinities and water levels rise. Photo – Wetlands group/DEC Science Division

It is estimated that at least 4,000 kilometres of deep open drains have been constructed in the Wheatbelt. Photo – John Lizamore/DEC Esperance

This generally results in species-poor communities of flora and fauna. The choice of where to put waste water is critical, especially where it is likely to move downstream over time.

There are other impacts or activities that threaten the health and biodiversity of wetlands in the region, such as clearing remnant vegetation around the fringes of wetlands, livestock grazing, feral animals (e.g. rabbits), weed invasion, rubbish disposal, recreation, mining and the use of fertilisers and other agricultural chemicals. Declining rainfall as a result of climate change is also of concern.

Although many aquatic plants and animals have probably been lost from the region, the Avon and wider Wheatbelt retain a large number of functioning aquatic ecosystems. These continue to support a very high diversity of wetland plants and animals, many of which are not known

Unfortunately wetlands are sometimes used as dumping grounds for rubbish. Photo – Wetlands group/ DEC Science Division

Minimally disturbed wetlands usually have healthy and diverse fringing vegetation communities. Photo – Wetlands group/DEC Science Division

from anywhere else in the world. The degree to which the region's wetlands continue to decline is dependent on what actions can be taken to manage and protect what is left.

Characteristics of a healthy wetland

There are a few key characteristics that indicate the health of a wetland. Some types of wetlands will have all of these characteristics, while others will have only a few. For example, freshwater claypans have little habitat diversity due to the turbid water and heavy clay sediments, but may still be healthy wetlands that provide an important habitat for particular animals.

Vegetation

The condition of vegetation within and around a wetland provides the most visible indicator of its health, and is often the first component to respond to disturbance. Regardless of whether a wetland is naturally saline or freshwater, one that is minimally disturbed will have diverse and healthy plant communities with distributions that are relatively stable. Fringing vegetation should consist of multiple layers, including an upper tree or shrub layer (e.g. some species of *Eucalyptus, Melaleuca or Casuarina*), a middle shrub layer (e.g. species of *Tecticornia* (samphire), *Atriplex, Frankenia* or *Grevillea*) and a lower herb or grass layer (e.g. some species of *Trachymene, Cotula* or *Triglochin*).

Compared to most freshwater systems, the fringing vegetation of naturally saline wetlands generally has more obvious vegetation zones. The zone closest to the water's edge usually consists of samphire communities, which are tolerant of seasonal inundation and high soil salinity. These communities are slowly accompanied and then replaced by taller shrubs and diverse herb communities moving away from the wetland to higher elevations. In the zone furthest from the water's edge, or the dryland area, all three structural layers are usually present including taller shrubs and trees. The species that grow in each of these zones depends on a combination of edaphic factors such as soil texture, salinity, pH and gypsum content, which vary with elevation and the direction of prevailing winds. When a wetland becomes degraded, particularly from increased flooding, the transitional zone is compressed so that there is often a wide zone of samphire, which extends up the bank to the dryland vegetation zone. This is usually associated with the loss of some wetland-dependent plant species as soil conditions become unsuitable for germination and growth.

Signs of disturbance or degradation may be evident in the vegetation communities long before other components of the wetland change. The effects of salinisation and/or prolonged inundation are initially

This vegetation is starting to show signs of stress from either an increase in salinity or period of inundation. This is evident in the loss of condition in the upper shrub layer. Photo – Wetlands group/DEC Science Division

The upper shrub layer of this degraded wetland has been lost entirely and replaced with samphire and weed communities. Photo – Wetlands group/ DEC Science Division

evident in the declining health or death of the tallest vegetation layer closest to the water's edge or within the wetland basin. Dead trees and large shrubs persist for some time and provide a lasting indicator of vegetation change long after conditions at a wetland may have stabilised. As conditions continue to

decline, more species are lost and diverse herb and shrub layers are often replaced by samphire communities, which are tolerant of increased salinity and inundation. An increase in the abundance of weeds also provides an indication of disturbance. Weeds are opportunistic and invade rapidly once a physical disturbance such as clearing occurs, or conditions become unsuitable for the germination of native species.

Water quality

Good water quality is important for maintaining healthy wetland communities. Of the various water quality indicators available, salinity and pH provide the most reliable indicators of a wetland's health.

Natural salinities vary depending on the type of wetland. To provide adequate conditions for plant and animal populations, freshwater wetlands should maintain salinities below around three grams per litre most of the time (but generally the lower, the better). Conversely, natural salt lakes have highly variable salinities, which increase as the wetland dries out. Consequently, there is no ideal salinity for a naturally saline wetland, but where a salt lake changes so that it is consistently very saline (greater than 50 grams per litre) the germination and survival of submerged plants will be severely affected and invertebrate diversity will be reduced. Some wetlands are naturally much more saline than this, especially in the eastern Avon where wetlands can occasionally have up to 10 times the salt concentration of seawater.

Most wetlands are alkaline (i.e. they have pH greater than seven) but a few freshwater wetlands, such as some pools on granite outcrops or swamps with dark water, are mildly acidic (pH six to seven) and some naturally saline wetlands are naturally very acidic (pH less than five). As a general rule, a pH greater than six is suitable for the survival of most plant and animal species within a wetland.

Hydrology

Healthy wetlands retain their natural hydrological cycle which, for most wetlands in the Avon, involves regular drying out. Dryland salinisation has resulted in many wetlands experiencing prolonged inundation. This affects the aquatic invertebrate communities as some species require a drying-out period for successful recolonisation. Dry periods also enable the growth of plants across the lake bed which, upon re-flooding, provides a vital food source for colonising invertebrates. Some herbaceous fringing plant species also require a receding waterline for germination or flowering, and drying provides shallow wetland edges for small wading birds, including migratory species.

Waterbirds

Depending on the type of wetland, waterbirds can be an indicator of a healthy ecosystem. Wetlands such as freshwater claypans and granite rock pools naturally have few waterbirds. Naturally saline wetlands usually support waterbirds at some stage of the hydrological cycle but generally have lower diversity than freshwater wetlands. Waterbirds usually disappear from wetlands when their preferred food or breeding habitat is no longer available. This usually happens when the wetland becomes highly saline and when nesting habitats and food resources are insufficient.

Habitat diversity

A healthy wetland usually has a variety of habitats present. By habitat we are referring to characteristics such as:

- fringing vegetation (shrubs and trees), which provides habitat for terrestrial fauna and nesting and resting waterbirds, as well as filtering runoff entering the wetland;
- deep water zones (more than one to 1.5 metres deep), which provide habitat for diving waterbirds;
- shallow water zones (less than 15 centimetres), which provide habitat for wading waterbirds;
- tree limbs, branches and leaf litter in the water, which provide food and habitat for invertebrates;
- submerged vegetation, which provides food and habitat for invertebrates and a food source for waterbirds;
- islands, which are a habitat for nesting waterbirds because they provide protection from land predators such as cats and foxes; and
- emergent vegetation, which provides a habitat for invertebrates and waterbirds.

Wetlands that become degraded often lack many of these habitats. This can be due to disturbances including infilling of deep water zones by additional sediment loads, clearing or death of surrounding vegetation through the process of dryland salinisation, loss of emergent vegetation from an increase in the period or extent of inundation or salinity, reduced water quality through processes such as acidification and salinisation, or physical disturbance to a wetland by activities such as earthworks.

Five ways you can improve your wetland

Although there are catchment-wide issues such as dryland salinisation and acidification that affect many wetlands in the region, there are small steps that individual landholders can take to protect and/or improve the health of their wetland and

retain flora and fauna. Financial and practical assistance to achieve these improvements can be sought from groups such as LandCare and *Land for Wildlife* (contacts listed on page 25).

1. Protect wetlands from livestock by fencing off the wetland and surrounding vegetation, preferably including all zones of wetland-associated fringing vegetation (as described above), which would normally extend about 50 metres from the high-water mark. Exclusion of livestock enables seedlings to establish and prevents compaction of the soil, erosion and trampling. This also limits nutrient enrichment caused by the breakdown of droppings.
2. Eradicate invasive plants. Removing invasive plants provides native vegetation with an improved chance of establishing and surviving without competition from aggressive, hardy exotic plants.
3. Revegetate areas surrounding the wetland and associated creeks with hardy, native plants. In salt-affected areas, salt-tolerant species such as *Casuarina obesa* and *Melaleuca cuticularis* should be planted, but further advice should be sought from the contacts provided.
4. Eliminate feral animals such as rabbits. Rabbits cause significant damage to the root zone of plants when digging their network of burrows. These pests can be very difficult to eradicate and will usually require some expert advice.
5. Provide habitat around the wetland for nesting waterbirds such as boxes, hollow logs and perches.

The photo on the left shows a wetland that has recently had revegetation work completed. The photo on the right shows more established revegetation on the banks of the Abbotts Lake System. Photos – (left) Wetlands group/ DEC Science Division and (right) Michael Marriott

Contacts for assistance in managing your wetland in the Avon region

Land for Wildlife

Department of Environment and Conservation

Phone: (08) 9334 0427

Email: claire.hall@dec.wa.gov.au

Caring for our Country - Landcare

Australian government website: www.daff.gov.au/natural-resources/landcare

Landcare Online website: www.landcareonline.com

Phone: 1800 552 008

Nature Conservation Covenant Program

Department of Environment and Conservation

Website: www.dec.wa.gov.au/management-and-protection/off-reserve-conservation/covenant-program.html

Phone: (08) 9334 0477

Email: anthea.jones@dec.wa.gov.au

Greencorps - Greening Australia WA

Website: http://greencorps.greeningaustralia.org.au

Phone: (08) 9360 6667

Email: anewbury@greenskills.org.au

Avon Catchment Council

Website: www.avonnrm.org.au

Phone: (08) 9690 2250

Email: avonnrm@agric.wa.gov.au

A useful resource that summarises the different programs that are available to landholders to provide assistance in improving their wetland is found on the Department of Environment and Conservation's website at www.dec.wa.gov.au/management-and-protection/off-reserve-conservation/index.html.

Invertebrates

There are six main groups of invertebrates found in the Avon, from left to right, top to bottom: rotifers (*Platyias quadricornis)*, worms (*Manayunkia* sp.), molluscs (*Coxiella* sp.), water mites (*Koenikea verrucosa*), crustaceans (*Austrochiltonia subtenuis*) and insects (*Sigara mullaka*).

Avon wetlands are rich in aquatic invertebrates with over 670 species recorded, many being endemic to the south-west. Major invertebrate groups represented include rotifers, crustaceans, insects, water mites, worms and molluscs. The region supports a diverse array of wetlands that are mostly ephemeral to seasonal. Adaptations to these conditions, such as the production of drought-resistant eggs, tolerance to salinity, burrowing behaviours and other life cycle adaptations have developed in the invertebrate fauna, promoting the evolution of unique species and communities.

Crustaceans, such as brine shrimp, seed shrimp and copepods, dominate the invertebrate communities of naturally saline wetlands. Although low in species numbers, naturally saline lakes contain a high proportion of endemics. Notably, Western Australian salt lakes have the highest number of species of brine shrimp, *Parartemia*, and salt lake snail, *Coxiella*, in Australia. Another unique species is the polychaete worm, *Manayunkia*, which is only one of two polychaete species that inhabit inland salt lakes in Australia.

Freshwater wetlands contain around 80 per cent of the total number of invertebrate species found in the Avon region and are generally dominated by aquatic insects. Claypans and granite outcrops are particularly important freshwater habitats because they support numerous endemic species.

Salinisation and acidification are the most significant threats to the persistence of invertebrate diversity in the region. As the salinity of a wetland increases, the number of invertebrate species declines until only a few salt tolerant species remain at very high salinities. Similarly, as the pH of a wetland falls below around six, fewer invertebrates can survive. Increased inundation periods are also a threat to invertebrates as many have adapted to survive in temporary waters.

The conservation of aquatic invertebrates in this region is important because of the uniqueness of the species and communities present. Invertebrates also form an essential role in the functioning of wetland ecosystems. Groups, such as larval midges, which feed on dead and decaying plant and animal matter, are important in the decomposition and cycling of organic material. The grazers, such as snails and water fleas, consume living aquatic vegetation and algae, which helps to maintain water quality and control the amount of plants and algae. Invertebrates also provide an important food source for fish, amphibians and waterbirds.

Rotifers or 'wheel animalcules'

Diversity and endemism

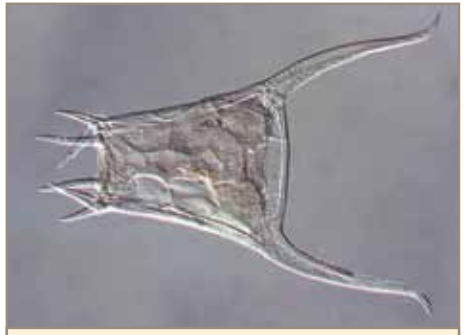
The south-west is a biodiversity hotspot for rotifers with over 100 species from four orders, Bdelloidea, Floscullariacea, Collothecacea and Ploimida, recorded in the Avon region. Rotifer species are generally widespread as their resting eggs are readily dispersed to other habitats by wind, birds and people.

Appearance

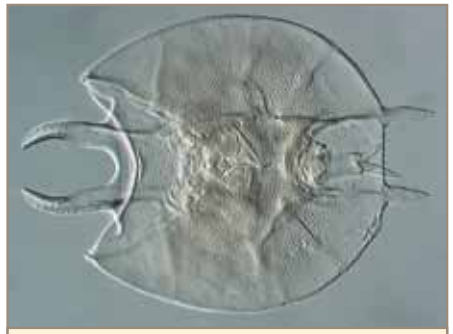
Rotifers are microscopic animals that are generally less than 0.5 millimetres. They are a morphologically diverse group and their shape can be 'box-like' or 'worm-like' depending on the rigidity of their outer layer or cuticle. Their body generally consists of a head, trunk, foot and toes, which are used as an anchor while feeding. Toes are absent or reduced in some planktonic groups. Their common name 'wheel animalcules' is derived from the movement of the cilia around the head, which resembles a revolving wheel.

Habitat

Rotifers can be free-swimming, free-floating, permanently attached to an object (sessile) or parasitic, and are commonly found in association with floating or submerged vegetation. Most are restricted to freshwater wetlands, although a few, such as *Keratella australis,* are tolerant of low salinities. Species that can inhabit moderately to highly saline wetlands include *Brachionus plicatilis* s.l. and *Hexarthra fennica*.



Keratella australis commonly occurs in freshwater wetlands of the Avon region.



Platyias quadricornis inhabits shallow waters.

Trichocerca tigris is asymmetrical in shape.

Biology and ecology

Most rotifers are omnivores that consume fine particles of organic matter by sweeping them into their mouth using the movement of cilia. More specialised predatory rotifers have forcep-like extendible teeth with which they grasp their prey, such as other rotifers or small crustaceans.

When food is abundant, rotifers can rapidly reproduce to achieve very high population densities. These large populations provide a plentiful food source for macroinvertebrates and fish. Most rotifer species alternate between asexual and sexual reproduction and produce drought-resistant eggs to survive dry periods. Bdelloid rotifers reproduce asexually and are able to survive for prolonged periods in an inert state after desiccation. When rehydrated, they are able to resume normal activity within a few hours.

Lecane quadridentata is a shield-shaped rotifer.

Worms and leeches

Many types of aquatic worms have been recorded from wetlands in the Avon region. Segmented worms belong to the Phylum Annelida and include leeches, aquatic earthworms (oligochaetes) and bristleworms (polychaetes). The unsegmented worms include roundworms (nematodes) and flatworms (platyhelminthes). Due to the difficulties in identifying these worms, many of the species are not formally described.

Temnosewellia minor is generally found attached to crayfish.

Flatworms
(Phylum Platyhelminthes)

Diversity and endemism

Two groups of flatworms have been recorded in the Avon: turbellarians and one species of Temnocephalidea, *Temnosewellia minor*. Little is known about the turbellarians that occur in the Avon region.

Appearance

Turbellarians are flat, thin, soft-bodied worms and are often black or grey. Temnocephalans have flat, oval-shaped bodies with finger-like tentacles at one end and a suction disc at the other.

Habitat

Turbellarians commonly occur in fresh to slightly saline wetlands. They are most frequently found underneath rocks and woody debris. *Temnosewellia minor* is mainly found attached to freshwater crayfish as external symbionts.

Biology and ecology

Turbellarians are omnivores that consume living and dead animal matter. Some temnocephalans are predators, feeding on small invertebrates, while others graze on algae and bacteria on the host's body. All flatworms are hermaphrodites with sexual cross-fertilisation the most common form of reproduction. Flatworms are able to regenerate into two individuals if they are cut in half.

Roundworms
(Phylum Nematoda)

Diversity and endemism

Nematodes are a very diverse group but individual species are difficult to distinguish. Little is known about the species that occur in the Avon.

Appearance

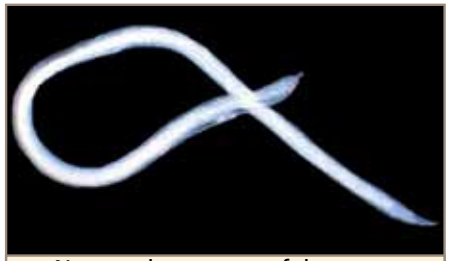
Nematodes are pale, round and very thin worms with pointed ends.

Habitat

Nematodes are able to survive where there is adequate moisture and occur in both fresh and saline wetlands. Species may be either free-living or parasitic or a combination of the two. Free-living forms are found in shallow water in or on the soil at the bottom of the wetland.

Biology and ecology

Free-living nematodes can be predatory or feed on bacteria, algae and detritus. Populations of nematodes contain both males and females with sexual reproduction resulting in the production of drought-resistant eggs.



Nematodes are one of the most abundant animals in the world.

Freshwater leeches (Class Clitellata)

Diversity and endemism

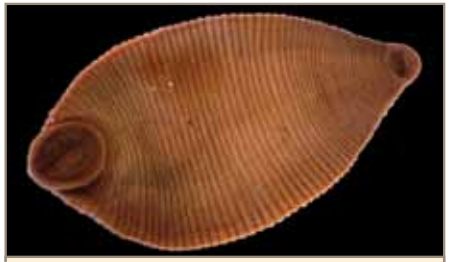
Two species have been recorded in the Avon region, *Helobdella papillornata* and an unidentified species from the genus *Alboglossiphonia*. *Helobdella papillornata* is widespread but is endemic to southern Australia.

Appearance

Leeches are segmented worms that are distinguished by the presence of suckers at each end of the body.

Habitat

Leeches occur in a variety of freshwater wetlands but are particularly intolerant of salinity. They are often found attached to submerged plants and rocks.



The leech, *Helobdella papillornata*, feeds exclusively on snails.

Biology and ecology

Leeches are either predators, consuming a variety of invertebrates, or ectoparasites, feeding on the blood of vertebrates. Most are sit-and-wait predators but some actively seek their prey. *Helobdella papillornata* feeds exclusively on snails, waiting in ambush and using its anterior sucker to catch and subdue its prey. Some leeches, including *Helobdella papillornata*, display a high level of parental care. Their young remain attached to the parent until they are capable of hunting for their own food.

Aquatic earthworms or oligochaetes (Class Clitellata)

Diversity and endemism

Thirteen described species of Naididae and Phreodrilidae have been recorded in the region plus several undescribed species of Enchytraeidae. Most aquatic earthworms occurring in the Avon region are widespread species, but a few are endemic to the south-west including *Ainudrilus nharna* and two species restricted to rock pools on granite outcrops (*Astacopsidrilus edwardi* and a related but undescribed species).

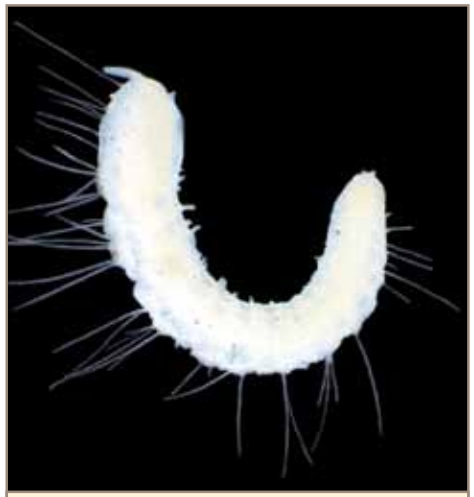
Appearance

Aquatic species are similar in appearance to terrestrial earthworms but are much thinner and shorter. They have bundles of chaetae (bristle-like hairs) on each body segment and some have short posterior gills or a proboscis on the head.

Habitat

Aquatic earthworms are found in a variety of habitats, including swamps and lakes, but are generally intolerant of salinity. Exceptions to this rule are the enchytraeids, *Ainudrilus nharna* and *Paranais litoralis*, which have been recorded in slightly to moderately saline wetlands.

Ainudrilus nharna is endemic to the south-west.



Pristina longiseta has long chaetae.

Biology and ecology

Oligochaetes are detritivores, grazers or predators. Some species, such as *Tubifex tubifex*, are renowned for their tolerance to pollution. Oligochaetes are hermaphrodites and reproduce sexually through cross-fertilisation but some reproduce asexually.

Bristleworms
(Class Polychaeta)

Diversity and endemism

An undescribed species of *Manayunkia* is the only polychaete recorded from the Avon region and is endemic to the salt lakes of the south-west.

Appearance

Polychaetes are segmented worms and have paired extensions (parapodia) bearing many bristle-like hairs called chaetae on the sides of each body segment.

Habitat

Polychaetes predominantly occur in marine and estuarine environments. Species from the genus *Manayunkia* are unique in Australia because they inhabit inland salt lakes. *Manayunkia* live in gelatinous tubes in the sediment.

Manayunkia sp.

Biology and ecology

Manayunkia is able to persist in periods of drought under vegetation in moist sediment.

Molluscs

Molluscs are soft-bodied animals, most of which live in a hard secreted shell. Two types of aquatic molluscs occur in the Avon region: snails (Gastropoda) and mussels (Bivalvia). Snails generally have a coiled shell that they carry on their backs, while mussels are enclosed in a pair of valved shells.

Salt lake snails
(Class Gastropoda)

Diversity and endemism

The snail genus, *Coxiella,* is endemic to the saline wetlands of Australia. The number of species within this group is unknown because species are very difficult to tell apart and a detailed study of them is required. It is likely that a majority of the species are restricted to the south-west, with at least four described and three undescribed species recorded in the Avon region.

Appearance

The shell of *Coxiella* is thick and coiled clockwise (dextrally). It often has a tall spire with a blunt (usually broken) tip and can reach 15 millimetres in height (usually smaller). *Coxiella* have a flexible operculum (hard plate attached to the foot of the animal covering the entrance to the shell), which blocks the entrance when the animal retreats into its shell.

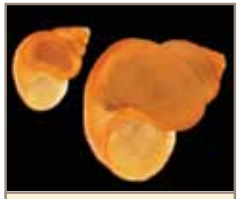
Habitat

Coxiella are one of only two non-marine snail genera in the world that can tolerate salinity levels above 30 grams per litre. They inhabit temporary and permanent saline wetlands.

Biology and ecology

Coxiella snails feed on detritus. Populations contain both males and females and reproduction is sexual. They avoid desiccation during dry periods by blocking the opening of the shell with the operculum and seeking refuge beneath dead vegetation, other objects and in mud cracks.

The shell of *Coxiella* snails are often pale and chalky.



An undescribed species of *Coxiella*.

Thousands of *Coxiella* shells on the shore of a salt lake.

Freshwater snails (Class Gastropoda)

Diversity and endemism

Most freshwater snails belong to the family Planorbidae and three genera have been recorded in the Avon: *Glyptophysa*, *Gyraulus* and *Isidorella*. Other freshwater gastropods recorded in the Avon are the south-west endemic *Westrapyrgus slacksmithae*, the Australian endemic *Ferrissia petterdi* (which looks like a tiny limpet), and *Physa acuta*, which is introduced and widespread.

Appearance

The shells of planorbids are coiled counter clockwise (sinistrally) and have a variety of shapes. They lack an operculum and are best distinguished from *Physa acuta* by the shape of the radula (teeth). *Ferrissia petterdi* is less than six millimetres in diameter and lacks a coil or sculpturing on its cap-shaped shell. *Westrapyrgus slacksmithae* has an operculum and a heavily pigmented body.

Habitat

Freshwater snails are confined to wetlands with low salinity and occur in rivers, lakes and streams. They can be found sitting on a variety of surfaces including rocks, woody debris and aquatic plants.

Biology and ecology

Freshwater snails graze on macrophytes and algae. The planorbid snails and *Physa acuta* are hermaphrodites and are able to self-fertilise. *Ferrissia petterdi* is also hermaphroditic but is incapable of self-fertilisation. Reproduction is sexual in *Westrapyrgus slacksmithae* with populations containing both males and females. Some freshwater snails are able to aestivate in moist mud during dry periods.

The freshwater limpet *Ferrissia petterdi.*

Glyptophysa cf. gibbosa is a planorbid snail and inhabits freshwater wetlands and rock pools on granite outcrops.

The planorbid snail, *Isidorella* sp. is found in a variety of freshwater wetlands.

Mussels (Class Bivalvia)

Diversity and endemism

Three species have been recorded in the Avon River, the south-west endemic freshwater mussel, *Westralunio carteri*, the widespread estuarine mussel *Fluviolanatus subtorta* and the freshwater clam *Musculium kendricki*.

Appearance

Mussels have a fleshy body enclosed in a pair of valved shells, which are joined by a hinge and strong flexible muscles. *Westralunio carteri* has valves that are brown and almost rectangular in shape. The valves of *Fluviolanatus subtorta* are brown, rectangular and unequal in shape, and the surface is irregular. *Musculium kendricki* has small, thin, white bi-valve shells.

Habitat

Westralunio carteri is found in the mud of lower salinity river pools and has disappeared from much of the Avon, whereas *Fluviolanatus subtorta* is an estuarine species that has moved up the Avon River in response to increasing salinity. *Musculium kendricki* has been recorded from artificial wetlands in the Avon region.

The estuarine mussel, *Fluviolanatus subtorta.*

Biology and ecology

Mussels are filter feeders, using siphons to pump water over their gills which filter out food such as microorganisms, plankton and detritus. Some mussel species are able to survive prolonged periods of drought by sealing their shell and burying themselves in damp mud.

Water mites

Diversity and endemism

Water mites are not as diverse in the Avon compared to many other parts of the State. Those belonging to the family Hydracarina, also known as true water mites, are the most common, with at least 12 species recorded in the region. Other mite groups with aquatic representatives are Oribatida, Trombidioidea, Halacaroidea and Mesostigmata but these are not so well known. Water mites are generally widespread but can be patchy in distribution. There are no water mites that are known to be endemic to the Avon region.

Appearance

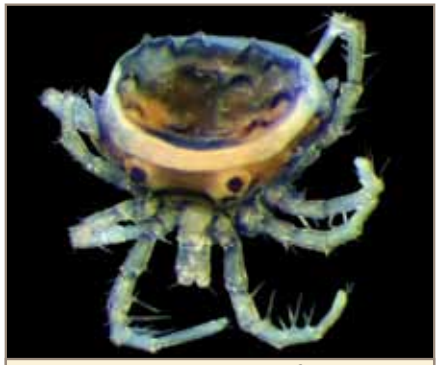
The head, thorax and abdomen of water mites are fused into one round body. They are related to spiders so they have eight legs, which in many species have long hairs that assist with swimming. Their mouthparts consist of a pair of palps and a beak-like rostrum used to pierce prey.

Habitat

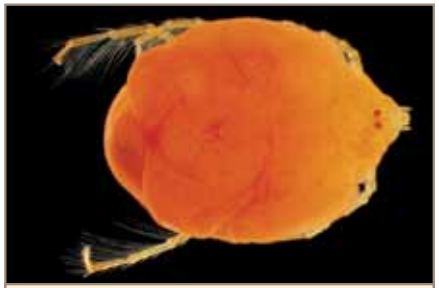
Water mites tend to prefer permanent freshwater, which is why there are few species in the Avon region. Species occurring in the Avon are commonly found in fresh to slightly saline wetlands with few tolerant of higher salinities. They are generally benthic or found in association with aquatic plants, though some are good swimmers.

Biology and ecology

The larvae of most water mite species are parasitic on invertebrates. They are easily dispersed by attaching to aerial insects before they leave the water. Adults are generally free-living and feed on invertebrates by sucking body fluids from their prey. The exception is oribatid mites, which feed on submerged vegetation, algae and detritus. Some water mites have defences against predators including hard plates with spines and blades. Many red mites secrete bad tasting substances and their bright colour warns predators not to eat them.



Koenikea verrucosa is found in freshwater wetlands.



The red colour of *Eylais* sp. warns predators not to eat it.

Crustaceans

Wetlands in the Avon support a high diversity of some crustacean groups and are part of a biodiversity hotspot for non-marine crustaceans in south-western Australia. Based on their size, crustaceans are commonly divided into two groups; microcrustaceans and macrocrustaceans.

Microcrustaceans include seed shrimp (ostracods), water fleas (cladocerans) and copepods and are present in every type of wetland. They are generally less than two millimetres long and species are difficult to distinguish from each other with the naked eye. Microcrustaceans are highly abundant and diverse, accounting for 25 per cent of the invertebrate richness in Avon wetlands. A large proportion of microcrustaceans are endemic to the south-west of Western Australia. Many of the species restricted to this region inhabit naturally saline wetlands and granite outcrop pools, making these habitats important for their conservation.

Microcrustaceans form an essential part of the wetland food chain. Through the consumption of detritus and algae, they incorporate these food sources into the animal food chain. This helps to maintain water quality through the control of algae. They also provide a food source for larger invertebrates, fish and some waterbirds.

The larger macrocrustaceans are found in a variety of wetland habitats. Shield shrimp, brine shrimp, fairy shrimp, and clam shrimp mostly occur in temporary waters and the latter three groups include a high proportion of endemic species. Species of isopods, amphipods, prawns and yabbies are also present, especially where there is permanent moisture.

The uniquely Australian brine shrimp belonging to the genus *Parartemia* are found in naturally saline wetlands. Western Australia has more species of this genus than anywhere else in the continent and many of the 14 Western Australian species occur in the Avon. Unfortunately, some species appear to be in decline, possibly due to increasing salinity, acidification and changes in water regimes due to rising groundwater.

Six species of fairy shrimp (*Branchinella*) occur in temporary freshwater wetlands of the Avon such as claypans and granite outcrops. The rare species *Branchinella kadjikadji* is endemic to claypans of the Avon region.

Copepods
(Order Copepoda)

Diversity and endemism

There are at least 43 species from 21 genera and three suborders (Calanoida, Cyclopoida and Harpacticoida) of copepods that occur in wetlands of the Avon.

Appearance

The bodies of copepods are 'torpedo'-shaped with distinctive antennae. Calanoid, cyclopoid and harpacticoid copepods differ in body shape and length of the antennae. Most species are less than two millimetres with the exception of some calanoid copepods, which can grow up to four millimetres.

Habitat

Copepods inhabit all types of wetlands and are often extremely abundant, with numerous species often occurring in the same wetland. Harpacticoid copepods are predominantly benthic and are typically found in sediments of lakes, swamps and rivers. Calanoid and cyclopoid copepods are more planktonic and commonly occur in lakes, swamps and dams.

Species vary in their tolerance to salinity and can be restricted to particular habitats. For example

Calamoecia trilobata is a calanoid copepod that is common in naturally saline, acidic wetlands, and is restricted to the south-west of WA.

Boeckella opaqua is an endemic calanoid copepod and is only found in pools on granite outcrops.

the calanoid copepod *Boeckella opaqua* is only found in pools (or gnammas) on granite rocks. Many inhabit moderately and highly saline wetlands such as *Calamoecia trilobata* (suborder Calanoida), *Meridiecyclops baylyi* (suborder Cyclopoida) and some species of *Nitocra* (suborder Harpacticoida).

Biology and ecology

Copepods predominately consume algae, bacteria and detritus. Calanoid and cyclopoid copepods can be predatory, feeding on juvenile copepods, rotifers and small cladocerans. Copepods are a food source for macroinvertebrates and fish.

To survive dry periods, most copepods produce drought-resistant eggs. The eggs lie dormant in the sediment and hatch when the wetland refills and environmental conditions are suitable.

Australocyclops australis is a common cyclopoid copepod found in freshwater wetlands.

Nitocra sp. is an undescribed harpacticoid copepod that inhabits salt lakes.

Seed shrimps
(Order Ostracoda)

Diversity and endemism

Seed shrimps are a particularly diverse group of microcrustaceans with 83 species from 27 genera recorded in the Avon, many only known from the Wheatbelt. A large proportion of endemic species are from the genera *Cypretta*, *Cypricercus*, *Ilyodromus* and *Reticypris*. Many seed shrimp species have not been formally named.

Appearance

Seed shrimps are completely enclosed in a hard bi-valved shell which varies greatly in colour, shape and sculpturing between species. Most species are less that two millimetres, but 'giant' ostracods can be greater than three millimetres.

Mytilocypris mytiloides is a 'giant' ostracod found in naturally and secondarily saline wetlands.

Habitat

Seed shrimp are found in all types of wetlands and are often very abundant with numerous species often occurring in the same wetland. Ostracods are generally found on the bottom of wetlands but can sometimes be found swimming in the water column.

Species vary in their tolerance to salinity, turbidity and acidity, which dictates the type of wetlands they occur in. Many species are only found in saline lakes such as the 'giant' ostracods, *Mytilocypris mytiloides* and *Australocypris insularis*. Most species are intolerant of acidic conditions because they interfere with the production of their shell. However, there are a few species, such as *Australocypris bennetti,* that do tolerate low pH. Seven species are only found on granite outcrops including some species of *Bennelongia* and *Ilyodromus candonites*. Others are restricted to freshwater or slightly saline wetlands such as *Candonocypris novaezelandiae*, *Bennelongia australis* and *Ilyodromus amplicolis.* Several species are most common in very turbid waters.

Biology and ecology

Seed shrimps are filter-feeding scavengers that consume detritus and algae. Reproduction varies between species and environmental conditions. Most ostracods produce drought-resistant eggs that hatch when the wetland refloods.

Ilyodromus candonites is restricted to granite outcrop pools.

Diacypris spinosa is a widespread species restricted to naturally and secondarily saline wetlands.

Water fleas
(Order Cladocera)

Diversity and endemism

There are at least 68 species from 25 genera of water fleas that occur in wetlands of the Avon. At least 18 species are restricted to the south-west of Western Australia but predominantly occur in the Wheatbelt, such as *Daphnia jollyi* and *D. wardi*.

Appearance

Cladocerans have a soft bi-valved carapace that covers the body and head but does not close completely except in species from the families Daphniidae and Chydoridae. Some of the larger species use their large branched antennae for swimming. Most species are less than two millimetres but some can grow up to six millimetres. Some grow long spines on the head and tail end of the carapace so that they are too large to be consumed by some predators.

Daphnia cephalata is only found in freshwater wetlands such as claypans, granite rock pools and swamps.

Daphnia truncata is tolerant of high salinity and is found in naturally and secondarily saline wetlands.

Macrothrix breviseta is found in fresh to slightly saline wetlands.

Habitat

Water fleas are predominantly found in fresh and slightly saline wetlands and occupy a variety of habitats, including open water, among aquatic plants and on the bottom of wetlands. A small number of species such as *Daphnia truncata, Daphnia pusilla* and *Daphnia wardi* are tolerant of high salinity. Four species are only known from pools on granite outcrops in the Wheatbelt, including *Macrothrix hardingi* and *Plurispina chauliodis*.

Biology and ecology

Benthic water fleas graze on algae, bacteria and detritus found on or in the sediment, while open water species are filter feeders. They are an important food source for larger invertebrates and fish.

Many water fleas alternate between asexual and sexual reproduction. When the wetland refills, females hatch from drought-resistant eggs and rapidly mature. While conditions are favourable, they continually produce unfertilised eggs that hatch female clones. When the water body begins to dry up and conditions become unfavourable, males are produced and sexual reproduction occurs. This results in the production of a future generation of drought-resistant eggs.

Clam shrimp
(Orders Laevicaudata and Spinicaudata)

Diversity and endemism

Six genera and seven species of clam shrimp have been recorded in the Avon region. At least three species, *Caenestheriella mariae* and two unnamed species from the genus *Caenestheria,* are endemic to the south-west of Western Australia.

Appearance

Clam shrimp are enclosed in a bi-valved shell and have between 10 and more than 30 legs. Most species have growth lines on the surface of their shells. Adults can grow up to 25 millimetres but species in the Avon are generally under 10 millimetres.

Habitat

Clam shrimp are relatively uncommon and are found in a variety of temporary freshwater wetlands including granite rock pools, claypans, swamps, dams and lakes. Some species occupy a range of habitats whereas others are more restricted. For example, *Caenestheriella mariae* only occurs in granite rock pools. It is common for multiple species belonging to different genera to co-exist in the same wetland.

The clam shrimp, *Limnadia* sp., is most commonly found in granite outcrop pools.

Biology and ecology

Clam shrimp are mostly filter feeders but can also scavenge by scraping and tearing food. For example, *Caenestheriella mariae* scrapes algae off rocks. Clam shrimp produce drought-resistant eggs which can lie dormant in the sediment until the wetland refloods.

Shield shrimp
(Order Notostraca)

Diversity and endemism

Two species of shield shrimp have been recorded in the Avon region, *Lepidurus apus viridis* and the less common *Triops australiensis australiensis,* which are endemic to Australia.

Appearance

Shield shrimp have a long shield-like carapace and a tail. Adults can grow up to 40 millimetres in length not including the tail.

Habitat

Both species are uncommon and have only been found in temporary freshwater wetlands of the Avon, such as claypans, granite rock pools and swamps.

Triops australiensis australiensis swimming in Lake Bryde. Photo – Natalie Nicholson/DEC Katanning.

Biology and ecology

Shield shrimp are omnivores and forage on the sediment for algae, rotifers, bacteria, tadpole eggs, fairy shrimp, rotting leaves and detritus. They have a life span of a few weeks to a few months and produce drought-resistant eggs as an adaptation to living in temporary pools. The eggs require a dry period before hatching.

Brine shrimp
(Order Anostraca)

Diversity and endemism

Artemia and *Parartemia* are the only two genera of brine shrimp that occur in saline wetlands of the Avon. *Parartemia* is endemic to Australia and most of its 19 species are only found in Western Australia, seven of which occur in the Avon. *Artemia* were introduced as fish food and to control algae in salt production ponds but they have spread into natural wetlands.

Appearance

Brine shrimp have long thin bodies with feathery appendages and swim upside down. *Parartemia* are easily distinguished by the elaborate antenna of the male that has been modified into a clasper. *Artemia* populations are predominately female (one species reproduces asexually) and are pink in colour. These animals range in length from 13 to 26 millimetres.

Habitat

Parartemia inhabit naturally saline wetlands and are rarely found in secondarily saline wetlands. They can tolerate salinities between 15 and over 300 grams per litre but tolerance depends on the species. *Parartemia contracta* is uniquely

Parartemia serventyi is a common species found in naturally saline wetlands.

restricted to acidic lakes (pH 2 to 6), while other species generally occur in alkaline wetlands. Species such as *Parartemia serventyi* and *Parartemia longicaudata* are common and widespread, while *Parartemia extracta* is rare and only known from a few sites. It is unusual to find more than one species of *Parartemia* in the same wetland. *Artemia* has been recorded in both naturally saline and secondarily saline wetlands.

Biology and ecology

Brine shrimp are filter feeders that consume benthic organic matter such as diatoms. They provide a food source for waterbirds in shallow playas.

As an adaptation to living in temporary waters, *Parartemia* produce two types of eggs. One type hatches immediately so that multiple generations are present when conditions in the wetland are favourable. The other is drought-resistant and lies dormant during the dry period. These hatch when the lake refills and conditions are suitable.

Fairy shrimp
(Order Anostraca)

Diversity and endemism

Branchinella is the only genus of fairy shrimp recorded in the Avon and one of only two in Australia. Six species are present in temporary wetlands of the Avon, with *Branchinella kadjikadji*, *Branchinella longirostris* and *Branchinella halsei* restricted to the south-west of Western Australia.

Appearance

Like the brine shrimp, *Branchinella* have long thin bodies with feathery appendages and swim upside down. They are distinguished by the elaborate antennae of the male. The average length of an adult is 10 to 20 millimetres.

Habitat

Branchinella longirostris is restricted to clear rock pools on granite outcrops, while *Branchinella affinis* prefer more turbid waters such as claypans. These two species are common and widespread compared to *Branchinella kadjikadji*, which has only been found in two claypans. Fairy shrimp are never found in wetlands inhabited by fish.

Branchinella halsei is endemic to the south-west and found in freshwater wetlands.

Biology and ecology

Fairy shrimp are mostly filter feeders, with the exception of *Branchinella occidentalis*, which preys on smaller fairy shrimp. Beetle and dragonfly larvae also eat fairy shrimp.

As an adaptation to drought, fairy shrimp produce drought-resistant eggs that can lie dormant for many years. The eggs hatch when the lake refills and environmental conditions are suitable. Due to the temporary nature of their habitat, some species are able to mature within four days of hatching. Only one generation is present during the wet phase of the wetland.

Side swimmers
(Order Amphipoda)

Diversity and endemism

Austrochiltonia subtenuis is the only amphipod that has been recorded in the Avon region and is widespread throughout southern Australia.

Appearance

Austrochiltonia subtenuis is laterally compressed (flattened from the sides). They are comprised of a head, thorax and abdomen and have seven pairs of walking legs. Adults vary between six and 10 millimetres in length.

Habitat

Austrochiltonia subtenuis is a common, widespread species that has been recorded in both freshwater and saline wetlands and rivers in the Avon region. It is most commonly found in shallow water among algae, reeds and sedges.

Austrochiltonia subtenuis.

Biology and ecology

Amphipods are omnivores and feed predominantly on decaying vegetation. They don't produce drought-resistant eggs so are more common in permanent waters but may survive short dry periods by taking refuge in damp areas such as mud or crayfish burrows.

Water slaters
(Order Isopoda)

Diversity and endemism

Haloniscus searlei is the only isopod that has been found in the Avon region and is widespread throughout southern Australia. Although a single name is used at present, there may be multiple species.

Appearance

Haloniscus searlei is dorso-ventrally compressed (flattened from above). They are comprised of a head, thorax and abdomen and have seven pairs of walking legs. Adults are six to 13 millimetres long.

Habitat

Haloniscus searlei is found in saline wetlands and can tolerate a wide range of salinities (10 to 140 grams per litre) making it unique among the isopods.

Haloniscus searlei.

Biology and ecology

Isopods feed on dead plants and animals. Unlike other crustaceans that inhabit temporary waters, they don't produce drought-resistant eggs. It is believed that *Haloniscus searlei* survives dry periods by seeking refuge in damp areas such as moist mud below the wetland surface.

Freshwater prawns (Order Decapoda)

Diversity and endemism

Palaemonetes australis is the only freshwater prawn that has been recorded in the Avon region and it is endemic to the south-west of Western Australia.

Appearance

Freshwater prawns have 10 legs and stalked eyes. Their second pair of legs is longer than the first pair and has pincers. *Palaemonetes australis* can grow up to 34 millimetres.

Habitat

Palaemonetes australis occurs in the permanent waters of the Avon River. It can be found in both fresh and saline waters up to around 25 grams per litre. It inhabits open water or vegetation in shallow water.

Palaemonetes australis.

Biology and ecology

Freshwater prawns are scavengers that feed on decaying plant and animal material. Copepods, amphipods, algae and chironomid larvae have been found in the gut of *Palaemonetes australis*.

Yabbies (Order Decapoda)

Diversity and endemism

There are two species of yabby that have been recorded in the Avon region, *Cherax destructor* and *Cherax quinquecarinatus*. *Cherax destructor* (dam yabby) has been introduced to Western Australia, while *Cherax quinquecarinatus* (gilgie) is endemic to the south-west.

Appearance

Yabbies have 10 legs and stalked eyes. Their front legs are modified into stout claws. *Cherax quinquecarinatus* is smaller, growing up to 13 centimetres, while *C. destructor* can grow up to 30 centimetres.

Habitat

Cherax destructor has been found in freshwater to slightly saline swamps and dams in the Avon region. They prefer turbid waters to avoid predation by waterbirds.

Cherax quinquecarinatus occupies a wide range of habitats including permanent and temporary waterways, and has been found in the Avon River.

The endemic *Cherax quinquecarinatus.*

Biology and ecology

Yabbies are predators but also opportunistically scavenge on almost anything including rotting vegetation. When food is scarce, cannibalistic behaviour has been observed.

To survive the dry periods, yabbies take refuge by burrowing up to two metres into the moist mud. They can lie dormant in their burrow for several years.

Insects

Insects can be distinguished from crustaceans and arachnids by having only three pairs of jointed legs and a single pair of antennae. Adult bodies are divided into three parts; the head, thorax and abdomen, although immature stages can look very different.

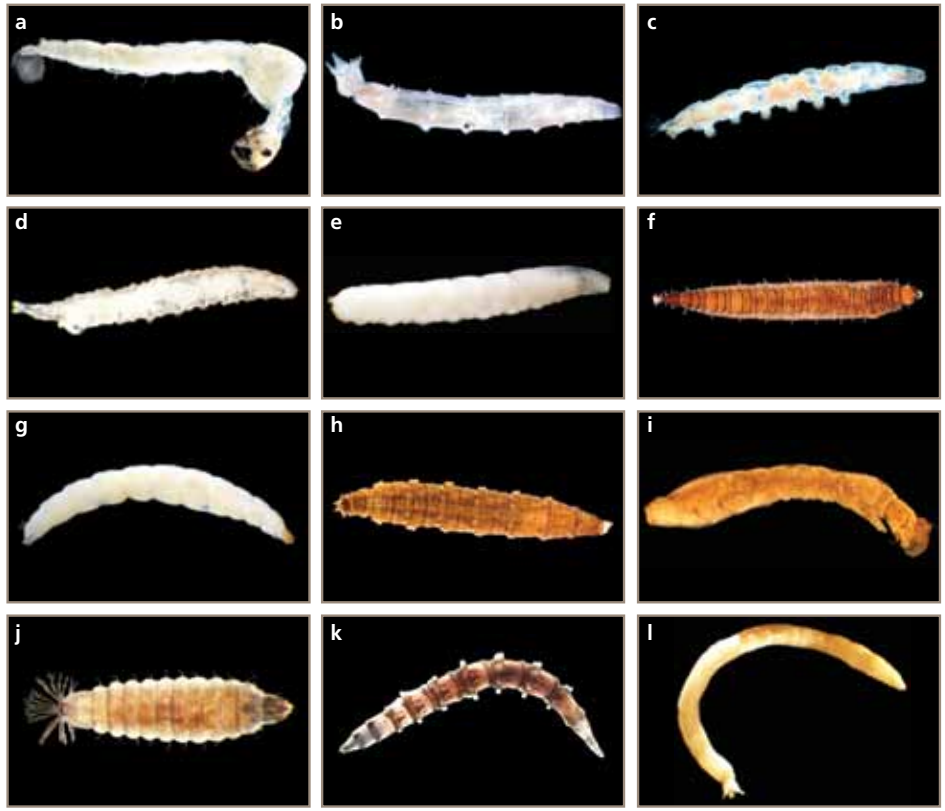
Aquatic insects are present in nearly every inland water body and are generally the dominant group in terms of species number and biomass in freshwater wetlands. Most insects are restricted to freshwater wetlands, though a few are tolerant of low salinities. There is a large range of aquatic insects found in the Avon region including caddisflies (Trichoptera), mayflies (Ephemeroptera), flies (Diptera), beetles (Coleoptera), water bugs (Hemiptera), moths (Lepidoptera), damselflies and dragonflies (Odonata).

To be considered aquatic, insects must have at least one fully aquatic phase in their life cycle. Most have a larval aquatic phase and a terrestrial adult phase, but some beetles and water bugs are fully aquatic. Since adults are capable of flight they can colonise newly flooded wetlands, either by diving straight into the water (e.g. beetles) or laying eggs at the water surface (e.g. dragonflies and mosquitoes).

Flies (Order Diptera)

There are 15 families of flies that have been recorded in the Avon region. Of these, families such as the non-biting midges (Chironomidae), biting midges (Ceratopogonidae) and mosquitoes (Culicidae) have the most species and are discussed in more detail in the sections below. Other families of flies, such as march flies (Tabanidae), crane flies (Tipulidae), marsh flies (Sciomyzidae), moth flies (Psychodidae), soldier flies (Stratiomyidae), shore flies (Ephydridae), black flies (Simuliidae), phantom midges (Chaoboridae) and species from the families Dolichopodidae, Empididae, Muscidae and Scatopsidae, will not be discussed in detail but pictures have been provided.

Flies have an aquatic larval stage and a terrestrial adult stage. Larvae can vary immensely in body structure but frequently look like worms or maggots, with up to 12 body segme nts. Most are fleshy and lack distinct heads, while others have well-developed head capsules and short legs near the head and/or the tail, such as chironomids. They can be found in a variety of wetland types including pools on granite outcrops, claypans and saline lakes. Larvae are found among organic debris, aquatic vegetation, sand, mud and gravel and may be associated with the water surface, water column and benthic zones. Larvae have a wide range of feeding habits and can be predators (e.g. march flies, crane flies, phantom midges, Dolichopodidae and Empididae), filter feeders (e.g. black flies) or detritivores that feed on decaying vegetation and algae (e.g. moth flies and soldier flies).



Examples from some of the families of aquatic fly larvae found in the Avon. (a) Chaoboridae (phantom midge), (b) Dolichopodidae (*Promochlonyx australiensis*), (c) Empididae, (d) Ephydridae (shore fly), (e) Muscidae, (f) Psychodidae (moth fly), (g) Scatopsidae, (h) Sciomyzidae (marsh fly), (i) Simuliidae (*Simulium ornatipes*), (j) Stratiomyidae (soldier fly), (k) Tabanidae (march fly), (l) Tipulidae (crane fly).

Species vary in their tolerance to salinity with taxa belonging to families such as Muscidae commonly occurring in highly saline wetlands, while other groups such as crane fly larvae, black flies, marsh flies and moth flies usually only occur in fresh to slightly saline wetlands.

Non-biting midges
(Family Chironomidae)

Diversity and endemism

Non-biting midges, or chironomids, are the most diverse group of insects that occur in wetlands of the Avon region, with at least 64 species recorded. Many of these are likely to be restricted to the south-west of Western Australia but cannot be named because they have not been reared through to adults. Species belonging to the genus *Archaeochlus* are found on granite outcrops and represent an ancient group occurring only in Australia and southern Africa.

Appearance

Chironomid larvae are worm-like animals with a fleshy body and distinct head. They generally have a pair of stumpy legs on the first and last body segment. While they vary in colour, some have haemoglobin in their bodies, giving them a red colour and hence the common name of 'blood worms'.

Habitat

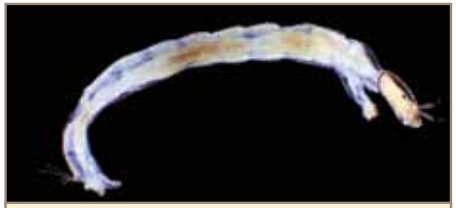
Chironomid larvae are widespread and are found in every type of wetland. They are generally found in association with benthic debris and aquatic plants and can be free-living or dwelling in a case made from secretions and fine sediment. Greatest species richness and abundance is often observed in nutrient-enriched fresh and slightly saline wetlands. Most chironomids are intolerant of high salinity, with the exception of a few species such as *Tanytarsus barbitarsis* and *Procladius paludicola*. Several species, such as unnamed species of *Allotrissocladius*, are restricted to pools on granite outcrops in the Avon region.

Biology and ecology

The feeding method of larvae varies between species. Species from the sub-family Tanypodinae are generally predatory and consume other chironomid larvae, oligochaetes, nematodes and small invertebrates. Other species are herbivorous, consuming plant detritus and algae. Dense swarms of mating adult chironomids can often be seen near wetlands around dusk, and in urban areas these can be a nuisance since they are attracted to lights. Plague midge populations are often associated with algal blooms.

Tanytarsus barbitarsis from the subfamily Chironominae is commonly found in saline wetlands.

A chironomid larva from the subfamily Tanypodinae.



A chironomid larva from the subfamily Orthocladiinae.

Biting midges
(Family Ceratopogonidae)

Diversity and endemism

There are at least 19 species from nine genera of ceratopogonids found in the Avon region.

Appearance

The appearance of the larvae varies depending on the subfamily. The Ceratopogoninae are the most common and are long and very thin. They have a distinct head capsule with hairs extending from the last body segment. The Dasyheleinae are similar in appearance to chironomids (see previous pages) but don't have prolegs on the first body segment, while the Forcipomyiinae are covered in hairs or spines.

Habitat

Biting midge larvae are found in a variety of habitats including pools on granite outcrops, claypans, streams and saline lakes. They are generally found in association with mud and rotting vegetation, though some will readily swim with a snake-like movement in the water column. Species vary in their tolerance to salinity, with species from the genera *Forcypomyia* and *Atrichopogon* generally found in freshwater to slightly saline wetlands and species from the genus *Culicoides* usually found in wetlands that are freshwater to highly saline.

Biology and ecology

Larvae consume detritus, algae and small invertebrates. Some adult females, such as *Culicoides*, suck blood from vertebrates, including humans, while *Dasyhelea* feed on flower nectar. Some species of *Atrichopogon* and *Forcipomyia* are parastitic on larger insects.

Culicoides sp. (subfamily Ceratopogoninae) is commonly found in wetlands in the Avon region

Dasyhelea sp. from the subfamily Dasyheleinae.

Undescribed species from the genus *Forcypomyia* (subfamily Forcipomyiinae).

Mosquitoes
(Family Culicidae)

Diversity and endemism

Thirteen species of mosquito larvae from four genera have been recorded in Avon wetlands. Of these, *Aedes occidentalis*, is endemic to the south-west and Goldfields, and is restricted to pools on granite outcrops.

Appearance

Mosquito larvae are more complex than most fly larvae and have bristle-covered bodies. The thorax (first three body segments) is generally much broader than the abdomen. When in the water, they have a wriggling motion and are often referred to as 'mosquito wrigglers'. Some have a siphon on the tail end which is used to penetrate through the water surface for breathing.

Habitat

Mosquito larvae are restricted to still or slow-moving water bodies, often in protected shallow areas. Most occur in freshwater and mildly saline wetlands but some species, such as *Aedes camptorhynchus,* are tolerant of highly saline conditions.

Biology and ecology

Larvae use a variety of feeding methods. *Anopheles* and most *Culex* are filter feeders that use mouth brushes to sweep algae and detritus into their mouths. Some species of *Aedes* and *Culex* are predators, feeding on other smaller mosquito larvae and invertebrates. Only adult females of some species feed on mammalian blood, which is required for egg production. Some feed only on birds or frogs. The eggs of some *Aedes* are resistant to desiccation, giving these species an advantage in temporary water bodies.

The endemic mosquito larva, *Aedes occidentalis*, is found in granite outcrop pools.

Mosquito larva *Aedes* sp.

Caddisflies
(Order Trichoptera)

Diversity and endemism

Eleven species from four families of caddisflies occur in the Avon, none of which are endemic to the region. Most species belong to the family Leptoceridae.

Appearance

Caddisflies are small, moth-like insects that have a long aquatic larval phase. For protection against predators most larvae live in portable cases constructed from a variety of materials such as sand, leaves, twigs, grass and bark. They can often be seen by looking for moving pieces of these materials. Others build retreats from silk-like secretions. Mature larvae can grow up to 25 millimetres in length but most are much smaller.

Hellyethira litua construct portable cases from silk-like secretions.

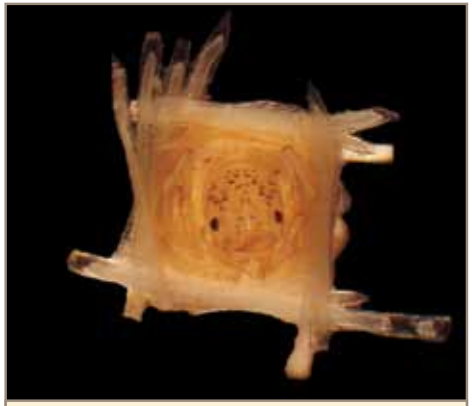
Habitat

Caddisfly larvae are found in a variety of fresh and slightly saline wetlands including slow-moving streams and temporary lakes. Some species from the family Leptoceridae can inhabit moderately saline wetlands, such as *Symphitoneuria wheeleri* and *Notalina spira*. One species, *Cheumatopsyche* sp. (family Hydropsychidae), occurs only in flowing streams.

Biology and ecology

Caddisfly larvae employ various feeding methods. Species with portable cases graze on algae, leaves and detritus, while those that make fixed retreats (family Hydropsychidae) spin nets which they use to filter food from flowing water. Free-living caddisfly larvae, such as species from the family Economidae, are nomadic predators. Caddisfly larvae are eaten by fish, frogs, dragonfly nymphs and other aquatic predators. They can be sensitive to water quality and are often used as an indicator of wetland health, though species in the Avon region tend to be fairly tolerant of a range of conditions.

Symphitoneuria wheeleri can tolerate moderately saline conditions.



Oecetis sp. in its portable case.

Moths and butterflies
(Order Lepidoptera)

Diversity and endemism

A small number of lepidopterans have an aquatic larval phase and are known as 'aquatic caterpillars'. Identifying larvae can be difficult because it is rarely known what species of adult it will mature into. Most of the aquatic caterpillars belong to the family Pyralidae with four undescribed pyralid species and two non-pyralid species found in the Avon region. Two of these species may be endemic to the south-west of Western Australia.

Appearance

Aquatic caterpillars have a similar appearance to terrestrial caterpillars because they have fleshy bodies and six short legs, but they are often covered in filamentous gills. Mature larvae can grow between 10 and 25 millimetres.

Habitat

Aquatic caterpillars have been recorded from fresh to moderately saline wetlands in the Avon, with the most common species occurring primarily in saline waters. They are generally found in association with aquatic plants or on rocks.

Unidentified larva from the family Pyralidae.

Biology and ecology

Aquatic caterpillars feed on algae and aquatic plants. For protection against predators, some larvae build portable cases from leaves and stems bound with silk. Adults (moths) are entirely terrestrial.

Mayflies
(Order Ephemeroptera)

Diversity and endemism

Two species of mayfly, *Cloeon* sp. and *Tasmanocoenis tillyardi*, have been recorded in the Avon region. These species are not restricted to the region.

Appearance

The aquatic immatures are known as nymphs and these are easily distinguished by their three caudal filaments or 'tails' and the presence of gills on the abdomen (covered by a protective plate in *Tasmanocoenis tillyardi*). Mature larvae can grow up to eight to 10 millimetres in length.

Habitat

Mayfly nymphs occur in fresh and slightly saline lakes, streams and swamps of the Avon. They are benthic and can be found on logs, soil and leaf litter or clinging to submerged plants. They generally inhabit permanent water but since adults are capable of flight they can colonise temporary waters.

The mayfly nymph *Tasmanocoenis tillyardi.*

Biology and ecology

The nymph phase is the longest stage in the mayfly life cycle as adult flies emerge only to reproduce and die within a few days: hence the scientific name for the group (which means short-lived with wings). Mayfly nymphs are herbivores and scrape algae, diatoms and detritus off rocks, wood and aquatic plants. They are preyed upon by fish and their appearance is often mimicked in the design of lures for the sport of fly fishing.

Damselflies and dragonflies (Order Odonata)

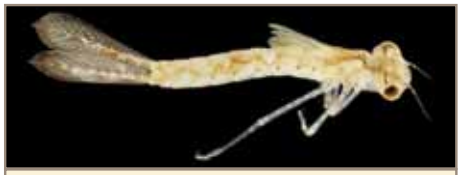
Diversity and endemism

Ten species of damselfly larvae and 10 species of dragonfly larvae have been recorded in wetlands of the Avon region. Of the species that occur in the Avon region, two, *Austrogomphus collaris* (dragonfly) and *Archiargiolestes pusillus* (damselfly), are endemic to the south-west of Western Australia.

Appearance

Damselfly larvae are slender and have three flat gills at the end of their abdomen. Dragonfly larvae are stouter and have the respiratory gills protected within the rectum. Both groups have six legs and large eyes on the sides of their mostly triangular heads. Mature odonate larvae develop wing buds and range between 10 and 40 millimetres in length.

Austrolestes annulosus is a common damselfly found in fresh to moderately saline wetlands.



Xanthagrion erythroneurum is a widespread damselfly found in fresh to slightly saline wetlands

Habitat

Odonate larvae inhabit both temporary and permanent wetlands. Most species are restricted to fresh and slightly saline wetlands but some, such as *Austrolestes annulosus* and *Austrolestes io* (damselfies) and *Hemicordulia tau* (dragonfly) have been frequently collected from moderately saline wetlands in the Avon. Odonate larvae are usually found in association with submerged macrophytes.

Aeshna brevistyla is a widespread dragonfly species restricted to fresh and slightly saline wetlands.

Austrogomphus collaris is an endemic dragonfly species.

Biology and ecology

Dragonflies and damselflies have an aquatic larval stage and terrestrial adult stage. Species colonising temporary wetlands such as *Hemicordulia tau* and *Ischnura aurora* have short life cycles. Odonate larvae are predators and use either an attack or an ambush strategy. They prey upon a wide variety of other invertebrates. Larvae from the damselfly family Coenagrionidae can be territorial and defend their hunting ground. As a means of escaping predators, dragonfly larvae are able to propel themselves by expelling water out of their anus. Some damselfly larvae are known to be sensitive to poor water quality and are often used as indicators of wetland health.

Water bugs
(Order Hemiptera)

Diversity and endemism

Although invertebrates are generally referred to as 'bugs', this group is more specifically referred to as the 'water bugs' or 'true bugs'. Twenty-two species from seven families of water bugs have been recorded from wetlands in the Avon, but most of these are widespread outside the region. The waterboatman, *Sigara mullaka* and the backswimmer, *Anisops baylii* are endemic to the south-west of Western Australia.

Appearance

Water bugs are easily distinguished by their mouthparts, which have been modified to form a rostrum (also known as the beak), so it is pointed on the ventral side. Juvenile water bugs are similar in appearance to adults because they do not go through a pupal stage.

Anisops thienemanni is a widespread backswimmer that can tolerate moderate salinity.

Habitat

There are two types of water bugs – those that are semi-aquatic and live on the water surface or shoreline, such as water striders (family Vellidae), and those that are fully aquatic and live beneath the water surface, such as waterboatmen (family Corixidae) and backswimmers (family Notonectidae). Water bugs occupy a variety of habitats including temporary pools, granite rock pools, lakes and rivers. They are mostly found in fresh and slightly saline wetlands, but some do occur in moderately and highly saline wetlands, such as the backswimmers, *Anisops thienemanni* and *Anisops gratus*.

Sigara mullaka is a waterboatman that is endemic to the south-west of Western Australia and distinguished by the stripes behind the head.

Micronecta robusta is a waterboatman that has only been recorded in fresh and slightly saline wetlands.

Biology and ecology

Most water bugs prey upon other aquatic invertebrates. They use their piercing mouthparts to harpoon then inject paralysing toxins into their prey. They then suck out the body fluids. The exception is the waterboatmen (so called because they use their middle pair of legs like oars), which mostly forage on the bottom for plant and animal detritus as well as small invertebrates. Water bugs are often present in large numbers and are an important food source for fish.

Beetles (Order Coleoptera)

Diversity and endemism

Forty-four species from 12 families of aquatic beetles have been recorded from wetlands in the Avon region, making them one of the most diverse insect groups. Nine of these are endemic to the south-west of Western Australia, including four species of *Paroster,* which are most commonly found in pools on granite outcrops in the Wheatbelt.

Appearance

The presence of long hairs on their hind legs (used to assist swimming) and a streamlined body distinguishes most adult aquatic beetles from their terrestrial counterparts. The soft-bodied larvae are very different in appearance to the adults and are generally elongate with three pairs of legs.

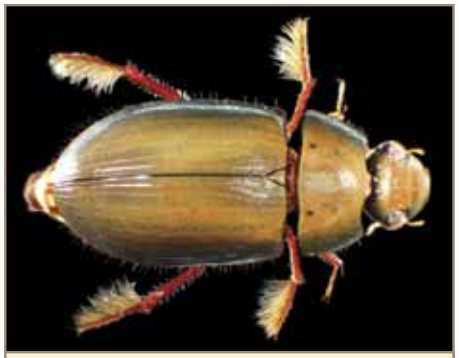
Habitat

Aquatic beetles occur in a variety of habitats including granite outcrop pools, saline lakes and swamps. Species vary in their tolerance to salinity, which influences the type of wetlands they occur in. A large proportion of species is restricted to fresh or only slightly saline water such as *Berosus approximans* and *Megaporus howitti*. *Necterosoma penicillatus* and *Berosus munitipennis* are commonly found in moderately to highly saline wetlands. *Eretes australis* is usually found in turbid claypans.

Biology and ecology

Aquatic beetles are predators, scavengers or herbivores. Although a large proportion of adult beetles is fully aquatic, most still maintain the ability to fly, enabling them to disperse to other habitats, and some can be found long distances from water.

The diving beetle, *Eretes australis*, has been recorded in claypans and granite outcrop pools in the Avon region.



The water scavenger beetle, *Limnoxenus zelandicus.*

Paroster sp. is an endemic species most commonly found in granite outcrop pools.

Megaporus sp. larvae.

Waterbirds

There are 63 species of waterbirds found in the Avon. From left to right, top to bottom: freckled duck, hoary-headed grebe with young, little pied cormorant, eastern great egret, hooded plover and swamp harrier. Photos (in order) - Ian Montgomery/Birdway, Babs and Bert Wells/DEC, Rohan Clarke/Wildlife Images, Ian Montgomery/Birdway, Ian Montgomery/Birdway, Rohan Clarke/Wildlife Images.

Sixty three waterbird species have been recorded in the Avon region since 1981 during various projects conducted by the Department of Environment and Conservation. Waterbirds such as freckled ducks, little grassbirds and bitterns have declined in abundance due to impacts from agriculture and other forms of development. Secondary effects of dryland salinisation, such as reduced plant cover, food, and freshwater availability, are the primary causes for reduced waterbird diversity in the region.

Natural freshwater wetlands, which are used by breeding waterbirds, have declined in abundance and condition. Artificial freshwater wetlands, such as farm dams, are important for the maintenance of some populations in the area, most notably the Australian shelduck and Australian wood duck, which have benefited from agriculture.

Emergent plants such as reeds, rushes and sedges are generally intolerant of even a slight increase in salinity, and are a continually declining habitat at wetlands in the Avon. This most significantly affects birds such as bitterns, waterhens, crakes, little grassbirds and Australian reed-warblers, which use this habitat for nesting. Emergent vegetation is also important because it offers waterbirds some protection from predators such as foxes, cats and birds of prey. The Australasian bittern is now listed as rare or likely to become extinct by the Western Australian government because their numbers have significantly declined.

The combination of an increase in salinity and excessive inundation or waterlogging kills trees and shrubs within a few years. This has implications for species such as herons, ibis and spoonbills that predominantly nest in live trees above water.

Submerged plants, aquatic invertebrates, fish, frogs and tortoises are tolerant of salinity to varying degrees. Egrets, herons, bitterns, cormorants and pelicans, which predominantly feed on larger animals such as fish, frogs, yabbies and tortoises, are significantly affected by salinisation because these prey are mainly intolerant of saline conditions. Some other waterbirds, such as ducks and shorebirds, which mostly feed on submerged plants and invertebrates, are the least affected by salinisation. Although these food resources decline in diversity and abundance with an increase in salinity, they are still present in moderately saline conditions. It has been observed that numbers of the Australian wood duck, the Australian shelduck and some waders have actually increased in the region since European settlement.

Ducks and swans

Ducks and swans are characterised by their short flat bills and webbed feet. Eleven species of duck and two species of swan have been recorded in the Avon region.

Congregation of grey teals.
Photo – Babs and Bert Wells/DEC

Ducks and swans (Family Anatidae)

Most ducks and swans can only bob their heads under the water to feed (dabblers), while some ducks can submerge themselves completely (divers). Dabblers have legs located in the middle of the body making it difficult for them to completely submerge their rumps, and can often be seen feeding with their tail in the air. Divers have legs situated at the rear of the body to propel the duck to the bottom of the lake to feed and then back up to the surface. Ducks and swans are generally found living in groups, but some can also live in pairs or alone. During the summer and autumn, flocks of thousands of individuals may be seen congregating on the larger, more permanent wetlands.

Chestnut teal *(Anas castanea)*

Distinctive features

The chestnut teal is similar in appearance to the grey teal, but generally darker in colour and without the paler throat. Breeding males have a green crown and neck, and chestnut breast and flanks. Size: 40 to 50 centimetres.

Feeding

It dabbles on aquatic vegetation and invertebrates.

Breeding

Nests are made of down in a variety of locations: on the ground, among reeds, or in tree hollows, logs or rabbit burrows.

Distribution

This bird is found in south-western and south-eastern Australia at freshwater and saline wetlands, but most commonly in the great southern coastal lakes and inlets.

Occurrence in the region

Uncommon.

Chestnut teal.
Photo – Babs and Bert Wells/DEC

Grey teal
(Anas gracilis)

Distinctive features

This inconspicuous species is distinguished from the chestnut teal by its paler throat. It is grey-brown in colour. Size: 37 to 48 centimetres.

Feeding

It dabbles on aquatic invertebrates, aquatic and terrestrial vegetation, seeds and insects.

Breeding

Grey teals are opportunistic breeders that nest on the ground, among reeds or in tree hollows, logs or rabbit burrows.

Distribution

They are found throughout Australia at freshwater and saline wetlands, estuaries and sheltered coastal areas.

Occurrence in the region

Common.

Grey teal.
Photo – Babs and Bert Wells/DEC

Australasian shoveler
(Anas rhynchotis)

Distinctive features

The Australasian shoveler has chestnut flanks and belly with a dull brown head and a large pointed (shovel-shaped) dark bill. Breeding males have a white-yellow vertical crescent in front of the eyes. Size: 47 to 53 centimetres.

Feeding

It dabbles on aquatic invertebrates and macrophytes by using special grooves along the edge of the bill to filter-feed.

Breeding

This bird nests on the ground in dense vegetation and occasionally in tree stumps or hollows standing in water.

Distribution

It is found throughout Australia, where it prefers large, permanent, heavily vegetated swamps but is also commonly recorded on open moderately saline wetlands and brackish inlets.

Occurrence in the region

Common.

Australasian shoveler.
Photo – Babs and Bert Wells/DEC

Pacific black duck
(Anas superciliosa)

Distinctive features

The Pacific black duck has characteristic horizontal black and white stripes on the head and a brown body.
Size: 50 to 60 centimetres.

Feeding

It dabbles on aquatic invertebrates and macrophyte seeds.

Breeding

This bird nests on the ground and in tree stumps and hollows around wetlands.

Distribution

It is common throughout Australia at freshwater to moderately saline wetlands, estuaries and sheltered coastal areas.

Occurrence in the region

Common.

Pacific black duck.
Photo – Babs and Bert Wells/DEC

Hardhead
(Aythya australis)

Distinctive features

The hardhead is a chestnut brown colour with a white undertail and a light blue tipped bill. The sexes can be distinguished by eye colour: males have white eyes, females have brown eyes.
Size: 45 to 60 centimetres.

Feeding

It dabbles and dives for food such as aquatic invertebrates and macrophytes.

Breeding

The hardhead prefers deep, open freshwater or densely vegetated wetlands for breeding. It builds its nests on a trampled platform of reeds, sticks and vegetation near water.

Distribution

This bird is found throughout Australia at freshwater to moderately saline wetlands.

Occurrence in the region

Common.

Hardhead (male).
Photo – Babs and Bert Wells/DEC

Musk duck
(Biziura lobata)

Distinctive features

The musk duck has dark plumage and a short triangular bill. It floats low in the water so the tail is partly submerged. The male has a large lobe beneath the bill and a distinctive spiky tail. It uses its feet to make loud splashing noises during courtship displays.
Size: 60 to 70 centimetres.

Feeding

This bird dives for aquatic invertebrates, macrophytes, molluscs, frogs and fish.

Breeding

It builds an untidy nest in reeds or tree hollows.

Distribution

The musk duck is found in south-western and south-eastern Australia at freshwater to moderately saline wetlands.

Occurrence in the region

Common.

Musk duck (male).
Photo – Babs and Bert Wells/DEC

Australian wood duck
(Chenonetta jubata)

Distinctive features

The Australian wood duck has a dark brown head with a mottled breast and neck and two dark stripes down the back. Males have grey sides and females have mottled brown and white sides. The short bill gives it a goose-like appearance.
Size: 45 to 60 centimetres.

Feeding

It grazes and dabbles mostly on terrestrial grasses and aquatic macrophytes.

Breeding

This bird makes a down nest in tree hollows near water.

Distribution

It is found throughout Australia at freshwater and sometimes moderately saline wetlands, but also commonly inhabits farm dams and flooded pastures.

Occurrence in the region

Common.

Australian wood duck.
Photo – Babs and Bert Wells/DEC

Black swan
(Cygnus atratus)

Distinctive features
The black swan has black plumage except for the white outer wing feathers that are sometimes visible when folded, and bright red bill.
Size: 1 to 1.4 metres.

Feeding
It dabbles on algae and macrophytes.

Breeding
The black swan makes its nest from reeds and sedges either built on an island, on mounds in shallow water, or floating in deep water.

Distribution
It is found throughout Australia at freshwater or saline wetlands and estuaries.

Occurrence in the region
Common.

Black swans and cygnets.
Photo – Babs and Bert Wells/DEC

Mute swan
(Cygnus olor)

Distinctive features
The mute swan is a large white swan with an orange bill and black on its fore face.
Size: 1.3 to 1.6 metres.

Feeding
It dabbles on aquatic macrophytes and occasionally eats frogs and tadpoles.

Breeding
The mute swan makes nests from reeds and sedges on an island or floating in deeper water.

Distribution
It was introduced to Australia in 1886. Some colonies are still present on the Avon River at Northam.

Occurrence in the region
Resident at Northam; very rare elsewhere.

Mute swan.
Photo – Babs and Bert Wells/DEC

Pink-eared duck *(Malacorhynchus membranaceus)*

Distinctive features

The pink-eared duck is so named for the pink spot behind the eye. It has a square-tipped grey bill and a white head, with dark markings around the eye, and a brown back. The neck, breast and flanks have zebra-like stripes.
Size: 38 to 45 centimetres.

Feeding

It dabbles on plankton by using special grooves along the edge of the bill to filter-feed.

Breeding

This bird makes its nest in those built by other species or in tree hollows near the water.

Distribution

It is found throughout Australia at freshwater to moderately saline wetlands.

Occurrence in the region

Common.

Pink-eared duck.
Photo – Babs and Bert Wells/DEC

Blue-billed duck *(Oxyura australis)*

Distinctive features

The male blue-billed duck has a very dark head and chestnut body while the female is mottled brown all over. The bill of breeding males turns bright blue.
Size: 36 to 44 centimetres.

Feeding

This duck dives for aquatic invertebrates and macrophytes.

Breeding

Its nest has a canopy and is built within dense reeds over water, lined with soft grass and down.

Distribution

It occurs in south-western and south-eastern Australia at freshwater lakes and swamps, and occasionally at moderately saline wetlands and estuaries.

Occurrence in the region

Uncommon.

Blue-billed duck (breeding male).
Photo – Babs and Bert Wells/DEC

Freckled duck
(Stictonetta naevosa)

Distinctive features
The freckled duck has dark plumage with light speckles. The crown of its head is slightly peaked and the bill curves slightly upwards.
Size: 50 to 60 centimetres.

Feeding
This duck dabbles on aquatic invertebrates and macrophytes.

Breeding
It uses down, twigs and debris to make a nest in dense reeds or in tree hollows.

Distribution
It is found throughout Australia. In south-western and south-eastern Australia it is most commonly found at freshwater lakes and swamps.

Occurrence in the region
Rare.

Freckled duck.
Photo – Ian Montgomery/Birdway

Australian shelduck
(Tadorna tadornoides)

Distinctive features
The Australian shelduck has black plumage with a cinnamon (male) or chestnut (female) chest, a white ring around the neck; and white around the eye and base of the bill (female only).
Size: 57 to 73 centimetres.

Feeding
It grazes on grass and dabbles on aquatic invertebrates and macrophytes.

Breeding
It usually nests in a hollow tree far from water, and sometimes on the ground under vegetation. In unusual cases, it nests in a rabbit burrow.

Distribution
It is found in south-western and south-eastern Australia at freshwater or saline wetlands and estuaries.

Occurrence in the region
Common.

Australian shelduck (male).
Photo – Babs and Bert Wells/DEC

Waterhens, coots and crakes

Waterhens, coots and crakes have a plump body (much like that of a hen), thick strong legs, long un-webbed toes, and a strong, stout bill.

Six species of waterhens, coots and crakes have been recorded on wetlands in the Avon region.

Eurasian coot and nest.
Photo – Babs and Bert Wells/DEC

Waterhens, coots and crakes (Family Rallidae)

The Eurasian coot and some waterhens possess a shield, which is an extension of the bill up between the eyes to the crown of the head. Behaviourally, most species tend to be secretive and are often found hiding and feeding in reeds, rushes and grasses surrounding a wetland.

Eurasian coot *(Fulica atra)*

Distinctive features

The entire body is dark grey to black with a white bill and shield extending up between red eyes. Size: 35 to 38 centimetres.

Feeding

It dives, dabbles or grazes on aquatic macrophytes, insects and rarely fish.

Breeding

Eurasian coots become very territorial and aggressive towards other birds when breeding. Nests are made of sticks, twigs, reeds and leaves in vegetation, at the base of trees or shrubs, on the ground or on the water. These birds have also been known to steal nests of other species and push their eggs into the water.

Distribution

This species is found throughout Australia at freshwater to moderately saline wetlands.

Occurrence in the region

Common.

Eurasian coot.
Photo – Babs and Bert Wells/DEC

Dusky moorhen
(Gallinula tenebrosa)

Distinctive features

It has dark brown plumage on the back and head, dark grey plumage on the belly and breast, and a white undertail. It has a yellow-tipped red bill with a red shield extending between the eyes.
Size: 35 to 40 centimetres.

Feeding

It dabbles and grazes on aquatic invertebrates and macrophyte seeds, shoots and roots.

Breeding

Their nests are made of sticks, reeds, bark and grass over water, on the ground near water or in low trees and reeds.

Distribution

This species occurs in south-western and eastern Australia at freshwater to slightly saline wetlands.

Occurrence in the region

Uncommon.

Dusky moorhen.
Photo – Babs and Bert Wells/DEC

Purple swamphen
(Porphyrio porphyrio)

Distinctive features

The purple swamphen has black plumage on the back and wings and purple-blue plumage on the breast, belly and neck, and a white undertail. It has a bright red bill and a shield extending between the eyes. It has large red legs and feet.
Size: 45 to 50 centimetres.

Feeding

It forages in shallow water and on land for aquatic vegetation, mostly reed and rush shoots. It is also known to take small animals such as frogs, snails and the occasional duckling.

Breeding

This species nests in emergent vegetation by trampling reeds to form a platform and lining it with softer grasses.

Distribution

This species is found in the south-western, eastern and northern parts of Australia. It inhabits freshwater to slightly saline wetlands and is also common around grasslands and pastures.

Occurrence in the region

Uncommon.

Purple swamphen.
Photo – Babs and Bert Wells/DEC

Australian spotted crake
(Porzana fluminea)

Distinctive features

The back and wings are mostly brown with black and white mottling, and the breast and face are grey. It has red eyes and a greenish bill with a red base.
Size: 19 to 22 centimetres.

Feeding

It forages in shallow water for aquatic invertebrates and macrophytes.

Breeding

It makes a shallow bowl-shaped nest of aquatic vegetation and grass hidden in reeds and rushes around wetlands.

Distribution

This species is nomadic and is found in south-western, eastern, and north-western Australia. It prefers vegetated margins of freshwater to moderately saline wetlands.

Occurrence in the region

Rare.

Australian spotted crake.
Photo – Babs and Bert Wells/DEC

Baillon's crake
(Porzana pusilla)

Distinctive features

The back and wings are a cinnamon-brown with black and white mottling. The underwing, neck and breast are grey and the belly is barred brown-black and white. It has red eyes and a yellow or green bill.
Size: 15 to 16 centimetres.

Feeding

It forages in shallow water for aquatic invertebrates and macrophytes.

Breeding

It builds a saucer-shaped nest made from reeds and grass in emergent vegetation surrounding wetlands.

Distribution

This species is found in south-western and south-eastern parts of Australia in dense emergent vegetation surrounding freshwater to slightly saline wetlands.

Occurrence in the region

Rare.

Baillon's crake.
Photo – Babs and Bert Wells/DEC

Black-tailed native hen
(Tribonyx ventralis)

Distinctive features
This bird has dark plumage with the black tail often held upright. The upper bill and shield is lime green and the lower bill is red. Their legs and feet are bright red and it has yellow eyes. Size: 32 to 38 centimetres.

Feeding
It wades and grazes on aquatic invertebrates and terrestrial and aquatic vegetation.

Breeding
Their nests are made of sticks, reeds, leaves, bark, grass and feathers in dense vegetation near water. It will breed at any time of the year after rainfall.

Distribution
This species is found throughout Australia at freshwater to moderately saline wetlands and permanent bores. It will appear at large inland wetlands to breed shortly after heavy rainfall.

Occurrence in the region
Uncommon in most years; large numbers occasionally.

Black-tailed native hen.
Photo – Babs and Bert Wells/DEC

Swamp harrier (Family Accipitridae)
(Circus approximans)

The swamp harrier requires wetlands for feeding and breeding and is closely related to other birds of prey such as eagles and hawks, which all have a hooked bill, long wings and strong talons that are used to grasp their prey.

Distinctive features
The plumage is variable, usually ranging from greyish-brown (adults) to dark brown (juveniles) with a distinctive white rump in adults and light outer underwing feathers. Mostly seen in flight. Size: 50 to 60 centimetres.

Feeding
It glides low over wetlands watching for movements of any small animal including small waterbirds, frogs, tortoises, fish, small mammals and large aquatic invertebrates.

Breeding
Nests are made of trampled rushes built in dense rush beds or tall grass, over water or near water.

Distribution
This bird is found throughout Australia at freshwater and saline wetlands, mangroves, estuaries and occasionally pastures.

Occurrence in the region
Uncommon.

Swamp harrier (juvenile).
Photo – Rohan Clarke/Wildlife Images

Grebes

Grebes superficially resemble small ducks but on closer inspection there are some distinct differences. Firstly, the bills on grebes are smaller and much pointier. Secondly, grebes do not have webbed feet like ducks, instead each toe is lobed similar to the blade of an oar.

Three species of grebes occur in Australia and have been recorded in the Avon region.

Australasian grebe with nest.
Photo – Babs and Bert Wells/DEC

Grebes (Family Podicipedidae)

The legs of grebes are placed at the rear of the body, which makes it easy to dive for food and escape danger. This feature makes it awkward for them to walk on land so they spend most of their time on the water. Grebes are rarely seen flying, except when disturbed by boats. Most movements between waterbodies occur at night.

Great crested grebe *(Podiceps cristatus)*

Distinctive features

This bird has a white face with a distinctive black crest and a brown and black ruff around the neck. The back of the neck, wings, flanks and tail are brown and the underparts are white. Size: 47 to 61 centimetres.

Feeding

It dives for small fish and aquatic invertebrates.

Breeding

The nest is round and is made of aquatic vegetation supported by reeds or partly submerged branches.

Distribution

This species is found throughout Australia at freshwater and occasionally moderately saline wetlands.

Occurrence in the region

Uncommon.

Great crested grebe.
Photo – Babs and Bert Wells/DEC

Hoary-headed grebe
(Poliocephalus poliocephalus)

Distinctive features
Breeding adults have a conspicuously white-streaked dark head. Non-breeding adults have a dark cap that ends just below the eye.
Size: 29 to 30 centimetres.

Feeding
It dives for aquatic invertebrates.

Breeding
This bird builds a nest of floating aquatic vegetation that is anchored and supported by reeds or fallen branches, usually far from the shore.

Distribution
This species is found throughout Australia at freshwater and saline wetlands.

Occurrence in the region
Common.

Hoary-headed grebe.
Photo – Babs and Bert Wells/DEC

Australasian grebe
(Tachybaptus novaehollandiae)

Distinctive features
Breeding adults have a prominent yellow marking behind the bill and a chestnut to red marking which extends from the side of the head to the upper half of the neck. Non-breeding adults appear very similar to the hoary-headed grebe but have a slightly browner, less greyish appearance and the lower edge of the dark head cap passes through the eye, not below it.
Size: 23 to 25 centimetres.

Feeding
It dives for small fish and aquatic invertebrates.

Breeding
Australasian grebes build a round nest of floating aquatic vegetation anchored and supported by reeds or fallen branches.

Distribution
This species is found throughout Australia at freshwater to slightly saline wetlands.

Occurrence in the region
Uncommon.

Australasian grebe.
Photo – Babs and Bert Wells/DEC

Cormorants and darters

Cormorants and darters are characterised by long bills and wings, short legs, and feet with all four toes webbed. They are piscivores, which means that they eat mostly fish. These birds float very low in the water and often only the head and neck may be visible. When not in the water, they may be seen perched on banks, logs or trees drying their plumage with their wings outstretched. This is because their feathers absorb rather than repel water, which reduces their buoyancy and thus assists them to submerge and dive for hours while feeding.

Little pied cormorants and Australasian darters can often be seen drying their plumage with their wings outstretched.
Photo – Rohan Clarke/Wildlife Images

Darters (Family Anhingidae)

Darters are a small group that are distinguished by a very long and pointed bill. One species has been recorded in the Avon region.

Australasian darter *(Anhinga novaehollandiae)*

Distinctive features

The Australasian darter has a streamlined body with a long slender neck, pointed yellow bill and a long, rounded tail. Adult males have dark plumage with some white on the wings and a chestnut breast. Females have brown and white mottled plumage on the back and pale underparts.
Size: 85 to 90 centimetres.

Feeding

It springs its long, kinked neck rapidly forwards to spear fish with its dagger-like bill. It is also known to feed on tortoises, aquatic invertebrates and vegetation.

Breeding

Nests are made of twigs and sticks and lined with leaves, built in a tree overhanging water. Breeding can be either solitary or occasionally in small colonies with other species.

Distribution

This species is found throughout Australia in estuaries and at open freshwater to slightly saline wetlands.

Occurrence in the region

Uncommon.

Australasian darter.
Photo – Babs and Bert Wells/DEC

Cormorants (Family Phalacrocoracidae)

Cormorants are most easily distinguished from other waterbirds by their long hooked bill. Four species have been recorded in the Avon region.

Little pied cormorant *(Microcarbo melanoleucos)*

Distinctive features

This species has black plumage on the crown of the head, back of the neck, back, wings and tail. It has white underparts, face, and a yellow bill.
Size: 55 to 60 centimetres.

Feeding

It dives for fish, frogs and aquatic invertebrates (mainly crustaceans).

Breeding

Nests are made of sticks and lined with leaves, built in a tree overhanging water. It usually breeds in colonies with other species.

Distribution

This species is found throughout Australia at freshwater to saline wetlands and along the coast.

Occurrence in the region

Uncommon.

Little pied cormorant.
Photo – Babs and Bert Wells/DEC

Great cormorant *(Phalacrocorax carbo)*

Distinctive features

It has mainly black plumage with white or yellow facial skin and a yellow to grey bill.
Size: 80 to 85 centimetres.

Feeding

It dives for fish, frogs and aquatic invertebrates.

Breeding

Nests are made of sticks and vegetation and are usually placed in trees or shrubs. It breeds in colonies with other species.

Distribution

This species is found throughout Australia at freshwater to slightly saline wetlands, and in estuaries, bays and inlets along the coast.

Occurrence in the region

Rare.

Great cormorant.
Photo – Ian Montgomery/Birdway

Little black cormorant
(Phalacrocorax sulcirostris)

Distinctive features
It has completely black plumage and a dark grey bill. This bird is similar to the great cormorant but is smaller and without the yellow facial skin.
Size: 55 to 65 centimetres.

Feeding
They mostly herd fish in groups. They will also eat frogs and aquatic invertebrates.

Breeding
They nest in a platform of sticks, leaves and feathers, which is built in trees over water. It breeds in colonies with other species.

Distribution
This species is found throughout Australia at freshwater to slightly saline wetlands and in sheltered coastal areas.

Occurrence in the region
Uncommon.

Little black cormorant.
Photo – Babs and Bert Wells/DEC

Pied cormorant
(Phalacrocorax varius)

Distinctive features
It has black plumage on the top of the head, neck, back, wings, tail and flanks and white underparts and cheeks. It has yellow, blue and pink skin on the face, and a grey bill.
Size: 70 to 80 centimetres.

Feeding
It dives for fish and aquatic invertebrates.

Breeding
Nests are made of sticks, plant stems and aquatic macrophytes and are built in trees and shrubs, sometimes in colonies with other species.

Distribution
This species is found throughout Australia, most commonly around the coastline but sometimes at freshwater wetlands.

Occurrence in the region
Rare.

Pied cormorant.
Photo – Babs and Bert Wells/DEC

Australian pelicans.
Photo – Babs and Bert Wells/DEC

Pelicans (Family Pelecanidae)

The pelican has webbed feet, short legs and is often seen swimming, or soaring in thermals. The Australian pelican is the only species found in Australia and has been recorded in the Avon region.

Australian pelican *(Pelecanus conspicillatus)*

Distinctive features

The Australian pelican is a large bird with a very long bill, large bill-pouch and yellow eye-rings. It has white plumage except for some black areas on the wings, rump and tail.
Size: 1.6 to 1.8 metres.

Feeding

The bill is used like a scoop to catch fish, shrimp and, very occasionally, small birds. Pelicans may feed alone, or in small to large groups that herd fish into shallow water.

Breeding

Pelicans breed mainly on islands and in small to very large colonies. Nests are made of a sparse gathering of sticks or vegetation in a shallow scraping on the ground.

Distribution

This species prefers large expanses of open water and occurs throughout Australia at freshwater and saline wetlands, and in estuaries.

Occurrence in the region

Uncommon.

Australian pelican.
Photo – Babs and Bert Wells/DEC

Large wading birds

Large wading birds are a distinctive group of waterbirds that are most easily recognised by their unwebbed feet, large size and long bill and legs. They are poor swimmers, so wading in shallow water and finding prey by eye or by sweeping or probing with submerged bills are the most efficient methods of feeding. These birds are good flyers but are rarely seen diving underwater.

Egrets and herons can be recognised in the air by the way they fold their necks during flight. Photo – Ian Montgomery/Birdway

Egrets, herons and bitterns (Family Ardeidae)

Egrets and herons have a long neck and legs and are often seen wading in open water, waterlogged pastures, or perched in trees overhanging water. Egrets differ from herons by having white plumage, while herons can have grey, black or brown plumage. Bitterns are solitary birds that tend to be much stockier, and are more commonly found hiding in emergent wetland vegetation. There are five species of egrets, herons and bitterns found in the Avon region.

Egrets, herons and bitterns are primarily piscivores and use various foraging techniques to catch their prey, including:

- standing very still and waiting for prey to swim by;
- stalking or chasing their prey in shallow water;
- sorting through the sediment for invertebrates;
- using their feet to stir up sediment and food items in deeper water; and
- locating fish from above and diving to catch them.

Eastern great egret *(Ardea modesta)*

Distinctive features

This species has white plumage, a yellow bill, and dark legs and feet. During the breeding season the bill turns black, the space between the eye and the bill (lore) turns blue-green, and long white plumes develop on the back.
Size: 85 to 105 centimetres.

Feeding

It wades in shallow or deeper water for fish, frogs, invertebrates and reptiles. It is also known to catch fish by diving from a flying position.

Breeding

They often breed in colonies with other species, nesting on a platform of sticks in a tree over water.

Distribution

This species is found throughout Australia at freshwater to moderately saline wetlands and along the coast at estuarine mudflats, mangroves and reefs.

Occurrence in the region

Uncommon.

Eastern great egret.
Photo – Babs and Bert Wells/DEC

White-necked heron
(Ardea pacifica)

Distinctive features
White-necked herons have dark grey wings, back and flanks with a white head and neck. When breeding the adults develop plum-coloured plumes on their back and breast.
Size: 75 to 105 centimetres.

Feeding
It wades in shallow water for fish, frogs and invertebrates.

Breeding
Nests are made of sticks, usually built more than 15 metres up a tree over water.

Distribution
This species is found throughout Australia at freshwater to moderately saline wetlands.

Occurrence in the region
Uncommon.

White-necked heron.
Photo – Babs and Bert Wells/DEC

Australasian bittern
(Botaurus poiciloptilus)

Distinctive features
The plumage is mottled with various shades of brown, tending to be darker on the back of the neck and wings. The throat and eye area are paler and the breast is streaked with off-white and dark brown. It has a large, stocky build.
Size: 65 to 75 centimetres.

Feeding
It wades in shallow water at night for fish, invertebrates, frogs, reptiles and small mammals and birds. It will sometimes hunt in deeper water from platforms of bent-over reeds.

Breeding
It nests in a large platform made of sticks and reeds in a shrub or low tree screened by reeds and rushes, just above the water level.

Distribution
This species is found in south-western and south-eastern Australia at freshwater wetlands and occasionally in estuaries.

Occurrence in the region
Rare.

Australasian bittern.
Photo – Ian Montgomery/Birdway

White-faced heron
(Egretta novaehollandiae)

Distinctive features

This species has a grey body and white face. When breeding, the adults develop brownish-grey plumes on their lower neck and grey plumes on their back.
Size: 66 to 69 centimetres.

Feeding

White-faced herons wade at various depths for fish, frogs and invertebrates.

Breeding

Nests are made of sticks and are usually built high up in a tree, either over water or up to three kilometres away from water.

Distribution

This species is found throughout Australia at freshwater and saline wetlands, farm dams, pastures, mudflats and shorelines.

Occurrence in the region

Common.

White-faced heron.
Photo – Babs and Bert Wells/DEC

Nankeen night heron
(Nycticorax caledonicus)

Distinctive features

The plumage is reddish-brown except for the black crown of the head and paler underparts. Two to three long white plumes arise from the back of the neck during breeding. Juvenile plumage is streaked and spotted, brown and white. It has a stocky build.
Size: 55 to 65 centimetres.

Feeding

It forages at night for fish, frogs and invertebrates. It is also known to scavenge under the nests of other waterbirds for fallen chicks and eggs.

Breeding

These birds often breed in colonies with other species, nesting on a platform of sticks in a tree over water.

Distribution

This species is found throughout Australia at freshwater to slightly saline wetlands and mangrove areas of estuaries.

Occurrence in the region

Uncommon.

Nankeen night heron.
Photo – Ian Montgomery/Birdway

Spoonbills and ibis (Family Threskiornithidae)

Ibis and spoonbills have a long neck, bill and legs. Spoonbills, as their name suggests, have a conspicuous long spoon-shaped bill. Ibis have bare skin on their heads and a long down-curved bill. Spoonbills and ibis are often seen perched in trees above water or circling above wetlands. Two species of spoonbill and three species of ibis have been recorded in the Avon region.

Yellow-billed spoonbill *(Platalea flavipes)*

Distinctive features

This species has a yellow spoon-shaped bill, long yellow legs, and white plumage. Breeding adults develop black filamentous plumes from the inner wings and pale yellow breast feathers. Size: 75 to 90 centimetres.

Feeding

It wades in shallow water for invertebrates, feeding by sweeping its slightly open bill from side to side in the water and soft muds. When prey is felt, the bill is snapped shut and lifted to let the food slide down the throat.

Breeding

This species breeds in colonies with other species. Nests are either made of sticks and twigs built in a tree over water, or made from trampled reeds in reed-beds.

Distribution

This species is found throughout Australia at freshwater to moderately saline wetlands and sometimes in pastures.

Occurrence in the region

Uncommon.

Yellow-billed spoonbill in breeding plumage.
Photo – Adrian Boyle/Wildlife Images

Royal spoonbill
(Platalea regia)

Distinctive features

This species has a black spoon-shaped bill, long black legs and white plumage. The face is black and adults have a small yellow patch above each eye.
Size: 75 to 80 centimetres.

Feeding

It wades in shallow water for fish, crustaceans, molluscs and other aquatic invertebrates using a similar feeding technique to the yellow-billed spoonbill.

Breeding

This species breeds in colonies with other species. Nests are built in a tree over water and are made of sticks and lined with leaves.

Distribution

This species is found mainly in northern and eastern Australia at freshwater to slightly saline wetlands, mudflats and mangroves.

Occurrence in the region

Rare.

Royal spoonbill.
Photo – Babs and Bert Wells/DEC

Glossy ibis
(Plegadis falcinellus)

Distinctive features

As its name suggests, the wings and tail of this species have a glossy iridescent green and purple sheen in the sunlight. At a distance the bird appears black. Breeding adults have a dark chestnut brown head, neck and back. Non-breeding adults and juveniles have browner plumage on the head, neck, back and underparts, with white flecks or streaks on the head and neck.
Size: 50 to 54 centimetres.

Feeding

It wades in shallow water and mud for fish, frogs and aquatic invertebrates.

Breeding

This bird breeds in colonies with other species. Nests are either made of sticks in a tree over water, or of trampled vegetation in reeds.

Distribution

This species is found mainly in northern and eastern Australia at freshwater to moderately saline wetlands and occasionally in sheltered bays and mangrove forests.

Occurrence in the region

Rare.

Glossy ibis.
Photo – Ian Montgomery/Birdway

Australian white ibis
(Threskiornis molucca)

Distinctive features

The plumage is white except for an unfeathered black head, black upper neck and a few black lacy plumes covering the tail. The bill is black and the legs are blackish, sometimes with a smudge of red.
Size: 65 to 75 centimetres.

Feeding

It often feeds in large groups and eats mostly aquatic and terrestrial invertebrates, but is also known to eat fish, frogs and garbage. They can be found foraging anywhere from pastures and wetlands to garbage tips in built-up areas.

Breeding

It breeds in dense colonies, often with other species. Nests are made of sticks and trampled reeds built in small trees or shrubs over water.

Distribution

This species is found throughout Australia at freshwater to moderately saline wetlands, grasslands and built-up areas.

Occurrence in the region

Uncommon.

Australian white ibis.
Photo – Babs and Bert Wells/DEC

Straw-necked ibis
(Threskiornis spinicollis)

Distinctive features

The plumage on the wings and back is black and appears glossy in the sunlight. The underparts and neck are white and the head is black and unfeathered with a black bill. Adults have yellowish straw-like feathers hanging from the lower neck.
Size: 60 to 70 centimetres.

Feeding

It forages in grasslands, pastures and swamp margins mostly for terrestrial invertebrates but also eats aquatic invertebrates, frogs, reptiles and small mammals.

Breeding

This bird breeds in colonies with other species. Nests are made of sticks, trampled plants and grass built in dense paperbark stands over water or among reeds.

Distribution

This species is found throughout Australia at freshwater to moderately saline wetlands and wet or dry grasslands.

Occurrence in the region

Uncommon.

Straw-necked ibis.
Photo – Babs and Bert Wells/DEC

Shorebirds

Small wading birds or 'waders' are now most commonly referred to as shorebirds. They forage on or near the shore and in shallow water along coastlines and in wetlands. Shorebirds are mostly less than 50 centimetres in length, have thin twig-like legs, and pointed bills.

Black-winged stilt nest.
Photo – Babs and Bert Wells/DEC

Plovers, dotterels and lapwings (Family Charadriidae)

Plovers, dotterels and lapwings are characterised by their short straight bills and moderately long legs. Plovers and dotterels have a characteristic foraging technique where they dart for short bursts along the shoreline, then stop abruptly and peck at the ground. Lapwings are larger than plovers and dotterels and prefer to forage in grassy habitats at various distances from wetlands. Plovers, dotterels and lapwings distract predators from eggs and chicks in their nest by feigning a wing injury. They run in the opposite direction to the nest with one wing dragging along the ground. Six species in this family have been recorded in the Avon region.

Red-capped plover *(Charadrius ruficapillus)*

Distinctive features

Males have a chestnut to red head and neck, which is brighter during breeding. Females have pale chestnut head and neck plumage and juveniles have brown head and neck plumage. The back, wings and tail are brown and the underparts are white.
Size: 14 to 16 centimetres.

Feeding

It forages along the shoreline for invertebrates and sometimes vegetation.

Breeding

Their eggs are laid in a shallow scraping on the ground close to the water, sometimes next to a small shrub or pebbles.

Distribution

This species is found throughout Australia at estuaries, inter-tidal flats, sandy beaches and saline wetlands. It is less-commonly seen at freshwater wetlands.

Occurrence in the region

Common.

Red-capped plover.
Photo – Babs and Bert Wells/DEC

Black-fronted dotterel
(Elseyornis melanops)

Distinctive features

Adults have a black stripe through the eye and a 'V'-shaped band on a white chest. They have a brown crown, back, wings and tail, and white underparts. The bill is red with a black tip and the eye ring is red. Juveniles lack the black chest band and have a brown eye stripe. Size: 16 to 18 centimetres.

Feeding

They eat aquatic and terrestrial invertebrates found in mud and shallow water.

Breeding

Eggs are laid in a shallow scraping in sand or gravel near water.

Distribution

This species is found throughout Australia at freshwater to slightly saline wetlands and on mudflats.

Occurrence in the region

Common.

Adult and chick of the black-fronted dotterel.
Photo – Babs and Bert Wells/DEC

Red-kneed dotterel
(Erythrogonys cinctus)

Distinctive features

Adults have black plumage on the head, back of neck and chest. The throat and underparts are white and the back and wings are brown. As its common name suggests, the knees and legs above the knee are red. The bill is red and tipped with black. Size: 17 to 19 centimetres.

Feeding

It forages along the shoreline and in shallow water for aquatic invertebrates and seeds.

Breeding

Nests are a scrape in the ground close to water, which is sometimes lined with sparse vegetation or is placed next to a small shrub.

Distribution

This species is found throughout Australia at freshwater and saline wetlands.

Occurrence in the region

Uncommon.

Red-kneed dotterel.
Photo – Babs and Bert Wells/DEC

Grey plover
(Pluvialis squatarola)

Distinctive features

The plumage of non-breeding adults and juveniles is mottled grey-brown and white except for white underparts. Full breeding plumage is not observed in Australia.
Size: 28 to 30 centimetres.

Feeding

It eats invertebrates and occasionally plants and seeds found in shallow water, mud, sand and sometimes pastures.

Breeding

Grey plovers breed in the Arctic tundra. The nest is a shallow scraping on the ground lined with sparse vegetation.

Distribution

This species occurs along the coastline of Australia at a variety of habitats including estuaries, lagoons and rarely at salt lakes that are close to the coast.

Occurrence in the region

Rare.

Grey plover in non-breeding plumage.
Photo – Ian Montgomery/Birdway

Hooded plover
(Thinornis rubricollis)

Distinctive features

Adults have a black 'hood' covering the entire head and a black collar at the back of the lower neck. The wings are a light grey to brown and the rest of the plumage is white. They have a red ring around the eye, pink legs and a black-tipped red bill. Juveniles have a mottled grey hood and collar, and pale brown wings.
Size: 19 to 23 centimetres.

Feeding

The hooded plover forages in intertidal zones and along shorelines of beaches and salt lakes for invertebrates.

Breeding

Nests are a shallow scraping in the sand located above the high water mark. They are sometimes built next to a rock or branch and lined with sparse vegetation, stones or shells.

Distribution

This species is found along the southern coastline of Australia and also at inland salt lakes in Western Australia.

Occurrence in the region

Uncommon.

Hooded plover in breeding plumage.
Photo – Ian Montgomery/Birdway

Banded lapwing
(Vanellus tricolor)

Distinctive features

The head has a black crown and band extending from the bill down the sides of the neck to the breast. There is a white stripe through the eye and a red wattle between large yellow eyes and a yellow bill. The underparts are white and the wings and back are pale brown. Juveniles appear similar to adults but with mottled dark brown features. Size: 25 to 29 centimetres.

Feeding

It mostly eats terrestrial invertebrates but also seeds, grass shoots and herbs.

Breeding

Nests are a shallow scraping in the ground sparsely lined with vegetation and are built in open areas after rainfall.

Distribution

This species occurs throughout Australia except for far northern areas and prefers short grassy habitats. They are sometimes found in the vicinity of salt lakes and claypans.

Occurrence in the region

Rare.

Banded lapwing.
Photo – Babs and Bert Wells/DEC

Stilts and avocets (Family Recurvirostridae)

Stilts and avocets are characterised by their very long and slender legs and bills. Stilts have the longest leg-to-body ratio of all the shorebirds. This enables them to forage in water that is inaccessible to other waders, which are often restricted to the shorelines and very shallow water. Avocets have slightly shorter legs but longer, up-curved bills.

A flock of black-winged stilts in flight.
Photo – Babs and Bert Wells/DEC

Banded stilt
(Cladorhynchus leucocephalus)

Distinctive features
The plumage is white except for black wings. The bill is long and straight and the legs are pink. Breeding adults have a chestnut to black band across the breast, while non-breeding adults have a faded band across the breast, or no band at all. Juveniles have black legs and no band across the breast. Size: 35 to 43 centimetres.

Feeding
They pick aquatic invertebrates, particularly brine shrimp, from the water's surface and occasionally feed on plants, seeds and roots.

Breeding
Banded stilts congregate on inland salt lakes after heavy rainfall to breed. Nests are a shallow scraping made on the ground mainly on small islands in salt lakes.

Distribution
This species is found in southern Australia at salt lakes, and around estuaries and mudflats.

Occurrence in the region
Common.

Banded stilt.
Photo – Babs and Bert Wells/DEC

Black-winged stilt
(Himantopus himantopus)

Distinctive features
The plumage is white except for the back of the neck and wings, which are black. The bill is long and straight and the legs are pink. Juveniles lack the black neck plumage but have a dark patch around the eye and a grey crown. Size: 35 to 43 centimetres.

Feeding
It picks aquatic invertebrates from the surface of the water and mud.

Breeding
They breed in pairs or in small colonies after heavy rainfall. Nests can be made in a shallow scraping on the ground on islands at temporary wetlands, on a grassy platform over shallow water or on damp ground.

Distribution
This species is found throughout Australia at freshwater to saline wetlands and mudflats.

Occurrence in the region
Common.

Black-winged stilt.
Photo – Babs and Bert Wells/DEC

Red-necked avocet *(Recurvirostra novaehollandiae)*

Distinctive features

This species has conspicuous chestnut plumage on its head and neck and a strongly up-curved slender bill. The rest of the body is white except for two black stripes along the wings.
Size: 40 to 48 centimetres.

Feeding

They forage for aquatic invertebrates, particularly brine shrimp, by sweeping the slightly open bill back and forth in the water.

Breeding

Red-necked avocets breed in small colonies at inland lakes. Nests are made in a shallow scraping on the ground, which is sometimes lined with vegetation or grass and built on islands or near water.

Distribution

This species is found throughout Australia at freshwater to saline wetlands and mudflats.

Occurrence in the region

Common.

Red-necked avocet.
Photo – Babs and Bert Wells/DEC

Sandpiper and allies (Family Scolopacidae)

Sandpipers and allies are migratory shorebirds. Those that migrate to Australia breed throughout most of Europe and the northern half of Asia (Eurasia). They fly 12,000 kilometres on the route known as the 'East Asian-Australasian Flyway', which extends from Eurasia and Alaska to Australia and New Zealand. They start arriving in Australia in August and stay through to about April.
Some individuals, particularly juveniles, may choose to overwinter in Australia rather than make the journey north to breed. Those that overwinter in Australia are mostly found in the northern areas where it is still warm and food is plentiful. All of the birds listed here are protected under bilateral agreements between Australia and China, Japan and the Republic of Korea.

These birds are most easily identified by their size and the size and shape of their bills. Their appearance may change from season to season, which can make identification difficult. The plumage of breeding adults can have slight to considerable differences in colour to non-breeding adults and juveniles. In Australia, birds are mostly seen in their non-breeding or juvenile plumage because they breed elsewhere, however, traces of breeding plumage may be present soon after they arrive in Australia. Eleven species have been found in the Avon region.

Common sandpiper
(Actitis hypoleucos)

Distinctive features

The plumage is brown apart from the chin and underparts, which are white. There is also a triangular white patch that extends between the wing and dark areas of the breast. The bill is straight and black.
Size: 19 to 21 centimetres.

Feeding

It eats aquatic invertebrates in shallow water and around rocks.

Breeding

It breeds across Eurasia, and builds nests that can vary from sparsely lined depressions in open areas, to complex structures of grass and leaves concealed in thick vegetation.

Distribution

This species is found throughout Australia at freshwater to saline wetlands and coastal habitats.

Occurrence in the region

Uncommon.

Common sandpiper in non-breeding plumage.
Photo – Babs and Bert Wells/DEC

Ruddy turnstone
(Arenaria interpres)

Distinctive features

Adults are distinguished by a black and white banding pattern on the head, neck, chest and back, a short slightly up-tilted bill and short, stocky orange legs. The wings and tail are chestnut and black, and the underparts are white. The plumage of non-breeding adults is slightly paler. Juveniles have brown upperparts and throat, and white underparts.
Size: 22 to 24 centimetres.

Feeding

It feeds on aquatic and terrestrial invertebrates along the shorelines of beaches or wetlands.

Breeding

They breed in the Arctic tundra. Nests are a shallow depression lined with vegetation and are often protected by a rock or small bush.

Distribution

This species is found along the coast of Australia mostly in sandy and stony habitats and occasionally at mudflats and saline wetlands.

Occurrence in the region

Rare.

Ruddy turnstone in non-breeding plumage.
Photo – Ian Montgomery/Birdway

Sharp-tailed sandpiper
(Calidris acuminata)

Distinctive features

Adult plumage is mottled brown and white throughout, with the wings and back tending to be darker than the underparts. The breeding adult plumage is edged with chestnut. The crown of the head is reddish-brown and the bill is slightly down-curved.
Size: 17 to 22 centimetres.

Feeding

It eats aquatic invertebrates found in shallow water or mud, and occasionally seeds.

Breeding

Nests are a well-hidden shallow depression in the ground lined with grass and leaves. They breed in the Arctic tundra of far north-eastern Siberia.

Distribution

This species is found throughout Australia at freshwater to saline wetlands, inundated pastures and in coastal habitats.

Occurrence in the region

Uncommon.

Sharp-tailed sandpiper in non-breeding plumage.
Photo – Babs and Bert Wells/DEC

Curlew sandpiper
(Calidris ferruginea)

Distinctive features

The bill is long and down-curved. Non-breeding adult plumage is pale brown to grey with white underparts. Breeding adult plumage is chestnut mottled with black and white on the back, wings and head, and chestnut with some white barring on the neck and belly.
Size: 18 to 23 centimetres.

Feeding

It forages for aquatic invertebrates, particularly worms, in shallow water.

Breeding

Breeding occurs in the Arctic tundra of far northern Siberia. Nests are typically a shallow depression sparsely lined with vegetation.

Distribution

This species is found throughout Australia on beaches, mudflats, estuaries and occasionally at inland freshwater to saline wetlands.

Occurrence in the region

Uncommon.

Curlew sandpiper in non-breeding plumage.
Photo – Babs and Bert Wells/DEC

Red-necked stint
(Calidris ruficollis)

Distinctive features

Non-breeding adults and juveniles have a mainly grey head, back, and wing plumage and white underparts. Breeding adults have a noticeable red neck and facial area while the back is mottled red, brown and white.
Size: 13 to 16 centimetres.

Feeding

It forages in mud and sand for aquatic invertebrates and occasionally eats plants and seeds.

Breeding

Breeding occurs in the arctic tundra of far north-eastern Siberia and north-western Alaska. Nests are a shallow depression lined with vegetation.

Distribution

This species is found throughout Australia at freshwater to saline wetlands, beaches, estuaries, and mudflats.

Occurrence in the region

Common.

Red-necked stint in non-breeding plumage.
Photo – Ian Montgomery/Birdway

Bar-tailed godwit
(Limosa lapponica)

Distinctive features

Non-breeding adults have pale brown to grey plumage and pale underparts. Breeding adults have mottled dark brown, chestnut and white back and wing plumage, and chestnut speckled with white underparts. Juveniles are similar to non-breeding adults. The basal part of the long and slightly up-curved bill is pink and the tip is black.
Size: 37 to 39 centimetres.

Feeding

It forages in mud, shallow water, and on beaches for aquatic invertebrates.

Breeding

Breeding occurs in the Arctic tundra of far northern Eurasia and Alaska. Nests are a shallow depression often lined with vegetation.

Distribution

This species is found throughout Australia at saline wetlands, beaches, mudflats and estuaries. In south-western Australia it is almost exclusively coastal.

Occurrence in the region

Rare.

Bar-tailed godwit in non-breeding plumage.
Photo – Babs and Bert Wells/DEC

Little curlew
(Numenius minutus)

Distinctive features

Juvenile and adult plumage is mainly mottled brown and white but tends to be darker on the wings, tail and crown of the head, and the underparts are white. The bill is gently curved downwards with a pink underside.
Size: 30 to 36 centimetres.

Feeding

It feeds on open grasslands for invertebrates and occasionally seeds.

Breeding

The little curlew breeds in the Arctic tundra of far northern Eurasia. Nests are a shallow depression lined with vegetation, usually in open areas.

Distribution

The little curlew is found in the northern coastal areas of Australia. They prefer grassy areas, but also occur at freshwater to saline wetlands and mudflats.

Occurrence in the region

Rare.

Little curlew in non-breeding plumage.
Photo – Ian Montgomery/Birdway

Wood sandpiper
(Tringa glareola)

Distinctive features

The non-breeding adult has yellow legs, brown, black and white speckled plumage on the back and wings, a brown and white streaked head, neck and breast, and white underparts.
The breeding adult is similar but the markings are darker.
Size: 20 to 22 centimetres.

Feeding

It forages around fallen tree branches and vegetation in shallow water or mud for aquatic invertebrates.

Breeding

Breeding occurs in northern Eurasia. Nests are usually a shallow depression lined with grass and leaves, and are sometimes the old nest of a songbird.

Distribution

This species is found throughout Australia at freshwater and saline wetlands and occasionally in mangroves.

Occurrence in the region

Rare.

Wood sandpiper in non-breeding plumage.
Photo – Ian Montgomery/Birdway

Common greenshank
(Tringa nebularia)

Distinctive features

Plumage is brown and white and is mottled on the back, wings and tail and streaked on the head, neck and breast. The underparts are white. Non-breeding plumage tends to be greyer than breeding adult and juvenile plumage. The bill is long and slightly up-curved, and the legs are long and yellow.
Size: 30 to 35 centimetres.

Feeding

It forages in shallow water for aquatic invertebrates and occasionally fish.

Breeding

It breeds in northern Eurasia. Nests are a shallow depression sparsely lined with vegetation and are often built next to boulders or tree stumps.

Distribution

This species is found throughout Australia at freshwater to saline wetlands, beaches and on mudflats.

Occurrence in the region

Uncommon.

Common greenshank in non-breeding plumage.
Photo – Babs and Bert Wells/DEC

Marsh sandpiper
(Tringa stagnatilis)

Distinctive features

It is characterised by very long grey to yellow legs and a fine, straight bill. Non-breeding adults have mostly pale brown to grey plumage with white areas above the eye and on the breast and underparts. The back and wing plumage of breeding adults is brown with dark brown specks and the head, neck, chin and chest are streaked or spotted brown and white.
Size: 22 to 26 centimetres.

Feeding

It feeds by picking aquatic invertebrates from the surface or by sweeping its bill from side to side through the water.

Breeding

The breeding grounds of this species stretch from eastern Europe to Asia. Nests are a shallow depression sparsely lined with grass built in open areas.

Distribution

This species is found throughout Australia, though rarely far inland in Western Australia. It occurs at freshwater to saline wetlands, mangrove areas and occasionally at sheltered beaches.

Occurrence in the region

Rare.

Marsh sandpiper in non-breeding plumage.
Photo – Ian Montgomery/Birdway

Gulls and terns

Gulls and terns are small to medium-sized birds that have webbed feet and are most often found in coastal areas.

There are three species of gulls and terns found in the Avon region.

Gulls and terns (Family Laridae)

Gulls and terns are mostly aerial feeders that either dive into the water to catch their prey, or fly low over the water to scoop up their prey from the surface. Silver gulls are also found scavenging around urban areas for garbage.

Gulls and terns.
Photo – Babs and Bert Wells/DEC

Whiskered tern *(Chlidonias hybrida)*

Distinctive features

Plumage on the back, upper wing and tail of non-breeding adults is a medium grey, and the belly, underwing and cheeks are white. The wings have dark outer edges and the bill is mainly black. Breeding adults have a black crown that extends from the bill to the back of the head, a dark grey belly, red bill and red legs. Non-breeding adults have a streaked black crown and black legs.
Size: 23 to 25 centimetres.

Feeding

Whiskered terns feed on fish, frogs and aquatic invertebrates. They may dive into the water to catch fish, or fly low and skim the top of the water with their bill to scoop up invertebrates.

Breeding

Whiskered terns breed in colonies at inland swamps. The nest is a platform of aquatic vegetation that is either floating or built on low shrubs in shallow water.

Distribution

This species is found throughout Australia at freshwater and saline wetlands and occasionally along estuaries.

Occurrence in the region

Uncommon.

Whiskered tern in non-breeding plumage.
Photo – Babs and Bert Wells/DEC

Silver gull
(Chroicocephalus novaehollandiae)

Distinctive features

Adults have white plumage with black-tipped grey wings, a red bill and red legs. Juveniles have mottled brown wings, a black bill and black legs. Size: 38 to 42 centimetres.

Feeding

Silver gulls eat fish and invertebrates, but in urban areas they will mostly scavenge on garbage.

Breeding

Silver gulls breed on islands and inland lakes. Nests are lined with vegetation and are built either in a small bush, on rocks and jetties or in a shallow scraping on the ground.

Distribution

This species is found throughout Australia at any wetland habitat, most commonly along the coast and in urban parks.

Occurrence in the region

Common.

Silver gull.
Photo – Wetlands group/DEC Science Division

Gull-billed tern
(Gelochelidon nilotica)

Distinctive features

Adult plumage is white, except for light grey wings with dark outer edges, a black eye patch and a streaked grey-brown crown. The short gull-like bill and legs are black and the tail is forked. Breeding adults have a dark crown that extends from the bill to the back of the head. Size: 36 to 42 centimetres.

Feeding

Gull-billed terns mainly eat fish, frogs, reptiles and aquatic invertebrates. They fly low over the water and grab their prey at the surface.

Breeding

Breeding takes place in large colonies at temporary inland lakes soon after heavy rainfall. Nests are lined with sparse vegetation and are made in shallow ground-scrapes on sand ridges and mud banks.

Distribution

This species is found throughout Australia at freshwater and saline wetlands, grasslands and coastal areas, but is rarely seen over the ocean.

Occurrence in the region

Uncommon.

Gull-billed tern in breeding plumage.
Photo – Babs and Bert Wells/DEC

Reed warblers

Australian reed-warbler (Family Acrocephalidae) *(Acrocephalus australis)*

Distinctive features

The Australian reed-warbler has plain reddish-brown to olive-brown plumage that tends to be slightly darker on the wings and tail, and paler on the underparts. The bill is small and pointed and the tail is long. This bird is not often seen but has a distinctive call. Its song is a loud complicated warble that can be heard from within the reeds and rushes where it spends most of its time.
Size: 16 to 17 centimetres.

Feeding

It feeds on aquatic and terrestrial invertebrates.

Breeding

Nests are built in reeds and are made of reeds and other aquatic vegetation woven together to form a deep cup-shaped structure that may be lined with grass and feathers.

Distribution

This species is found throughout Australia at freshwater to moderately saline wetlands with dense stands of reeds, rushes and sedges.

Occurrence in the region

Rare.

Australian reed-warbler and nest.
Photo – Babs and Bert Wells/DEC

Grassbirds

Little grassbird (Family Megaluridae) *(Megalurus gramineus)*

Distinctive features

Plumage is streaked and mottled brown and black apart from black wing feathers that are edged with white, and mottled white and brown underparts. The bill is short, pointed and pale black to pinkish-brown, and the tail is long. The little grassbird is a secretive species whose presence is often only known by its call, which is a series of mournful whistles. The first whistle is short and the second and third whistles are drawn out and slightly higher pitched.
Size: 13 to 15 centimetres.

Feeding

It forages for invertebrates among vegetation such as grass and reeds.

Breeding

Nests are built in reeds or small shrubs and are made of reeds and other aquatic vegetation woven together to form a deep cup-shaped structure that may be lined with grass and feathers.

Distribution

This species is found in south-western, eastern and central Australia, and Tasmania, at freshwater to slightly saline wetlands, mangroves and tidal marshes with dense stands of reeds, rushes and sedges.

Occurrence in the region

Uncommon.

Little grassbird and young.
Photo – Babs and Bert Wells/DEC

Glossary

Acidification
The process by which environments become acidic (or have a low pH).

Adductor muscles
Muscles at the anterior and posterior ends of a mussel that enable the mussel to open and close its shell.

Aestivation
State of dormancy where an animal slows its metabolic activity to survive a hot or dry period.

Appendage
Parts or organs that are joined to an organism's body (e.g. legs or wings).

Asexual
Reproduction without fertilisation or the fusion of sex cells (gametes). This can occur in a variety of ways, including splitting of one animal into two or more new individuals, or the production of spores.

Benthic
Occupying the bottom of a body of water.

Biomass
The mass of a particular living material in a specified area.

Biodiversity
The diversity of life in a particular habitat or region. This can refer to diversity of genes, organisms or communities.

Carapace
Hard outer shell of organisms such as crustaceans and insects.

Caudal
Towards the tail or posterior end of an organism.

Cilia
Fine hairs on the surface of a plant or animal, which can be moving or non-moving.

Cuticle
Protective, hardened or membranous outer-covering or case of many invertebrates, such as rotifers.

Dabbling
A feeding strategy used by waterbirds where in shallow water they bob their head under water to feed from the bottom, and in deeper water they feed from the surface by filtering or pecking at food.

Degradation
In ecological terms it refers to unnatural damage to an ecosystem.

Dessication
The process of drying out.

Detritivore
An animal that feeds on dead plant and animal matter.

Detritus
Dead animal and plant matter.

Duricrust
A thin, hardened layer on or near the surface of the soil formed by the precipitation of various substances including silica, salts and calcium carbonate.

Ecological community
A group of different types of organisms occurring together.

Edaphic
Of or influenced by the soil.

Endemic
An organism that is only known to occur in a particular region.

Ephemeral
Short-lived.

Filter feeders
Animals that use a filtering mechanism to remove small particles of food from the water column.

Flanks
The part of a bird's body located between the wings and the belly.

Freshwater
Water with very low salinity (generally less than three grams per litre).

Genus
A group of closely related species, although a particularly unique species may have a genus of its own. Forms the first half of the scientific name of an organism: e.g. the beetle *Eretes australis* belongs to the genus *Eretes*.

Geomorphology
The study of the origin of landforms.

Gill
An appendage found on aquatic organisms that improves their ability to breathe underwater.

Gnamma
Pool found on a granite outcrop.

Hermaphrodite
An animal that has both male and female reproductive organs.

Highly saline
The salinity of the water is greater than 50 grams per litre.

Glossary

Hydrology
The way in which water moves through a system.

Inundation
To be flooded.

JAMBA
Japan-Australia Migratory Bird Agreement.

Kankar
Detrital, often nodular calcium carbonate formed in soils of semi-arid regions. It can also be referred to as duricrust.

Larvae
An immature form that is very different to the adult and that pupates before turning into an adult. This is in contrast to 'nymph' below.

Laterite
Soil layer that is rich in iron oxide and is derived from the weathering of various rocks under strongly oxidising and leaching conditions.

Macrophyte
Aquatic plant that can be submerged, emergent or floating.

Moderately saline
The salinity of the water is between 10 and 50 grams per litre.

Nomadic
Regularly moving from one place to another.

Nymph
An immature form, usually resembling the adult. This is in contrast to 'larvae' above.

Omnivore
An animal that eats a range of food, including plants and animals.

Overwinter
To wait out the winter season.

Palaeo-drainage
Old, ancient or prehistoric drainage. In the Avon this refers to ancient river systems that are now filled in and occur as chains of salt lakes.

Palps
An appendage found near the mouth of invertebrates, often used for movement, feeding and as a sensory organ.

Piscivores
Animals that eat fish.

Plankton
Organisms that occur in the water column.

Planktonic
Occurring in the water column.

Playa
Flat-bottomed intermittently inundated lake maintained by wind blowing off sediments when they dry.

Plumage
Coating of feathers.

Plumes
Delicate filmy feathers that usually appear on birds during breeding.

Proboscis
Hollow tube connected to the head or mouth of some invertebrates, used to consume food and water.

Pupa
The stage some insects go through to transform from a larva into an adult.

Predator
An animal that feeds on living animals.

Prolegs
Fleshy, stubby legs found on the underside of insect larvae.

Rostrum
A projection at the front of the head, often beak-like.

Salinisation
The process of becoming saline.

Secondarily saline
A system that has become saline as a result of human activities.

Slightly saline
The salinity of the water is between three and 10 grams per litre.

Species richness
Number of species occurring in a specified region or habitat.

Symbiont
An organism that benefits from living in a close, prolonged relationship with another organism, which may or may not benefit from the relationship.

Talon
Claw of an animal, usually a bird of prey.

Turbid
Water that has high concentrations of suspended matter; cloudy or muddy.

Ventral
On the underside of an organism.

Wattle (on a bird)
A fleshy lump or lobe located on the head or neck.

Wetland
Any area of land that is either permanently or temporarily inundated, or waterlogged.

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