

Case Study 5

Estuaries, Mudflats and Migratory Waders

What is Biodiversity?

Biodiversity represents the sum of all living organisms, such as plants, animals and micro-organisms, their genetic variations and their interconnections within complex ecosystems.

Biodiversity exists everywhere: in forests, mountains, deserts, lakes, rivers and oceans. It is present in cities, houses and backyards, on farms and in any human modified environment, as well as around our bodies, on our skin and in our internal organs.

Biodiversity includes not only the plants and animals that we see around us (including ourselves), but also the myriad of microscopic organisms that inhabit our environment, such as fungi, algae, bacteria and viruses.

Most of the Earth's biodiversity consists of a large number of invertebrates, fungi, bacteria and non-flowering plants. Vertebrate animals and flowering plants represent only a small fraction of the total biodiversity, probably less than 1% in number of all species on Earth.

Biodiversity is the variety of life forms which exist on the Earth.

Estuaries: a Hidden World of Biological Wealth

Estuaries are an important part of coastal environments in the South-west of Western Australia (Figure 1). Most South-west rivers flow into a shallow estuary that connects with the ocean through a channel. The channel is usually closed by a sand bar during the most of the year and opens in winter if there is enough rain.

An artificial channel is sometimes dug to increase the flow of water between the ocean and the estuary; for example, the Dawesville Channel, south of Mandurah, linking the Peel Inlet with the ocean.

Estuaries are complex ecosystems that are habitats for a diversity of organisms, large and small (some of them so small that they are invisible to the naked eye): minute phytoplankton, bacteria, fungi, algae, tiny invertebrates (worms, shellfish, crustaceans, aquatic insects), many species of birds, a great variety of fish, and plants with remarkable adaptations to a highly variable environment.

An estuary connects a river to the ocean.

Estuaries contain a large number of organisms.

Parts of an Estuary

There are many different ecosystems that make up estuaries:

- samphire flats, saltmarshes and mudflats;
- swamps and fringing reeds;
- islands, sandbars and sandpits;
- seasonal floodlands;
- open waters.

Many different ecosystems are found in estuaries.

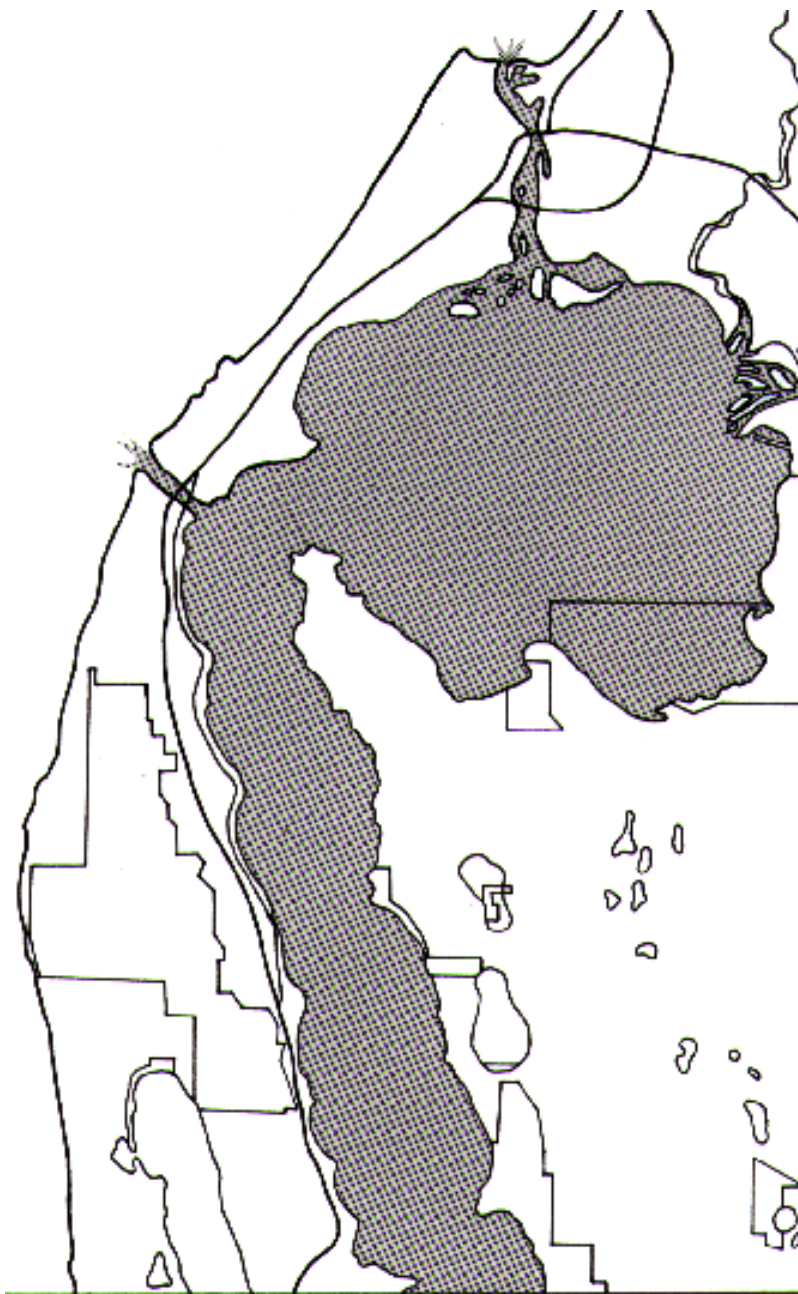


Figure 1. Map of the Peel-Harvey Estuary (Source: Peel Inlet Management Authority).

Samphire flats, saltmarshes and mudflats are a major component of most estuaries. Samphire are plants, adapted to saline environments, with thick fleshy round stems and no apparent leaves. Samphire flats, saltmarshes and mudflats support a large biomass of mud-dwelling invertebrates, which, in turn, provide food for great numbers of birds and other wildlife. Mudflats provide an essential habitat and food resource for many waders that visit the South-west estuaries from the Northern Hemisphere between September and April.

Open waters are used by many birds and fish. Estuaries contain pockets of permanently salty water in deeper areas, and the rest is of variable salinity depending on the tide, the flow of water between the ocean and the estuary, and the input of freshwater from streams and rivers flowing into the estuary. Fish have adapted to this diverse environment and many move between the estuary and ocean at certain times of the year.

Samphire are plants that can tolerate a high level of salinity.

Estuaries contain water of varying salinity, depending on tides and the flow of water.

The Role of South-west Estuaries in Conserving Biodiversity

Each year, two million waders of 47 species reach Australian shores in their migration from northern Asia and Alaska. Waders are small shorebirds such as plovers, dotterels, sandpipers, stints and curlews that find their food in mudflats and saltmarshes.

Many waders breed in the Northern Hemisphere and migrate to the Southern Hemisphere to escape the harsh northern winter. They begin to arrive in the South-west in September. On their return migration, waders leave our shores in April to May and reach their breeding grounds in northern Asia in June. The Red-necked Stint and the Eastern Curlew have some of the longest migrations in the animal kingdom (see Figure 2).

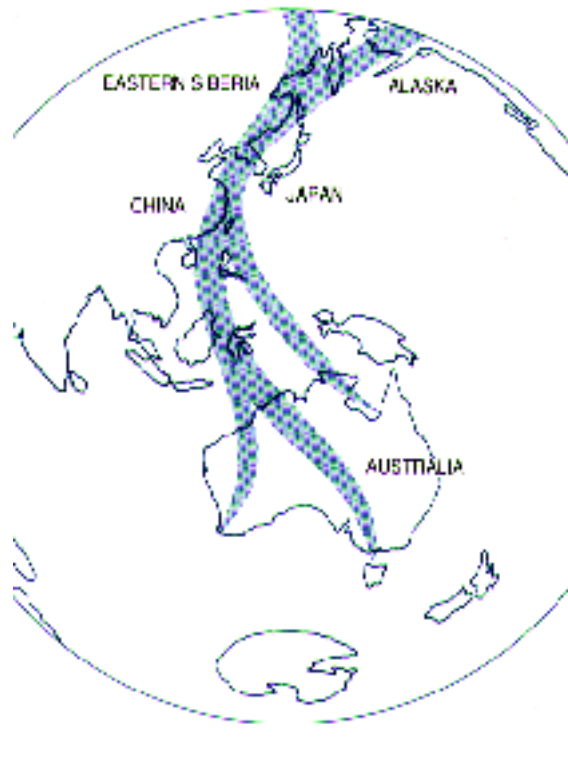


Figure 2. Migration of the Red-necked Stint (Source: 'Birdlife of South-west Estuaries', Information No. 3, Waterways Commission, 1990).

This extraordinary voyage extends over 10,000 kilometres and across 20 countries. Estuaries in the South-west play an essential role as Southern Hemisphere wintering grounds for waders.

Waders occur in great numbers and variety in the South-west estuaries. Up to 100 000 birds of 75 species, many of which would have been waders, have been recorded on the Peel-Harvey Estuary (near Mandurah) during a single bird count.

Plants and Animals of South-west Estuaries

Here are some of the common animal and plant species that can be found in South-west estuaries.

Fauna

Birds

Waders rely on a complex web of life for their survival. Their beaks are different shapes and sizes to reach various invertebrates and molluscs in the mud. The length of their legs is suited to the depth of water in which they feed.

Not all waders are migratory. Some waders, such as the Hooded Plover or the Pied Oystercatcher, breed and stay on Australian shores all year round.

Many wading birds depend on estuaries.

Many waders migrate from the Northern Hemisphere to estuaries in the South-west.

About 75 different bird species have been recorded in the Peel-Harvey Estuary.

Waders differ in beak shape and leg length, depending on their food source.

Fish, Crabs, Shellfish and Other Invertebrates

Many fish, crabs and shellfish rely on estuaries for food and as nursery grounds. Juvenile fish can grow safely in estuaries; they represent up to 90% of the Tailor, Black and Silver bream, Skipjack Trevally, Snapper, Flathead, Whiting and Flounder caught in estuaries. Depending on their requirements, they inhabit different water depths with different levels of salinity. Black Bream is one of the few truly estuarine fish species and spends all its life cycle inside this highly variable environment.

The Blue Manna Crab spends a large part of its life cycle in estuaries: as tiny crabs they enter the estuary to feed and grow to adult size in shallow regions. Fully-grown adults mate in the estuary, then females leave the estuary for the ocean to spawn.

Estuaries are habitat for a large variety of macroinvertebrates, such as marine worms, molluscs (snails, mussels), crustaceans (shrimps, prawns) and aquatic insects. A wide variety of microinvertebrates, such as tiny worms, filter-feeding crustaceans, and the larval stages of mosquitoes, flies and larger invertebrates, also live in estuaries. Microbial bacteria and fungi are also present and they break down organic matter from plants and animals.

Flora

Samphire flats, saltmarshes and mudflats contain a rich diversity of fauna and flora that are closely interconnected.

Larger Plants

The plants that grow in saltmarshes are adapted to a saline or brackish environment and some can survive under water for part of the year. The main salt-tolerant plants are:

- trees: Saltwater Paperbark, Flooded Gum, Saltwater She-oak, found near or around saltmarshes;
- shrubs: samphire, sea-heath, salt bush;
- sedges, herbs and grasses (such as Marine Couch).

Algae

Phytoplankton (tiny single-celled algae) are found mainly in the water and are an essential part of the food web of estuaries. Algae are an important food for macro and microinvertebrates. Outbreaks of blue-green algae and dinoflagellates (another type of single-celled algae) are caused by excess nutrients and can make the water unsafe for animals and humans to drink or swim in.

Fungi and Bacteria

Fungi and bacteria play a key role in the decomposition of the organic plant and animal matter that comes from water catchments surrounding the estuary. Much of this runoff comes from farms and contains waste products from livestock.

The product of decomposition is, in turn, a food source for many invertebrates in the estuary that make up the base of the food chain for the larger species.

Estuaries are important breeding and nursery grounds for many species of fish.

Macro = large.
Many invertebrates live in estuaries.

Microinvertebrates = small animals, often just visible with the naked eye.

Brackish = water that contains some salt.

Blue-green algae may cause water to become unsafe to humans and animals alike.

Fungi and bacteria are decomposers - they break down organic matter.

Estuaries - a Fragile Environment Under Pressure

Environmental problems in estuaries originate in rivers, streams and catchments that are often a long way from the coast. Thus, it is important to address human impacts where they occur, from the headwaters of rivers all the way to the coast.

Urban and Industrial Development

New suburbs, canal estates, marinas, roads and industrial developments are often established at the expense of wetlands, saltmarshes and mudflats. Critical habitat for migratory waders and fish are lost in the process.

Pollution

Estuaries concentrate pollution caused by waste waters from urban areas, the dumping of toxic waste from industry and runoff containing agricultural pesticides and fertilisers. These effects on estuaries can be made worse by the contamination of the water table by pollutants which can eventually seep into estuaries.

Nutrient Enrichment

Organic sediment and fertiliser runoff from pastures and intensive feedlots increases the amount of nutrients going into estuaries, causing excessive growth of phytoplankton and blue green algae. This leads to a loss of oxygen in the water, and results in the death of fish and other aquatic fauna.

Changes to Estuary Water Flow

A lack of natural water exchange between the estuary and the ocean can lead to an excess of nutrients in the estuary and cause algal blooms. Opening a channel to the ocean may assist with this natural process. However, it is not clear how an artificial channel affects the life cycles of aquatic fauna and flora within the estuary.

Disturbance of Wildlife by Humans

People living around estuaries can disturb feeding waders and nesting birds. Dogs, four-wheel-drive vehicles, jet skis and boats can chase wildlife away. For example, the Hooded Plover, a small wader which nests on sandy beaches, is particularly sensitive to being chased away by beach users, particularly dogs and vehicles, and is on the decline throughout Australia.

Conserving Estuaries and Saltmarshes

Many migratory waders are protected under international treaties, such as the Japan and China-Australia Migratory Bird Agreements. Wetlands of international importance are also listed under the Ramsar International Convention, which aims to protect wetlands of world-wide significance.

Nature reserves such as the Austin Bay Nature Reserve in the Peel-Harvey Estuary (see Figure 1) protect parts of these diverse estuaries. However, some important migratory wader habitats are not adequately protected and are being used for marinas, canal estates and housing subdivisions.

New human developments may remove essential habitat areas for birds.

Pollutants are detrimental to life in estuaries.

Excess nutrients in estuaries cause algae overgrowth and oxygen depletion.

Human activities affect migratory and nesting birds.

When mudflats and saltmarshes disappear, so do important feeding grounds for migratory waders and essential components of the estuary web of life. Waders cannot use other places to feed and may not be able to store enough body fat to fuel their return voyage to their breeding grounds in the Northern Hemisphere. Fewer waders stay the winter in the South-west than ever before. Thus, the survival of a large number of migratory birds may depend on the protection of the South-west mudflats and estuaries.

Mudflats and saltmarshes are essential habitat for many migratory birds.

What We Can Do

We can become responsible users of natural areas and share our space wisely with other living things. Whenever possible, we should walk rather than drive: it is the ideal way of getting to know the rich wildlife found around estuaries.

We can contribute to an improvement in water quality in estuaries by reducing the amount of chemicals and nutrients being discharged into the catchment from suburban backyards, farmland and industrial areas.

Reducing our use of chemicals will help improve water quality in estuaries.

By joining a rivercare or coastcare group we can contribute to conserving local estuaries. Many such groups exist and some are listed in the 'Contacts' section that follows. These groups often help protect estuaries by negotiating with government and conservation agencies for the protection of important areas of wetlands as nature reserves.

Suggested Activities

Student Government - the Land of Estuary

The aims of this activity is to put into practice the process of decision making within a Parliamentary debate, to engage students in speaking to a particular case, and to practice research skills for informed discussion.

Students to form a Parliament in the Land of Estuary. Each 'party' is to represent a particular aspect of the Estuary ecosystem - the majority party is the 'Humans' who must also be represented by a group of students.

The Parliament has to develop strategies to save the Estuary, taking into account all of the different needs of each group. Each 'party' will represent its case to the Parliament, explaining their special needs, the relationships with other 'parties' and the effect the Humans are having on the land.

A 'Speaker' should be elected to facilitate the discussion to ensure that it stays on topic and each party has time to present their case.

The teacher should record the main points made in some way that is visible to the class.

Once the cases have been presented, the Parliament should then decide on a series of practical strategies that the members of the class could actively undertake within their daily or community lives.

Students to discuss the impact of a 'majority' in the making of decisions.

Model Estuary

Make a three dimensional model of an Estuary environment. Representations of the types of plants and animals found in and around the estuary are to be incorporated in the model.

In addition, the model should include some representation of the various countries that migratory birds originate from to show the international dimension of the Estuary (e.g small flags of each country).

Emphasis in the project would vary depending on the subject area but it is of key importance that the factual information is accurate.

Application to the Student Outcome Statements

Society and Environment - Place and Space (Features of Places, People and Places, Care of Places); Natural and Social Systems (Natural Systems, Political and Legal Systems); Investigation, Communication and Participation (Conducting Investigations, Processes and Interpreting Information, Evaluating and Applying Findings);

English - Speaking and Listening (Use of Texts, Contextual Understanding, Conventions, Processes and Strategies); Reading (Use of Texts, Contextual Understanding, Processes and Strategies)

Extension Activities for Students

Science, and Society and Environment

1. Choose one of the parts of an estuary listed earlier: mudflat, swamp, beach or open water, and draw a web of life for the species found there.
2. Draw pictures of ten species of waders using the same scale. Notice the difference in overall size, bill length and shape, and length of the legs. What are the possible reasons for all these differences in terms of their feeding habits?
3. Draw ten different plants (trees, shrubs and ground species) that grow in saltmarshes. Note their leaf shape and size, and comment on their adaptations to this harsh environment, particularly windy, salty and hot conditions.
4. Map the migration of the Red-necked Stint on a world atlas and describe the various countries visited on the way, their climate and dominant coastal environments.
5. On the map of the Peel-Harvey estuary, find which areas are protected as part of a nature reserve or national park. Calculate the proportion of the estuary that is effectively protected.
6. Visit the website of the 'National Wetlands Program' website at: <http://www.anca.gov.au/environm/wetlands/>
Describe either a research or management project aimed at conserving wetlands and migratory birds, or report on a publication or a newsletter related to the protection of wetlands.

The Arts and English

Drama: write and act out a play based on the travels of the migratory Red-necked Stint. Include the breeding ground of the wader in northern Siberia, its summer visit to the estuaries of the South-west of Western Australia and migration across Asia.

Art: create your own art work inspired by an estuary in a coastal landscape. Imagine and then blend the colours of the sky, the estuary, saltmarshes and mudflats, and shapes of plants and wildlife.

Field Studies

Visit a wetland or estuary near your school (if you live away from the coast, a swamp or creek bed would be suitable).

1. Note what the different types of habitat are and describe the vegetation in each habitat (trees, shrubs and ground vegetation) and the bird and insect life. Use direct observation, tracks in the mud and any other telltale signs for the presence of animals.
2. Record the various species of animals (such as insects, birds and mammals) that live in each habitat. Use a sieve to discover which animals live in the mud or in the water. Hint: use sieves of different mesh sizes to catch a variety of species. Sketch the various animals that you have observed in a note book and describe their habitat in a few words on the same page.
3. Start a Ribbons of Blue program in your school and monitor water quality in the wetland. The contact for your local Ribbons of Blue coordinator can be obtained from the nearest Water and Rivers Commission regional office.

Further Reading

On Estuaries

Chalmers, L. and Wheeler, J. (1997). 'Native Vegetation of Estuaries and Saline Waterways in south Western Australia'. Water and Rivers Commission and Department of Conservation and Land Management, Perth.

Fisheries Department of Western Australia. 'Estuaries: Our Fish Nurseries'.

Water and Rivers Commission. (1996). 'Macroinvertebrates and Water Quality'. Water Facts 2.

Water and Rivers Commission. (1997). 'River and Estuary Pollution'. Water Facts 3.

Latchford, J. (1994). 'Sapphire Flats of the Peel-Harvey Estuary'. Peel Preservation Group.

Water and Rivers Commission. (1998). 'Water Words'. Water Facts 1.

Water and Rivers Commission. (1998). 'Living Streams'. Water Facts 4.

Species List

List of the species commonly found in estuaries, with their common and scientific names. Migratory waders are marked by a 'star' (*).

Type of organism	Common name	Scientific name
Plants		
	Saltwater Paperbark	<i>Melaleuca cuticularis</i>
	Saltwater Sheoak	<i>Casuarina obesa</i>
	Flooded Gum	<i>Eucalyptus rudis</i>
	Samphire	<i>Halosarcia</i> and <i>Sarcocornia</i> sp.
	Sea heath	<i>Frankenia</i> sp.
	Salt bush	<i>Atriplex</i> sp.
	Sedges	<i>Juncus</i> and <i>Lepidosperma</i> sp.
	Marine Couch	<i>Sporobolus virginicus</i>
Birds		
Very large (>80 cm)	Black Swan	<i>Cygnus atratus</i>
	Australian Pelican	<i>Pelecanus conspicillatus</i>
Large (50–80 cm)	White-faced Heron	<i>Ardea</i> <i>novaehollandiae</i>
	Great Egret	<i>Egretta alba</i>
	Straw-necked Ibis	<i>Threskiornis spinicollis</i>
	Yellow-billed Spoonbill	<i>Platalea flavipes</i>
	Australian Shelduck	<i>Tadorna tadornoides</i>
Medium (30–50 cm)	Australian Grey Teal	<i>Anas gracilis</i>
	Black-winged Stilt	<i>Himantopus himantopus</i>
	Pied Oystercatcher	<i>Haematopus longirostris</i>
	Eastern Curlew*	<i>Numenius</i> <i>madascariensis</i>
Small (15–30 cm)	Bar-tailed Godwit*	<i>Limosa laponica</i>
	Grey Plover*	<i>Pluvialis squatarola</i>
	Grey-tailed Tattler*	<i>Tringa brevipes</i>
	Common Sandpiper*	<i>Tringa hypoleucos</i>
	Curlew Sandpiper*	<i>Calidris ferruginea</i>
	Red-necked Stint*	<i>Calidris ruficollis</i>
	Red-capped Plover	<i>Charadrius ruficapillus</i>
	Hooded Plover	<i>Charadrius cucullatus</i>
Fish		
	Tailor	<i>Pomatomus saltatrix</i>
	Whiting	<i>Sillago</i> sp.
	Black Bream	<i>Acanthopagrus butcheri</i>
	Silver Bream	<i>Rhabdosargus sarba</i>
	Flathead	<i>Platycephalus</i> sp.
	Skipjack Trevally	<i>Pseudocaranx dentex</i>
	Snapper	<i>Chrysophrys auratus</i>
	Flounder	<i>Pseudohombus</i> sp.
Crustaceans		
	Blue Manna Crab	<i>Portunus pelagicus</i>
	Western King Prawn	<i>Penaeus latisulcatus</i>
	River Prawn	<i>Metapenaeus dalli</i>

On Migratory Birds

Bowden, L. and Driscoll, P. (1997). 'Following the Flight of the Eastern Curlew'. Australian Marine Conservation Society Bulletin. Vol. 20, No. 1: 6-7.

Schodde, R. and Tidemann, S. C. (Eds). (1997). 'The Reader's Digest Complete Book of Australian Birds'. Reader's Digest Publ., Sydney.

Watkins, D. (1997). 'Maintaining Mudflats for the Migrants'. Australian Marine Conservation Society Bulletin. Vol. 20, No. 1: 6.

Wykes, B. and Bamford, M. (1990). 'Birdlife of South-west Estuaries'. Waterways Information No. 3, Waterways Commission (now Water and Rivers Commission), Perth.

Contacts

Government Agencies

Department of Conservation and Land Management, Telephone (08) 9334 0333.

Department of Environmental Protection, Tel. (08) 9222 7000.

Environment Australia, Community Information Unit, Canberra, Tel. (FREECALL) 1800 803 772.

Fisheries Western Australia, Tel. (08) 9482 7333.

Leschenault Inlet Management Authority, Bunbury, Telephone (08) 9721 1875.

Peel Inlet Management Authority, Mandurah, Tel. (08) 9535 3411.

Swan Catchment Centre, Tel. (08) 9221 3840.

Swan River Trust, Tel. (08) 9278 0400.

Water and Rivers Commission, Tel. (08) 9278 0300.

Wilson Inlet Management Authority, Denmark (WA), Telephone (08) 9848 1866.

Non-government Organisations

Australian Marine Conservation Society, (08) 9220 0679.

Birds Australia - WA Group, Tel. (08) 9383 7749.

Busselton-Dunsborough Environment Centre, Tel. (08) 9754 2049.

Coastal Waters Alliance of Western Australia, c/- B. Slight, Telephone (08) 9307 7290.

Coastcare, Telephone (08) 9264 7574.

Conservation Council of Western Australia, Tel. (08) 9220 0652.

Denmark Environment Centre, Tel. (08) 9848 1644.

Marine and Coastal Community Network, Tel. (08) 9220 0662.

Ribbons of Blue, c/- Water and Rivers Commission. Ten regional coordinators in the South-west.

South-West Environment Centre, Tel. (08) 9791 3210.

WA Gould League, Herdsman Lake Wildlife Centre, Tel. (08) 9387 6079.

Waterbird Conservation Group, c/- J. Payne, Tel. (08) 9371 1670.

Wetlands Conservation Society, c/- P. Jennings, Tel. (08) 9360 2274.

Glossary

Most of the following definitions have been adapted from 'Water Words. Water Facts No. 1 Information Sheet' (Water and Rivers Commission, Jan. 1998).

Algae

A diverse group of aquatic plants containing chlorophyll. Many are microscopic (often being single cells) but some can be large, including the large seaweeds. They grow as single cells (see Phytoplankton) or as an aggregation of cells (colonies).

Algal bloom

The rapid growth of algae, generally caused by high nutrient levels. Can result in the loss of oxygen in the water when the algae die, leading to the death of plants, fish and other aquatic fauna.

Biomass

The mass of living or dead matter present in an environment.

Blue green algae

Blue green algae are a sort of phytoplankton that has evolved from an ancient group of bacteria which produce their own energy from sunlight. A number of species produce toxins.

Brackish

See Salinity. Lower salt concentration than seawater, but greater than 500 ppm.

Catchment

An area of land which collects rainfall to streams, rivers, wetlands or groundwater.

Ecosystem

Term used to describe a specific environment and all the interconnections between its different parts, including animals, plants and micro-organisms.

Estuary

An enclosed or semi-enclosed coastal body of water having an open or intermittently open connection to marine waters and fresh input from land runoff.

Fertilisers

Chemicals or organic matter used to increase nutrients available to cultivated plants.

Habitat

Part of an ecosystem used by a species for its breeding, feeding and resting needs.

Macroinvertebrates

Macroinvertebrates are animals without a backbone, big enough to be seen with the human eye (though they can be very small). The main groups are worms, snails, crustaceans (e.g. prawns) and insects.

Micro-organism

An organism so small as to be invisible to the naked eye.

Nutrients

Minerals contained in various mediums (such as water, soil, and living and dead matter) that are used by plants and animals as food, or for their well being.

Pesticides

Chemicals used to control insects, fungi, weeds, algae, rodents that are damaging to human activities.

Phytoplankton

Microscopic aquatic plants (up to 1 to 2 mm in diameter).

Runoff

Water that flows over the ground surface from a catchment area into streams and other water bodies.

Salinity

The measure of salt constituents in water. Water is classified as fresh, brackish or saline according to the level of salinity (low, medium, high).

Sediment

Particles of mud or sand that accumulate at the bottom of water.

Acknowledgments

Primary sources of information for this material came from pamphlets by the Waterways Commission (1990), the Peel Preservation Group (1994) and the Water Facts information sheets produced by the Water and Rivers Commission.

Figure 3. Birds commonly seen in estuaries.