FLOWERS OF THE OCEAN:
WA'S EXPANSIVE SEAGRASS MEADOWS

WATCH the flowers bloom around your home this spring, then imagine the same wonder of nature taking place underwater in fields of seagrasses within snorkelling distance of the Western Australian coast.

The shallow coastal beds shared by other unique marine plants and animals act as natural buffers against erosion and pollution. They are important nurseries and refuges for rock lobsters, prawns, starfish, mussels, sea urchins, turtles and dugongs – some of which support the State's lucrative commercial and recreational fisheries, not to mention leisure, sport and tourism pursuits. *Carmelo Amalfi* explores the beauty and biodiversity of Western Australia's seagrass meadows.

The seagrass meadows off the Western Australian coastline are some of the biggest and most diverse in the world. At last count in 2000, seagrasses covered about 51,000 square kilometres of Australia's shallow coastal environment, with the most diverse in south-western Western Australia. In fact, Western Australia's coast is home to the biggest seagrass population in the world, covering about 22,000 square kilometres or the same area covered by rainforests across all of Australia.

Seagrasses harbour and support a huge variety of marine life. In fact, an estimated 100 square metres of seagrass supports about 500 tonnes of fish a year, with one square metre generating up to 10 litres of oxygen a day.

Seagrasses act as a nutrient store; when their leaves are replaced with new ones or lost in storms, their stored-up nutrients are released into the water and sediment where they are used in a complex web of life and death. Most of this organic matter enters the food chain as particle-sized detritus broken down mechanically by water turbulence and bacteria and fungi. Crustaceans, molluscs and worms dine on the detritus and in turn fish and birds dine on them. Small planktonic invertebrates feed on the bacteria and protozoans and larger invertebrates living in the seagrasses feed on the smaller invertebrates.

Seagrass leaves act as a host for epiphytes such as algae and epifauna such as protozoans. And in turn, fish such as leatherjackets, luderick and mullet graze on them. Encrusting alga are common epiphytes which grow on seagrass leaves.

Seagrasses are links in a complex ecological chain. They are not eaten directly by most herbivores except grazers such as dugongs or sea cows and some species of turtles. They grow quickly, which is why they shed a great deal of organic material - a square kilometre of seagrass meadow may produce up to 20 tonnes of leaf material each year.

Seagrasses have a stabilising influence on the marine environment, slowing water movement, trapping sand and sediments and providing calmer, protected areas that are favourable to the survival and growth of juvenile fish.

Seadragons are one type of fish that thrive in seagrasses. They use the leafy blades and colourful seagrass flowers decorating the seafloor as camouflage. Being poor swimmers, they shelter within the grassy meadows to snack on invertebrates feeding on decomposing seagrass.

At sheltered Cliff Head lagoon south of Dongara, a 50 square kilometre meadow of *Posidonia* seagrass is regarded as the centre of the State's Western Rock Lobster Fishery because the dense seagrasses are sites of settlement and nocturnal foraging for juvenile rock lobster, *Panilirus cygnus*.

Species of *Zostera*, or eelgrass, are an important habitat for juvenile fish, which settle in the seagrass to find food and protection while they grow. They include the young of many commercially and

Seagrasses are found in all climatic zones – in tropical mangroves, for example. Photo: Clay Bryce

recreationally important species including bream, sea mullet, dusky flathead, trumpeter whiting, blue groper and juvenile baldchin groper.

Luderick juveniles settle in *Zostera* beds in summer and migrate to mangrove habitats in autumn while fan-bellied leatherjackets also settle first in the *Zostera* before migrating to meadows of dense *Posidonia*.

The juveniles of king prawns and blue swimmer crabs, both popular crustaceans in Western Australia, also settle in *Zostera* beds. Adult blue swimmer crabs are abundant in *Posidonia* seagrass.

Angiosperms

Seagrasses are angiosperms, or flowering plants, believed to have evolved from terrestrial ancestors about 70 million years ago; more closely related to terrestrial lillies and gingers.

They photosynthesise and reproduce by producing pollen and flowers, and the pollen they produce is dispersed by currents until it runs into another plant, where it attaches and fertilises the flower.

Seagrasses anchor themselves to the sandy sea bottom with extensive horizontal stems called rhizomes. These dense systems help stabilise sediments, reducing the amount of erosion in shallow waters, in much the same way deep-rooted plants are used to rehabilitate eroded sand dunes and other areas.

Their leaves can range in length from a few centimetres to seven metres.

Seagrasses are commonly found in shallow coastal sites, salt-marshes and estuaries in the tropics where they are associated with mangroves. They are different to seaweeds and algae because they have true roots and flowers.

Seagrasses form biologically diverse "forests" of marine life spread out, often in patches, over hundreds of square kilometres of seafloor between one and 35 metres of water.

The Indian Ocean is renowned for its abundant seagrass meadows, particularly in northern Australia and regions further south, along the sub-temperate and cooler Gascoyne, Mid-West and South coastlines.

Australia has more seagrass species than any other country. A present, there are nearly 60 species recognised in 12 genera, of which Australia is home to 30 species. Of those, Western Australia has the lion's share – 27!

Shark Bay, a World Heritage Area, harbours 12 species, growing over an estimated 4,500 square kilometres of seabed. At Esperance, seagrasses have been found growing at water depths of up to 47 metres. By contrast in many estuaries, two metres is the limit - such as the Perth and Canning rivers, which support about five square kilometres of seagrass.

Concern over seagrass losses

Substantial seagrass areas have been destroyed in the name of progress. Heavy industry development and industrial waste discharges during the 1950s and 1960s eradicated most of most of the seagrasses in the natural harbour south of Fremantle, with 97 per cent of its original 34 square kilometres of seagrasses destroyed by 1978.

Princess Royal and Oyster harbours at Albany have lost 66 per cent (over seven square kilometres) and 46 per cent (over eight square kilometres), respectively. Princess Royal Harbour was used as a dumping ground for industrial and sewage waste while Oyster Harbour was overloaded with agricultural nutrients (eutrophication) flowing through the King and Kalgan rivers.

Eutrophication can lead to blooms of microalgae, causing increased growth of epiphytes on the leaf surfaces that reduce the amount of light reaching seagrass leaves. Sources of nutrients include agricultural and fertiliser run-off, sewage discharges and industrial effluent, such as nutrient-rich wastewaters.

A gallery of grasses

Family *Cymodoceacene* (Wireweed)
The temperate wireweed or sea nymph, *Amphibolis antarctica*, is the dominant species of seagrass in the World Heritage Area of Shark Bay. It covers about 85 per cent of the total seagrass area and forms mostly dense stands with wiry stems, which are branched woody upright and up to two metres long. The leaves are small relative to the stems and flat with smooth margins that end in a blunt tip sporting two "teeth" at each end. Leaves occur in clusters of eight to 20 and can grow to five centimetres. Stems can reach 1.5 metres. The elongated leaves support a diverse assemblage of algal epiphytes. Wireweed also supports about 40 associated marine animals, including invertebrates, fish and sea snakes, that shelter and feed in it.

Family *Posidonia* (Ribbonweed)
The eight Australian species of *Posidonia* are all found in Western Australia. *P. australis*, known as Southern strapweed, is the most widespread species between Shark Bay and South Australia. It has long and narrow ribbonlike leaves up to two centimetres wide and 60 centimetres long that provide a favourable attachment point for many plants and animals. It has an extensive rhizome root system, wit up to 90 per cent of the plant below the sand. When *Posidonia* dies, big quantities of its tough fibre remains are washed ashore by waves, forming small "fibre balls". Popular in a World Cup year!

Family *Zosteraceae* (Eelgrass)
Another temperate seagrass, *Zostera capricorni*, forms mostly mono-specific beds though not as extensive as wireweed. It is supported in the water by a more extensive rhizome system, with up to 90 per cent of the actual plant below the sediment. It has a fibrous root system where the thin, ribbon-like leaves grow straight from the rhizome. It also provides refuge for a variety of plants and animals. Large seagrass meadows are important habitats for juvenile prawns. *Z. capricorni* can be found thriving in up to seven metres of water.

Frenchman's Bay near Albany, Princess Royal and Oyster harbours and Geographe Bay have extensive areas of seagrasses. *P. australis* and *P. sinuosa* dominate these protected habitats. *Amphibolis* and other species also occur in small areas. Around Perth, *P. sinuosa* is the dominant species, covering many hundreds of hectares.

Family *Hydrocharitacea* (Paddleweed or paddlegrass)
Described from its paddle-shaped leaves with round tips, *Halophila ovalis* occurs in the Indo-West Pacific and on the continental shelf near the Indian River Lagoon, Gulf of Mexico and Caribbean. Off Western Australia, it grows in both tropical and temperate waters. The paddleweeds *H. ovalis* and *H. decipiens* have paired oval leaves, which can grow to 20cm wide and up to 5cm long. Photos: Clay Bryce.

Coastal and port developments have a big impact on seagrass meadows, which do not do well when sand and silt become suspended in water or fall on seagrass leaves to reduce the amount of light the plant needs to photosynthesise.

Damage by boat propellers, anchors and chains also were common. Aerial images of boat moorings around Rottnest Island reveal the clear, distinct circular scours in the meadows cleared by the slack in mooring chains as they move in the wind.

Former CSIRO seagrass expert Hugh Kirkman and researchers from the State Herbarium and universities of WA, Murdoch and Edith Cowan mapped most of Western Australia's seagrass beds during the 1980s and 1990s at a time of growing concerns over the destruction and clearing of seagrasses for marinas and other coastal developments.

Dr Kirkman found the genus *Posidonia* was abundant along the west coast, particularly on the southern coast and suggested that the southern coastline of WA is the centre of speciation of Australian *Posidonia*.

A useful material on dry land

The next time you stumble across a pile of decaying seagrass on the local beach, consider some of the uses that it has been put to over the past few hundred years:

1. Seagrass insulation: Because of its high silicon content, seagrass material is fireproof, its thermal and sound-proofing properties derived largely from air spaces in mats of seagrass matter. Seagrass is a popular form of insulation in the United States, where it is called a Cabot's quilt, consisting of a mat of dried seagrass material inserted into the walls of houses. The material was also used to sound-proof radio studios in the US and UK.
2. Seagrass "tiling". Seagrass material was popularly used to thatch roofs in many rural coastal areas of Europe and the UK. A good substitute for straw, it has been used from the 17th century, and possibly earlier. Seagrass thatching was slow to rot and was flea-proof. It also did not catch fire as easily as some modern materials, such as timber.
3. Seagrass soils. Seagrasses have been used extensively to bind or stabilise clay and soil, such as in the dams or dikes of the Netherlands. Seagrass material also has proved successful as a mulch in stabilising sand dunes. It can form an erosion-resistant mat which is useful for seed germination in sand dune rehabilitation programs.
4. Seagrass stuffing. Some seagrasses have proved useful as a substitute for horse hair in Europe and America as a material for stuffing pillows, mattresses and upholstery. A good packing material for exporting seafood, seagrass fibre was used to fill leaks in ship hulls in the 17th century.
5. Seagrass manures and stock feed. *Posidonia oceanica*, mixed with lime and phosphates, was used in the Mediterranean as a meal for feeding poultry.
6. Seagrass weaving. Japanese fishers used *Phyllospadix iwatensis* as a material for making wet weather gear up to the 1930s. Seagrass fibre may also have been used for weaving baskets on the east coast of the US. Seagrass fibre is used to make mats and rugs in Australia.

Seagrass wracks washed up on the beach. Photo: Larisa Vanstien.

Diver over seagrass. Photo: Clay Bryce.

That was one of the reasons why they were worth protecting, Dr Kirkman concluded in a scientific paper published in the proceedings of an international seagrass workshop held at Rottnest Island in 1996.

Posidonia seagrasses are the most important marine flowering plant in temperate Australia – forming dense beds or patchy stands of pure or mixed species anchored to the sandy seafloor. Like their terrestrial cousins, seagrasses flower and produce fruit regularly – but unlike their terrestrial relatives, once they are gone they are gone. Cleared forests on land can regrow or, more importantly, can be regrown over large areas relatively quickly. But attempts to regrow seagrasses are costly and largely ineffective because it can take many decades to regrow over big areas.

A 1999 seagrass review by marine scientists from the CSIRO, Australian universities and industry found seagrass beds in Australia were being cleared unchecked at a rate that threatened their diversity and attraction to other plants and animals.

The comprehensive examination of the state of Australian seagrasses, and their role in the marine ecosystem, found that their removal was like throwing out the baby with the bath water. Once the grasses are gone, so too are the grass dwellers such as fish and crustaceans.

Once seagrasses, including their rhizomes, have been removed, they tend not to regrow in or recolonise that area. This is bad news for a variety of marine species.

Juveniles of the western rock lobster forage for food in seagrass beds near reefs in which they shelter before moving offshore; blue swimmer crabs feed on scraps; octopi dig burrows in bare patches of meadows; and squid use them to hide in and wait for prey.

Seagrasses use nutrients from the water and sediments, the latter believed to be a

primary source of its survival. However, overload the water column with nutrients from urban run-off, pollution or chemical spills and stress sets in.

Such nutrients can cause the big algal outbreaks seen in the Swan and Canning rivers where blooms of phytoplankton reduce the amount of light reaching seagrass beds below the surface.

Though some species can tolerate salinities higher than seawater, they can find it difficult to cope with long periods of sedimentation or pollution.

Seagrass provides important habitat for fish and other marine creatures. Photo: Clay Bryce.

Transplantation programs

Calling for better management and more research, the 1999 national review of seagrasses funded by the Fisheries Research and Development Corporation recommended keeping a check on further loss through monitoring and regulating coastal activities including shipping, dredging and residential and industrial developments.

The review also identified two research projects, both in Western Australia, which promised to improve the transplantation rates of seagrasses over large areas. One was in Cockburn Sound, and run by WA lime producer Cockburn Cement, which removes the calcium carbonate below the seagrass roots to process into lime. The other is in Albany harbour.

There are two major research projects being carried out in WA looking at seagrass transplantation. Photo: Clay Bryce.

Cockburn Cement, with researchers at Murdoch University and the University of Western Australia, has developed a submersible, Ecosub, which since November 1996 has successfully extracted and replanted hundreds of sods of seagrass. Most survived; shoot densities dropping in winter and increasing in summer. Until a few years ago, rates of replanting had reached 50 square metres a day, and the technology is improving all the time.

Prevention of loss in the first place is clearly a better option than costly and painfully slow restoration of seagrass meadows. Governments and coastal authorities have introduced rules for more responsible boat practices and limited the industrial discharges to save the State's remaining seagrass meadows.

Seagrasses rank with coral reefs and mangroves as some of the world's most productive coastal habitats. Reversing the damage done is a complex and sometimes controversial problem. But with community effort and education, Western Australians can play a direct role in protecting these "flowers of the sea". ■

Rottnest Island's seagrass communities

Nine species of seagrass are found in the Perth region, including at Rottnest Island where *Amphibolis* thrives in clear waters overlying limestone rock. Rottnest is second only to Shark Bay in species diversity, with some bays containing habitats of relatively undisturbed mixed seagrass habitats.

Seagrasses are a major component of the ecosystem on the Rottnest Shelf, thriving in waters ranging in depth from intertidal to 45 metres. More than 340 species of macroalgae (including 54 species of green algae, 71 species of brown algae, and 222 species of red algae) have been recorded from rock platforms around Rottnest Island. University of Western Australia botanist Diane Walker has identified *Amphibolis antarctica*, *A. griffithii*, *Posidonia australis*, *P. sinuosa*, *Heterozostera tasmanica*, *Syringodium isoetifolium*, *Thalassodendron pachyrhizum* and *Halophila ovalis* at Rottnest.

All of the species, except *S. isoetifolium* and *H. ovalis*, are endemic to temperate areas of southern Australia. Most species are homogeneously distributed within each of the meadow types.

At Rocky Bay, on the north side of the island where it is protected from big swells and strong south to south-westerly winds, a mix of dense seagrass meadow consisting of *Amphibolis* and *Posidonia* thrive.

The meadows around Rottnest Island serve as nurseries for juveniles of many fish species, and are home to species such as the cobbler and long-headed flathead.