# Case Study 6
# Seagrass Meadows: Supporting the Coastal Web of Life

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

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.

## Seagrass Meadows: the Source of Life in Coastal Waters

Seagrass meadows and mangroves are the foundation of the ecological web of life in coastal marine areas. In Western Australia, where mangroves are only common from Shark Bay northwards, seagrasses play a major part in supporting the marine web of life. Seagrasses are not algae, like kelp, but are true flowering plants that live underwater. They get their energy from sunlight through photosynthesis like most algae and terrestrial plants.

Seagrasses are marine flowering plants.

Seagrass meadows provide food, shelter, and breeding and nursery grounds for many species of fish. In estuaries and coastal areas, seagrasses are important habitat for marine invertebrates, such as Blue Manna crabs, worms, molluscs and small crustaceans, which play an important role in food chains.

Seagrasses are important habitat and feeding grounds for marine organisms.

Seagrasses also shelter the larval stages of many fish and other sea creatures. Among the fish that live in seagrasses are leatherjackets, mullet and whiting, as well as juvenile Tailor, Buffalo Bream and flathead, and the elegant seadragons.

Many fish shelter ir seagrasses.

Many seabirds, such as terns, Fairy Penguins and cormorants, and sea mammals, like sealions and dolphins, feed on fish. Thus, seagrasses may be important for the long term survival of these animals.

Without seagrasses many populations of fish and crustaceans would probably collapse. The loss of seagrasses in coastal sites may have far-reaching effects because juvenile fish, crabs and prawns need them as nursery grounds and for protection. Seagrasses are important not only for their role in maintaining biodiversity in the marine environment, but also for their value in supporting human activities such as commercial and recreational fishing.

Seagrasses are important nursery grounds for fish, and they support many human commercial activities.

**Seagrasses**
Australia has the highest diversity of seagrasses in the world, with 37 species.
Common names for seagrasses are eelweed, paddleweed, strapweed and ribbonweed.
The largest area of seagrasses in the world, the Wooramel seagrass bed, is found in Shark Bay, Western Australia. It covers 1000 $km^2$, has taken 5000 years to develop and supports over 10,000 dugongs. The Dugong is a sea mammal that feeds exclusively on seagrasses. It is endangered world-wide and is declining in Australia.
Much of the oxygen in the Earth's atmosphere is produced by phytoplankton in the ocean. Seagrasses also contribute to the oxygen produced by the ocean's plants.
Seagrasses produce pollen just like flowering plants on land. The pollen drifts in water currents until it meets another seagrass flower and pollinates it.

The largest seagrass beds in the world are found at Shark Bay.

## The Seadragon's Tale

Of all the sea creatures living in seagrass meadows, seadragons help us best understand the reasons why seagrasses are so fragile. These remarkable fish are related to seahorses, but have developed seaweed-like extensions which provide a perfect camouflage against an underwater background of seaweeds and seagrasses.

Seadragons are special fish which are found in seagrasses.

There are two species of seadragons in the waters of South-western Australia: the Leafy Seadragon and the Weedy (or Common) Seadragon. The Leafy Seadragon has longer and wider extensions than the Weedy Seadragon and is rarer. Both species are found only in the waters of southern Australia. The Leafy Seadragon is fully protected in Western Australia.

There are two species of seadragons in the waters of southern WA.

Seadragons are part of the pipefish family, called Syngnathidae, which also include seahorses and pipefish. About 200 species of Syngnathidae exist world-wide. Seahorses have a unique characteristic: the female transfers the eggs into a special pouch-like fold on the male's abdomen. Attachments are formed between the egg and the abdominal wall of the male and nourishment is transmitted from the bloodstream of the parent. About 2 weeks after the eggs are laid there, the brood pouch of the male breaks, releasing the young into the water.

Seahorse males incubate eggs in their abdominal pouch.

The female seadragon transfers the eggs onto the underside of the male. Details about the reproductive biology of the seadragon are not clear, but a similar link may exist between the eggs and the bloodstream of the male. Young seadragon hatch and are released in the water where they start feeding almost immediately on tiny organisms.

Male seadragons may be able to supply nourishment to developing eggs.

Seadragons feed on shrimp and other minute crustaceans which they find in seagrass meadows and kelp forests (kelp is a giant seaweed that grows on the south coast of Australia).

Seadragons feed on crustaceans.

Researchers at Underwater World (Hillarys, Perth) have made advances towards unravelling the life history of seadragons, as young have been born there from a male which already had eggs in its pouch and observations could easily be made.

Seadragons are threatened because of collection for the aquarium trade, and also because of damage to seagrass beds and ever-diminishing area of habitat

Seadragons are becoming rarer due to ever-diminishing habitat.

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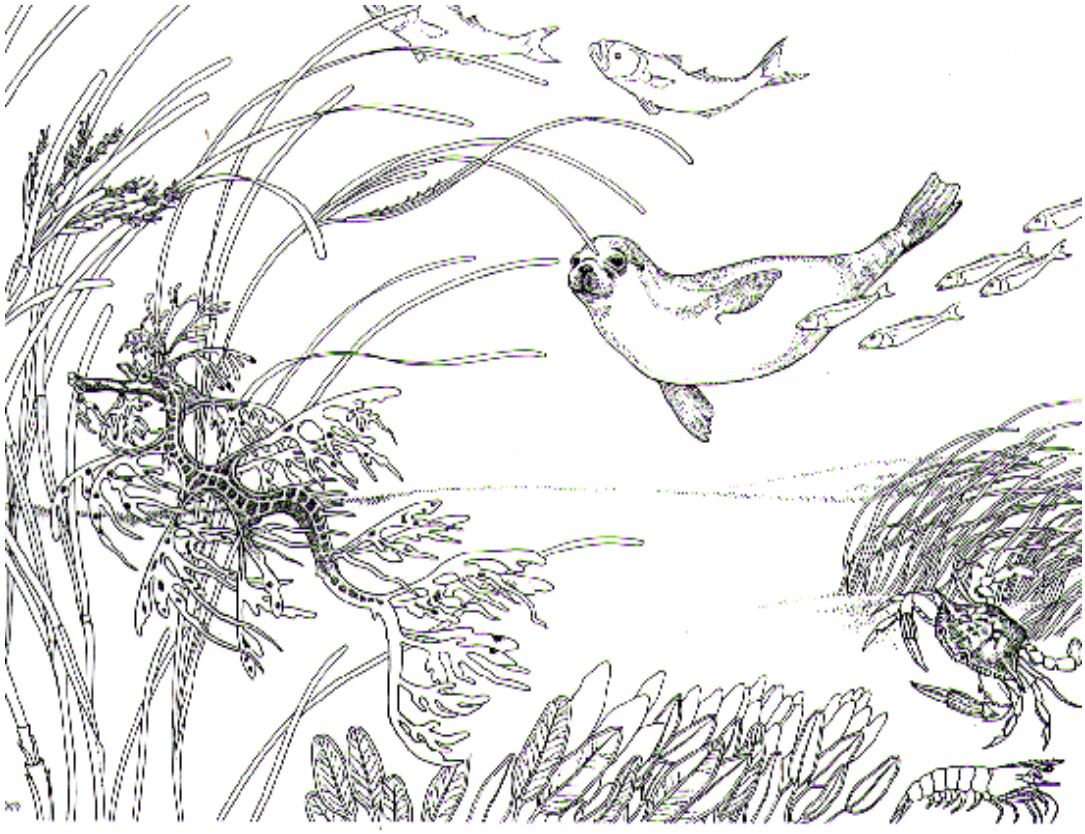

Figure 1. Seagrasses in the Web of Life.

## Human Impacts: Seagrasses in Crisis

In recent years, seagrasses have suffered a great decline around Australia. The loss of seagrass beds is one of the major issues affecting Australia's marine environment (see Figure 2). The State of the Environment Report 1996 for Australia states (Chapter 10, page 20):

Seagrass meadow areas are on the decline around Australia.

"A particularly serious problem appears to be the loss of seagrass beds, with more than 1600 $km^2$ (about three per cent of the total known area of Australian seagrass) lost in recent decades around the coast.

Some of the loss of seagrass meadows is due to human activities.

Much of this loss is attributed to floods and cyclones, with the remainder due to human changes such as increased nutrient levels, runoff, water muddiness, dredging and reclamation.

Prospects for recovery are poor as there are very few records of temperate seagrass recovering from damage or loss.

Seagrass beds are critical habitats for turtles and dugong, as well as being important nursery areas for commercial and recreational fisheries. Their loss must cause concern, especially as the temperate seagrass areas may not respond successfully to changes in climate."

Turtles and dugongs depend on seagrasses for their survival

### Reasons for Seagrass Loss

There are many causes for the loss of seagrasses around Australia. Some of these relate to what happens on land, even in areas which are a long way from the coast, while others causes are linked to problems in the sea.

Figure 2. The major areas of seagrass loss in Australia. (Source: "Our Sea, Our Future?" State of the Marine Environment Report, 1995).

### Water Muddiness

Healthy vegetation reduces erosion and runoff when it rains. Land clearing, overgrazing, mining, logging and frequent burning, however, reduce vegetation cover and cause erosion. Rivers carry sand or mud particles to the sea, damaging seagrass beds. The impact of floods is greatly increased by clearing of catchments for agriculture and urban development, which increases the speed and volume of rivers flowing into the ocean.

Sediments from land erosion are continually flowing into the ocean.

Excess sediments in the sea kill seagrasses by reducing the amount of light reaching the plants and smothering their leaf blades, thus reducing the ability of the plants to receive light and to grow. Water muddiness can be caused by sand and mud particles being carried by rivers into the ocean, by dredging, and the action of ships, small boats and jet skis. Cyclones and floods can cause great damage to seagrass beds by burying them under sand and mud.

Excess sediments reduce light penetration in the water.

### Pollution and Excess Nutrients

Pollution comes from industrial areas and from pesticides and other chemicals used in agriculture. Excess nutrients usually come from agricultural land (runoff of fertilisers and livestock waste products), from urban sewage as well as polluted runoff from roads and suburban backyards.

Pollution and excess nutrients are causing the decline of seagrasses.

Pollution and excess nutrients in the sea lead to the decline of seagrasses. Excess nutrients in the water cause algal growth on the leaves of seagrasses. This restricts the amount of light seagrasses receive and they eventually die. Large areas of seagrasses have been lost in Oyster Harbour and

Large areas of seagrass beds have been lost in the Southwest.

Princess Royal Harbour near Albany due to the build-up of nutrients from sewage outfalls and agricultural wastes. Limited regrowth has occurred over the last few years and may indicate a recent improvement of water quality in these harbours.

**Impact of Boating**

Anchors can inflict severe damage to seagrass beds, ripping out large clumps of seagrasses. Moorings often cause large holes in seagrass beds as the chain drags across the bottom when the boats swing around. In shallow areas, boat propellers and jet skis can open a cut through a seagrass bed that takes years to regrow.

Boats and moorings are further reducing seagrass meadows.

**Decline of Seagrasses: the Example of Cockburn Sound**

The location of the Kwinana heavy industry area on the shores of Cockburn Sound led to the loss of up to 97% of seagrass beds in the Sound by 1978:

Industrial discharge can kill seagrasses.

"... industrial discharges into Cockburn Sound in Western Australia have been associated with massive loss of seagrasses and substantial levels of contamination of sediments and fish" ('Australia: State of the Environment 1996', Chapter 8, page 25).

Whereas in the 1970s most of the pollution in Cockburn Sound came directly from the Kwinana industrial area, now 70% of the pollution that is leached into the ocean comes from the contaminated groundwater table and sediments that have stored high levels of nutrients. The amount of pollution is now returning to the worst known levels of 25 years ago. A new deep water port the size of Fremantle is planned in Jervoise Bay and is likely to increase the environmental pressures on the Sound.

Dredging for lime sands is a major threat to seagrass beds. In Success Bank, just outside Cockburn Sound, ongoing lime sand extraction is threatening seagrass meadows by increasing both turbidity and seagrass removal.

Dredging for lime sand is threatening seagrass meadows.

Figure 3. Seagrass cover and loss in Cockburn Sound 1954-93. (Source: South Metropolitan Waters Study, Dept Environmental Protection 1996 ).

There is no simple way of restoring seagrass beds once they have been destroyed. Seagrasses are slow-growing and it is not known how long natural regeneration will take. Experiments to replant seagrasses after dredging have shown that small seagrass clumps can be grown. However, there is no indication that seagrasses can be grown over large areas.

Seagrass meadows are slow to recover and re-grow.

# Seagrasses: Our Best Ally to Protect the Coast

## Protection of the Coastline from Storm Damage

Seagrass beds help protect the coastline from storm damage and are nature's engineering solution to the impact of erosion caused by the force of water on the coastline. Seagrasses play an important role in trapping and stabilising sand and sediments that drift along the coast by slowing down the flow of water and reducing the action of swells and waves on the coastline.

Seagrasses moderate water flow along the coastline.

## Value of Coastal Areas

Humans are constant users of the coast and coastal waters. These uses include amateur and commercial fishing, tourism, and industrial and urban development. Leisure activities, such as boating and family outings to the local beach, are an important part of the Australian way of life. Without a healthy environment and adequate environmental protection, many of these uses may soon no longer be possible or viable.

# What We Can Do

Protection of seagrasses can be achieved by making it illegal to damage or kill seagrasses, by giving incentives to improve land conservation practices in agricultural catchments, by increasing awareness about the need to conserve seagrasses, and by encouraging boat owners not to drop anchors in seagrass beds or damage seagrasses with boat propellers or jet skis. Moorings can be redesigned to have a chain that does not drag on the ocean floor.

We must start to protect our seagrass meadows from damage and destruction.

The Marine and Coastal Community Network or Australian Marine Conservation Society can organise a talk at your school or let you know which activities are taking place on the coast. Many activities take place on Ocean Care Day on the first Sunday of December, or during SeaWeek in March each year.

# Suggested Activities

## Super Seagrass Marketing Campaign

The *Super Seagrass Saviours* is a company that has been set up to inform Western Australians about the value of Seagrass in the Coastal Web of Life. Students in your class have been selected to create the campaign.

Divide the class into workgroups who are each responsible for the creation of a marketing campaign that includes a brochure, advertising poster and information booklet about the contribution to biodiversity made by Seagrass.

The campaign should be presented as part of an oral presentation to the rest of the class *or* a panel of peers (if this is not possible, then teachers or

visitors) who will act as the *Super Seagrass Saviours Pty. Ltd.* (This provides an opportunity for peer evaluation and immediate constructive feedback).

## Seagrass Mural

Invite students to suggest a series of outcomes if all grass were removed from the land and consider the impact of that on their lives.

Once the discussion has been exhausted, introduce the "term" seagrass and invite students to consider where it might be found and what its role might be in the sea environment.

Use this discussion to lead into the information about the seagrass contained in the biodiversity package.

After reading the information, each student to take one species from the seagrass meadow (use species list contained in package) and research it.

As a class, create a large mural that shows the biodiversity of the seagrass meadow. Once the mural is completed, the class can use it as a basis to discuss the reasons for Seagrass loss and create ways to add these reasons to the mural. Consider the possibility of destroying parts of the mural in the process and enable students to explore their reactions to this - link this to the destruction of the seagrass environment.

Discuss ways in which the students can utilise their energy and reactions to help save the seagrass.

## Application to the Student Outcome Statements

**Arts** - Using arts skills, techniques, technologies and processes; Communicating Arts Ideas.

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

# Extension Activities for Students

## Science, and Society and Environment

1. For each map of seagrass meadows in Cockburn Sound in 1954–62, 1972 and 1993 (Figure 3), measure the area of seagrasses and place these values on a graph with time on the X (horizontal) axis and seagrass area on the Y (vertical) axis.

   Calculate the percentage of decrease in seagrass area between 1954–62 and 1972, and between 1954-62 and 1993. What will happen to seagrasses in Cockburn Sound if the same trend continues?
2. Draw a food web of the different types of animals that inhabit seagrasses and other coastal habitats, from crabs and prawns to sealions, dolphins and sea birds. Keep in mind the ratio of each species which should exist. For example, animals on the top of the food web are fewer in number than seagrasses and crustaceans at the bottom end.

3. Seagrasses use the sun's energy for their growth. This process is called photosynthesis. Carbon dioxide from the air (but dissolved in water) and other chemicals in the water are used by the plant and changed into oxygen and food.
   Using Figure 1, describe what happens if the sea water contains too many particles of mud and silt. What happens when the sea water contains too many nutrients and there is an increase of algae on the leaf blades of seagrasses?
4. Draw an explosion chart or mind map to show ways to protect seagrasses along the coast nearest to where you live.
   Identify the threats to their survival and what could be done to remedy these problems.

## The Arts and English

Drama: write and act out a play based on the life story of the Seadragon including as many species as possible that rely on seagrasses for their living (don't forget humans).

Use puppets and costumes to act out the story.

Art: create a composition of the underwater world in a seagrass meadow.

## Field Studies

1. Visit your local beach and look for washed-up seagrasses.
   Note the different types of seagrasses present. How do you think they have arrived there?
2. Go snorkelling and observe life in a seagrass meadow.
   For information on where to go, call the Australian Marine Conservation Society or the Education Unit at CALM, Fremantle.
3. Join the National Dragon Search project by calling the project coordinator on (08) 9220 0679.
4. Organise a visit to Underwater World with your class.

## Species List

List of the species connected to seagrasses with their common and scientific names.

| Type of organism | Common name | Scientific name |
|---|---|---|
| **Seagrasses** | | |
| | Eelgrass | *Zostera* spp. |
| | Paddle Weed | *Halophila ovalis* |
| | Ribbon Weed | *Posidonia australis*, *P. sinuosa* |
| | Strapweed | *Amphibolis antartica*, *A. griffithii* |
| **Crustaceans** | | |
| | Blue Manna Crab | *Portunus pelagicus* |
| | Western King Prawn | *Penaeus latisulcatus* |
| | Swan River Prawn | *Metapenaeus dalli* |
| | Crayfish or Western Rock Lobster | *Panulirus cygnus* |
| **Fish** | | |
| | Leafy Seadragon | *Phycodurus eques* |
| | Weedy Seadragon | *Phyllopteryx taeniolatus* |
| | Seahorses | *Hippocampus* spp. |
| | Buffalo Bream | *Kyphosus cornelii* |
| | Flathead | *Platycephalus* spp. |
| | Mullet | *Liza* spp., *Myxus elongatus*, *Mugil cephalus* |
| | Tailor | *Pomatomus saltatrix* |
| | Whiting | *Sillago* spp. |
| **Mammals** | | |
| | Australian Sealion | *Neophoca cinerea* |
| | Bottlenose Dolphin | *Tursiops truncatus* |
| | Dugong | *Dugong dugon* |
| **Birds** | | |
| | Fairy Penguin | *Eudyptula minor* |
| | Cormorants | *Phalacrocorax* spp. |
| | Terns | *Sterna* spp. |

## Specific Websites

**Marine Information Sites**

Australian Marine Conservation Society website:
http://www.ozemail.com.au/~amcs/

Marine and Coastal Community Network website:
http://www.ozemail.com.au/~mccnet/

ABC's oceans website: http://www.abc.net.au/oceans/alive.htm

Marine studies textbook: http://www.wetpaper.com.au/

**Seadragon Sites**

Dragon Search home page: http://www.dragonsearch.asn.au

Dragon Search home page (Marine and Coastal Community Network-South Australia):
http://www.nexus.edu.au/schools/kingscot/pelican/Seadragon/Sd_index.htm

Underwater World Seadragon page (Singapore):
http://www.underwaterworld.com.sg/seadrago.htm

Underwater World (Hillarys, Perth) Seadragon page:
http://coralworld.com/perth/gallery/seadragons/

# Further Reading

## General


AMCS. (1997). 'How to Save our Coast and Oceans'. Coastal Community Resource Kit. Australian Marine Conservation Society, Perth.

ASTA. (1998). 'Exploring Oceans'. A Resource Book of Activities and Information for National Science Week. Australian Science Teachers Association, Deakin, ACT.

Dakin, W.J. (1987). 'Australian Seashores'. Angus and Robertson, Sydney.

DEP. (1996). 'South Metropolitan Coastal Waters Study (1991–1994)'. Summary Report. Department of Environmental Protection, Perth.

Environment Australia. (1996). 'Australia: State of the Environment 1996'. CSIRO Publishing, Collingwood, Victoria. Also on CD-ROM available from Environment Australia, Community Information Unit, Tel. (FREECALL) 1800 803 772.

Zann, L. (1995). 'Our sea, Our Future'. State of the Marine Environment Report for Australia. Department of Environment, Sport and Territories, Canberra. Available from Environment Australia, Community Information Unit, Tel. (FREECALL) 1800 803 772.


## On Seadragons and Seahorses


Kuiter, R. H. (1988). 'The Birth of a Leafy Seadragon'. Australian Geographic No. 12.

McDonald, K. (1998). 'Seadragons: Icons of the Deep'. Earth 2000. The West Australian, 9 Feb.

National Dragon Search Project. 'The Dragon's Lair' newsletter (twice a year). See Dragon Search website.

'Seahorses' (1994). Australian Geographic No. 33.

### On Seagrasses

Open Channel. (1989). 'The Seagrass Story - Seagrass Event '89'. Video in association with the Westernport Peninsula Protection Council and Ian Cumming (30 min). Available from Community Arts Network (WA), Tel. (08) 9226 2422.

Walker, D. (1992). 'Grasses of the Sea'. Landscope, Summer 1991/92: 42-46.

## Contacts

**Australian Marine Conservation Society (WA)**, Tel. (08) 9220 0679.

**Coastal Waters Alliance of Western Australia**, C/- Bob Slight, Tel. (08) 9307 7290.

**Department of Conservation and Land Management**, Marine Conservation Branch, Tel. (08) 9432 5100.

**Edith Cowan University**, Department of Environmental Management, Tel. (08) 9400 5189.

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

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

**Murdoch University**, Dr Eric Paling, Tel. (08) 9360 6121.

**Coasts and Clean Seas program**, Environment Australia, Tel. (FREECALL) 1800 803 772.

**Underwater World**, Hillarys, Tel. (08) 9447 7500.

**University of Western Australia**, Department of Botany, Telephone (08) 9380 2089.

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

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

## Glossary

The following definitions have been taken 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 or an aggregation of cells (colonies). Phytoplankton is one type of microalgae.

**Ecosystem**

Term used to describe the web of life within a community and its specific environment, such as lake, mountain, coast, forest.

**Habitat**

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

**Invertebrate**

Animal without a backbone.

**Nutrients**
Minerals dissolved in water, particularly nitrates, ammonia and phosphates which provide food for plant growth.

**Nutrient enrichment**
Excessive enrichment of water by dissolved nutrients, particularly nitrates and phosphates, which lead to excessive growth of aquatic plants.

**Phytoplankton** (see Algae)

**Photosynthesis**
Use of sunlight energy by plants to transform carbon dioxide and water into sugars and other complex organic substances.

**Reclamation**
Filling coastal areas with rocks and soil to create new land.

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

**Seagrass**
Marine flowering plant adapted to living wholly submerged in seawater. They are not true grasses, but many have a grass-like form.

**Sediment**
Particles of mud or sand that accumulate on the bottom of a water body.

**Water Pollution**
Water pollution occurs when waste products such as effluent, rubbish, noxious chemicals, sewage or contaminated runoff, change the quality of the water.