Exploring

OCEANS

A resource book of activities and information for National Science Week 1998

AUSTRALIAN
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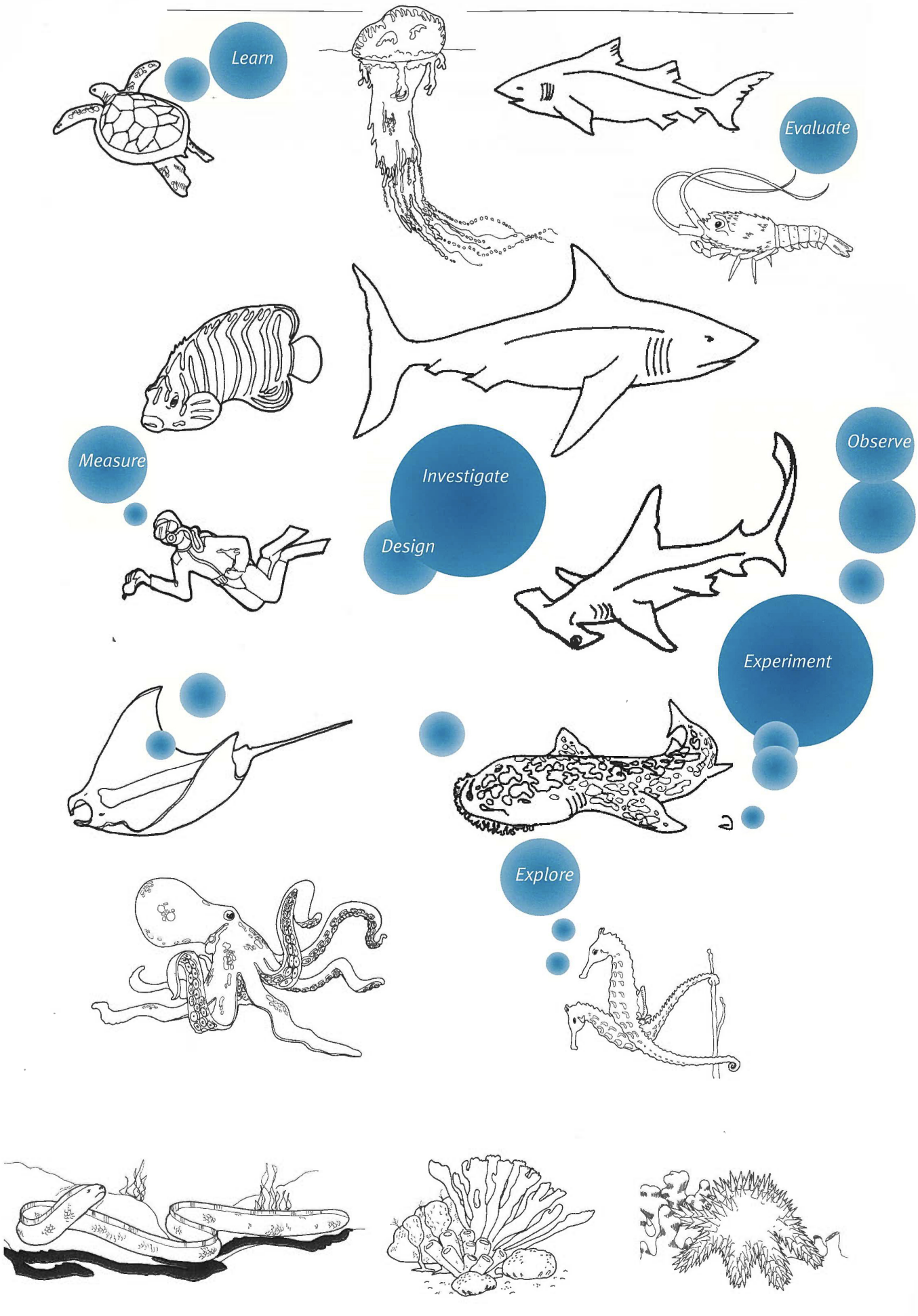
ASSOCIATION


Learn
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Design
Observe
Experiment
Explore

AUSTRALIAN SCIENCE TEACHERS ASSOCIATION

Exploring oceans

A resource book for National Science Week 1998

Exploring oceans is a resource book of activities and information published by the Australian Science Teachers Association (ASTA). It is designed for teachers and students and provides many exciting activities for use at school and at home. The book can be used during National Science Week and throughout the year.

This year sees the launch of the first National Science Week, a partnership between ASTA, the ABC and the Australian Science Festival. It builds on *Science in Schools Week*, an initiative of ASTA which was first held in 1984 and has been held every year since. It aims to focus community attention on science and its importance in the school curriculum and to promote the image of science. National Science Week involves students at all levels of schooling, parents, scientists and other members of the community in a broad range of science-related activities which show that science is enjoyable.

During National Science Week ASTA hopes that teachers will be able to organise a celebration of science and that this book will provide useful ideas for the theme *Exploring oceans.*

As well as providing this resource book, ASTA has a National Science Week Coordinator in each State and Territory who organises activities and events during National Science Week. If you would like more information or would like to help organise activities in your State/Territory please contact your local National Science Week Coordinating Committee the contact details of whose Chair is listed in the pull-out Resource List in the centre of this book.

National Science Week is one of many programs which ASTA organises to enrich school science education for students and teachers in primary and secondary schools. If you would like to find out more about these and other programs, please contact ASTA or your State/Territory Science Teachers' Association. A free copy of this resource book is one of the many benefits of membership.

On behalf of ASTA I would like to thank and congratulate the authors and designers of this book *Exploring oceans,* the National Science Week Coordinators in each State and Territory of Australia and all the teachers who become involved with National Science Week activities.

I do hope you find this resource book useful, interesting and enjoyable. Please write to me or ring me to let me know your views and opinions about the resource book or National Science Week in general.

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Exploring Oceans

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Introduction

Beneath the ocean surface is an environment, hostile to humans, but filled with colour, diversity and mystery. As each year passes we unravel more of the mysteries of the ocean and marvel at the complexities of the ecosystems, the adaptations of the life forms, the constant movement of energy and the human technology that has enabled us to learn so much.

As individuals, we can learn much about the shallow ocean from activities such as snorkelling and scuba diving. These activities have not been included in this booklet as they require specialised support and skills. However, it should be pointed out that one of the best ways to study the Great Barrier Reef, for example, is to snorkel or dive with a marine biologist. Older students might like to make this a future goal.

Exploring Oceans is a brief introduction to some, but not all, of the major aspects of our oceans. It raises questions such as: what lives in the oceans, what is along the ocean edge, what is the human impact on the oceans, what is in sea water, what is at the bottom of the oceans and how and why does the sea move?

It is hoped that by raising awareness and appreciation of this beautiful but fragile environment, it will be better cared for by future generations. As the battle between the need for care and conservation and the need to extract human food from the oceans continues, our students will grow into informed adults capable of making important decisions when necessary.

The booklet looks at a variety of important aspects of our oceans and ends with an important case study, the Great Barrier Reef. This amazing environment is one of which we can all be proud, and one which we all would benefit from understanding better. We are indeed fortunate to have this amazing environment on our coastline. It is unique, it brings much tourism into this country, nearly all Australians want to see it, and it is something which we should all work to preserve.

Many of the activities suggested here could also be modified for a creek, stream, river or estuary environment. This opens the topic up for students away from the coast.

⚠ Safety warning

All student activities recommended in *Exploring Oceans* have been designed to minimise hazards. However, there is no guarantee expressed or implied that an activity or procedure will cause no injury. Teachers selecting an activity should test it with their own materials before using it in class.

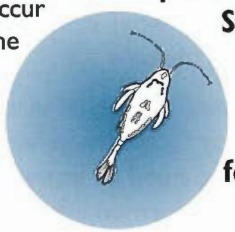
Any necessary safety precautions should be clearly outlined by the teacher and all safety equipment provided to the students before starting the activity.

Teachers' notes

1. What lives in the ocean?

A complex environment and food web

Many exciting and unusual life forms live in our oceans, contributing to a very complex but delicate mixture of interrelating and interdependent organisms. All the animals in the sea ultimately depend on plants for their food and energy. Plants manufacture their own food by a process called photosynthesis, depending only on themselves, sunlight, carbon dioxide and nutrients from the water. This makes plants the beginning of all food chains. Plants occur mainly as seaweed and sea grass along the coastlines and phytoplankton in the water near the surface of the open oceans. Plants are producers.



Producers are organisms that make their own food by photosynthesis and provide food for many other organisms.

Producers are eaten by animals which are called herbivores. These include the tiny crustaceans called zooplankton, countless species of fish and the large whalebone whales which are mammals. Animals which eat other animals are called carnivores, and animals which eat both plants and animals are called omnivores. Herbivores, carnivores and omnivores are called consumers.

Consumers are organisms which depend on eating other organisms for survival.

When organisms which are not eaten as part of the food chain die, they are eaten by scavengers or decomposed by bacteria to give nutrients back to the ocean. These bacteria are called decomposers.

Decomposers are organisms which break down dead organic matter into nutrients.

The millions of organisms in the sea make up a complex and prolific biomass. Unfortunately, we can mention only a very few of the many ocean life forms and give some ideas about their communities, environment and interrelationships.

The theme 'what lives in the oceans' could lead to numerous investigations along the edge of the ocean, along a river bank, near a creek or beside a dam. In more arid areas, even dry creek beds could provide an investigation site. Students could investigate such things as life forms along a section or within an area, and/or interrelationships of life forms in the area.

The smallest living things

Among the smallest of the marine organisms are phytoplankton and zooplankton. Together they are referred to as the plankton. These tiny organisms mostly drift with the current in sea water where light can penetrate. The plankton contains adult forms but also larval forms of many organisms. All are able to float in the upper ocean because of their very small weight and because they have many adaptations which allow their weight to be spread.

Phytoplankton are microscopic plant cells which produce their own food by photosynthesis. They are mostly invisible unless placed under a low powered microscope. This can be achieved by first catching them in a fine meshed net. They are producers on which many sea creatures feed directly and on which they depend. Most are single celled. Many have geometric shapes with some having exotic, delicate shapes.

The zooplankton are microscopic, transparent crustaceans. They are consumers. They do not produce their own food but feed on the even smaller phytoplankton.

Teachers' notes

Many sea creatures have adapted feeding systems which allow them to filter or sieve water for plankton. Zooplankton and phytoplankton exist in such prolific numbers that huge whales are able to survive on them as their main food source.

The biggest animals

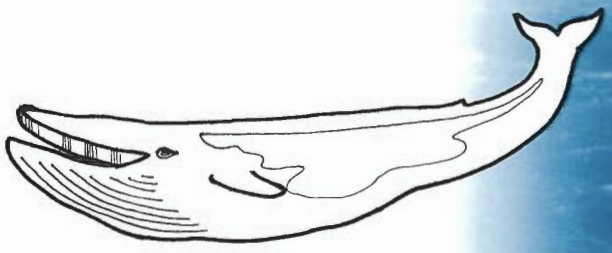
Whales are the biggest animals that live in the ocean. These vertebrates are the only mammals which live their entire life in the water and are well adapted to their aquatic environment. All whales belong to the order *Cetacea*. As mammals, they are warm blooded, have lungs and breathe air, have fur or hair as part of their body covering at some stage of their life and feed their young with milk. They come to the surface to take in air through a blowhole on the top of their head. When they reach the surface they are often seen blowing out gases from the blowhole before they inhale. When submerged the blowhole is closed by a ring of muscles to exclude water.

Whales, between breaths, can stay submerged for up to two hours and have been known to descend to depths of over 1,000 metres.

Whales are intelligent and able to communicate by emitting and receiving sounds through the water. They are the biggest animals on Earth. Some have reached a length of 30 metres and a weight of 140 tons. Just under the surface of the skin is a layer of blubber, rich in fats and oils. This has many uses and has been the source of income for the whaling industry in the past. Today, we value the presence of these beautiful animals and the mass killing of them for blubber has ceased in Australia.

There are two types of whales, the whalebone whales and the toothed whales.

The whalebone whales feed on the plankton, in particular a small crustacean in the plankton called krill. Inside their mouths are many bristles, called the 'baleen', which act as a sieve. The whale takes in huge mouthfuls of water, then forces the water out trapping the krill in its mouth. They mostly live in the cold waters of the antarctic during the summer and then follow the krill north in the winter months. Whalebone whales include the blue whale and the right whale.



The toothed whales include the killer whale and the sperm whale and, as their name suggests, have teeth rather than a sieve. They feed on other animals in the sea. Killer whales have been known to cooperate with each other and with humans in rounding up prey into shallow water.

Dolphins are also whales. The common dolphin is the bottlenose dolphin *Tursiops truncatus*. Dolphins are social animals, often interacting with humans, and living in large schools. Scientists have observed them assisting other members of their school who are injured or giving birth. Because of their high intelligence, streamlined appearance, ability to manoeuvre in the water, playful nature, well developed communication skills and ability to learn, they have become much appreciated and liked by humans. Not only are they powerful swimmers, they are powerful jumpers, using their extremely strong tails to propel themselves through and out of the water.

Teachers' notes

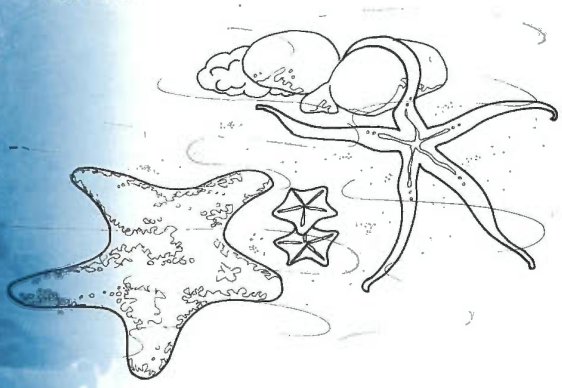
Some other interesting sea creatures

Starfish

The common starfish is *Protoeaster lincki*

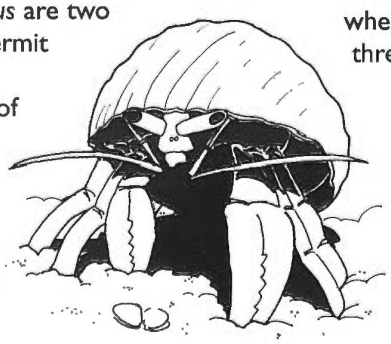
These beautiful animals vary greatly in colour, size and the number of tentacles. They can range from less than a centimetre to just less than a metre across, and have from four to fifty tentacles. The most common starfish have five tentacles.

They are a common sight in rockpools in the intertidal zone around the Australian shoreline.



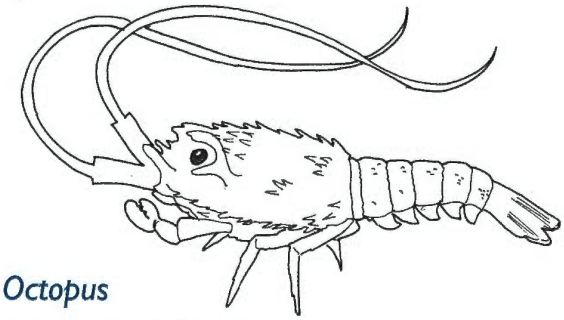
Crab

Crabs are crustaceans that all belong to the sub-class *Malacostraca*. There are many species with most living in shallow oceans, but others living in rock pools, sandy beaches or the deeper ocean. They are bottom dwellers, with an exoskeleton, eight walking legs and two huge pincers which they use for eating and self protection. They have flat bodies, walk sideways and are excellent at hiding and camouflage. One particularly interesting group of crabs is the hermit crab. (*Eupagurus sinuatus* and *Eupagurus lacertosus* are two common Australian hermit crabs.) They have the unusual characteristic of living in an empty mollusc shell. When they grow too big for the shell they simply move to a bigger shell.



Lobster

Lobsters are also crustaceans that belong to the sub-class *Malacostraca*. These large, prawn-like animals live on the sea floor, are usually blue black in colour, and have powerful jaws and claws. They have a fan-like tail and a tough exoskeleton or shell. As they grow they shed the shell in a process called moulting. Adult lobsters moult once a year. They are an important food source and are marketed live. The characteristic red colour develops during the cooking process.

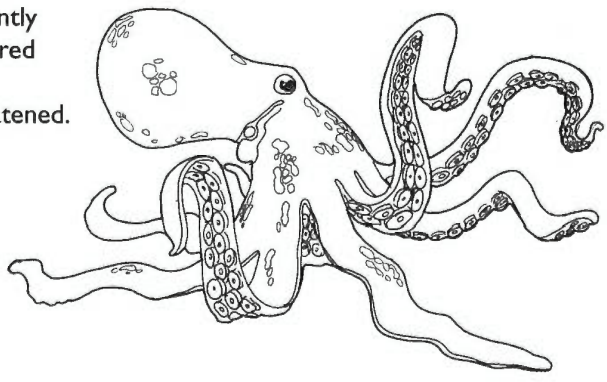


Octopus

Octopus vulgaris is a common octopus.

The octopus is a tentacled mollusc which lives in the sea and has no shell or internal skeleton. Its body consists of a soft tissue sack which extends into eight tentacles with webbing in between. Suckers which occur along the underside of the tentacles allow the octopus to move over and adhere to surfaces.

Prey is grabbed with the tentacles and often torn apart. Most octopii can change their colour and exude ink as a visual shield when threatened. There are over one hundred species of octopus. One very dangerous species is the deadly blue ringed octopus which occurs on the Australian coast and becomes brilliantly coloured when threatened.

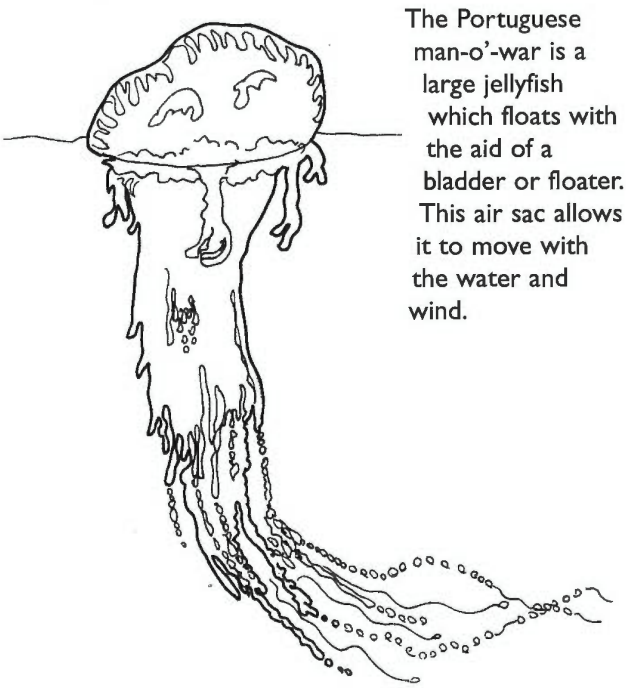


Teachers' notes

Portuguese Man-o'-War

Physalia physalis

(Atlantic Portuguese man-o'-war)



The Portuguese man-o'-war is a large jellyfish which floats with the aid of a bladder or floater. This air sac allows it to move with the water and wind.

The gas in the bladder is produced by a gas gland which in turn is controlled by the muscles which surround it. The bladder is capable of deflating during stormy weather so that the organism can submerge and avoid the difficult weather. When the weather clears the organism reinflates its bladder. Stinging tentacles, which are suspended below the bladder, are a feared feature of these organisms.

Fish

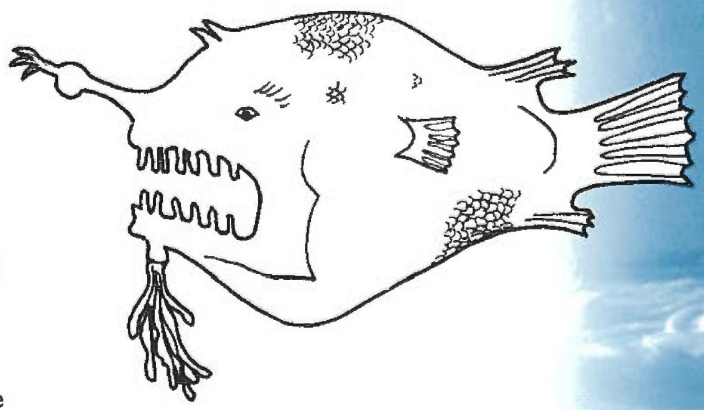
It is thought that life on our planet began in the sea millions of years ago during the pre-Cambrian period. Fish were the first vertebrates to evolve and have been prolific in numbers and species ever since. There is a large number of fish species in our oceans and many occur in huge numbers. They are an extremely diverse group of animals, an essential part of the ecology and a very important food resource for humans. They live in a very delicate, easily polluted environment which needs to be understood. Fish which live near the surface of the sea are called pelagic and many of these are harvested as food. You will have heard of many of these from fishing stories. They include tuna, salmon, mackerel, herring, sardines, sharks, and Moray eels.

Most fish are streamlined in shape and have well adapted fins and tails to allow them to move smoothly through the water. They reproduce sexually by external fertilisation and display many interesting adaptations which are species specific. For example, fish such as the flat bodied plaice are excellent at camouflage. They lie on the sea floor and merge into their surroundings.

There are far too many species to consider. However below is a more detailed description of a few interesting fish or fish groups.

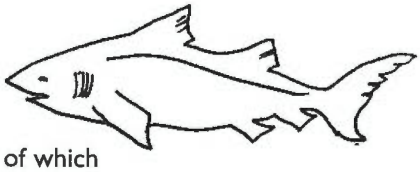
Anglerfish

This name is appropriate for a variety of fish which live in the deep ocean. They have adapted to living in this dark environment under high pressures due to the depth at which they live. They are equipped with a light which is just above their head on a protrusion a little like a fishing rod and hence its name. The light allows them some sight and the ability to attract prey into their mouth. Most have large mouths and very strong teeth. Many deep sea creatures can see and give off light. Light produced by animals is called bioluminescence and is emitted by organs called photophores.

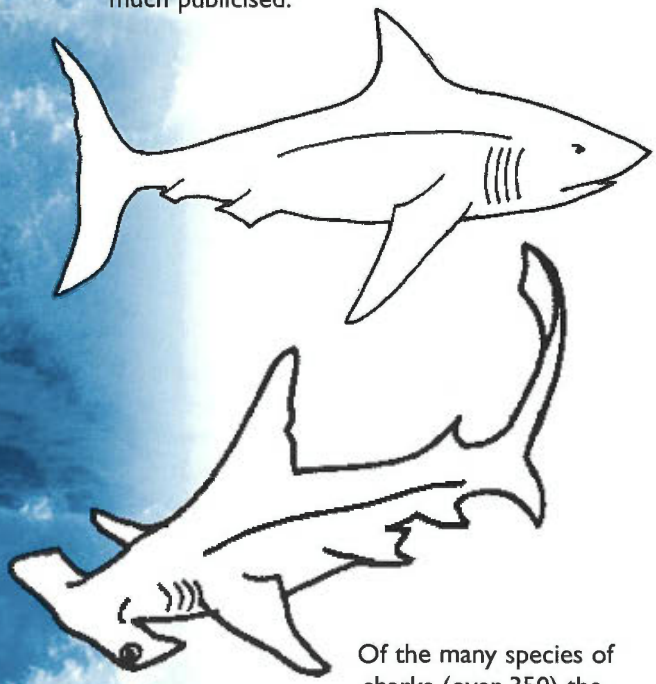


Teachers' notes

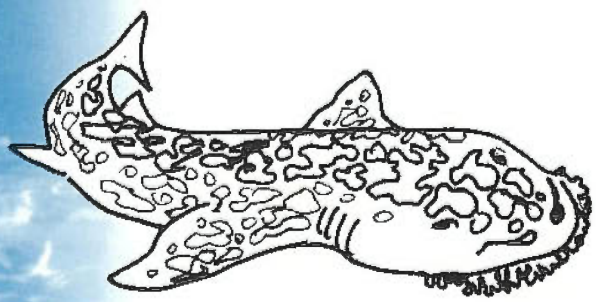
Shark



There are over 300 species of shark, most of which live in the oceans. They are predators feared by some humans, caught and eaten by others. Shark meat sold as flake is eaten in many countries. Shark attacks are in fact reasonably rare but when they do occur are horrific and much publicised.



Of the many species of sharks (over 350) the best known are the beautifully tapered and streamlined species which cruise the shallow waters off the continental land masses. One well known shark is the great white shark or white pointer *Carcharodon carcharias*. They are known as fast swimmers and efficient hunters with overlapping rows of pointed sharp teeth. They have skeletons made of cartilage and rough skin rather than scales.

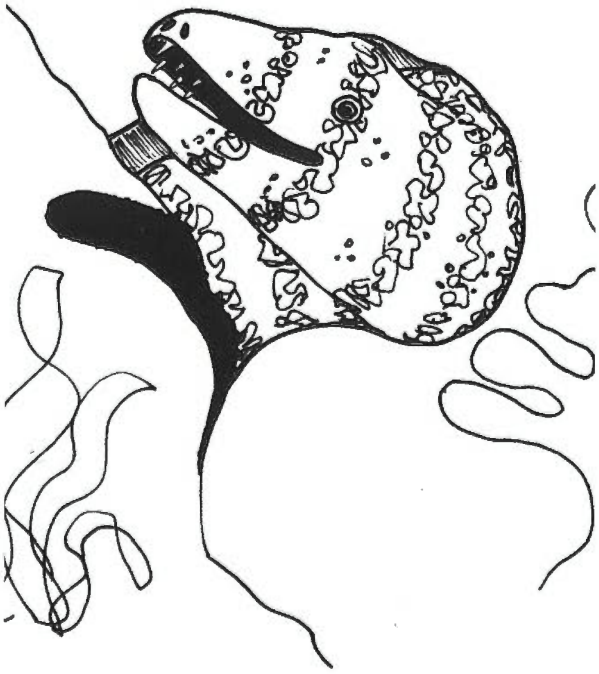


The mouth is on the underside of the head and they have five to seven gill slits on each side of the head.

While they are predators at sea, they are also the target of game fishermen and an important human food source. Shark meat is often sold as flake.

Eel

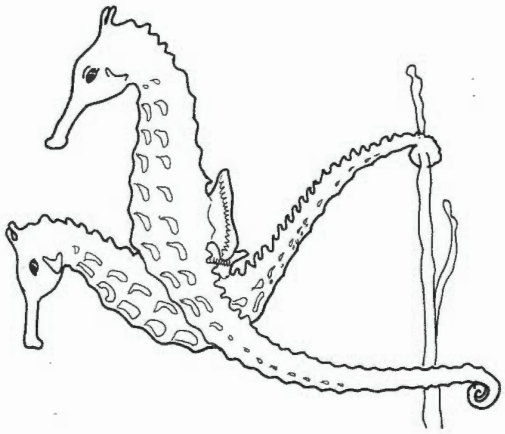
Eels are long, elongated, almost snake like fish with thick skin rather than scales. The freshwater eel, *Anguilla anguilla* is an amazing animal which can live in both fresh water and sea water. It lives most of its life in rivers but goes to sea to spawn. A small eel is called an elver. The common salt water eels are called Moray eels. There are over 150 species which live in warm seas and are particularly common around coral reefs. Moray eels are predators which tend to live in rock cavities or lairs. One poisonous eel is the spotted Moray eel, *Gymnothorax faragineus*.



Teachers' notes

Sea horse

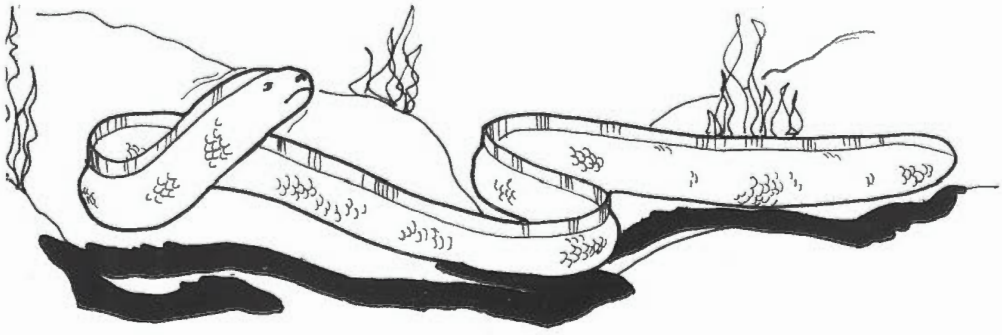
Hippocampus novae-hollandiae is the common sea horse. They are fish that swim upright and have a horse shaped head. They use tiny fins to swim and can curl their prehensile tails around seaweed to give them stability. Many have bony ridges that stand out and appear as rings. One Australian sea horse has strip like outgrowths which allow it to hide easily in seaweed. The male nurtures the young in a pouch.



Yellow bellied sea snake

Pelamis platurus

The poisonous yellow bellied sea snake likes tropical waters, bears its young alive and feeds at the surface. It has a paddle shaped tail which assists it to swim and an enlarged lung which extends to the end of its tail. This allows it to stay under water for longer periods of time. It prefers to live in a temperature range of 20°C to 30°C



Emperor penguin

The emperor penguin, *Aptenodytes forsteri* is one of many animals that live in and near the sea. It is the largest of the penguins, living in the Antarctic and spending much time at sea. The emperor penguin feeds exclusively at sea. Although they are birds, their 'wings' have adapted to swimming rather than flying and resemble flippers. Egg laying occurs on land where the penguins congregate in rookeries. Both parents are involved at first in incubating the egg by carrying it on their feet covered by large flaps of skin. The female leaves the rookery and returns to the sea to feed during the later part of the incubation. She then returns to feed the chick.

Student activities

1. What lives in the ocean?

Information searches

- Find out as much as you can about the adaptations of particular sea creatures to their environment eg. the Moray eel has a tail like a paddle to help it move through the water. To get you started make a list of sea creatures which you find interesting and about which you would like to know more.
- Find out as much as you can about any group of marine creatures in which you are interested eg. whales, sharks, seals, birds that feed from the sea, lobsters, salmon, Moray eels, fish that live in the deep sea, plankton, seaweed etc.
- Find out as much as you can about food chains, symbiotic relationships, or particular environments in the oceans.
- Challenge: Surf the Web. Use any search engine. Type in a key word. You could start with 'Fish' or 'Plankton'.

Practical investigations

Set up a salt water aquarium

This activity should begin with a visit to the local pet shop. Here advice can be obtained, along with the necessary apparatus, booklet with instructions, the salts to make salt water and the organisms for your aquarium. Great care and thorough preliminary research are essential to create this very delicate environment. Under no conditions should water or organisms be taken from natural environments such as our beaches or rock pools.

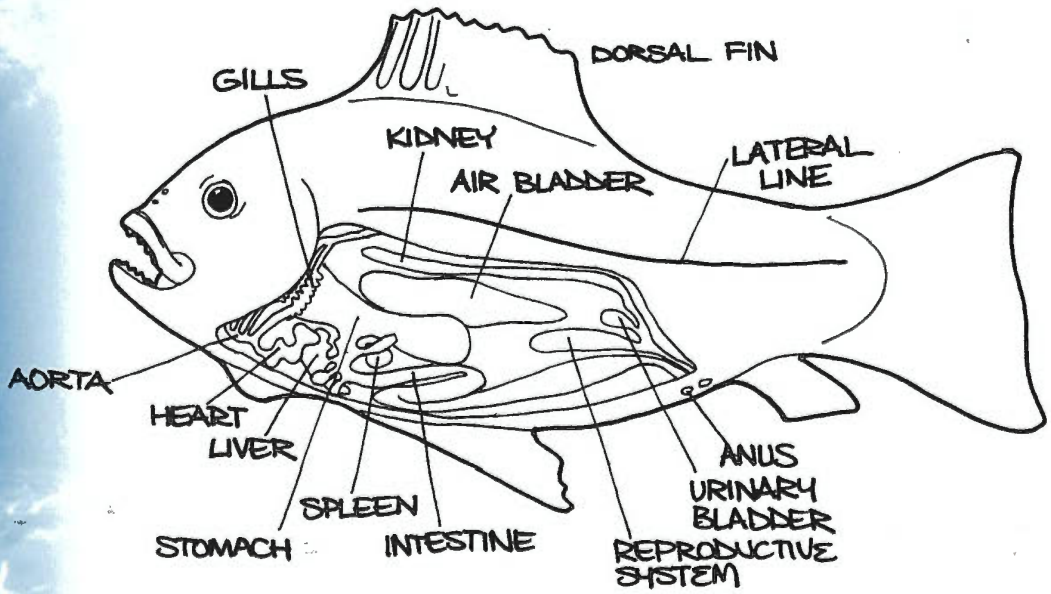
Dissect a fish

Examine a fish externally and internally.

The following may be useful:

An ungutted fish from the fish market or shop, a tray or board on which to carry out the dissection, paper towelling, scalpel, forceps and dissecting scissors, newspaper.

The diagram below may help you investigate.



Student activities

Dissect a prawn

Examine a prawn externally and internally.

The following may be useful:

A fresh uncooked prawn, a tray or board on which to carry out the dissection, paper towelling, scalpel, forceps and dissecting scissors, newspaper.

Design an experiment for a marine biologist which will investigate your question

Creative activities

Create with playdough

Using plasticine or playdough make models of any sea creatures of your choice. Playdough can be made by combining one cup of salt, 4 teaspoons of cream of tartar and 2 cups of plain flour in a bowl. Mix thoroughly and add 2 cups of water, 2 tablespoons of oil, and some food colouring. Cook while constantly stirring, for 3 to 5 minutes in a saucepan. The playdough is cooked when the mixture leaves the side of the saucepan. Knead it when cool. It can be stored in an air tight container or plastic bag in the refrigerator.

Make up a crossword or other word puzzle

Use only clues and answers that relate to water locations.

Design a board game which relates to water locations

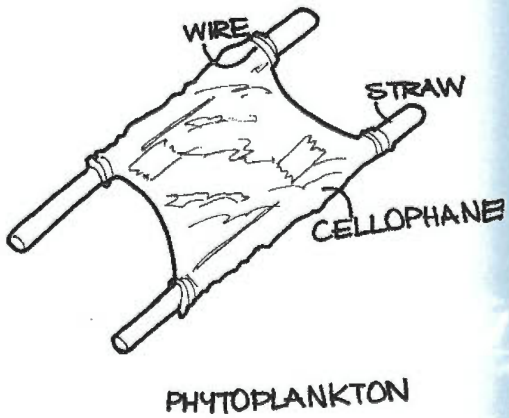
The game could have a theme such as 'survival of fish in the ocean or in a river' with each player being a fish.

Make a 'What am I' pictorial book (class activity)

Each student could make a page about a sea creature of his/her choice and write out five clues. The answer to the 'What am I' could be under a flap and be in the form of a picture.

Make a model

Research the appearance of phytoplankton and zooplankton, depicting them by making models. You could use wires, cellophane, straws or other materials. Your models will be much bigger than real phytoplankton or zooplankton.

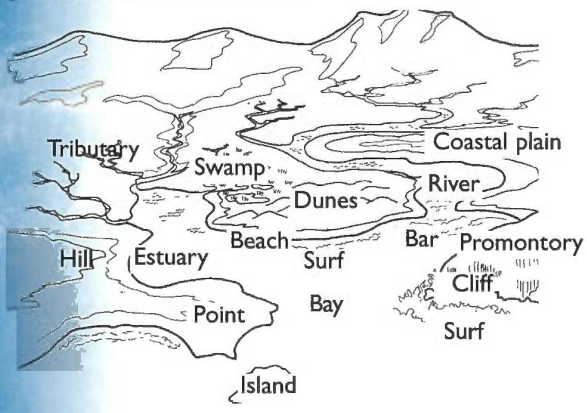


Teachers' notes

2. The ocean edge

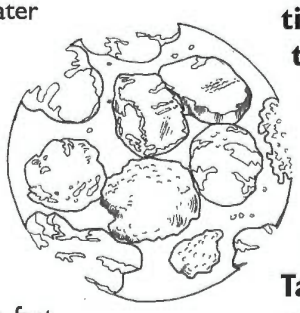
Coastal land forms

The landforms illustrated below are common along Australian coastlines.



No landforms are permanent, they are constantly changing. Wind and water have the greatest impact on the shape of the coastline. Other factors include sea movements, gravity, hardness of the rocks, nature of the rocks and sand movements .

Coastlines also are constantly changing. A dramatic example of the changes which can be brought about by natural forces is the collapse of the popular sea arch called London Bridge, part of the twelve apostle group in the Great Australian Bight in southern Australia. The natural forces in this case included huge swells and high winds coming from the direction of Antarctica, erosion by sand carried by both wind and water and gravity.



Sand

Beach sand particles are derived from weathered rock material and marine organisms. They are well rounded particles due to the fact that any sharp edges are rounded off as particles knock against each other or abrade each other. A sand particle is classified by geologists as a particle between 0.06 millimetres and 2.00 millimetres in diameter or length. The composition of sands can vary considerable. Some on the east coast beaches are rich in black sand, often called mineral sands. They include minerals such as rutile. Many beach sands are mined for minerals.

The intertidal zone

The intertidal zone is an exciting mix of interdependent life forms which make up fascinating communities. It is also a zone which shows interesting separations between community types. Organisms which colonise the low tide mark are very different from those that colonise the high tide mark. Also, organisms which live in the sand are quite different from those that prefer the rocky habitats. Biologists refer to the changes in organisms from the low tide mark to the high tide mark as zonation of the marine organisms.

When planning an excursion to the intertidal zone make sure that you go during low tide. There are two low tides each day, and the times can be ascertained from the daily newspaper. You need to plan your visit to an area which is rich in life forms.

⚠ Remember

Supervise all students carefully at all times, have students face the sea as they work and in case of the unexpected, have a staff member who is a strong swimmer. Make sure you have buoyancy vests and rescue equipment with you.

Leave everything as you found it. Take nothing back with you except what you brought, photographs and pleasant memories. Leave this fragile environment intact for future generations but mostly for the organisms themselves.

Teachers' notes

The zones within the intertidal zone in rocky areas

Black periwinkle zone. This zone above the high tide level is characterised by the numerous periwinkles and the noddywink. The three most common periwinkles are a small blue periwinkle with a smooth shell called *Littorina unifasciata*; a dark coloured almost black periwinkle called *Littorina acutispira* and a larger mollusc with a knobbly shell commonly known as the noddywink and correctly called *Nodilittorina pyramidalis*. Also present in this zone are microscopic plants and a type of blue green algae which give the rocks in this zone a dark, blackish colour.

Barnacle zone. The barnacles which live higher up in the zone are called *Chthamalus antennatus* and are characterised by six valves. All barnacles are fixed solidly to the rock, are made of very hard shell and have a characteristic beak type structure at the top. A smaller barnacle which lives a little lower is commonly known as the honeycomb barnacle. It is more numerous and correctly called *Chamaesipho columna*. A third type of barnacle lives where the waves are constantly crashing onto the rock. It is called the surf barnacle or *Catomerus polymerus*. Also common in this zone are brown seaweeds including *Hormosira banksii*, the five pointed sea star, *Patiriella exigua*, red sea anemone, *Actinia tenebrosa*, green sea anemone, multi coloured sea anemones, *Oulactis mucosa*, the fast crab, *Leptograpsus variegatus*, limpets, including the common limpet, *Cellana tramoserica*, periwinkles and sea snails.

***Galeolaria* zone.** *Galeolaria* species are worms which live in very hard, sharp tubes which curl and intertwine. These tubes form massive colonies on the rock surface. When under water the black worm inside comes to the entrance to feed. When the waves recede the worm closes its tube to prevent dessication and being eaten by predators. Among the worm tubes are often found chitons of various kinds including *Chiton poneropilli*.

Cunjevoi zone. One common cunjevoi is *Pyura praeputialis*. Cunjevoi is a favourite with fishermen who use it as bait. Individual organisms live in colonies along the low tide line and are often seen squirting out a jet of water when they are exposed above the water. Sea urchins, *Heliocidaris erthrogramma* are also found in this zone.

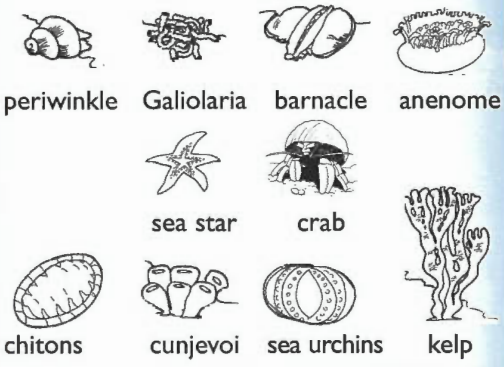
Brown kelp zone. This is a zone of brown seaweeds which provides a habitat for many small creatures including fish. Common seaweeds here include the kelp, *Ecklonia sp* and the much bigger seaweed, *Phyllospora sp*.

Common organisms on the sandy beaches

The three most common organisms that make sandy beaches their home are the sand crab, *Matuta lunaris* which burrows into the sand, the common pipi, *Donax deltoide* which buries itself in the sand, and the giant beachworm used for fishing, *Australonuphis teres*.

Identification aid for common life forms found in the intertidal zone

Rocky habitat common life forms



Sandy beach common life forms

The theme 'ocean edges' could lead to numerous investigations along the edge of a river bank, creek or dam. In more arid areas, even dry creek beds could provide an investigation site. Along these edges students could investigate such things as: profiles, sections, plant and animal communities, landforms and erosion, or daily and seasonal changes.

Student activities

2. The ocean edge

What dangers do the ocean edge hold for me?

Information searches

An investigation

The topics associated with beaches are limitless and include issues of beach management, beach conservation, marine biology, coastal geography, ecology, and mineral sand mining. Choose a topic which interests you. Research, write up and present your information as a newspaper article. Class members could put the articles together to make a class newspaper or journal.

Challenge: Surf the Web

Using any search engine type in any key word. Try 'Beach' to get you started.

Practical investigations (excursions)

Explore a rock pool

Explore a rock pool. Observe carefully and look at the diversity of life. Look for periwinkles, oysters, crags including the hermit crab, sea stars, anemones, sea urchins, tiny fish, and as many varieties of seaweed as you can find. Look at the range of colours present in the rock pool and the way the organisms are arranged around the rock. Make sure that you leave the rock pool exactly as you found it without damaging any of the sea creatures or their habitat. You could list and describe the organisms which you see. Try to find their name in resource books, determine what their food source is and if there is anything in their environment that considers it a food source. Try to find out how the organisms relate to each other.

Observe waves

Sit on a rock and watch the waves for ten minutes. Record all your observations.

You could begin by observing such things as what colour the sea is, how high are the waves when they break, do they break more than once, what is the distance between waves, what can you smell, are the waves all travelling in the same direction, how does the direction change, is there a wind, is it an onshore wind or an offshore wind? You may think of many more things to observe.

Explore the beach

Spend fifteen minutes exploring the beach. During this time make two lists, one of all the natural things that you find on the beach eg. cuttlebone, seaweed, shells, pumice, bluebottles etc, the other, a list of all the unnatural things which you can find rubbishing the beach. If you are fortunate, your beach will have very little rubbish. Make sure you do not touch any rubbish on the beach. Try to find out as much as you can about all the natural things you found on the beach. Discuss with a group the best ways of keeping our beaches unpolluted and clean in the future. Write out what you think is the best strategy.

Examine sand

If the tide is coming in, build a series of different shaped castles in the sand. Use damp sand. Observe how the waves affect each of the castles as the tide comes in. If the tide is going out, observe how the sand is left by the outgoing waves.

Observe some sand grains using a magnifying glass. What shape are they? Are they all the same? Are they all the same size? Is there any broken shell material mixed with the sand grains? Can you identify anything else in the sand? (try sea urchin exoskeletons, spines from a sea urchin, crab claws, pieces of coral or fish skeletons). What colour are the individual sand grains? Is there any variation in the sand colour over the beach? What effect has the sand in wind and moving water had on the surrounding landscape?

Student activities

Explore the intertidal zone

If you visit the beach at low tide you will have an excellent opportunity to examine the intertidal zone. This is particularly interesting in rocky, wave cut, rock platform type areas. Look at all the marine organisms. Investigate which part of the intertidal zone each prefers. Compile a cross section of the intertidal zone showing which organisms occur where. Use a reference to identify each of the organisms. Only do this activity under the strictest supervision and always face the sea. Being caught by an unexpected wave can be dangerous. You could draw a cross section of the intertidal zone and draw in the appropriate organisms in their preferred living position.

Observe coastal landforms

Look at the entire beach. List all the different landforms you can see. Draw a map or a landscape view of the landforms. Try and find out how each landform came to be as it is now.

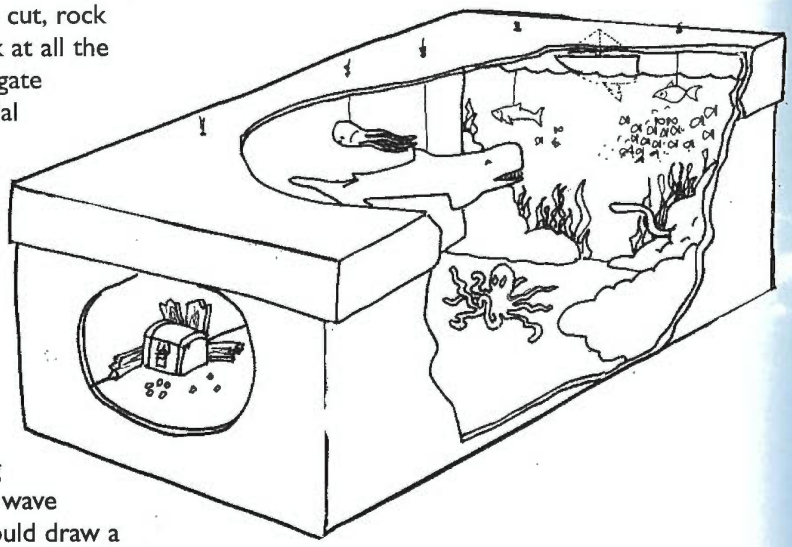
Draw and examine a cross section of the beach

Select a cross section of the beach which is interesting and not too wide. It should be a line at right angles to the water edge. Start as far up the beach as you wish and take data from your beginning point to the edge of the water. Using a long measuring tape, fully extend it along your cross section line. Hold it horizontally. A builders level will allow you to make sure your tape is horizontal. At every metre mark find the height of the tape above the sand.

You may have to shift position with your tape several times. You will need to take into account the distance between the tape positions each time.

Creative activities

Make a model



Models can be made of almost anything. You could make a beach, a rock pool, a rock platform, any organism that lives at the beach, sand dunes, or coastal landforms. Make labels of all the features in your model and place them correctly. You could also make cut outs of appropriate organisms and add them to your model.

Teachers' notes

3. Human impact

Introduction

Humans use and change the sea in a multitude of ways. Unfortunately, some humans abuse the sea. It is necessary for us to manage our impact and become more conscious of the fragility of the ecosystems which the sea contains.

Exploring under the surface

To humans, under the sea surface has often been seen as a hostile environment, so exploring it has been a challenge throughout history. Originally instruments were lowered on ropes to determine information such as sea depth and temperature.

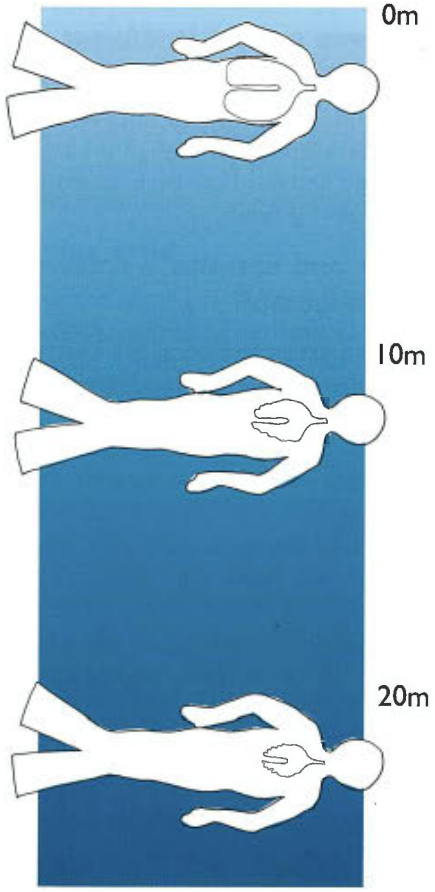
The aquired ability of humans to dive was an immense leap forward. Early methods involved a breathing tube to the surface and a large head covering to which the air tube was connected. With time, advances such as the scuba tank, underwater cameras, more sophisticated diving equipment, sonar, underwater laboratories and observation satellites etc. have helped us discover much more about our oceans.

Diving presents problems other than the need for oxygen. Measures have to be taken to protect humans against the extreme cold and the great pressures. The air pressure at sea level is 1 atmosphere. As a diver descends he or she will experience an increase of 1 atmosphere pressure with every 10 metres descended.

Special suits have to be worn by deep divers to prevent their bodies from being crushed. Great care and a slow ascent from depth is also necessary to prevent gases which dissolve in the blood with increased pressure from causing bubbles in the blood stream and causing great pain or death. This condition is called the bends.

The first successful underwater exploration craft or submersible, was launched in 1930. One scientist only could sit in the craft and be lowered from a boat to a depth of 900 meters. An American scientist, William Beebe was the first human to descend to this depth and photograph what was then a new frontier. His craft was called a bathysphere. This was followed by a bathyscaphe in 1960 which carried two men and was not attached to a craft at the surface. This craft was called the Trieste.

The famous French diver and explorer Jaques Cousteau, was responsible for the first manouverable submersible called the Soucoupe. It was built in 1959 and could descend to 300 meters. Since that time Jaques Cousteau and others have explored the sea and its creatures in a manner unthought of before.



Teachers' notes

Exploiting the ocean

Humans have overexploited the oceans in their search for food and economic gain. Many fish species face extinction, whale numbers have been reduced by the whaling industry and dolphin numbers have been reduced in places due to the fact that they have been caught in nets. These are just a few examples which point to the need for proper ocean management and laws concerning responsible fishing.

Whaling has now mostly been discontinued throughout the world.

The ocean is an important economic resource and source of food including fish, sqid, crabs, crayfish, prawns, molluscs such as scallops etc. and can continue to be with wise management. However, it does need wise management such as the prohibition of overfishing a species and leaving breeding areas alone.

Another way we are exploiting the ocean is by harvesting natural gas and oil from below the sea. This is often done with oil rig platforms which are equipped for drilling the sea floor and extracting the fossil fuel. Our increasing need for fuels and crude oil derived products means that offshore exploration is increasing. Balancing meeting our needs with preserving our ocean environment is very difficult.

Leisure

Yachting, spearfishing, diving, surfing, fishing are just a few human leisure pastimes that impact on our oceans.

Pollution

Oil spills are dramatic and attract world wide concern. Dumping of industrial waste, ocean transport vessels, shipping accidents, storm water and raw sewage in the sea do much damage over time but are not as noticeable. The Norfolk Island Pines at Sydney's Manly Beach are dying. The reason is the high detergent levels in the sea spray which coat the leaves of the tree and prevent them from functioning effectively.

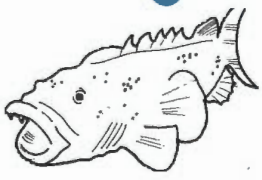
Fertilising nutrients are washed into our rivers and reach the sea, changing the nutrient balance in the ocean and therefore changing the ecology and the environment.

Rubbish left at the beach which is washed out to sea is also a problem. Marine organisms have mistaken plastic bags for jellyfish and died as a result of eating them.

The theme 'environmental impact' could lead to numerous investigations in any environment. Students could investigate such things as: the impact of humans, feral animals, agriculture, natural disasters, greenhouse gases, air pollution and/or water pollution.

Write a question about marine animals that you would like to know the answer to.

How would you find the answer to your question?



Student activities

3. Human impact

Information searches

Energy from the sea

Research ways that energy from the tides, waves or currents could be harnessed to provide energy for society. The advantage is that it is a clean source of renewable energy. What are the problems?

Find out how oil and gas are extracted from under the sea

Carry out an information search using any resource to which you have access . Remember people are an excellent resource and are often only a telephone call, fax or Email away.

Why is Jaques Cousteau well known?

What contributions did he made to ocean exploration?

How did humans develop the techniques of modern diving?

Write an article on the history of human diving. (It could be published in your school newspaper.)

Write a letter to a politician

After researching beach and ocean management, write a letter to, or lobby, a local politicion, giving a reasoned argument for more responsible ocean management. Outline a possible responsible management plan.

Debate responsible ocean management

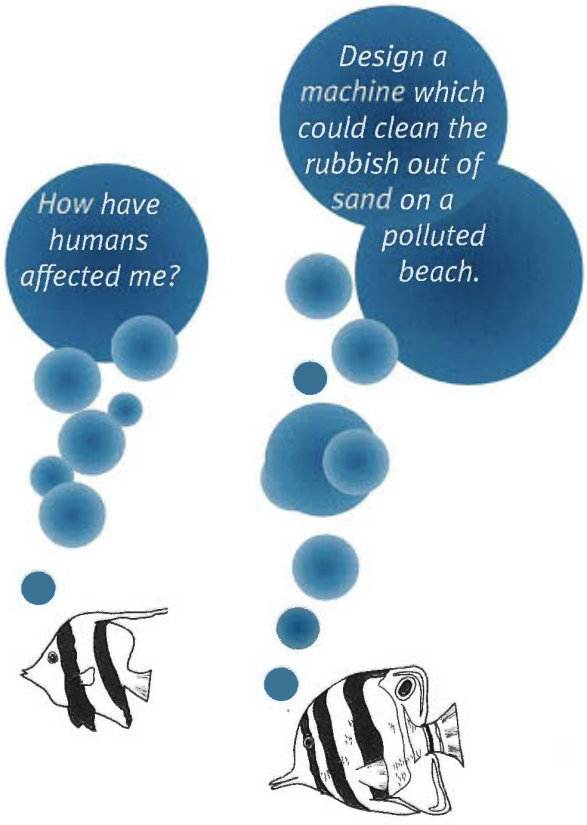
After researching beach and ocean management, decide on two teams - one representing conservationists and the other representing people who depend on fishing for their income. Carry out a normal debate on a topic of your choice. Suitable topics could be 'Our beaches are well managed', 'Local communities should make rules concerning beaches', or 'People use beaches wisely.'

Design experiments which will investigate the effects of various pollutants, on sea weed if you can obtain it, or fresh water plants if you cannot.

Design an experiment which will demonstrate the effects of high nutrient levels on plants.

Find out what fish live in water bodies close to your school. Are they native or introduced fish?

Select any local stream, river or dam and find out by any available means the human impact on this feature over recent years.



Student activities

Practical investigations

An oily challenge

Half fill a clear plastic food container with water. On top of the water pour a small quantity of black oil. Your challenge is to remove the oil without affecting the water quality or damaging the environment (plastic food container).

Investigate the properties of water containing detergent.

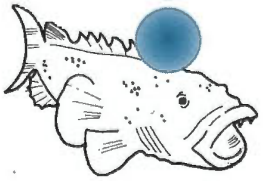
Add sufficient detergent to a container of water to produce 1cm of froth when shaken. using an identical quantity of fresh water as a control, design and carry out investigations to determine the effect which detergent in water has in a variety of circumstances.

What effect do common pollutants have on fresh water?

Make a list of common water pollutants. Then take a series of identical containers, almost filled with fresh water. Add one of the polutants on your list to each. Leave them to stand for one week and observe the water quality after that time. Have an identical container of fresh water as a control.

Investigate the effect of oil, water plus detergent and clean water have on a bird feather.

Make sure you use discarded feathers only, and not feathers still attached to birds.



Solve the problem

To a glass jar, add nineteen parts water to one part detergent. Add a lid to the jar and shake it. Notice the froth formed by the detergent. Your problem is to find out how many times the solution has to be diluted before you cannot detect the presence of froth. Clean water will have no froth. Check to make sure this statement is true.

Creative activities

Design and make a model submarine

Begin with a large plastic drink bottle floating on water and a question. How can you make a model submarine which will descend to depth when you want it to and rise to the surface when you want it to?

If and only if you need a hint, you may find attaching a rubber tube to the opening of the bottle and constantly moving it above the water level helps. Try putting water inside the bottle.

Clean up a beach

Organise an event to clean up a beach or local area, removing all rubbish, and if possible, any other results of negative human impact. Write an article for a newspaper on the human impact on this area.

Teachers' notes

4. Sea water versus fresh water

Introduction

Water is the universal solvent. It dissolves more substances than any other liquid. Because of this property, as it travelled over land on its way to the sea throughout geological time, it dissolved all kinds of soluble material and took them offshore.

Once in the oceans the dissolved materials have been thoroughly mixed by the action of waves, tides and currents. The result is the salty water that we know as sea water.

The chemistry of sea water

The composition of sea water is complex. The concentration of substances dissolved in it is usually expressed in parts per million (ppm). These substances are mostly present in sea water in the forms of ions.

Ions are tiny charged particles formed from atoms when one or more electrons are gained or lost. Salts are made up of ions and when mixed with water are able to move around freely in the water.

The main ions in sea water are sodium, magnesium and chlorine. These are by no means the only ions present. Even gold is present in sea water in the average concentration of 0.006 parts per million.

The following table gives the average concentration in parts per million for the ions which are most prolific in sea water.

Many other ions exist in lesser quantities.

Chlorine	18980	Silicon	4.0
Sodium	10561	Fluorine	1.4
Magnesium	1272	Nitrogen	0.7
Sulphur	884	Aluminium	0.5
Calcium	400	Rubidium	0.2
Potassium	380	Lithium	0.1
Bromine	65	Phosphorus	0.1
Carbon	28	Barium	0.05
Strontium	13	Iodine	0.05
Boron	4.6		

Properties of sea water

The combined sum of all the salts dissolved in seawater is referred to as its salinity. Salinity can vary. For example it is very high in the Dead Sea and in the water under the Poles. It is high in the Dead Sea because it is an enclosed sea and the dissolved salts only have this enclosed sea in which to mix .

The water under the Poles has high salinity because as sea water turns to ice it forms pure ice, leaving all the salts behind in a lesser volume of water. This is a major cause of ocean currents. The dense, salty water under the ice cap falls and reemerges at the surface the other side of the Equator many hundreds of thousands of years later.

As the salinity of water increases, so does its density. It is much easier for a person to float in sea water than it is in fresh water.

Water constantly evaporates to form clouds which can travel inland and produce rain. Some of this then finds its way back to the sea. This is known as the water cycle.

When water evaporates from the sea it evaporates as pure water leaving the dissolved salts in the sea. The salts do not return to the land.

Often fresh water which has travelled out to sea from a river will stay unmixed with the sea water for some distance. This means that a ship sailing past a river entrance can sometimes obtain fresh water from the top of the sea, several kilometres from shore. The water at Milford Sound in New Zealand is fresh water at the surface and salt water deeper down.

The activities in this section can be done by students from anywhere in Australia. Sea salt mix can be bought from pet shops which sell fish.

CSIRO Education Programs

CSIRO Education Programs operates a range of exciting science education projects which aim to encourage students to participate in scientific activities, especially those related to the applications of science.

CSIRO's Double Helix Science Club

The Club offers HEAPS including:

- *The Helix* - a 40 page, full-colour, bi-monthly magazine containing competitions, experiments to try, members' contributions and features on today's science.
- Double Helix School Science Prize - Every year Double Helix offers all schools in Australia a year's free membership to the Club. This prize can be used however the school desires.
- National experiments - Double Helix runs national research experiments where members get the chance to work with scientists on real research.
- Teacher's resources - Double Helix produces a **catalogue** full of exciting, educational science resources.

CREST (*CRE*ativity in *S*cience and *T*echnology)

CREST students undertake their own science and technology investigative projects that involve three elements - creativity, perseverance and application. The projects are offered at both primary and secondary level. At higher levels, links are made with industry or community workers and students gain a new understanding of the role of science and engineering in the community. A program of Professional Development for teachers and extensive written material for both teachers and students is included. Over 3,000 CREST Awards were completed in 1997.

BHP Science Awards

CSIRO organises these Awards jointly with BHP. The Awards recognise and reward both students undertaking scientific research and innovative, committed science teachers at primary and secondary levels. There are over 400 cash prizes and trips for students. There are also four teacher awards each of $10,000, ten prizes of $1,000 and ten of $250.

GLOBE Australia

The GLOBE (Global Learning and Observations to Benefit the Environment) Program is a unique opportunity for your students to explore the environment around them and share their knowledge with other students in Australia and across the world. GLOBE creates an international network of students in primary and secondary schools, studying environmental issues, making environmental measurements, and sharing useful data with the international environmental science community. Additional information can be found by visiting the GLOBE Australia Home Page at the URL address: http://www.environment.gov.au/net/ausglobe.html GLOBE is a DEST/DEETYA/CSIRO Project.

CSIRO Science Education Centres (CSIROSECs)

CSIROSECs are hands-on science laboratories that excite and inform students through experiments and demonstrations. CSIROSECs show "science at work"— scientific research playing a vital role in the community. The nine CSIROSECs operate in each capital city plus Townsville. CSIROSECs may also be able to visit your region/school.

For information on any of these projects, phone (02) 6276 6643, fax (02) 62766 641,emaileducation-programs@helix.csiro.au or see our home page on the WWW at http://www.csiro.au/communication/csiroedp/csiroedp.htm or write to:

CSIRO Education Programs, PO Box 225, DICKSON ACT 2602

Please send me more information about (please tick):

❑ CSIRO's Double Helix Science Club
❑ Educational science catalogue ❑ School Science Prize ❑ GLOBE ❑ BHP Science Awards
❑ CSIRO Education Centre in my state ❑ CREST ❑ I haven't read *The Helix* and would like a free copy

Name School name Address

Postcode Telephone ( )

Student activities

4. Sea water versus fresh water

Information searches

What is in sea water?

Use any source of information available to you to find out.

Is the sea blue, and if it is, why is it?

Use any source of information available to you to find out.

Practical investigations

Design your own investigations to compare sea water with fresh water

Carry out the investigations and report your findings. Remember substitute sea water can be made by adding a salt mixture available at your local pet shop to water.

Further compare sea water and fresh water

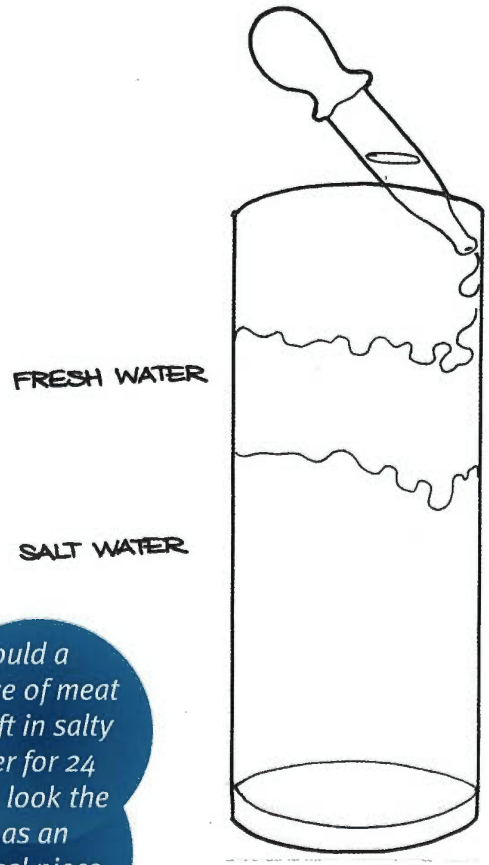
Differences which can be looked at are taste, buoyancy, salt content (evaporate both to extract and measure salt content), effect on growing plants, effect on tin, iron and copper, boiling points, freezing times and freezing points.

Investigate metal corrosion by sea water

Design a test to examine the effect of salt water on a range of metals over time. How will you incorporate a scientific control in your experiment. List your findings from the metals which are easiest to corrode to those which are the hardest to corrode.

Find out if fresh water can sit on salt water

Dissolve as much salt as you can in a jar of water. Decant off the saturated salt solution leaving any undissolved salt behind. Colour this solution with blue food colouring. Pour some into a tall thin glass container, until it is almost half full. Fill another container with fresh tap water and add red food colouring to it. Very carefully, dribble the fresh water down the side of the tall container so that it sits on top of the salt water. If you have access to a pipette, the fresh water could be carefully added with it. Leave the container to stand and note what happens over a period of days. Try to explain your results.



Would a piece of meat left in salty water for 24 hours look the same as an identical piece left for the same time in fresh water?

Try dribbling salt water on top of fresh water. What happens? What do you think happens in the ocean if a less salty solution finds itself under a more salty solution? Could this affect water movement in the oceans?

Student activities

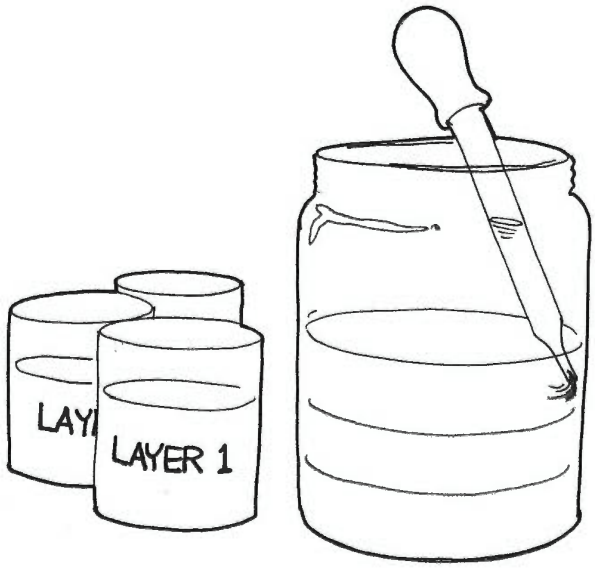
Find out how much salt is in sea water

Design a test to find out how much salt is in 50ml of sea water. Here is an idea. Determine the mass of an evaporating basin or container. Also determine the mass of 50ml of sea water. (Remember to subtract the mass of the container.) Add the salt water to the evaporating basin and leave it in a warm position until the water has all evaporated. Determine the mass of the evaporating basin plus the salt. Then calculate the mass of salt in your 50ml sample of sea water.

Challenge: Find out how the density of sea water varies

Make up a saturated solution of table salt. Take 60ml of this and add it to 140ml of tap water. Fill a jar with this solution and place it upright in the freezer. Pull it out carefully and let it thaw. Then replace it in the freezer and refreeze. Again allow it to thaw. Repeat the process several times.

When it has thawed, use a pipette to suck off 1cm of the solution at a time, keeping each portion separate. Colour each portion with a different colour dye. Determine the mass of 10ml of each layer and compare the densities. Then carefully add each portion to the jar again in the reverse order to removing them. What did you observe?



Design an experiment to investigate the concentration of salts in sea water from the surface to the sea floor.

Would you expect the salt concentration to vary? If it does, can you think of possible reasons for this concentration? At the mouth of rivers where fresh water enters the ocean would you expect a variation in salt concentration?

Investigate the effect that salt water has on land plants

Design a test to find out how salt water affects land plants. Here is an idea. Take two stalks of celery. Place one in fresh water and one in sea water. Leave them overnight and observe what has happened the next day. Find out what osmosis is and then try to explain your result.

Teachers' notes

5. What is at the bottom of the oceans?

Introduction

The sea floor has a landscape consisting of geographic features which include: continental shelves, oceanic ridges, deep sea trenches, underwater volcanoes, abyssal floors, abyssal hills and abyssal plains.

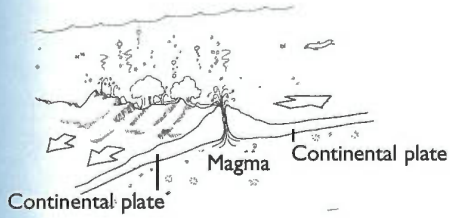
The deep sea floor is under great pressure from the water above it and dark, as it is too deep for light to penetrate. It is only in the last century that scientists have begun to develop a clear picture of what the sea floor is like.

Continental shelves

The continental shelf is an accumulation of sediment, eroded from the continent. It has been deposited offshore as the velocity of the river water carrying it slows down and becomes part of the ocean. This sedimentary shelf can extend for many kilometres out from the coastline and then drop away into the deep sea floor. It is an area of shallow ocean which supports prolific marine life. There are huge numbers of fish in these shallow ocean areas which make them an important economic resource for the country they adjoin.

Oceanic ridges

These elongated, raised ridges run along the sea floor often in the middle of oceans and along the edge of the plates. Plates are huge sections of the Earth which move in relation to each other causing earthquakes, faulting and continental drift. The oceanic ridges are areas where huge convection



currents cause magma to rise from the mantle to become part of the crust. The magma reaches the sea floor, forms lava, cools and solidifies. The rock formed spreads sideways away from the trench as new magma rises. This process is called sea floor spreading and forms new crust under the sea.

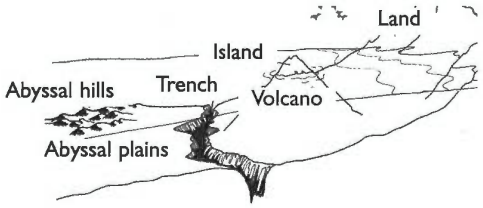
These ridges are very geologically unstable areas crossed by multiple fractures.

As new crust is forming, old crust is disappearing back into the Earth's interior. This occurs at the edge of continents in an area called a subduction zone. The process is called subduction and often causes instability and volcanic activity.

Deep sea trenches

These are long deep groves in the sea floor. It is in these trenches that the sea reaches its greatest depth. The famous Mariana Trench in the Pacific Ocean is the deepest and has a maximum depth of 11,000m below sea level.

Underwater volcanoes and seamounts



Volcanoes occur on the sea floor as well as on land masses. Underwater volcanoes are called submarine volcanoes and usually produce a cone shaped hill called a seamount. Some submarine volcanoes produce seamounts which rise above sea level and become islands. The Hawaiian islands have been formed in this manner.

Abyssal floors, abyssal hills and abyssal plains.

Extending from the continental shelf to the oceanic ridges, is the abyssal floor which consists of large flat areas known as the abyssal plains and countless small hills known as the abyssal hills.

The theme 'landscapes on the ocean floor' could lead to numerous investigations in any locality. Students could investigate landscapes in their area.

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- provide opportunities to develop communication skills in the widest sense, including languages other than their own.
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ASTA98

Student activities

5. What is at the bottom of the oceans?

Information search

Research the sea floor

Find out what is below the ocean.

Research oceanic trenches

Find out what they are, where they are, how deep they are, what their names are and any other questions you can think of.

Research underwater volcanoes

While researching you might like to find how the Hawaiian Islands were formed.

Practical investigation

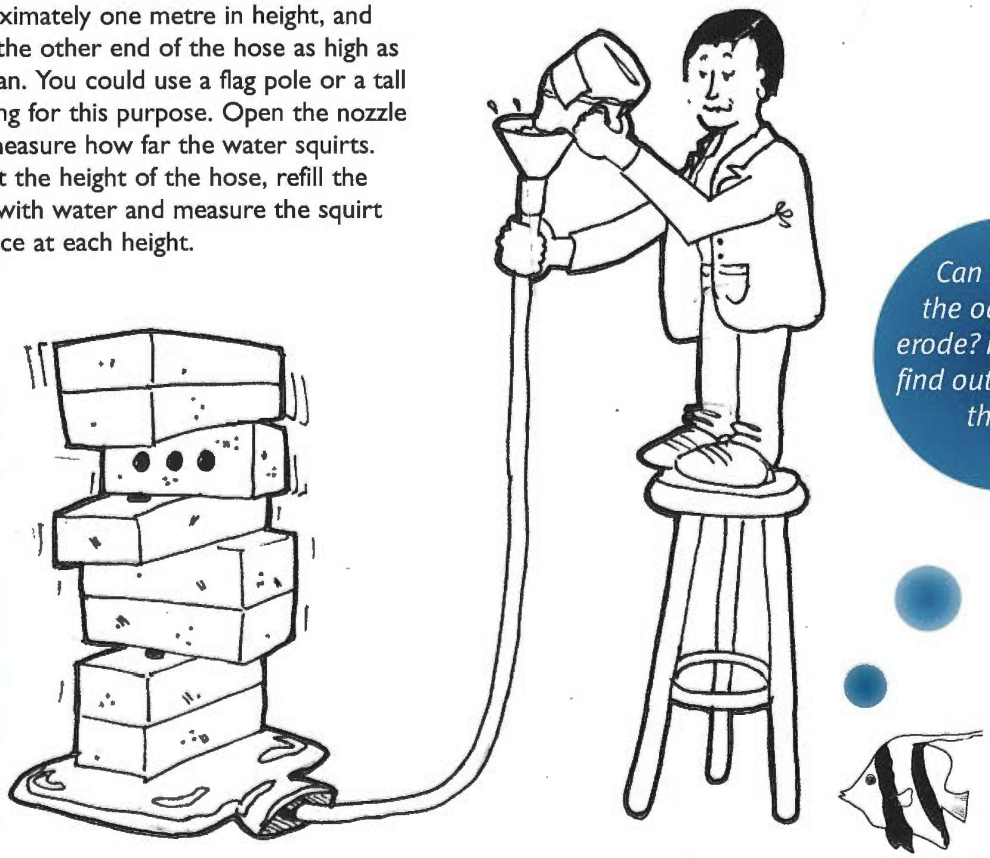
Investigate water pressure

Obtain a length of hose with a spray attachment at one end. Fill the hose with water, keep the spray attachment at approximately one metre in height, and raise the other end of the hose as high as you can. You could use a flag pole or a tall building for this purpose. Open the nozzle and measure how far the water squirts. Adjust the height of the hose, refill the hose with water and measure the squirt distance at each height.

Does squirt distance and therefore pressure increase with the height of the water producing the squirt? Do you think fish at depth are subjected to greater pressures than fish living near the surface?

Investigate water pressure again

Attach a hot water bottle to a long piece (approximately 2 metres) of flexible tubing. Make sure that the tubing is attached to the hot water bottle so that leakage cannot occur. Lie the hot water bottle on the floor and place eight bricks on it. Take the connected tube and stand on a stool with it. Pour water down the tube. (You may need a funnel). Observe what happens to the bricks. Why do you think this occurred?



Can hills on the ocean floor erode? How can you find out more about this?

Student activities

Design your own experiments to investigate water pressure

Predict your results and carry out your investigations.

Investigate light penetration

Fill a tall glass container with murky water. This can be made by adding chalk dust to the water and stirring it to make a uniform suspension. Darken the room as much as possible and shine a torch from the water surface down to the container bottom. How does the light intensity vary?

Balloon size at depth

Inflate two small balloons to the same size. Use one balloon as a control. Design and carry out an experiment which will show how the balloon size varies with depth under water. Why does this happen? How do fish living deep in the ocean cope with the conditions?

Creative activity

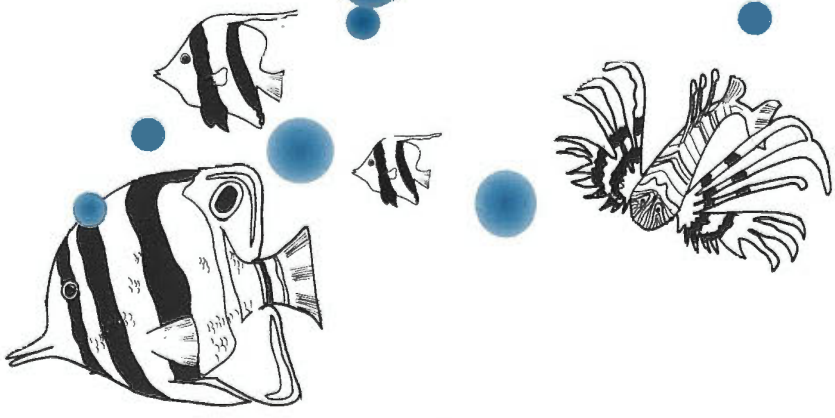
Make a model of the sea floor

Collect a sheet of white cardboard, playdough, waterproof pen, blue and yellow colouring pencils or equivalent. (The recipe for playdough is on page 11).

Research ocean floor profiles and make models of the sea floor. You could include trenches, seamounts, abyssal hills and plains, continental shelves etc.

Why are water reservoirs, or large tanks used to supply town water in country towns, put on top of hills?

In what ways could fish living at depth be adapted to live in their environment?



Teachers' notes

6. How and why does the sea move?

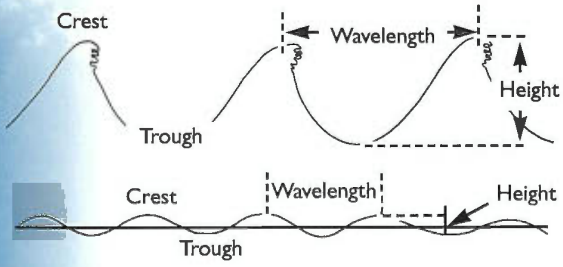
Introduction

More than 50% of the Earth's surface is covered by water. More water is trapped as ice at the Poles. There is thought to be over 1,000,000,000 cu km of water in the ocean. The oceans are an extremely significant and important part of our planet.

The seas are a constantly moving mass of water which is home to an amazing assortment of organisms. It is sometimes called the restless sea. Why and how the sea moves, and the constant display of forces and energy, has fascinated scientists as well as casual observers for centuries.

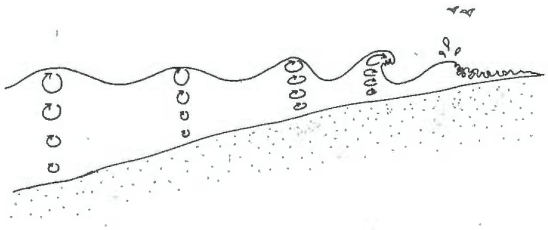
Waves

When a wave moves over the ocean, water does not travel with the wave. Energy travels with the wave. Water particles move up and down in a circular motion without moving in the direction of the wave. This means that a piece of seaweed, a boat or a floating seagull will simply bob up and down on the water as the wave passes. Like the water particles they will not travel with the wave.



Waves and ripples (small waves) consist of a series of crests and troughs. The distance between any two consecutive crests or troughs is called the wavelength of the wave.

Waves breaking or falling over on themselves are a common sight along Australias coast lines. This happens when the depth of the water becomes less than half the wavelength of the wave and the lower circling water particles begin to drag on the sea floor. The energy being transferred at the surface is travelling faster than the energy being transferred along the sea floor. This causes the wave crests to become closer and closer together and lean over more and more until the crests topple over or the waves break

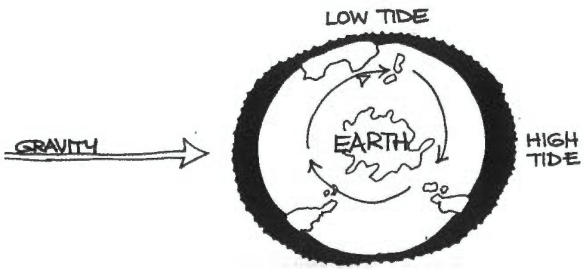


Tides

The constant rise and fall of the tides creates a special intertidal zone which is home to many life forms which have adapted to the ever changing conditions there. Life in a tidal rock pool is something which fascinates most humans.

The tides which create this specialised environment are caused by the complex interaction between the Earth and the Moon. The Earth and the Moon are attracted by gravitational forces. The gravitational force exerted by the Moon on the Earth pulls the water closest to it out into a bulge pointing towards the Moon. At the same time the Earth and the Moon are rotating in space as if they are a single entity. They are rotating about their combined centre of gravity which is on a line between the Earth's centre to the Moon's centre. The centre of gravity is inside the Earth, but removed a considerable distance along the line between the Earth and Moon centres.

Teachers' notes



As both are revolving around that point, the fluid water will form another bulge in the ocean which is on the opposite side of the Earth to the Moon. The force which causes this is called centrifugal force. The bulges cause high tides. In between the bulges, the lesser volumes of water cause low tides. As the Earth spins below the bulges every twenty four hours, each bulge will move around the world once. As there are two bulges most of the Earth's surface will experience two high tides and two low tides each day.

Currents

Currents are large consistent movements of water throughout the oceans.

In the Northern Hemisphere, currents tend to flow in a clockwise direction. In the southern hemisphere they tend to move in an anticlockwise direction. The directions of the major Earth currents are shown on the diagram below.

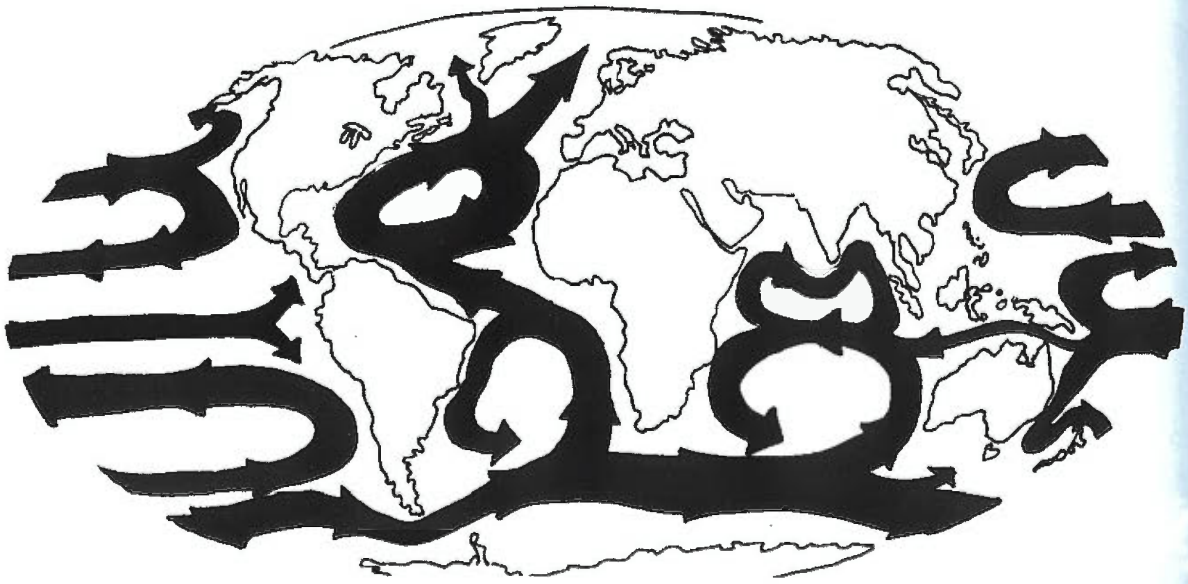
The existence and nature of currents is due to:

(a) winds such as the trade winds at the equator or the westerly winds at the Poles,

(b) the effect the Earth's spin has on movement within the water mass (known as the Coriolis effect), *and*

(c) the deflecting effect of land masses.

The theme 'how and why does the sea move' could lead to numerous investigations along the edge of the ocean, along a river bank, near a creek, or in a child's swimming pool. Students could investigate such things as how do waves carry energy, what happens when waves hit barriers, what happens when a stream of hot water is poured into cold water and vice versa, what happens to objects floating on the surface of the water as a wave passes, or how to make waves break?



Student activities

6. How and why does the sea move?

Information searches

Winds and currents

Find out the names of the major winds and paths of the major currents in the world. How are these two things related?

Challenge: What is the Coriolis effect?

Find out as much as you can about the Coriolis effect.

Practical investigations

Investigate wave behaviour

This activity should only be done under direct supervision of a teacher.

Using a long shallow water tight tray, place a thin layer of sand along the bottom, building it up at one end to the height of the tray. Add water until it reaches three quarters of the way up the side of the tray. Use a flat board to generate waves at the end of the tray furthest from the beach. Make as many observations about the waves and the effect of the waves on the sand as you can. Design and carry out some more experiments with your wave tank.

You could improve your wave machine by designing and building a wave generator. You could use a small motor with an off centre cam attached.

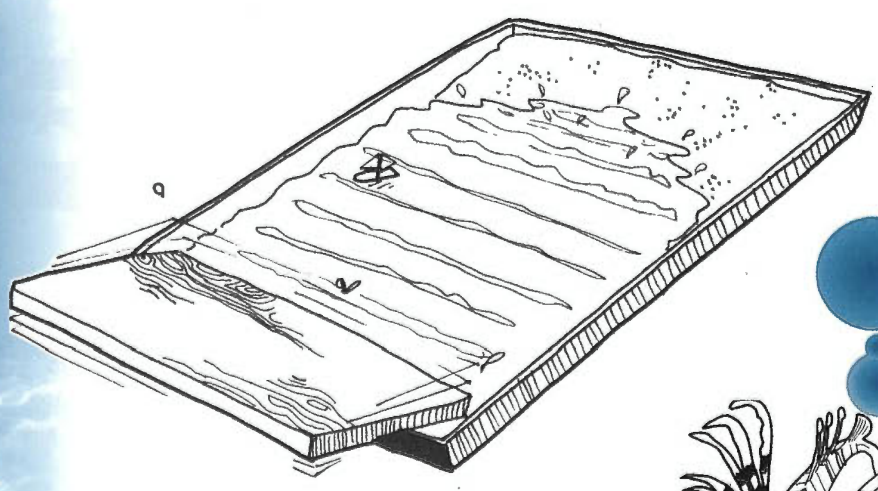
Change the shape of the sea floor and see how it affects the waves. Put a 'coral reef' into the sea and note how it affects the waves.

Slowly submerge a heavy object into the water and then remove it, to simulate tidal activity. Locate the intertidal zone.

Make a toy boat and place it on the water. How does it move when you make a series of waves?

Model high tides

Place a bar magnet end on below a sheet of white paper. Add iron filings to the area where the pole of the magnet is just above the paper. The loosely held iron filings represent the water surrounding the Earth. Use a weaker magnet to gently circle the iron filings at a distance. The effect of the weaker magnet on the iron filings is like the effect of the moon on the Earth's water. As a safety precautiuon place the iron filings between two overhead transparency sheets. Avoid students handling the iron filings.



Does El Nino cause variations in sea temperatures?

Student activities

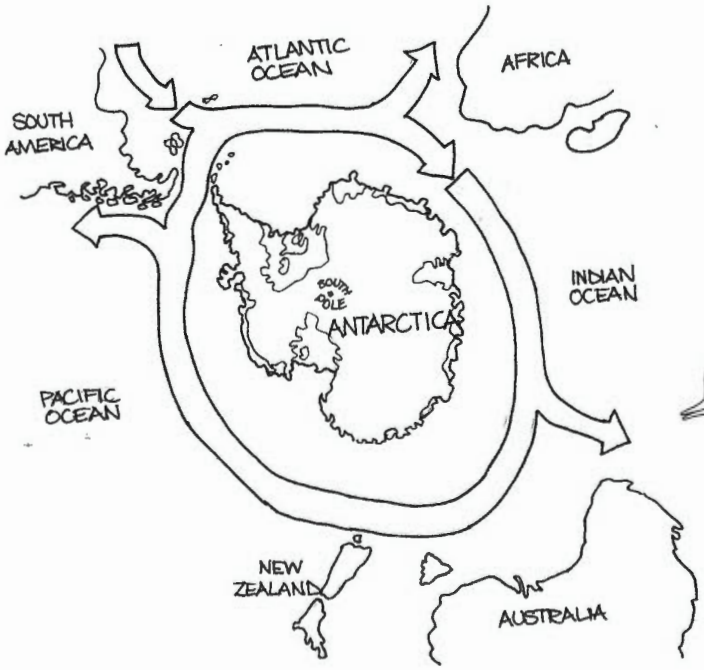
Collect Moon and tide information

Make a chart for a month recording the Moon's phases, (Moon rise, Moon set, high tide and low tide for the coastal area closest to you), and the height of the tide. Use newspapers to get the information and record your observations at night. When the chart is completed, look for patterns in your data.

Investigate currents around the Antarctic

Make a hemispherical model of the continents around the Antarctic. (You could cut it out of a plaster of Paris mould made using a filled balloon). Cover the hemisphere with a clear bowl. Fill it with water to which you have added tiny flecks of aluminium foil. Seal off the bowl with plastic food wrap. Rotate your model and observe the water movement around the antarctic. Compare your induced currents with the real currents which occur.

(See below).

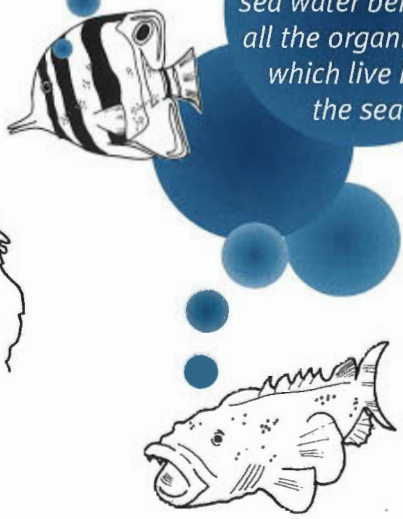


Design a method of converting tidal energy to electrical energy

Tidal energy could possibly be used to supply energy for community use. Think about how this could be done. You could try to build a model of your idea.

Can a photo taken from a satellite tell us anything about ocean currents?

How does movement of sea water benefit all the organisms which live in the sea?



Teachers' notes

7. The Great Barrier Reef

Introduction

The Great Barrier Reef, like all other parts of our oceans, uses the Sun's energy to maintain a complex web of life. Plants utilise the Sun's energy by photosynthesis to make their own food and in doing so provide food for countless other organisms on the reef. Some of these organisms are, in turn, food for other mostly larger organisms. The ecology of the reef, the interdependence of life forms, how a coral reef forms and the effects of pollution on the reef are all interesting areas to research.

The colours, prolific life, warm clear water and the coral are all impressive features of the reef.

The 'Great Barrier Reef' is a case study of a particular marine environment of interest to most Australians. However, case studies could be done on particular environments in any locality. Possible areas for study could be a wetland, rainforest, forest area or desert area.

Organisms of the reef

The great variety and colour of organisms on the reef can only be briefly referred to here by listing some of the more common organism groups.

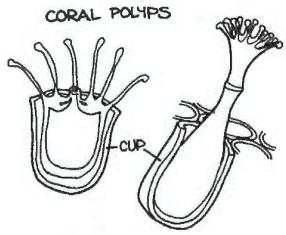
Plants are the beginning of all food chains on the reef. They include sea grass and algae.

Many microscopic species of algae live in symbiotic relationships with other organisms of the reef.

Corals, which are an essential part of the reef, only grow in warm, clear waters with a low level of nutrients and stable salinity.

An increase in nutrients, an increase in suspended sediment, a reduction of light, or variation in salinity can damage corals and therefore the reef. For this reason human activities in a reef area must be carefully monitored. A reef is a very fragile environment.

Coral, although plant like, is actually a colony of tiny animals. Each coral is a tiny soft bodied animal which lives in a calcium carbonate cup.



The animal emerges to feed and withdraws into the cup for protection. The coral has tentacles and stinging cells which it uses to secure its food, and one opening between the tentacles which serves as both food intake and a waste exit point. A coral is actually made of many corals all of which live on its surface. Below the outer layer of living corals is a mass of coral cups which once belonged to living corals.

Each coral also lives in a symbiotic relationship with an algae called *Zooxanthellae* which lives inside its body.

Teachers' notes

This is only made possible by the light penetration through the clear water. It is also the reason why coral is not able to survive at a depth of more than 4.5 metres. The coral depends on the *Zooxanthellae* to supply it with energy to supplement the energy it obtains from food.

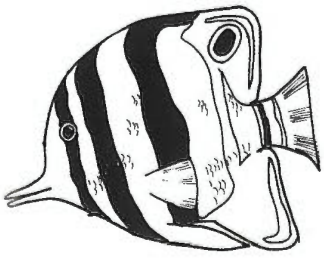
Corals can reproduce asexually or sexually. In the case of sexual reproduction the coral eggs and sperm are released *en masse* into the water during spawning. This gives rise to new corals which then begin a new colony.

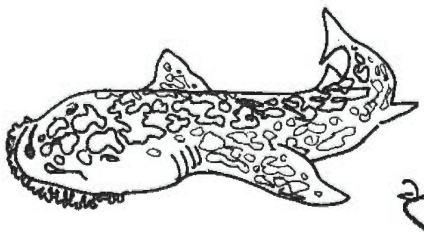
The shape of coral colonies varies considerably and is not determined by the coral species. Instead it is determined by local environmental conditions. For this reason colony shape cannot be used in species identification. Coral colonies are given common names based on their shape. A common example is the brain coral.

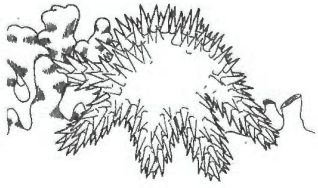
There are many predators of the coral, including fish such as the colourful parrot fish, and slugs.The most publicised coral predator is the Crown of Thorns starfish. Its role is to control the growth of the more prolific corals. The balance is very delicate and is causing some concern among scientists.

Fish are varied, colourful and display an amazing diversity and range of adaptations. For example the coral fish has a dark spot on its rear fin which looks very much like an eye. Its real eye is well hidden by a stripe of colour. This confuses predators and helps the fish survive.

Sharks are a special group of fish which are the larger predators seen cruising the reef. They include the tiger shark and the wobbegongs.







They are cartilaginous fish some of which lay eggs.

Sponges are primitive animals which have an irregular shape and a limestone structure instead of a skeleton. The sponge filter feeds by pumping water through its body. It is grown and harvested for commercial purposes in some parts of the world and sometimes ends up as a bathroom accessory.

Turtles which were once prized and killed for their shells go ashore to lay their eggs. The temperature of the sand in which the eggs are laid determines the sex of the young turtles.

Birds don't live in the ocean but feed from the ocean and are an important part of the food chain and ecology.

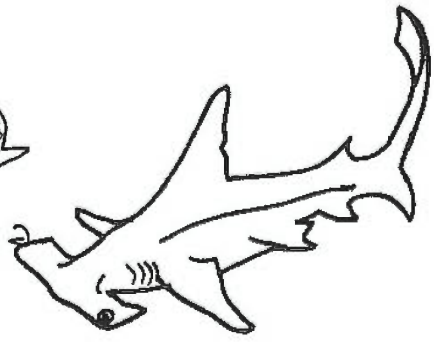
The colourful shrimp, crayfish, and crabs with their jointed legs, segmented bodies and exoskeletons are common organisms found on the reef.

Starfish and sea urchins with their radial symmetry add even more variety to the biomass on the reef.

Many shellfish of the reef have a feeding organ called a radula which has sharp teeth like structures used to scrape algae from the reef. Others are filter feeders. Shellfish include the giant clam and colourful nudibranks which are snails without a shell.

Squid and octopi along with the shelled organism called the nautilus are another group of common inhabitants of the reef.

Worms have many bristles and many segments. They are a highly coloured part of the ecosystem. Some live in hard calcium carbonate tubes with a flap at the top which is closed to protect the worm from predators.



Student activities

7. The Great Barrier Reef

Information searches

Resource search

Find out if your school has, or can borrow, any resources such as videos or CD roms on the Great Barrier Reef. Find out to whom you can write , fax or Email for information leaflets.

Collect and investigate all these resources.

Information search

Find out as much information as you can from as many different sources as you can, about any aspects of the reef that interest you. Some ideas are: the fish of the reef, coral classification, the life cycle of corals, reef sharks, danger on the reef, sea slugs, human impact on the reef, interrelationships between organisms on the reef, the symbiotic relationship of corals, food chains, clown fish, turtles, parrot fish, Moray eels, or adaptations of organisms to the environment.

Practical investigations

What factors affect light penetration of water?

Corals need clear water through which sunlight easily passes. Design and carry out an experiment which determines what substances affect light penetration through water. These substances will be a threat to coral on the reef if they enter the reef waters. Write up your findings as a newspaper article with an appropriate heading.

What are we adding to our waterways and oceans?

Make a list of all the types of substances that humans are adding to their waterways.

Take any one of these and determine, by looking at packets or containers, to what products these substances are added.

An interesting group to look at, with respect to the reef, is fertilisers. Nutrient levels in water are critical in reef areas as well as rivers. Increasing nutrient levels can lead to such things as prolific growth of blue green algae in rivers and decline in corals in reef areas.

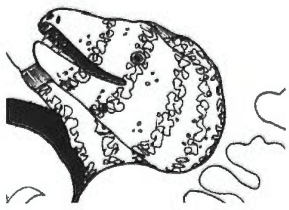
Research the effect of increased nutrient levels on the Australian coast.

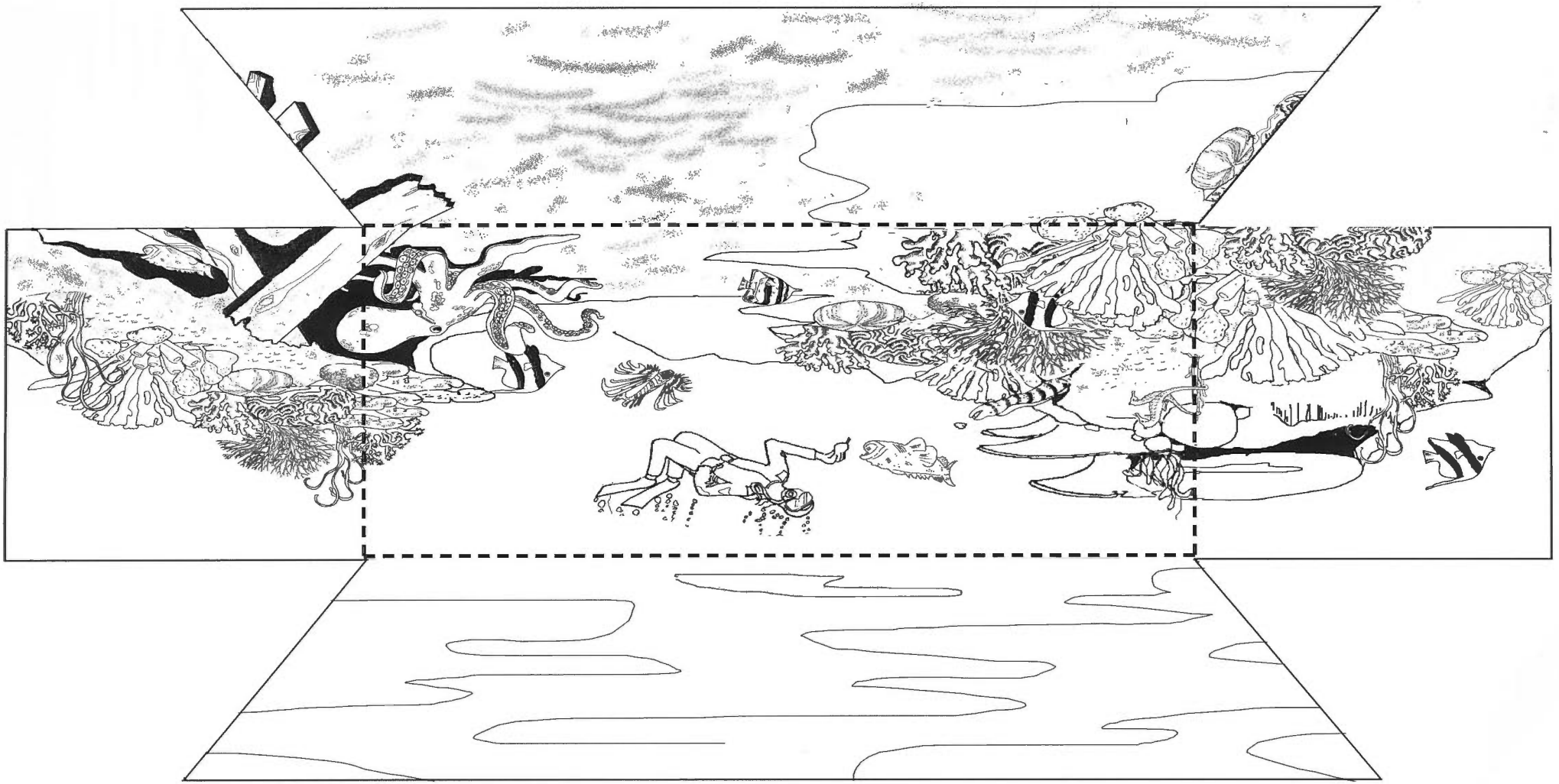
Creative activities

Make a model of part of a coral reef

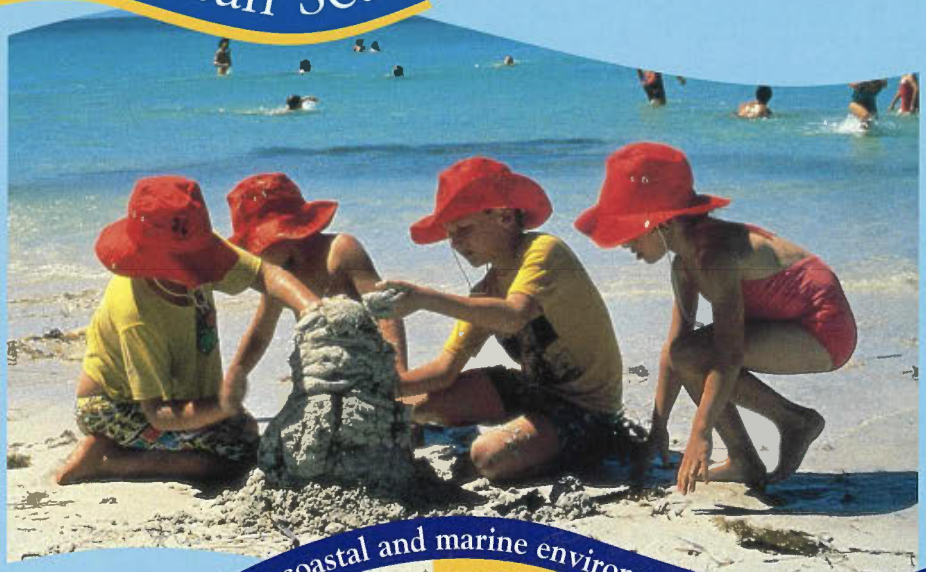
Teacher's note: *Students may either research and draw their own backdrop, or in the case of younger students, be given the one on the next page. This backdrop can be enlarged, duplicated on A3 paper and issued to students.*

Draw and/or colour a background scene of the reef noting the range, type and names of organisms present. Research what free swimming organisms could be found in this environment. Draw them in an appropriate size, colour them correctly, cut them out and use sticky tape or glue to attach them to strings. Fold your backdrop along the dotted lines . Use sticky tape to put the flaps into position. Make tiny holes in the top of your model. Thread one string with an organism attached through each hole, position it appropriately and secure the string on top with sticky tape.





Coasts & Clean Seas



The coastal and marine environments occupy a special place in the lives of most Australians.

Coasts and Clean Seas supports the conservation, sustainable use and repair of Australia's coastal and marine environments. The program targets coastal and marine pollution, threats to marine biodiversity and habitat degredation, and promotes the sustainable use of coastal and marine resources.

In this, the International Year of the Ocean, it is timely that an integrated and comprehensive oceans policy for Australia is to be finalised and released.

The Australian Oceans Policy will provide a national framework for activities in conservation, industry, recreation and other ocean uses. It will promote knowledge, sustainable use and caring for the oceans to ensure that they are healthy and productive, benefiting all Australians.

For further information contact Environment Australia's Community Information Unit on 1800 803 772.

Environment Australia
Department of the Environment