Workbook
Challengecoralreef

2008 Pacific Year of the Reef

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Coral reefs are very important to Pacific island life; they provide food, medicine, inspiration for arts and culture and sustain our livelihoods. During storms and cyclones, coral reefs protect land, villages and towns from rough seas that would normally destroy our islands. In this climate of global change, the health of coral reefs is critical – the stronger our coral reefs, the stronger our islands.

Reefs protect. It's time to give back.
The way we manage our islands today will determine how well they survive in the future.

One of the key challenges we face in the Pacific is how to encourage people to think about the actions they take, and how to encourage sustainable behaviours – that is, actions with as little impact on our environment, communities and future prospects as possible.

challengecoralreef background
As part of the 2008 Pacific Year of the Reef, SPREP, with key partners, is pleased to announce challengecoralreef, a regional competition for school groups (aged 13-18 years of age) to develop and implement plans to protect reefs in their local communities.

challengecoralreef aims to encourage school groups throughout the Pacific to take action to care for their local coral reefs. Through developing their own 'Action Plans', schools learn about the importance of coral reefs to Pacific island life, as well as committing to making a difference to improve the health of coral reefs in their local community. Through challengecoralreef, schools compete for funding to implement their Action Plans, and also have the chance to travel to the International Coral Reef Symposium in Florida, USA in July 2008 to share their ideas for how to strengthen and protect their coral reefs.

There are three main phases in the competition:

Phase 1: Learning and linking
In this phase, any school group (with students aged between 13-18 years of age) of SPREP member countries and territories, can learn about coral reefs, and develop an Action Plan to protect a coral reef near or in their community. Each group will be required to fill in a challengecoralreef Action Plan. Use this challengecoralreef workbook to help with your teaching plans.

Phase 2: Coral Reef Champion Teams
SPREP with key partners will select five teams from around the region as 'Coral Reef Champion Teams'. The Champion Teams will be provided with funding to implement the key priorities of their Action Plans.

Phase 3: Sharing solutions
Each Coral Reef Champion Team will be filmed for a regional documentary that will be shown at the International Coral Reef Symposium in Florida, USA. A representative from the winning team will be invited to attend the Symposium with a SPREP representative, to present their school's Action Plan and the documentary on challengecoralreef.

challengecoralreef is an innovative regional competition to encourage ACTION on our islands. Our challenge is not to get people to KNOW more but to ACT more. This includes revisiting our current behaviours, determining the damage they are having on our fragile reefs, and adopting behaviours that reduce their impact on our environment.

At the core of this challenge is the belief that only through taking action are we able to address the key issues facing our islands.

We hope that through challengecoralreef you will encourage the Pacific's future leaders to adopt a more proactive approach to saving coral reefs, and to build on the strengths within their communities to keep our coral reefs strong against future threats.

How to use this workbook
This work is divided into three sections:

Section 1: Learn about coral reefs
Section 2: Activities
Section 3: Take action! challengecoralreef Action Plan template

Use this workbook to teach students about the importance of coral reefs and to help guide the development of their Action Plans.

Fill out the Action Plan template and send to: *challengecoralreef,*
C/-SPREP, PO Box 240, Apia, Samoa by 25 February 2008.

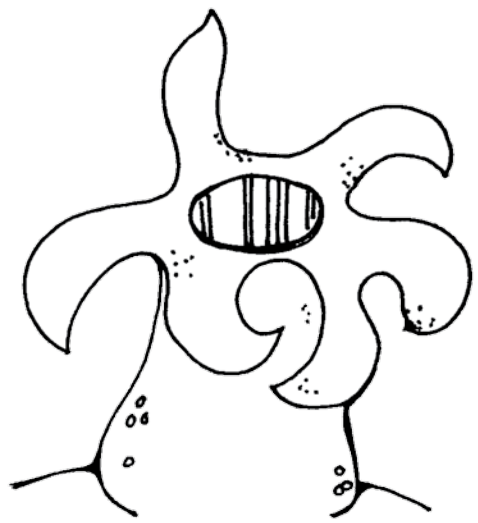
Contents

What are corals?

Corals are living animals which build reefs. Corals are invertebrate animals composed of hundreds or thousands of individual animals called polyps. A coral polyp is a simple jellyfish animal with a simple stomach with a single mouth opening surrounded by stinging tentacles which it uses to protect and feed itself.

Coral are generally classified as either 'hard coral' or 'soft coral'. There are around 800 known species of hard coral, also known as the 'reef building' corals. Only the thin outermost layer of the reef is alive with coral polyps. When they die, the next generation will build onto their skeletons. This is how reefs grow. The structures built by corals provide a home for the coral reef community and food for our families.

Soft corals, which include seas fans, sea feathers and sea whips, don't have the rock-like calcareous skeleton like the others, instead they grow wood-like cores for support and fleshy rinds for protection. Soft corals often resemble brightly coloured plants or trees, and are easy to tell apart from hard corals as their polyps have tentacles that occur in numerals of eight, and have a distinctive feathery appearance. Soft corals are found in oceans from the equator to the north and south poles, generally in caves or ledges. Here, they hang down in order to capture food floating by in the currents that are usually typical of these places.



Coral polyp

Perhaps the most unique feature of corals is the highly evolved form of symbiosis. Coral polyps have developed this relationship with tiny single-celled algae, known as zooxanthellae. Inside the tissues of each coral polyp live these microscopic, single-celled algae, sharing space, gas exchange and nutrients to survive.

This symbiosis between plant and animal also contributes to the brilliant colors of coral on a reef.

How do corals feed?

Most corals feed at night. To capture their food, corals use stinging cells called nematocysts. These cells are located in the coral polyp's tentacles and outer tissues. Food enters the stomach through the mouth. After the food is consumed, waste products are expelled through the same opening. If you've ever been stung by a jellyfish, you've encountered nematocysts.

Nematocysts are capable of delivering powerful, often lethal, toxins, and are essential in capturing prey. A coral's prey ranges in size from nearly microscopic animals called zooplankton to small fish, depending on the size of the coral polyps. In addition to capturing zooplankton and larger animals with their tentacles, many corals also collect fine organic particles in mucous film and strands, which they then draw into their mouths.
However, this type of feeding only provides around 10% of the needs of the coral. The other 90% comes from the zooxanthellae that use light and nutrients to produce oxygen and food for itself and the polyp through a process called photosynthesis.

How do corals reproduce?

Coral reproduction can be both sexual and asexual. Sexual reproduction means that there is cross-fertilization between female and male gametes coming from two different coral individuals. The new coral is a mix between the two coral parents. Asexual reproduction means that there is no fertilization, with the new coral similar to its parent.

Many coral species reproduce sexually once or twice each year. Most coral species spawn by releasing eggs and sperm into the water, but the period of spawning varies from one species to another. When an egg and a sperm meet they form a larva. The baby coral looks like a little tiny jellyfish and floats around near the surface at first, and then in the water column until it finds a suitable space to call home - usually a hard surface to attach to. Other limited distribution coral species are brooders. This is where only male gametes are released into the water, then taken in by female coral animals containing egg cells. Fertilization occurs inside the female coral, and a small planula develops inside it. This planula is released through the mouth of the female coral and drifts or crawls away to settle elsewhere and grow into a new colony.

Two types of asexual reproduction take place, the budding, in which an identical polyp sprouts out of the polyp's side, and the fragmentation in which broken pieces of corals that land on a suitable substrate may begin growing and produce a new colony.

What are coral reefs?

Coral reefs are the largest living structure on the planet, having evolved on earth over the past 200 to 300 million years. Coral reefs are the only living structure to be visible from space.

Coral reefs are created by millions of tiny polyps forming large carbonate structures through extracting calcium from surrounding seawater. This is used to create a hardened framework for protection and growth as well as the foundations for homes of hundreds of thousands, if not millions, of other species.

Coral reefs are part of a larger ecosystem that includes mangroves and seagrass beds. Mangroves are salt-tolerant trees with submerged roots that provide nursery and breeding grounds for marine life, that then migrate to the reef. Mangroves also trap and produce nutrients for food, stabilise the shoreline, protect the coastal zone from storms, and help filter land based pollutants from run off. Seagrasses are flowering marine plants that are a key primary producer in the food web. They provide food and habitat for turtles, seahorses, manatees, fish and foraging sea life such as urchins and sea cucumbers, and are also a nursery for many juvenile species of sea animals. Seagrass beds are like fields that sit in shallow waters off the beach, filtering sediments out of the water, releasing oxygen and stabilising the bottom.

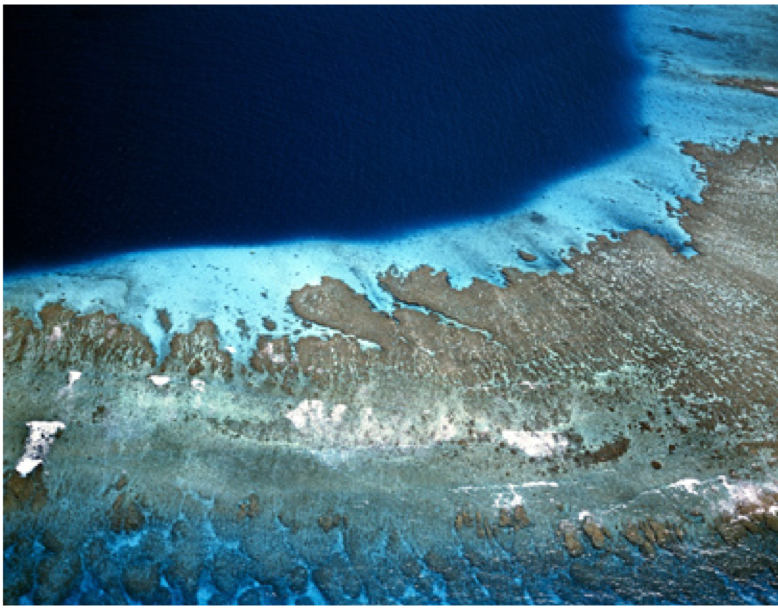


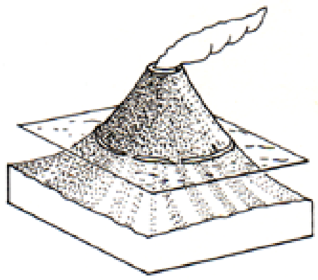
Photo: Stuart Chape

Where are coral reefs found?

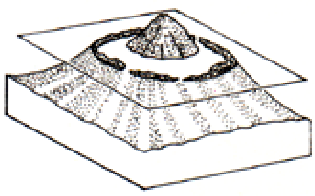
Coral reefs are found throughout the oceans, from deep, cold waters to shallow, tropical waters. Tropical reefs, however, are formed only in a zone extending at most from 30°N to 30°S of the equator. The reef-building corals prefer to grow at depths shallower than 30m (100ft), where the temperature range is between 18-30°C and light levels are high.

What does a coral reef look like?

Fringing reefs lie near emergent land. They are fairly shallow, narrow and recently formed.

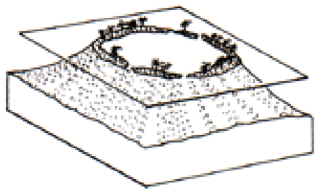


Barrier reefs are broader and lie farther away from the coast. They are separated from the shore by a stretch of water called a channel. Sandy islands covered with vegetation sometimes form on top of barrier reefs.



A fringing reef, a channel and a barrier reef form a lagoon.

Atolls are large, ring-shaped reefs lying off the coast, with a lagoon in their middle. The emergent part of the reef is often covered with accumulated sediments covered with different types of bushes and coconut trees. The atoll formation process involves the gradual sinking of an oceanic volcano over thousands of years. The fringing reef around the original island actively grows as the island slowly sinks. Eventually a lagoon forms between the sinking island. The growing fringing reef becomes a barrier reef.



‘Rainforests of the sea’: diversity of life on the coral reef

A coral reef contains more life than most other natural areas in the world. Coral reefs are often called the rainforests of the sea, both due to the large number of species they feed and shelter, many of them too small to see with the naked eye.

The total mass of plant materials on the reef is very high, rivalling that of the rainforest. All the life on the reef depends on the plants. The plants are sometimes brown or red but they contain green chlorophyll as well, which enables them to manufacture carbohydrates by photosynthesis.

Based on current estimates, shallow water coral reefs occupy somewhere between 284,000 and 512,000km^2 of the planet (cold-water/deep coral reefs occupy even more space). If all the world’s shallow water coral reefs were crammed together, the space would equal somewhere between an area of land ranging from the country of Ecuador (the low estimate) to Spain (the higher estimate). This area represents less than 0.015% of the ocean, yet coral reefs harbor more than one quarter of the ocean’s biodiversity. In the Pacific, some coral reefs hold up to 3,000 different species!

Reef life
Crustaceans

Crustaceans (including shrimps, lobsters and crabs) can be likened to insects on land. Like insects, there is an enormous variety and number of different species and all have jointed limbs. They have an 'external skeleton' in the form of a rigid, armour-like shell.

To grow, crustaceans have to cast off their shells periodically, a process called moulting, during which the animal breaks and removes its body shell. When it has discarded its shell, it quickly increases in size before its new shell (which is initially soft) hardens. Another interesting feature is their ability to 'cast off' a limb in order to escape. A new one then automatically grows in its place.

Shrimps or prawns
Many different types of shrimps live in the pools of coral reefs. Some shrimps, known as snapping or pistol shrimps can snap the end parts of their claws together to make a loud cracking sound – that can often be heard walking across the reef, particularly at night.

Crayfish
Crayfish live in ledges in coral reefs from which they crawl in search of food. Crayfish are caught in Pacific islands either by diving or by collecting them on the reef at night.

The eggs are carried on the swimming legs on the 'tail' (abdomen) of the female crayfish. They hatch as small larvae which drift with other zooplankton until they settle in new areas of the reef.

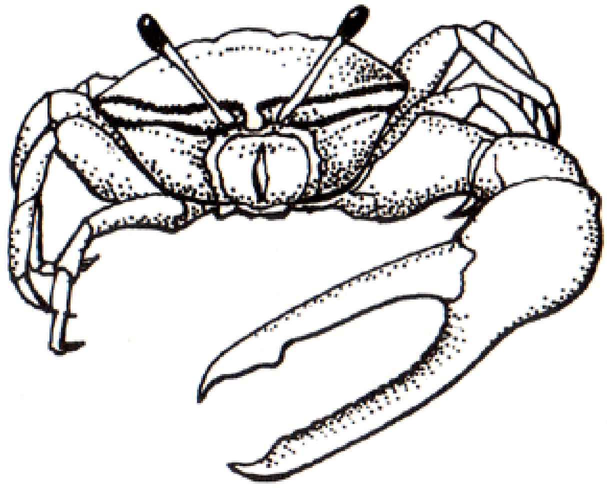
Crabs

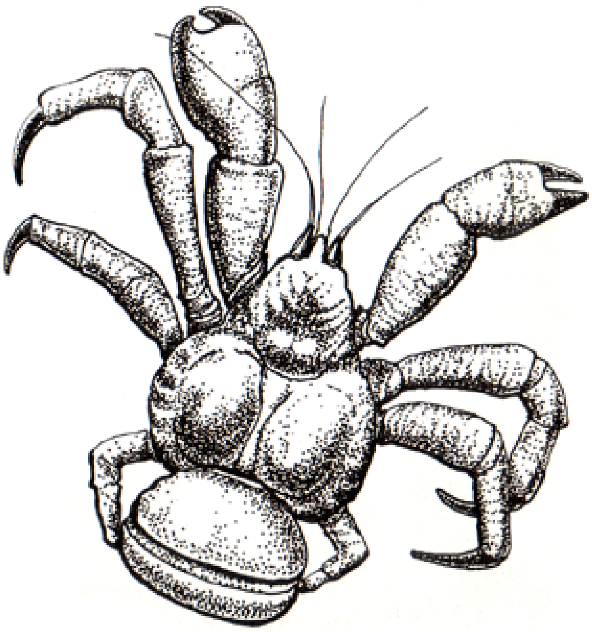
A crab has the same type of body as a spiny lobster except that its abdomen is reduced to a mere flap which curls back and is tucked under its large 'head'.

Crabs have two large claws one of which may be bigger than the other.

The fiddler crab, *Uca*, uses its large claw to attract females and to warn off other males, as well as predators. Hermit crabs, have a soft, unprotected abdomen. To protect itself, the hermit crab uses the empty shells of molluscs as its home. As its body grows it must search for a larger shell in which to live.

Sometimes hermit crabs will even attack a living mollusc and tear it from its shell or will attempt to pull out another hermit crab from its home.





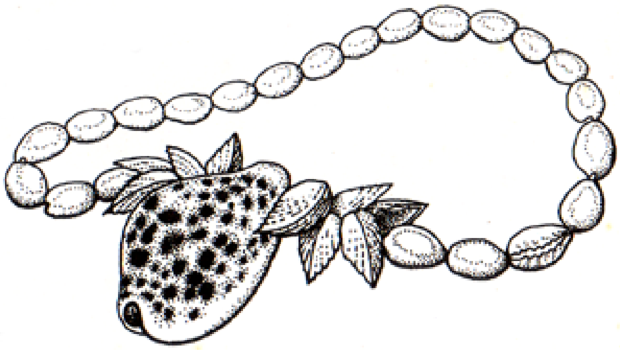
There are also terrestrial hermit crabs including the large coconut crab, *Birgus latro*. They begin their lives in the sea, but through a process of moulting develop the ability to breathe air. After the last developmental moult, the young hermit crab will drown if left in water for an indefinite period of time. Young hermit crabs use empty shells to protect themselves until their own shell hardens after a year. Then, they stay shell-less and grow up to 4kg. They are the largest terrestrial crabs. But, their link with the sea is never entirely broken however, as hermit crabs carry a small amount of water in their shells at all times to keep their abdomen moist and their modified gills hydrated.

Molluscs

Molluscs have soft bodies and many can produce hard shells like the cowry and cone shells that often wash up on beaches.

In the Pacific islands shells are used to make jewellery, fish hooks, musical instruments and elaborate ornaments.

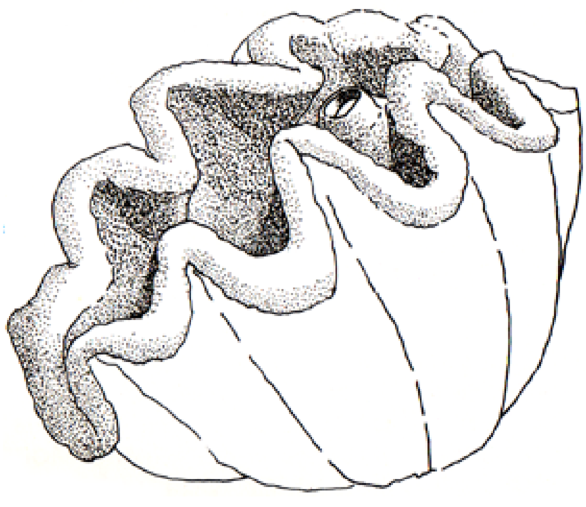
The eggs of molluscs hatch into small larvae which drift as part of the plankton before settling on the substrate and transforming into adults. Molluscs include snail-like creatures (gastropods), two-shelled species (bivalves) and animals such as the squid and octopus (cephalopods).



Gastropods: snail-like molluscs

Most gastropods, such as cowries, cones and tritons, have one external shell – others, such as the sea slugs have no shell. Many live above the low tide mark and when they are out of the water, remain tightly clamped to the rocks. At high tide, they move under the water looking for food. The shell of the cowry is highly polished. When the cowry is active, the shell is covered by the mantle (a sheet of tissue) which protects it and keeps its glossy finish.

The cone shell, *Conus*, captures moving prey such as sea worms and small fish by spearing them with its tongue (or radula). Which is in the form of a spear with grooves for carrying poison.



Bivalves: two-shelled molluscs

The bivalves have two shells hinged at one end. The shells, which are held shut by one or two strong muscles, form a strong refuge from all except the largest predators which crush the whole shell, or small ones which bore through it. Bivalves feed by filtering phytoplankton from the surrounding water. Giant clams, *Tridacna*, are the most conspicuous of the bivalves found on the coral reef.

A large clam may weigh as much as 250kg and live to over a hundred years old.

The mantle of a giant clam contains symbiotic algae (like coral polyps) allowing them to 'feed' on light as well as phytoplankton. As with coral, the symbiotic algae give the mantle its bright colours.

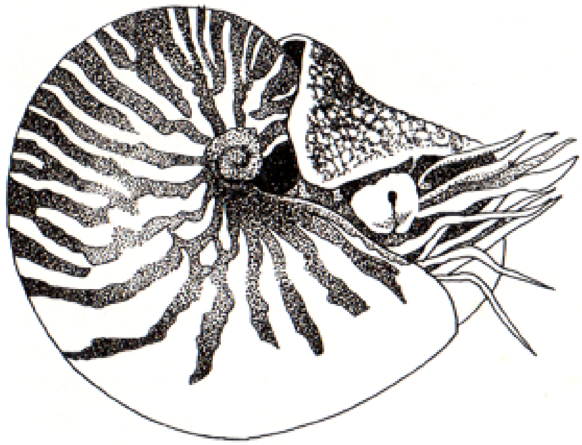
Cephalopods

Cephalopods are molluscs with a circle of arms or tentacles on their heads. The only member of this group with an external shell is the *Nautilus*, found only in the western Pacific ocean.

The cuttlefish has an internal shell or cuttlebone. The cuttlebone is very light and often found washed up on beaches.

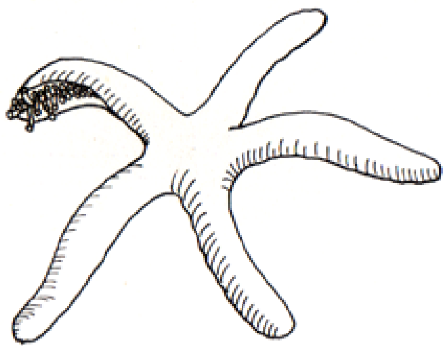
The octopus, which has no shell at all, is commonly found under coral boulders on reef flats.

All cephalopods are active hunters and catch other molluscs, crustaceans and fish. Many have a powerful beak in addition to the radula of gastropods. The beak of some cephalopods has poison glands to kill its prey and can also harm humans.



Echinoderms

Animals in this group include the sea stars, sea urchins and sea cucumbers. Many have a radial symmetry in their body plan, like the spokes of a wheel. They also have tube feet connected to a special hydraulic (water vascular) system. Water is taken into the body and sent to the tube feet by a system of canals.



Sea stars

Sea stars or starfish have a set of arms (often five) which radiate from a central body. There is no head, and movement can be made in any direction using the two rows of tube feet on each of the arms. The arms are extensions of the body, containing reproductive organs, digestive tract and other body components.

The bright blue sea star, *Linckia laevigata*, is common on Pacific coral reefs.

One particular sea star, the Crown-of-Thorns, *Acanthaster planci*, feeds on corals. Its stomach extends outside its body and over coral polyps which are digested.

Growth and erosion: the life cycle of coral reefs

A fine balance

While corals are the chief architects of reef structure, they are not the only builders. Algae such as *Halimeda* are stony algae, made up of limestone. They are very common on the reef, and add a huge amount of calcareous sediment (small particles) to the reef, especially the sparkling white sand on reefs and coral islands. Other algae such as *Coralline* encrusting algae serve to cement together some of the rubble from reef decay, and form a solid base. Parrotfish and other grazers are also important in the cycle of growth and decay, they break off pieces of coral to feed on the polyps and algae growing around their base. The coral is either broken off in chunks, or chewed down to sand. This physical breakdown of the reef is a process of both erosion and growth. The calcareous framework of the reef is broken down into finer sediment and consolidated (concreted) by coralline algae. This new substrate provides a solid base for new growth of corals and other plants and animals on the reef.

Erosion is just as important for the reef, as growth, to provide a solid platform for expansion of the reef. Firstly bioeroders such as certain grazing fish, boring sponges and bivalves, and algae contribute to the physical breakdown of the reef by biting bits of coral off or by boring into the coral colonies, weakening them and eventually causing them to collapse or dissolve. Large storms and cyclones occasionally cause great damage to patches of the reef, turning large areas of reef into piles of coral rubble. These areas are soon colonised by algae, but gradually corals start to grow there again and the cycle of reef growth is renewed. This recovery can take many years, usually anywhere from 10 to 25 years, depending on what state the reef has to recover to. These processes are natural ones, and have been occurring on reefs during most of their evolution. There has been a certain balance between the processes of growth and erosion over the millennia, and coral reefs have so far managed to thrive in the face of these disturbances.

Why are coral reefs important?

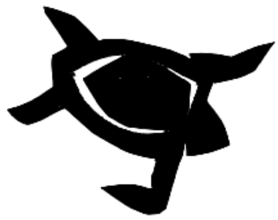
Providing Pacific island life
Covering less than one percent of the ocean floor, reefs support an estimated twenty-five percent of all marine life, with over 4,000 species of fish alone. Reefs provide spawning, nursery, refuge and feeding areas for a large variety of organisms, including sponges, worms, crustaceans (including shrimp, crayfish and crabs), molluscs (including cephalopods), echinoderms (including starfish, sea urchins and sea cucumbers), sea squirts, sea turtles and sea snakes.

Protecting Pacific island life
Reef structures play an important role as natural breakwaters. The skeletons of corals break down to rubble and eventually to sand, which helps build up shorelines and beaches. Coral reefs also protect coastlines and coastal villages from large ocean waves created by storms and cyclones.

Barrier reefs form sheltered lagoons where more delicate plants and animals can live and where people can safely go fishing. Coral reefs create a place where animals such as crabs, crayfish, clams and reef fish can live and provide food for nearby villages.

Without coral reefs, many coastal areas in the Pacific would be without protection from the sea and without such a variety of seafood.

The stronger the reef, the greater the protection to our island homes.



Economy
Coral reefs contribute to local economies. Millions of tourists visit the region to view our vibrant and diverse coral reefs.

Several attempts have been made to estimate the monetary value of coral reefs. Benefits from coral reefs can be categorized into two types: ‘direct use values’ (fisheries and tourism industry), and ‘indirect use values’ (benefit derived from coastline protection).

People
Healthy reefs sustain the lives of many Pacific islanders. More than 80% of Pacific islanders live near or in coastal areas and draw from the coral reefs for their livelihoods.

Coral reefs hold the potential for treatments for many of the world’s most prevalent and dangerous illnesses and diseases.

What damages coral reefs?

Soil: precious on land, a coral reef killer
The soil and fertilisers that help plants grow on land will smother and kill our coral reefs if they wash into the sea. The roots of trees and plants hold the soil together during storms. Do not clear steep slopes or remove plants that are holding the soil together. Good farming keeps the soil on land and protects our coral reefs.

Pollution: don't let our reefs go down the drain!
Pollution kills our coral reefs. Rain also washes fertilizers, pesticides and other pollution into the sea and onto the reefs that can smother and kill the corals. Apply fertilizer thoughtfully so that only the plants get the benefits.

Dynamite and poison
Dynamite kills more than the fish you want to catch. It also kills the fish's food, their homes and their young. It is like cutting down the tree to pick up the fruit.

Anchor damage
Anchoring on coral and swinging anchor chains can smash over an acre of coral in a few hours.

Coral walking
Coral is alive and protects itself from the harmful effects of the sun by producing mucus. We remove this protection and break coral if we walk on or touch coral. Try to walk on the sand only and do not touch coral if you can avoid it.

Taking too much from the reef
Harvesting too much coral, bêche-de-mer, fish, and other animals disrupts the balance in coral reef communities. The loss of one important level of the food chain can mean the death of many other organisms found on the reef and ultimately destroys our way of life. Only take what you need, and use what you take.

Coral reefs and climate change

We've all heard about climate change these past few years, but what does it actually mean for coral reefs?

Climate change will have four major effects on the oceans:

1. The sea will get warmer
The seawater temperature is a very critical factor for coral reefs. Coral reefs usually tolerate temperatures ranging from 20-30°C. In the Pacific, most of them live in 26-29°C waters. This means that even a slight rise in temperature can put their lives at stake.

What does happen when the sea gets warmer? The polyp expels its zooxanthellae and, as this small alga gives its colour to the coral and without it turns white. This is called coral bleaching. It is very important to note that a bleached coral is NOT a dead coral, just a bit sick. The coral will continue to feed by itself but it cannot live long without the food contribution of the alga. Two scenarios can take place from there; the polyp takes the zooxanthellae back and corals return to their former state, colourful and healthy; or the polyp does not take the algae back and it dies. When a coral is dead, it slowly loses its bright white colour, turns grey and tiny filamentous alga starts to grow on it.

Scientists are forecasting a seawater temperature rise between 1-2°C by 2100. Corals are already experiencing many bleaching events and this is likely to increase in the future. Corals take between five and 25 years to recover from a bleaching or a storm. If bleaching becomes more frequent, corals will not have time to recover anymore and will disappear. However, scientists have observed that certain corals can resist higher temperatures than others and this generates some hope for the future.

2. Sea levels will rise
Sea level rise is not a threat to corals, as they will grow at the same time and still be near the surface. This is a slow enough process for the corals to keep up with it.

3. Storms will be stronger
According to scientists, climate change will have an impact on storms. Storms would not be more frequent but more intense, causing more damage. If storms are stronger, they will destroy more corals.

4. The concentration of carbon dioxide (CO^2) will be higher
We call this Ocean Acidification and this is a big problem. Carbon dioxide from the atmosphere naturally dissolves in the water to produce carbonic acid (HCO^3) and hydrogen ion (H^+). As more and more carbon dioxide is produced by human activities, more of it is dissolved in the ocean and more acid components are produced. As a result the ocean becomes more acidic. As previously mentioned, corals are made of lime. Lime is dissolved if put with an acid substance: break a piece of coral, put vinegar or lime juice on it and observe the effect on the coral. The same thing happens in the ocean - if the water gets more acid, it will prevent corals from growing normally and they will ultimately stop growing.

Ocean acidification is a very recent theory and lots of experiments are currently underway to teach us more about the extent of the phenomena and the real impacts on coral reefs.

Climate change means a lot for the future of coral reefs as it will affect them in various ways that can lead to their extinction.

Ways to protect our coral reefs

The threat of climate change might make us think that saving coral reefs is beyond our power. This is not true. We can help corals to better resist the effects of climate change. We need to make our reefs resilient to climate change so that they will have the capacity to absorb, resist or recover from disturbances or adapt to change. To help our reefs become resilient, we can all take small actions in our day-to-day lives to reduce our impact on coral reefs. The healthier they are, the stronger their resilience.

These are some tips to maintain healthy reefs.

Local people, reef owners, reef users

- Take only what you need and use what you take
- Avoid using destructive fishing methods such as poison or dynamite
- Avoid building pigpens and toilets on the shoreline
- Help promote value of coral reefs as protection against the effects of climate change
- Use alternative materials other than coral reef materials for construction purposes
- Observe traditional customs to help manage your reef
- Tread carefully when walking, swimming, snorkelling and boating on and around coral reefs
- Support and respect Marine Protected Areas and sanctuary areas
- Participate in and support coral reef awareness programmes

Fishers

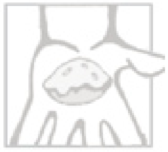
- Obey fisheries regulations and do not take undersized fish
- Use only a line or net to fish, not dynamite or poison. If using a net, make sure the mesh is not too small
- Return undersized or unwanted fish to the water immediately, to minimize injury or damage

Boat operators

- Anchor in mud and sand away from live corals and make sure the line is clear
- Motor towards the anchor when hauling the line in
- Use moorings instead of anchoring to the reef

Top Ten Tips for Thoughtful Tourists

1. Take only pictures and leave only bubbles. If you pick up anything, living or dead, always return it to where you found it.



2. If you dive, don't touch! Keep your fins, gear, and hands away from the reef, as this contact can hurt you and will damage the delicate coral animals. Stay off the bottom because disturbed sediments can smother the corals.

3. Don't stand or walk on coral.

4. Do not poke or prod animals and plants.

5. Take your own bags and say no to plastic bags – help keep rubbish out of the ocean.

6. Take the time to learn about coral reefs and the marine environment.

7. Encourage tourism establishments to consider ways to protect the reef. The stronger the reefs, the better for business.

8. Don't buy jewelry or other materials made from coral or shells. Your dollars are putting a value on the harvesting of shells. Support the local economy in other ways.

9. Participate in coral replanting.

10. Contribute to local community projects that protect the coral reefs.

Activity 1: Visioning coral reef conservation

Objective:
Support students to think critically about a reef in their community. Help students see the different ways of exploring knowledge about this reef.

Six hats of thinking
This exercise is based on the idea of 'Six Hats of Thinking' developed by Edward de Bono. This is a good exercise to use in your school or community to encourage thinking about an issue or topic.

Each colour 'hat' represents a different way of thinking:

Red: feelings, intuition: a place to express emotions without explanation
White: source information, facts
Blue: used to manage the six hats of thinking (the teacher can draw the students back to the objectives of the different hats)
Green: focuses on creativity, possibilities, alternatives and new ideas. It is an opportunity to express new concepts and new perceptions
Black: signifies caution and critical thinking - do not overuse! Why something may not work
Yellow: symbolises brightness and optimism. You can explore the positives and probe for value and benefit

By wearing each 'hat', students can learn to think in different ways, and explore different opinions or views. Focusing on each 'hat' helps to guide and manage the discussion in the group.

Materials:
- Coloured cardboard/paper in red, white, blue, green, black or yellow.
- Paper
- Coloured pencils

Actions:

1. Cut out six hats, one from each colour, of draw six hats (in the different colours).
2. Use the text below to guide discussions under each hat.
3. Start with the red hat. Hold it up and say, "We are all now wearing the red hat, by wearing this hat, we will talk about what the coral reefs mean to us, our history, tradition, culture and future".
4. Work through the different coloured hats. Use the blue hat to draw people back to the specific colour/theme if the discussion strays.
5. The other way you can do this is to hand the six hats to six participants in the group and ask them questions from the cards in front of the group.
6. You can swap the hats between the students to highlight the different opinions/ thoughts/ideas that people can have.
7. Use the thoughts from this exercise to guide the development of your Action Plan.

Red Hat (Feelings) What are my feelings about the coral reef in my area? How are the coral reefs important for Pacific culture, tradition, and identity? How does the coral reef inspire you?	White Hat (Information) What do we already know about the coral reef? What do we know about how the coral reefs are used? What information do we need?
Blue Hat (Remembering the process) Return to the different meanings of the hats to manage the discussion and to remind students of the purpose of the exercise.	Green Hat (New ideas) What are some of the ways we can protect this coral reef? What are some ways that we can help (daily, monthly, yearly) to reduce our impact on the coral reefs?)
Black Hat (Weaknesses) What are some of the reasons that our ideas and plans to protect the coral reef may not work? What are some of the barriers/issues that may affect our ideas?	Yellow Hat (Strengths) What are some of the existing ways, practices that we can use to support our project (use this hat to explore traditional fishing methods, traditional knowledge etc)

Adapted from ReefHQ Education
Teaching Unit, Reef Writers
Great Barrier Reef Marine Park Authority, Government of Australia

Activity 2: Traditional Fishing Methods

Objective:
This activity aims to identify some local traditional methods of fishing and traditional fishing gear, and to investigate their value to current fishing practices.

Materials:
- Chart showing local traditional and modern fishing methods
- Any available local fishing gear: modern and traditional

Actions:
1. The teacher should prepare a chart showing local traditional and modern methods of teaching.
2. Organise the children to bring some local fishing gear used today to the classroom and if possible older traditional gear.
3. Invite a local fisherman to talk about the values of both fishing methods.
4. Class project: divide the class into groups, assigning each group one of these tasks in finding out about modern and traditional fishing in: the lagoon, the outside reef, the open ocean.
5. Have each group prepare charts and notes for a fifteen-minute talk to the rest of the class.
6. Ask the students to find the names of local plants, animals and birds, used to make some of the traditional fishing gear (eg: fish traps).

Fill in the table:

Name of local material	Name of traditional gear
Plant:	
Animal:	
Bird:	
Shell:	
Corals:	

Activity 3: Impacts of humans

Objective:
Assess the influence of humans on a reef area.

Materials:
• Pen and paper

Actions:
Visit a reef or coastal area. Keep the following questions in mind when you are at the reef. Make notes of any evidence you observe yourself. Ask questions of other visitors or long-term residents.

1. What are the human activities?
2. Make a list of five human activities that occur here.
3. For each of these, suggest two or three possible effects on the island or reef environment. Will these effects harm or benefit the environment?

Pollution
- What forms of pollution occur here?
- What evidence is there of pollution?
- What human activities cause pollution here?
- Do you observe any measures designed to control or minimise pollution?
- How could pollution be further controlled here?
- Is one part of the reef more polluted than another?
- Summarise your findings using a map to show polluted areas and perhaps a graph to show frequency of pollution over time.

Other effects of humans:
- How might people have changed the following aspects of the island and reef?
  - o Flora and fauna (plants and animals) of this area
  - o Life form of the reef
  - o Shape of the island and reef
- What evidence can you see of such changes?

Activity 4: Effects of building projects

Objective:
To observe and assess the effects of construction works taking place on an island.

Materials:
• Pen and paper

Actions:
You may see engineering or building projects going on around you. Consider the following questions and make some detailed notes.

1. Where is the project?
2. What is its purpose?
3. Who is responsible for it?
4. How many workers are involved?
5. What happens to material removed from the site?
6. What appear to be the damages to the environment?
7. Are flora or fauna (plants or animals) being removed from the site?
8. Does the final project meet local/national requirements?
9. What is being done to minimise the damage to the environment?
10. What recommendations would you make to reduce its impacts on the environment?

Compare your findings with others. Do you all agree?

Activity 5: What's the environmental impact?

Objective:
Prepare a statement of possible environmental impacts of a hypothetical tourist development near or on a reef in your community.

Materials:
- Information on the reef near you
- Pamphlets, booklets or other material which depict or describe tourist activities and facilities in the reef areas
- Pencil and paper

An environmental impact statement is a document which is prepared to help government bodies make decisions about whether a proposed new development such as a road, building, resort or harbour work should be allowed to go ahead. It describes the existing environment and analyses the proposed development and environmental impacts it will cause.

Actions:
1. In some environmental impact assessments, the impact of the proposed development project is summarized using a grid.
2. The grid is basically a checklist of all the possible interactions between the activities of the project and the factors of the environment that may be changed. These interactions are the effects of impacts.
3. The worksheet briefly describes a hypothetical proposed tourist development on the reef. Make up a grid listing probable factors of the environment and actions of the proposed project. Mark the boxes on the grid to show possible impacts of each 'Project Action' on each 'Environmental Factor'. Discuss your ideas with others in small groups.
4. Discuss with others your assessment of the overall impact of the project. On environmental grounds, do you think it should be allowed to go ahead? Are there other considerations that should be taken into account? What information is needed to help with the decision making?

WORKSHEET

What impact?

Imaginary proposed development of a reef in your community

Imagine that a developer has proposed setting up a floating hotel to accommodate 20 people for week-long diving and fishing holidays near an outer reef near your community. The hotel will be serviced regularly by boat and by daily seaplane flights. It will be moored about 500 metres from an uninhabited, sparsely-vegetated cay which is frequented by birds and turtles. What will be its environmental impacts? The impacts can be shown on the matrix below.

Using the matrix to show impacts

What kinds of actions will the proposed project involve? What are some of the existing characters of the environment? Discuss these questions with others. Then make lists of project actions and environmental characters along the top and side of a matrix. Using the symbols on the key, mark the boxes on the matrix to show possible impacts of each project action on each environmental character. Impacts are interactions between actions and environmental characters. Show the impacts you think most likely to occur.

Project actions

Environmental characters

ENVIRONMENTAL FACTORS	Increased anchorage												
Live coral reef cover	=												

Key

0	No interaction likely
★	Minor beneficial impact
★ ★	Major beneficial impact
–	Minor detrimental impact
=	Major detrimental impact

Fill out this form and send to *challengecoralreef, C/-SPREP, PO Box 240, Apia, Samoa by 25 February 2008.*

Name of school: ______________________

Grade/s or age group of school group: ______________________

Coordinator/Principal: ______________________

Telephone: ______________________

Postal address: ______________________

Email (if applicable): ______________________

Country: ______________________

1. Choose a coral reef that your school group could help improve and describe why you chose it. (Describe where the reef is, where your school is ie village, town, or city and the reasons you have chosen to focus on that reef).

2. Why is the reef important to your community? How do people use the reef?

3. What are the negative impacts on the reef? (Describe what your school group considers problems of your coral reef).

4. Which impacts would you like to change and how would you do that? (Describe what actions your school group would take to remedy problems identified in question 1).

5. Who will be implementing the proposed actions of your school group and when will they do them? (Highlight the age/s, grade/s or other details that will help us know more about the school group that will be implementing this project).

6. Use the table below to describe the five priority actions that need to be undertaken to improve the health of your coral reef.

Action		**When?**	**How much will it cost?**

7. How will you share your project with your community, other groups, or the media? (Consider how you could spread the word about why and how people could protect their coral reefs).

8. How did you hear about challengecoralreef?

Thank you for you becoming a challengecoralreef school. By filling out this Action Plan, you have taken the first important steps to protecting a coral reef near you. Once we receive this Action Plan, we will send you a Coral Reef Education Pack and challengecoralreef school certificate.

Only five schools from around the Pacific will become challengecoralreef Champions and receive funding to implement their actions to save a coral reef. However, every school will be recognised for their contribution to the Pacific Year of the Reef.

Every school also can do their bit to save the coral reefs in their community. Talk to your community members, and local groups about how to implement the actions in your action plan. Talk to the media about the importance of protecting coral reefs. Your contribution can help strengthen the Pacific's coral reefs to protect our homes and continue to support and promote Pacific island life.

Fill out this form and send to *challengecoralreef, C/-SPREP, PO Box 240, Apia, Samoa by 25 February 2008.*

Glossary

Biodiversity: The variety of life on Earth

Bioeroders: Bioeroders are organisms such as Crustaceans (shrimps, crabs), Molluscs (snails), Echinoderms (sea-urchins) and fish (parrot and surgeon) that cause the biological breakdown of calcareous reef material. This process is called bioerosion.

Calcium carbonate: The white limestone material that makes up the skeletons of coral polyps and the shells of molluscs such as giant clams and trochus. The chalk used on blackboards is mostly calcium carbonate.

Chlorophyll: Green pigments in plants that facilitate photosynthesis.

Coralline: Coralline algae are red algae containing calcareous deposits in their cells. Many are typically encrusting and rock-like, found in tropical marine waters all over the world. Colors are most typically pink or some other shade of red, but may be purple, yellow, blue, white or gray-green.

Coral polyp: A small individual coral animal with a tube-shaped body and a mouth surrounded by tentacles.

Gametes: Reproductive cells (ovules: female cells; spermatozoids: male cells).

Halimeda: The Halimeda constitute a kind of green algae that looks like a small string of tough scales. It fixes calcium carbonate, which gives its rigidity and makes inedible for most herbivores.

Invertebrate: An animal without a backbone, such as snails, worms, and insects.

Nematocysts: Specialized stinging cells for defence and capturing food.

Organisms: Any living plant or animal.

Photosynthesis: The process by which plants produce oxygen and nutriments from carbon dioxide using the sunlight.

Symbiosis: A relationship between two different creatures that live together for the benefit of both. Plant cells (Zooxanthellae) have a symbiotic relationship with coral polyps.

Zooplankton: Small animals, or the larvae of larger animals which drift in the sea.

Zooxanthellae: Small plant cells living in coral polyps.

Sources

Much of the material in this workbook is provided courtesy of the 2008 International Year of the Reef, a global campaign to raise awareness of the world's coral reefs. For more information visit: www.iyor.org.

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Dr Michael King for SPREP

Activities: Project Reef-Ed, Great Barrier Reef Educational Activities, Great Barrier Reef Marine Park Authority.

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SPREP is an intergovernmental organisation working with Pacific island countries and territories to strengthen environmental management and promote sustainable development.

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