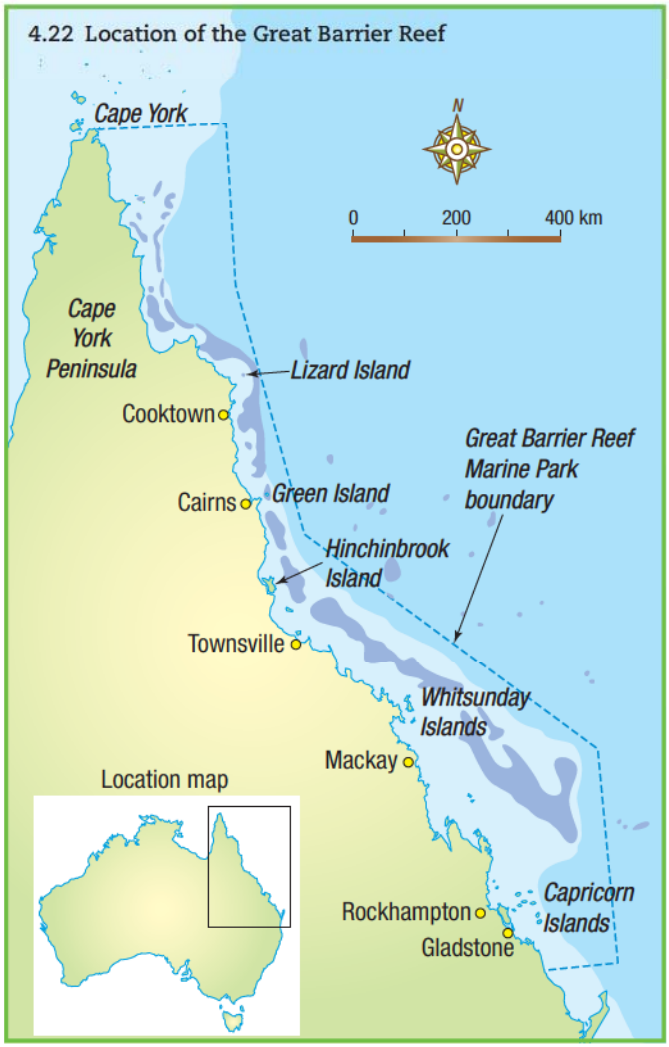
4.6 The Great Barrier Reef

The Great Barrier Reef is located off the Queensland coast, stretching over 2300 kilometres from the tip of Cape York to just north of Fraser Island. It is the longest barrier reef system in the world. The Great Barrier Reef Marine Park is made up of a complex pattern of patch, fringing and barrier reefs. It has an overall area of 348 000 square kilometres and contains the world's largest World Heritage area.

4.21 Tourists from all over the world are drawn to the Great Barrier Reef to look at the wonders of the unique environment.

4.22 Location of the Great Barrier Reef



WHY IS THE GREAT BARRIER REEF UNIQUE?

The size of the Great Barrier Reef makes it the largest continuous collection of coral reefs in the world. It consists of over 2900 separate coral reefs and 940 islands, 300 of which are coral cays.

The range of living plants and animals on the reef also makes it unique for its biodiversity, which includes this variety of species:

- 360 types of hard coral
- one-third of the world's soft coral species
- 1500 species of fish
- thirty species of marine mammals including the endangered dugong
- six of the world's seven endangered turtle species
- 5000 mollusc species
- 800 species of echinoderms (starfish, sea urchins)
- 215 bird species
- thousands of different sponges, worms and crustaceans.

WHAT IS THE REEF'S VALUE?

The Great Barrier Reef supports a range of activities that earn money for Australia. The economic value of the reef and related activities has been estimated to be as high as AU$5.8 billion. Tourism alone is worth around AU$4.3 billion per year while commercial fishing is worth AU$120 million.

The reef also acts as a barrier that protects property from damaging ocean swells. Also, some of the reef's plants and animal species contain medicines that could one day provide cures for diseases.

4.23 The Great Barrier Reef is the largest World Heritage area on the planet and is often referred to as the only living organism that can be seen from space. This is only partly true, as the reef itself is actually made up of many millions of tiny organisms called polyps.

PROTECTING THE GREAT BARRIER REEF

The Great Barrier Reef is an environment that is worth protecting for the future. The process of protection has been influenced by government decisions.

Between 1970 and 1974 a royal commission investigated the possibility of oil mining on the Great Barrier Reef. The results recommended against oil exploration, instead finding that the area should be protected through the establishment of a government authority to manage the reef.

As a result of this, on 20 June 1975, the Australian Government formed an organisation called the Great Barrier Reef Marine Park Authority (GBRMPA). This organisation has managed the reef environment ever since.

The importance of this reef environment and its careful management has made the Great Barrier Reef globally significant. A precious resource like this is worthy of World Heritage listing and in 1981 the area was added to the World Heritage List.

The management of activities within the area is a complex task. There are a range of activities around the reef that influence it as well as a range of groups who want to use the area. The aim is to ensure a balance between humans using the reef and maintaining the area's natural and cultural features.

GEOGRAPHY FOCUS

Whitehaven Beach is a 9-kilometre stretch of pristine, pure white silica sand fringed by brilliant blue water. It is one of the 74 islands of the Whitsunday group in the Great Barrier Reef close to Proserpine on the mainland.

4.24 Whitehaven Beach is considered to be one of the most beautiful beaches in the world.

4.25 This concept map shows the range of activities that influence the Great Barrier Reef and highlights why it needs protecting.

Indigenous heritage

The Indigenous heritage of the Great Barrier Reef is an important aspect of its World Heritage listing. Aboriginal and Torres Strait Islander peoples have built a lifestyle around the marine environment and have a great deal of knowledge about the resources offered by the animals and plants of the area. Today more than 50 traditional owner groups live along the coast and islands from Bundaberg to Cape York Peninsula.

Urbanisation

The climate, scenery and lifestyle along the coastal strip of Queensland attract both tourists and permanent residents. The growth of cities such as Cairns has placed increasing pressure on the reef as a result of pollution and the number of people who use the reef as a recreation area.

Tourism

Over 85 per cent of visitors to the reef go to the offshore areas around Cairns, Port Douglas and the Whitsunday islands, which make up less than 10 per cent of the total marine park. This means that tourism is concentrated in a small area of the reef. Tourism operators are one of the key groups aiming to manage the reef in a sustainable way.

HUMAN ACTIVITY IN THE GREAT BARRIER REEF REGION

Scientific research and management

GBRMPA plays an important role in the management of the reef. An essential part of their work is to ensure that they learn about the interactions that occur within the reef environment. Only with increased scientific knowledge can geographers make plans for the management of the reef into the future.

Shipping

The Great Barrier Reef is located on an important shipping route and unwary captains can cause damage to the reef. The grounding of ships on the reef and oil leakages into the waters continue to occur. Strict rules are in place to ensure that ships have only a minimal impact.

Agriculture

Cattle grazing in the headwaters of the rivers that flow to the coast and sugarcane farming along the coastline pose a threat to the Great Barrier Reef. Runoff containing soil smothers the reef. Fertilisers and pesticides used on the farms change the balance of the nutrients in the water.

Commercial fishing

The commercial fishing fleet on the Great Barrier Reef catches around 24 000 tonnes of seafood valued AU$120 million per year.

4.26 Runoff from agriculture can destroy coral reefs.

Activities

Knowledge

1 Describe the spatial dimensions of the Great Barrier Reef.

2 Name the three types of coral reefs that form the Great Barrier Reef Marine Park.

3 Why is the Great Barrier Reef a globally significant environment?

4 Give four examples that highlight the level of biodiversity found in the Great Barrier Reef.

5 What is the total estimated value of the Great Barrier Reef to the Australian economy?

6 Describe four ways that the Great Barrier Reef is considered to be of value to the people of Australia.

7 What activity did a royal commission investigate for the Great Barrier Reef between 1970 and 1974? Why do you think the royal commission recommended against the activity?

8 What was the outcome of the royal commission in 1975 and what impact did this have on the management of the Great Barrier Reef?

9 When was the Great Barrier Reef added to the World Heritage List? Give two reasons why you think it was added to this list.

10 Construct a two-column table titled 'Groups who use the Great Barrier Reef'. Name the left column 'User group' and the right column 'Impacts'. Use the information in the concept map in 4.25 to write a brief description of the way these groups impact on the reef.

11 Explain why the management of activities within the Great Barrier Reef area is such a complex task.

Skills

12 Use 4.26 to create a sketch map of the area shown. You will need to include the river, the river mouth and the sediment in your map.

Application

13 **Class debate**: 'The money-making opportunities from the reef environment are more important than any impact these activities might have on the coral reef.'

14 **Community meeting**: Set up the classroom to hold a public meeting using the following scenario:

> GBRMPA is currently developing a management plan for an area of the reef. The Authority has called a public meeting to get ideas and concerns about the use and management of an area that is to be rezoned from a highly protected area with only a few human impacts to an area that will be developed and allow unlimited access. All interested groups have been invited to attend the meeting.

First appoint a chairperson representing the GBRMPA to run the meeting and to decide on the rezoning of the area once the meeting has finished.

Next divide the class into the groups listed in 4.25. Research the issues and benefits of your group using the reef.

Prepare a short presentation. Each group will be given a three-minute time slot to present their opinion. After the presentations the meeting will debate the issues that arise before a final decision is made by the chairperson.

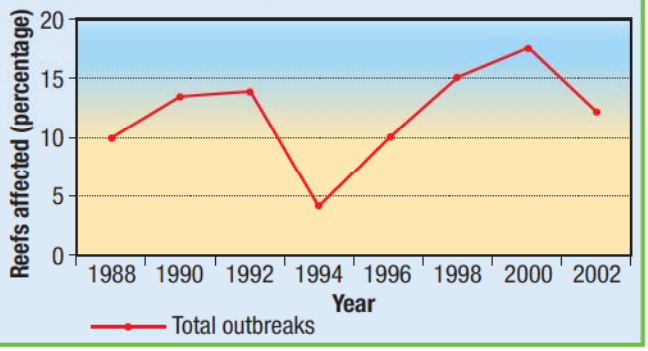
Surf ICT CW

4.7 Natural threats to coral reefs

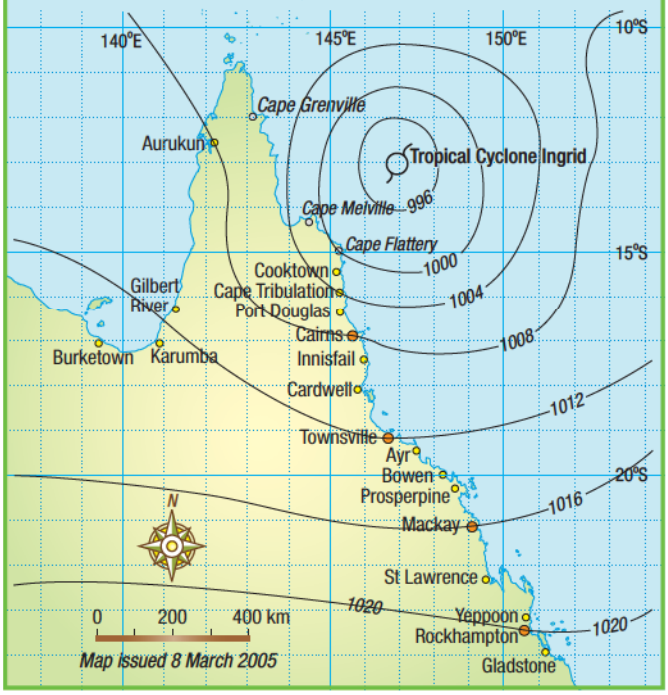
As well as the human threats to coral reefs there are also some natural threats that put the reef environment at risk. This unit examines two of the natural threats to the Great Barrier Reef.

4.27 **Damage caused by the crown-of-thorn starfish. In order to eat coral polyps, the crown-of-thorns starfish forces its stomach out through its mouth and releases a special enzyme that breaks down the polyp. After four to six hours the polyp is absorbed, the stomach is retracted back through the animal's mouth and the starfish moves on.**

4.28 **Percentage of reefs in the Great Barrier Reef Marine Park with crown-of-thorns starfish outbreaks**



4.29 **Synoptic chart for March 2005**



PEST INFESTATIONS

Another type of natural threat to reef environments comes from plants and animals that threaten areas by growing to plague proportions.

One of the animals found on many coral reefs of the world is the crown-of-thorns starfish. The starfish are a normal part of reefs. However, at times there has been an outbreak of them, causing severe damage.

One theory on the cause of these infestations is that changes in the balance of the reef ecosystem occur when nutrients from urban areas, septic tanks and agricultural activities enter the water. These nutrients encourage the growth of algae, which is the favoured diet of the crown-of-thorns starfish. This increased food supply causes starfish numbers to increase. When this happens it does not take too long before parts of the reef are destroyed due to the starfish's preferred diet of coral polyps.

TROPICAL CYCLONES

A tropical cyclone is a natural hazard event. Cyclones form over the warm oceans of the tropical regions of the world. They are intense tropical storms that create large waves and big tides that are sometimes large enough to wash completely over coral cays. Tropical Cyclone Ingrid occurred in March 2005 and threatened the Great Barrier Reef.

GEOGRAPHY FOCUS

Each crown-of-thorns starfish eats between 5 and 6 square metres of coral per year.

STUDY REVEALS CYCLONE DAMAGE TO CORAL REEFS 100 KILOMETRES FROM EYE OF CYCLONE

4.30 A section of the Great Barrier Reef before Tropical Cyclone Ingrid

17 August 2005

When Tropical Cyclone Ingrid crossed the far northern Great Barrier Reef it left a trail of destruction to 260 coral reefs across a path over 200 kilometres wide. Researchers from the Australian Institute of Marine Science (AIMS), such as Dr Katharina Fabricius, were keen to find out about the level of damage.

'We investigated the impact of seven types of cyclone damage to the reef: coral breakage, movement of massive corals, stripping of soft corals, coral sand movement, scarring of coral by debris, algal blooms, and removal of plants from the reef.

'These surveys examine how wave damage to coral communities differs between sheltered and exposed sites. The corals on outer reefs appear to be more resistant to breakage compared with the more fragile inshore reefs.

'The reef provided its own protection from wave damage, leaving many corals in the protected areas intact. These surviving corals will help restore the worse affected areas,' Dr Fabricius said.

Corals at the outer edge will probably take 2–3 years to recover, those at ground zero were stripped bare and could take up to two decades to bounce back.

Estimates from the Australian Bureau of Meteorology suggest that wind speeds reached at least 250 kilometres per hour and wave heights as high as 10 metres occurred within the Great Barrier Reef area.

Activities

Knowledge

1 What is another name for the intense tropical storms that cause damage to coral reefs? Describe why these storms are so destructive to the reef.

2 Read the newspaper article and study the synoptic chart in 4.29:
   - a How many coral reefs were damaged by the cyclone?
   - b Name the seven types of cyclone damage to reefs the researchers investigated.
   - c What role will the surviving corals play in repairing the damage to the reef caused by the tropical cyclone?
   - d What was the wind speed and wave height caused by the cyclone? Why would these have caused damage to the coral reef?
   - e Compare the date when Tropical Cyclone Ingrid formed over the Great Barrier Reef and the date the newspaper article was written. Explain why they are different.
   - f Estimate the air pressure on 8 March at Cairns, Townsville, Mackay, Aurukun, Cardwell St Lawrence and Yeppoon.
   - g Estimate the latitude and longitude of Tropical Cyclone Ingrid on 8 March 2005.

3 Name the three sources of nutrients that are believed to cause the outbreaks of the crown-of-thorns starfish.

4 Describe how increased nutrients in seawater are believed to cause an increase in the crown-of-thorns starfish numbers.

5 Describe the way the crown-of-thorns starfish eats the coral polyps.

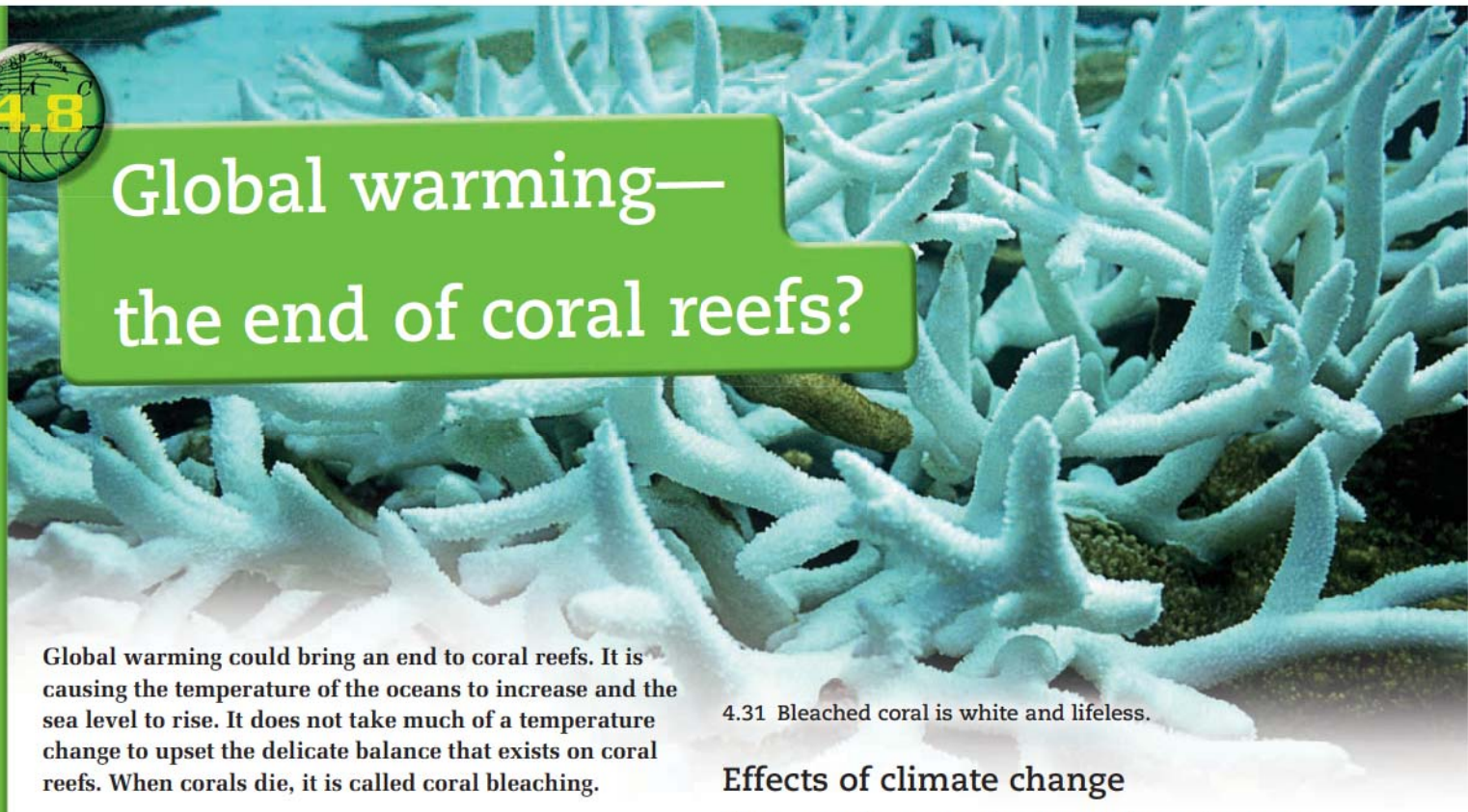
Skills

6 Refer to 4.28:
   - a What was the total outbreak of the crown-of-thorns starfish in 1992, 1998 and 2002?
   - b Which year did the total outbreak have the least impact on the reef?
   - c Which year did the total outbreak have the greatest impact on the reef?
   - d Rank the years in order from greatest percentage of reefs affected to least percentage of reefs affected in terms of the total outbreak of the crown-of-thorns starfish.

Surf ICT CW

4.8

Global warming—the end of coral reefs?



Global warming could bring an end to coral reefs. It is causing the temperature of the oceans to increase and the sea level to rise. It does not take much of a temperature change to upset the delicate balance that exists on coral reefs. When corals die, it is called coral bleaching.

4.31 Bleached coral is white and lifeless.

EVIDENCE AND EFFECT OF GLOBAL WARMING ON REEFS

The line graphs in 4.32 show that increases in carbon dioxide and methane gases in the atmosphere follow the same shape as the temperature of Antarctica and sea level change. It is not just the increase in temperature that is causing the problem for coral reefs, it is the speed at which the temperature change will occur.

Coral reefs growth relies on the symbiotic relationship between the zooxanthellae and the coral polyp. This in turn relies on sunlight, clear oceans and warm water. When the water gets too hot, the coral polyp spurts out the zooxanthellae and this essential relationship is broken. Other plants and animals start to die because of the break in the food chain, and the reef dies.

Bleached coral reefs are like white graveyards—all that is left is the coral skeleton. It takes years for reefs to recover. Some reefs may never recover. If the sea temperature continues to rise, corals around the world will be threatened.

GEOGRAPHY FOCUS

Mass coral bleaching in 1998 and 2002 was caused by a change in sea temperature of less than 1°C. Scientists are predicting sea temperature changes of 2 to 6°C in the future.

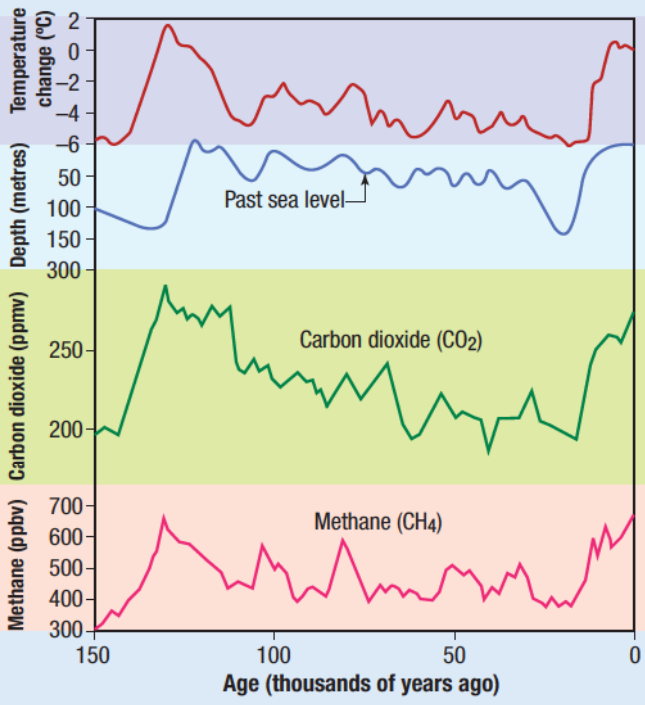
When did this threat occur?

Widespread coral bleaching was first noticed in 1998. High sea surface water temperatures caused the bleaching of reefs around the world. The second worst year on record was 2002.

Effects of climate change

Many scientists suggest that some reefs could disappear completely by 2020 due to coral bleaching and that the entire global environment of coral reefs could be destroyed over the next 100 years due to sea temperature rises.

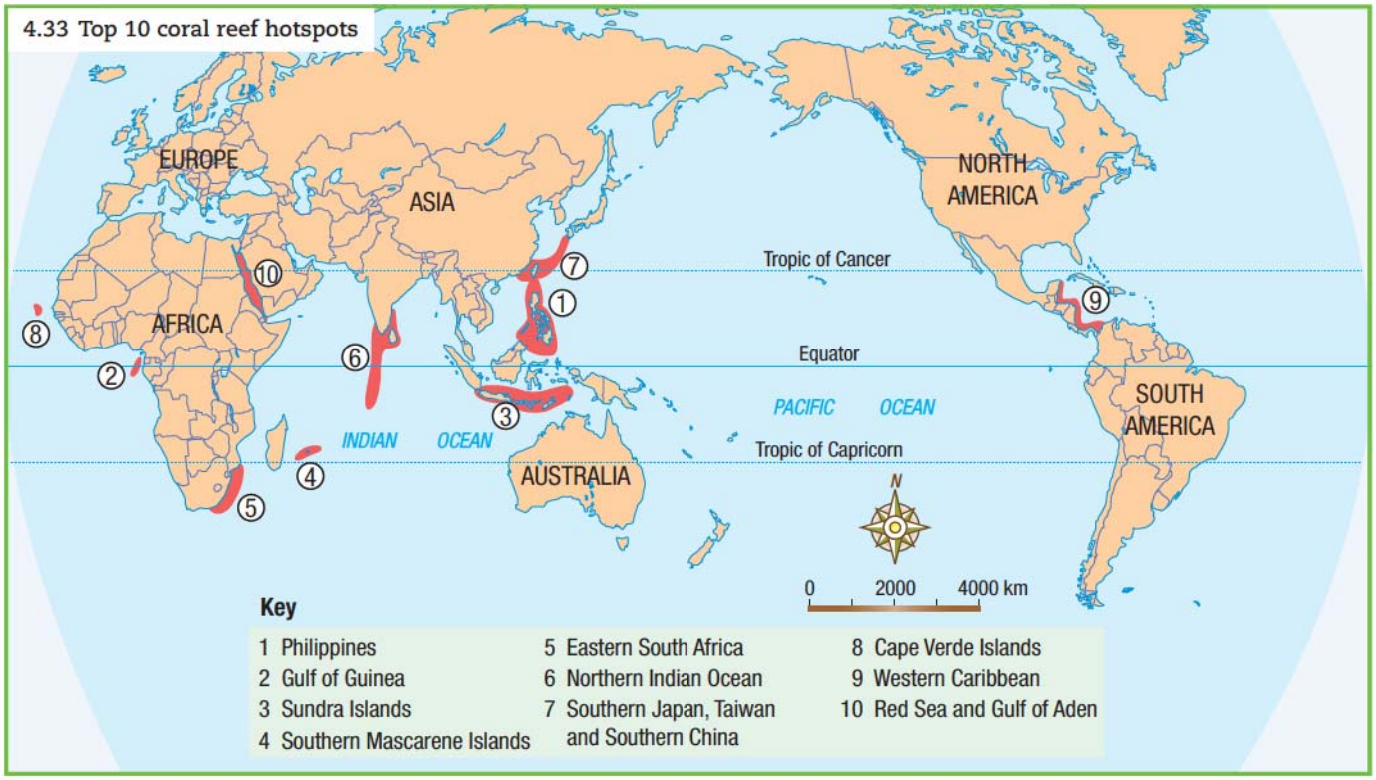
4.32 Climate change variations in Antarctica over 150 000 years



ppmv parts per million by volume—or parts per million in the atmosphere

ppbv parts per billion by volume—or parts per billion in the atmosphere

4.33 Top 10 coral reef hotspots



In addition, a rise in the sea level will cover some coral cays. This could mean that whole island communities in the Pacific Ocean will have to relocate. Some residents of Pacific atolls and cays have already had to move their homes to higher ground and are leaving the islands altogether, as in the case of Tuvalu.

Climatic change will also mean more frequent tropical cyclones which are very destructive to the coral reef. Cyclones are a natural threat that reefs are able to recover from but global warming will cause the number of tropical cyclones to increase, placing additional stress on reefs. Add to this the bleaching of reefs and their ability to recover from these events will be severely reduced.

Nature can cope with change over thousands of years but humans cause change in decades.

SOLUTIONS TO CORAL BLEACHING

While the 10 reefs most at risk shown in 4.33 can be protected from local threats, it will take a global approach to solve the coral bleaching issue.

Electricity generation is the biggest source of greenhouse gases—the pollution that is causing global warming. Existing world energy consumption is predicted to increase by 50 per cent in the next 20 years and the future for coral reefs cannot be assured. Countries and individuals need to think about how energy is used and the sources that it comes from. (This concept is explored further in chapter 10.)

Activities

Knowledge

1 What two impacts of global warming threaten coral reefs?
2 Why is water temperature important to coral reefs? How does a change in it destroy the reef ecosystem?
3 What will be the end result of global warming on coral reef ecosystems?
4 How long is it predicted to take before global warming affects all coral reefs?
5 Describe the impact global warming will have on island communities of the Pacific Ocean.
6 In what way will global warming cause tropical cyclones to have a greater impact on coral reefs?
7 What activity creates the most greenhouse gases? What is likely to happen to this pollution source in the future?

Skills

8 Refer to 4.32:
- a What is the relationship between the temperature change graph and the methane and carbon dioxide gas graphs?
- b Approximately how many thousands of years ago was the first rise in sea level?
- c What is the trend for the temperature graph over the past 100 years? Do you expect this trend to continue?
- d What relationship exists between sea level, temperature change and increases in methane and carbon dioxide?

Skills

4.9

Coral reef destruction—a global issue

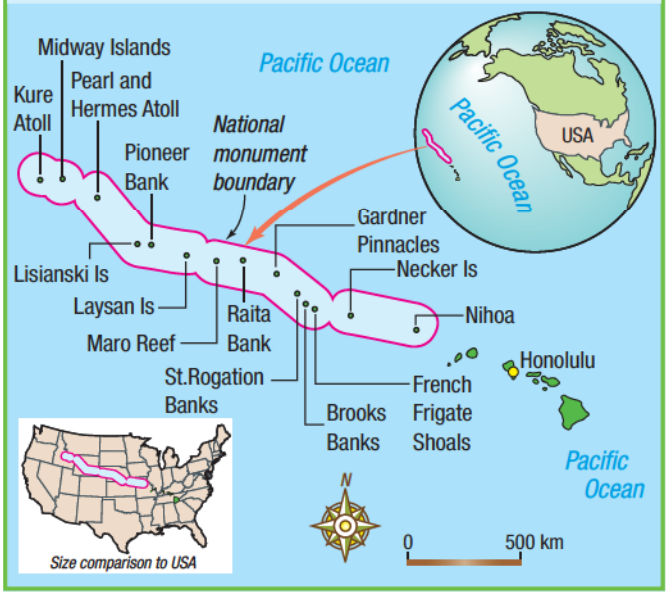
The destruction of coral reefs is a worldwide problem that the global community has to address. Responses come from all levels. At the global level the United Nations acts to protect and preserve these environments. There is also action from national governments and from international organisations.

GLOBAL TREATIES AND AGREEMENTS

Two treaties administered by the United Nations are:

- The World Heritage Convention—Twenty World Heritage sites contain coral reefs. The unique nature of corals is being protected in an attempt to protect all types of coral reef and as much biodiversity as possible.
- The Convention on International Trade in Endangered Species (CITES)—Member nations watch and monitor the trade in reef species. This is especially important considering the trade in seahorses has led to a 25 per cent decline in seahorse numbers and as the aquarium hobby increases the illegal trade in live coral and reef fish species also increases.

4.35 Protecting areas of the world's coral reefs in marine parks is an essential step in ensuring that they exist in the future.



4.34 Protests can be an effective way to raise awareness of the need to protect coral reefs.

GOVERNMENT PROTECTION

At the regional level countries cooperate to protect and preserve coral reefs. A part of this is the formation of protected marine parks. They are similar to national parks except that they are in the sea (see Snapshot).

NGOs

Non-government organisations—commonly known as NGOs—also get involved in preserving coral reefs. These organisations rely on people to take action at a variety of levels including the local level. The forms of action vary and can involve email campaigns, letter writing and even protests. If protests are planned wisely, they can attract media attention from around the world with the potential to raise pressure from nations as well as individuals. NGOs can also receive government funding for research activities.

INDIVIDUAL ACTION

Learning about the coral reef environment and the threats to it are the first steps towards exercising your rights as a global citizen. Geographical knowledge used the right way can be a powerful tool that can move countries and their organisations towards using the world's resources sustainably. Taking action in an informed way on environmental issues is one of the important things geographers do.

SNAPSHOT

Regional protection of marine areas

On 15 June 2006 the President of the United States signed a document that created the world's biggest marine reserve. The Northwestern Hawaiian Islands Marine National Monument covers an area of 363 000 square kilometres of the Pacific Ocean, stretching from the Islands of Hawaii to Midway and Kure atolls in the Pacific Ocean. It is one of the world's most isolated marine sanctuaries.

The park itself consists of largely uninhabited islands and contains 70 per cent of the United States' shallow water coral reefs that provide a habitat for 7000 marine species and 14 million seabirds.

Part of the protection of the area will involve controlling all human activities—even people wishing to visit parts of the sanctuary to snorkel and take photographs will need to get a permit. While its isolation remains the largest factor that will protect the marine reserve, other regulations have been put in place. All fishing will be banned, as will the removal of animals, especially coral.

The main aim of creating the reserve was to signal that the area needed to remain a totally natural environment.

SKILLS MASTER

Writing an email or letter

Email is rapidly taking over global communications and is an effective way to lobby leaders for global change. NGOs have email campaigns that you can easily be a part of to influence the future of the world, its people and its resources.

Why not have a go at writing your own. Pick an issue, work out who is responsible then get writing! Write to the organisation's leader or a representative of the group. This information can usually be found on a website. Your email or letter does not have to be long but it should follow this four-paragraph outline.

1. **Attention**—What are you concerned about? (Put in some facts and figures that highlight the issue.)
2. **Interest**—Why are you involved in this action? What is your interest?
3. **Desire**—What would you like to see happen? What solutions or actions need to happen to improve the situation?
4. **Action**—What do you require the organisation to do?

Make sure you spell all words correctly and that you use formal language.

The rest is up to you. Why not take what you learn in Geography and use it to make the world a better place?

Activities

Knowledge

1. At what scale does the United Nations act to protect coral reefs?
2. Describe how global conventions help protect coral reefs.
3. Describe one way countries can act to help protect coral reefs.
4. What are NGOs? List three forms of actions they may organise to protect coral reefs.

Skills

5. Read the snapshot:
   - a Describe the location and size of the Northwestern Hawaiian Islands National Monument marine park.
   - b What types of marine species will be protected by the creation of the marine park?
   - c What activities have been banned from the park?

Application

6. How can a well designed protest attract the attention of people in other countries? How effective do you think this form of action is in raising awareness of global issues?
7. Read the following email a student wrote supporting the creation of the Northwestern Hawaiian Islands National Monument marine park. Explain why you think this email would not be effective.

To: President of the United States
CC:
Subject: You Beauty m8

Hi Pres
Just hrd that u made the NWHINM marine park, that's gr8.
Ppl told me it was > the GBRMP and I LOL
Jst hrd, its tru
;)
Cul8r

8. Write another email following the 'attention, interest, desire and action' format to the president about his or her decision to create the Northwestern Hawaiian Islands National Monument marine park.

Surf