Environmental Studies
FACT SHEET
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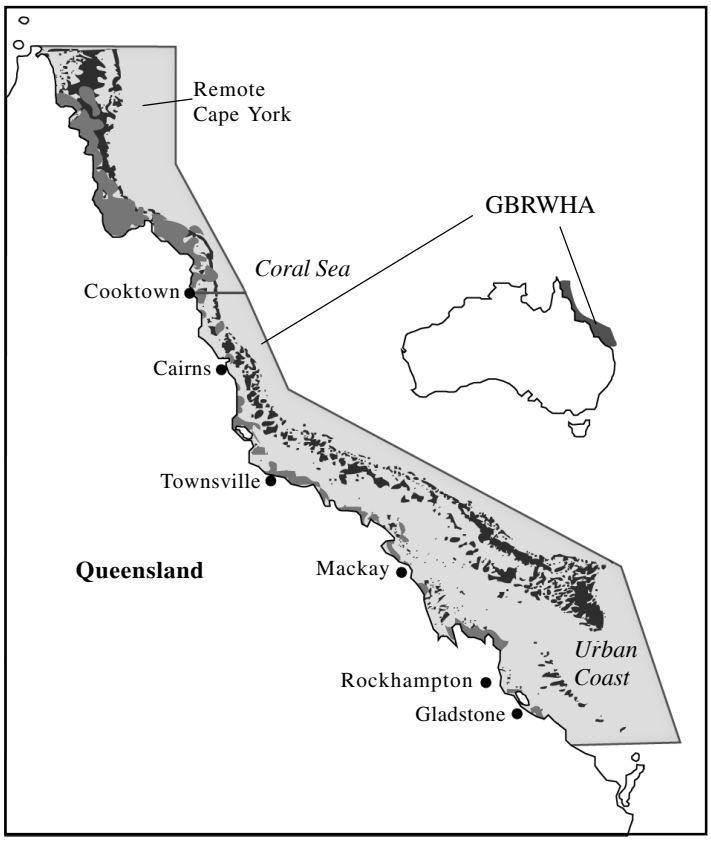
Number 118

Managing the Great Barrier Reef

Covering 348,000km^2 the Great Barrier Reef World Heritage Area (GBRWHA) of Queensland, Australia, is the world's largest World Heritage site (Fig.1).

Fig 1. Great Barrier Reef



Stretching over 2000km along Australia's north-east coastline, the GBRWHA is the world's largest system of coral reefs and includes lagoon, seagrass, mangrove and estuarine communities. (Table 1)

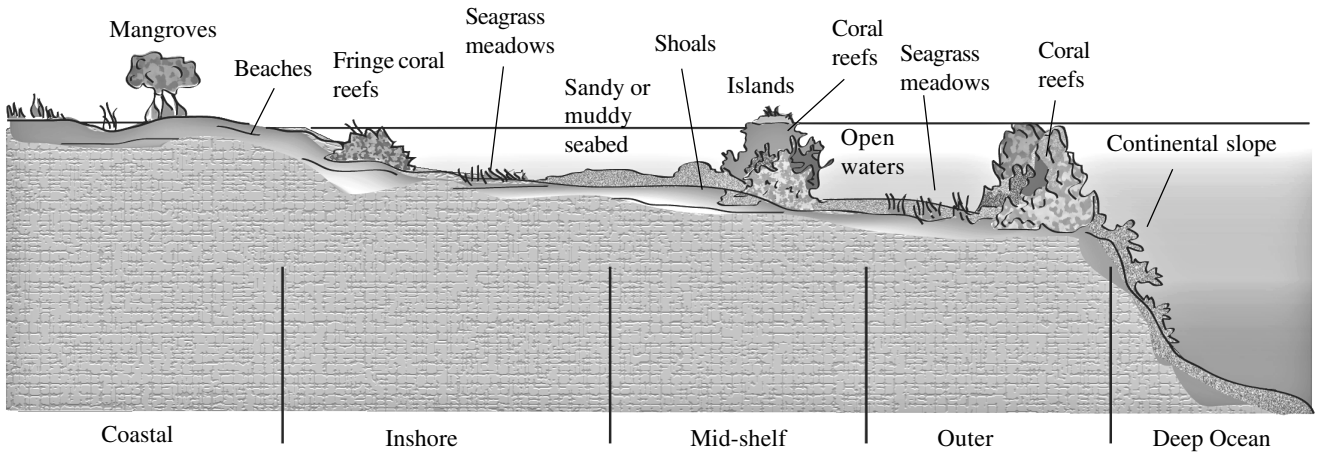
Table 1. Habitat type by area in the GBRWHA

Habitat type	% of the area
Seagrass, shoals and sandy/muddy seabed (<200m deep)	61
Deep ocean wters (>1000m deep)	16
Continental slope (200m – 1000m)	15
Coral reefs	7
Islands	1

These habitats support many endangered, rare or threatened species, thousands of species of coral, bony fish, sharks, rays, marine mammals, marine turtles, sea snakes and seabirds.

There are dramatic changes in the Great Barrier Reef ecosystem from the inshore coastal zone to the offshore outer reefs. As a result, most habitat and species variation occurs across the Great Barrier Reef rather than down its length (Fig2)

Fig 2. The Great Barrier Reef habitats



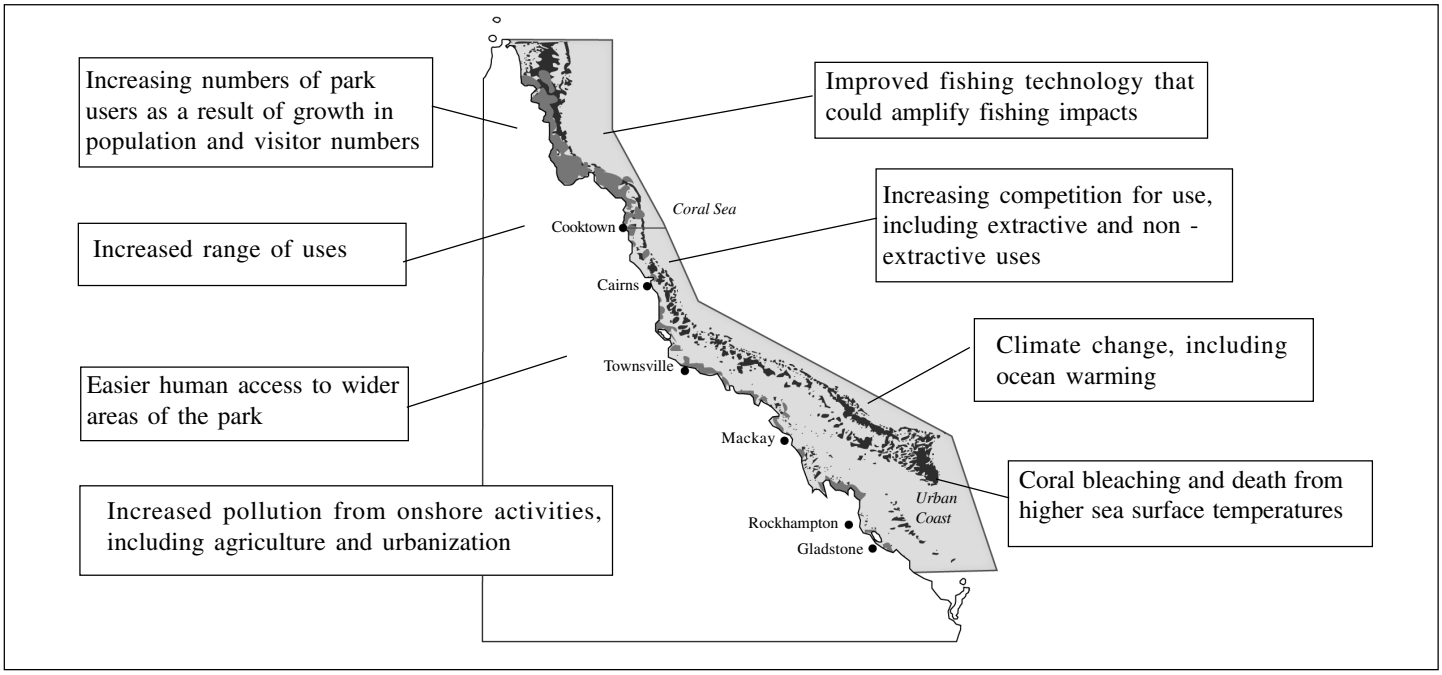
Threats to the reef

Coral reefs provide ecosystem services worth billions of dollars:

- food (including fish)
- coastal protection
- recreation
- tourism
- ecosystem maintenance

The Great Barrier Reef ecosystem, like others around the world is facing a diverse range of impacts (Fig 3):

Fig 3. Great Barrier Reef impacts



Coral bleaching

Most corals live in partnership (symbiosis) with single-celled algae (zooxanthellae). Corals provide protection and nutrients for the algae, and the algae produce food for the coral and give it its colour. When corals are under stress, e.g. when they are too hot, they expel their zooxanthellae, thus losing their colour and appearing bleached. Corals can survive for days or weeks without the algae, but if they are stressed for too long or too severely and do not regain algae, they die.

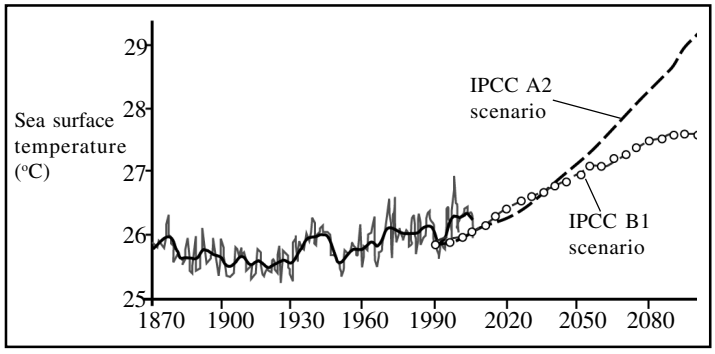
This affects many food chains. The fish and other organisms dependent on the living coral also die if they cannot move elsewhere. In turn, the fish and other animals higher up the food chain (including the top predators) also either die or move elsewhere. The overall effects are less coral cover, lower species diversity and numbers, the dominace of more hardy coral species and higher concentrations of algae.

Mass coral bleaching was virtually unknown in the Great Barrier Reef region before 1979. Such bleaching episodes now occur frequently.

Rising sea temperatures

Average sea temperature fluctuates from year to year, but the trend is that it is increasing. Fig. 4 shows the trend and two future scenarios from the Intergovernmental Panel on Climate Change (IPCC)

Fig.4 Observed and predicted sea surface temperatures on the Great Barrier Reef



Rising sea levels

Sea level on the Great Barrier Reef has already risen by approximately 3mm per year since 1991. This has been due to a combination of thermal expansion in the oceans and ice melting.

Many habitats are shallow and we do not know how the organisms that live there will respond to deeper immersion. Tidal habitats in mangroves will also alter and low-lying freshwater habitats will become saline.

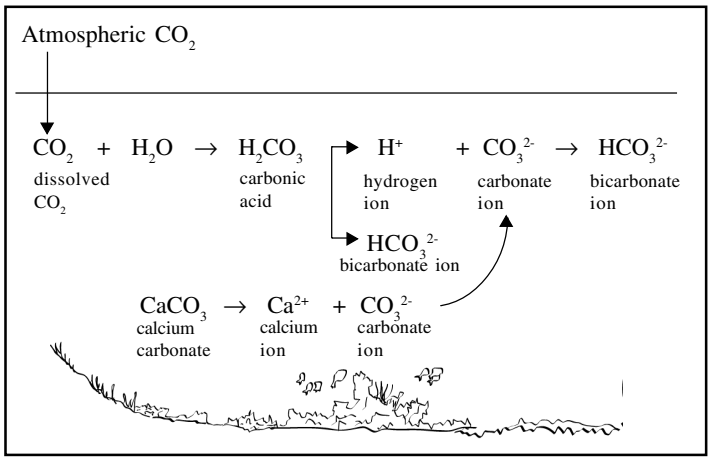
Increased weather variability

Although the total number of cyclones affecting the reef has decreased over the last 20 years, the number of severe cyclones capable of damaging the reef has increased. However, it is extremely difficult to predict what effect global climate change will have on weather or hazardous climatic events in the region….

Ocean acidification

This is likely to be the most significant climate factor affecting the Great Barrier Reef ecosystem. When carbon dioxide dissolves in seawater some of it forms carbonic acid which reacts with carbonate and bicarbonate ions in the ocean causing the former to change to the latter (Fig 5).

Fig 5. Ocean acidification



As the concentration of atmospheric carbon dioxide increases, it overwhelms the capacity of phytoplankton to take it up. It also decreases the carbonate ion content of the ocean surface waters causing a decrease in pH. Corals need carbonate to build reefs and even relatively small increases in ocean acidity decrease the capacity of corals to build skeletons which in turn decreases their capacity to create habitat for reef biodiversity in general.

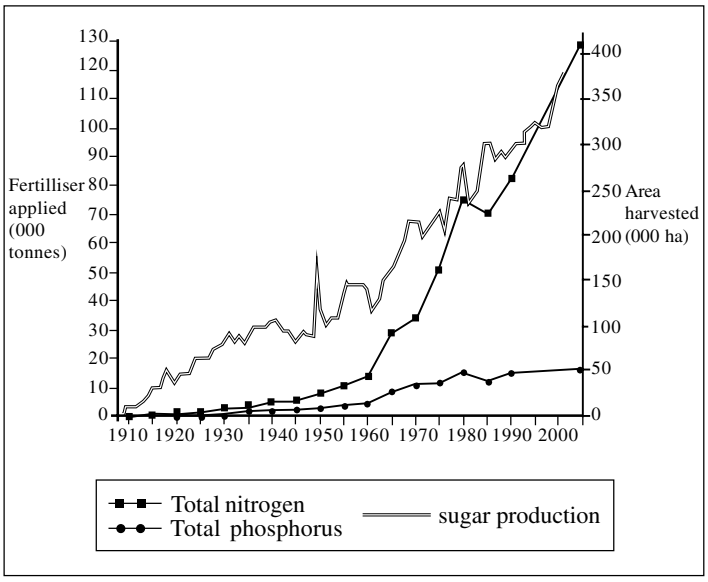
Catchment runoff

The Great Barrier Reef receives the runoff from 38 major catchments which drain 424 000 km^2 of coastal Queensland.

Declining water quality is becoming a major threat to the ecosystem. The problems are **fertilsers, pesticides** and **sediments**

Increased use of artificial fertilizers (Fig 6) by farmers growing grain and sugar has significantly increased the amount of dissolved inorganic nitrogen and phosphorus that is entering the Great Barrier Reef.

Fig 6. Fertiliser use in the Great Barrier Reef



The use of pesticides (including herbicides, insecticides and fungicides) continues within the Great Barrier Reef catchment particularly in areas under crop cultivation. Currently, seven herbicides (diuron, atrazine, ametryn, simazine, hexazinone, 2,4-D, and tebuthiuron) are in widespread use in the catchment.

Activity

Use the internet to identify which, if any, of these pesticides are persistent and which has the longest half-life.

These pesticides are being widely detected in the waters and animals of the Great Barrier Reef. If herbicides end up killing primary producers in the Reef, they will harm entire food chains and damage food webs.

Most **sediment** comes from catchments that have large grazing areas. Clearing land to establish pasture increases soil erosion, as does overgrazing. Increased sediment has also resulted from forest clearance for sugarcane.

Increased sediments damage the ecosystem by reducing light penetration, smothering coral and other small invertebrates and transporting nutrients and pesticides into the Reef.

Managing the GBRWHA

The GBRWHA is managed according to a 25-year Strategic Plan for the Area. The Plan was developed by more than 60 user and interest groups, indigenous peoples and government agencies. Besides protecting the area from several threats, both natural e.g. cyclones and man-made e.g. overfishing, the Plan has to ensure that indigenous people, tourists and scientists are all able to co-exist.

The main management tool involves **space zoning**. This aims to minimise conflict between different user groups

Specific measures used to prevent **overfishing** include:

- All trawlers must have electronic devices to reduce bycatch (unwanted species caught in the nets) and that prevent them from catching turtles in their nets
- All boats catching prawns must be fitted with satellite tracking devices, to enable the authorities to track their location on the Great Barrier Reef

Other measures target **tourists**:

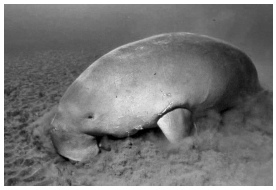
- Tourist tickets include an environmental management fee which is used to pay for ongoing scientific research on the Great Barrier Reef
- Limits on the number of tourists have been introduced in some highly used areas
- Extensive use of moorings and markers to try to reduce damage to the coral substrate by anchoring, snorkelling and diving

Measures that target **agriculture and industry** include:

- Agricultural 'Best Practice' codes to address environmental problems caused by industries such as sugar, dairy, horticulture, cotton and aquaculture
- Farmers are encouraged to adopt sustainable farming practices

Measures to **protect particular species** include:

- 16 dugong protection areas
- Whale, dolphin and turtle policies for the entire Great Barrier Reef
- Control of the numbers of crown-of-thorns starfish at some high use tourism sites
- A Representative Areas Program to protect areas of the Great Barrier Reef that 'represent' different habitats and animal and plant communities



Globally significant populations of the dugong (*Dugong dugon*) or sea cow inhabit the shallow inshore waters of the GBRWHA and are one of several reasons for the region's World Heritage listing.

Dugongs are listed globally as vulnerable by the World Conservation Union (IUCN) and their conservation is important for several reasons:

- They are the only herbivorous mammal that is strictly marine
- They have high cultural and nutritional value to indigenous Australians
- They are regarded as a **flagship species** by non - indigenous Australians

Threats to dugongs or their sea grass habitats include indigenous hunting, physical injury from ships and boats and poor water quality resulting from terrestrial runoff. To try to reduce bycatch of dugongs and other valuable species, in 2004 a new Zoning Plan was introduced.

Previously, just 4.5% of the Area had been designated as no-catch zones in which no commercial netting or trawling was allowed. 80% of this area was reef, thus protection in seagrass beds, lagoons and deep waters was very poor. The new Zoning Plan increased this to cover 33% of the Great Barrier Reef Marine Park and the contiguous Great Barrier Reef Coast Marine Park. This has greatly improved protection of the range of biodiversity within the Park, while still allowing activities such as boating, swimming, sailing and snorkeling.

Tourism programs are allowed in all zones except the Preservation Zone, but permits are required which aim to avoid conflicting activities e.g. bird watching and speed boating in the same area at the same time (Table 2)

Characteristics of no-take areas

Characteristic	Reason
At least 20 km long on the smallest dimension. Better to have fewer, larger areas than many small areas	Adequate area to provide for the maintenance of populations of plants and animals and to minimise edge effects resulting from use of the surrounding areas
Have 3 or 4 NTAs in each bioregion	Provides an insurance policy if one NTA is damaged
Where a reef is incorporated into an NTA, include the whole reef, not just a part of it	Reefs are relatively integral biological units with a high level of connectivity among habitats within them
Include some proportion of every habitat	All habitats are in some ways interconnected so the only way to protect fully any individual type is to protect a past of each one

These measures, and others were designed to:

- maintain biological diversity of the ecosystem, habitat, species, population and genes
- allow species to evolve and function undisturbed
- provide an ecological safety margin against human-induced impacts
- provide a solid ecological base from which threatened species or habitats could recover
- maintain ecological processes and systems

Table 2. Allowed activities in GBRMP zones

Activity	Zone						
	General use	Habitat protection	Conservation park	Buffer	Scientific Research	Marine National Park - no take	Preservation - no go
Trawling	allowed						
Netting	allowed	allowed					
Bat netting, crabbing Snorkel spearfishing, line fishing	allowed	allowed	allowed				
Limited collecting	allowed	allowed	allowed				
Trolling	allowed	allowed	allowed	allowed			
Boating, diving, photography	allowed	allowed	allowed	allowed	allowed	allowed	
Traditional uses of marine resources	allowed	allowed	allowed	allowed	allowed	allowed	
Limited impact research	allowed	allowed	allowed	allowed	allowed	allowed	permit
Dive-based fishing	permit	permit					
Aquaculture	permit	permit	permit				
Shipping	allowed	permit	permit	permit	permit	permit	
Tourism program	permit	permit	permit	permit	permit	permit	
Research	permit	permit	permit	permit	permit	permit	permit

Indigenous groups

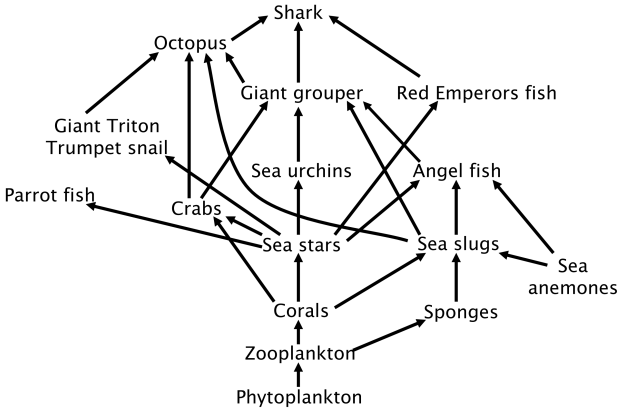
However, Management Plans must also incorporate the rights and wishes of the people who actually live in the area. The region is home to over 70 indigenous groups, all of whom claim country states i.e. they believe that the land/reef/water is legally theirs.

In 1992 the High Court agreed with them and recognised (for the first time) that indigenous Australians were the first and original occupants of Australia.

Subsequent court decisions established that indigenous peoples have rights to their sea country and estates, although these rights do not give exclusive access and use. The GBRWHA 25 year management Plan attempts to incorporate these rights whilst also ensuring the conservation of wildlife species and habitats.

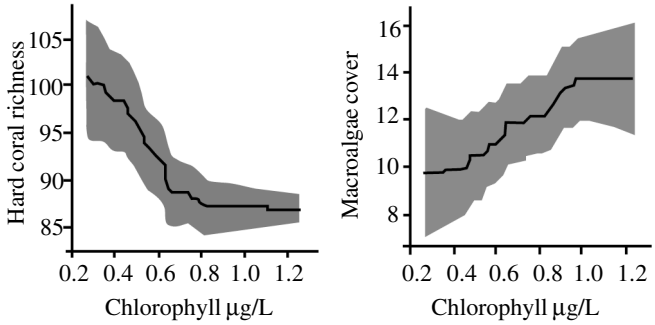
Practice Questions

1. The diagram shows a food web on a coral reef



(a) Use the diagram to explain why a coral reef can be described as an ecosystem (2).
(b) Explain why it is difficult to predict the effect that shark overfishing world have on the coral (5)

2. The graphs show the relationship between chlorophyll concentration in seawater and the quality of the coral ecosystem.



` Chlorophyll concentration can be used as an index of coral ecosystem health. Explain how. (3)

3. Outline the threat to the Great Barrier Reef from each of the following.
(a) Increasing sea-surface temperature (2)
(b) Decreasing ocean pH (2)

Markscheemes

1. (a) Community of organisms;
Interacting/ref to trophic levels/feeding;
(b) Coral predators increase or decrease;
↑ Giant Grouper → ↓ Sea Urchin →↑ Sea Star → ↓Coral;
↑ Giant Grouper → ↓ Crabs → ↑Coral;
↑ Giant Grouper → ↓ Sea Slug → ↑Corals;
↑ Red Emperors Fish → ↓ Sea Star → ↑Coral;
↑ Giant Grouper → ↓ Angel Fish → ↑ Sea Star → Coral;
↑ Octopus → ↓ Crabs → ↑Coral;
↑ Octopus → ↓ Crabs → ↑Sea Star → ↓Coral;
etc.

2. Nutrients/nitrates/phosphates entering water cause growth of macroalgae/ algal blooms etc;
Reduced water clarity/increased turbidity;
Less hard coral diversity;
Ref to expulsion of algae/zooxanthellae;

3. (a) Causes coral bleaching;
Without the algae/ zooxanthellae, the coral eventually die;
(b) Reduced carbonate levels;
Needed to make the coral skeleton/ shells etc;

Acknowledgments: This Factsheet was researched and written by Kevin Byrne. *Curriculum Press, Bank House, 105 King Street, Wellington, Shropshire, TF1 1NU*. Environmental Science Factsheets may be copied free of charge by teaching staff or students, provided that their school is a registered subscriber. **ISSN 1351-5136**