4. THE GREAT BARRIER REEF

A WORLD TREASURE

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The Great Barrier Reef is a collection of many underwater habitats, from shallow sea-grass beds to the clear waters and coral reefs of the outer shelf. They are connected through the currents that wash over them, and the animals and plants that use them for food and shelter during their life cycles. The varied seascape we see today has been moulded by changing climates, and the erosive power of water, over long periods of time. This chapter takes a tour of some of the main habitats found across the Great Barrier Reef, describing their formation and influence on the seascape, and how wildlife makes use of them.

A complex seascape

To swim or scuba dive on the Great Barrier Reef where the water is clear and the coral pristine, rates as one of life's big adventures. Fleets of vessels take travellers from Cairns and Port Douglas to explore the vast coral gardens swarming with fish, or to walk the sandy cays and rocky islands that dot the coast. Yet few visitors would know that in the deeper waters, beyond the limits of scuba diving, is a vast world of underwater habitats every bit as rugged and complex as those on land. Ocean scientists are now utilising advanced remote sensing technologies to explore these hidden realms. Their new 'eyes' provide images of the seabed, from the shallow coastal zone and the clear waters of the continental shelf, to the deep abyss beyond the limits of light.

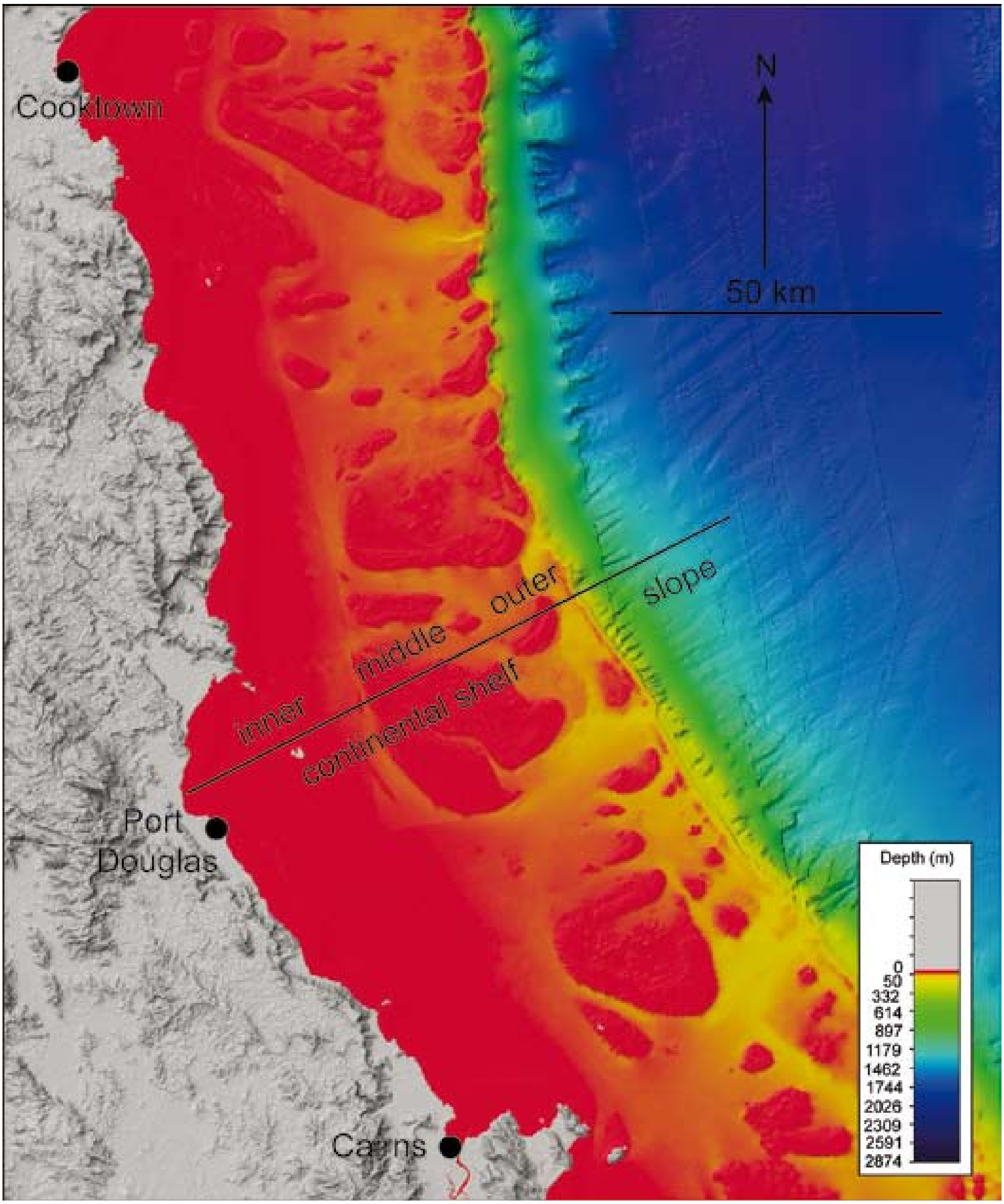
The detailed remote sensing images reveal a complex seascape shaped by the interplay of tropical marine growth with the natural forces of water, air and time. Studies show that the continental shelf, upon which the reefs have grown, has been exposed and flooded by at least four to five glacial/interglacial cycles within the past 500,000 years. During glacial periods, the Earth cooled, more ice was locked up in polar regions, and the sea-level dropped by as much as 120 m. The vast Queensland continental shelf was uncovered and the coral reefs were exposed to the air, to stand out as great flat-topped hills of eroded limestone. Large rivers meandered between the limestone hills delivering sediment to a coastline much further to the east. During interglacial periods the Earth warmed and sea-levels rose, so the ocean flooded the continental shelf again, pushing the coastline westward. A new phase of coral growth was triggered once the warmer seas covered the limestone hills. Each cycle of lower and higher sea-levels left an imprint on the varied habitats that contribute to the modern Great Barrier Reef.

The continental shelf – edge of Australia

Let's take a tour of some of the main underwater habitats across the continental shelf, remembering that they are all interconnected through the waters that swirl over them, and the myriad animals and plants that use them for food and shelter.

The continental shelf is actually the gently sloping, submerged edge of the Australian continent. Off Cairns, the shelf is about 50 km wide and is usually divided into three parts: 1) an inner shelf from the coast to about 30 m depth; 2) the middle shelf from approximately 30 to 50 m depth; and 3) the outer shelf from 50 to 100 m. Beyond the shelf edge is the continental slope, which is a region of steep slopes with depths over 100 m.

What underwater habitats will we discover as we venture across the continental shelf and then further offshore?



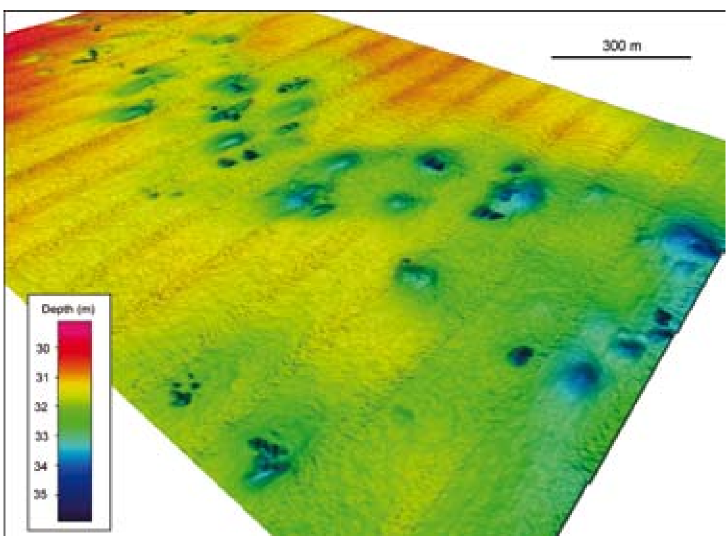
Regional bathymetry model of the northern Great Barrier Reef divided into the inner, middle and outer continental shelf, and the continental slope.

The inner shelf – coast meets the sea

The shallow seabed of the inner shelf is easily disturbed by waves and along-shore currents driven by strong trade winds, which stir up fine sediments and reduce the light to the seabed. Yet these waters are home to great beds of *sea-grass*, which are the nurseries of juvenile fish and crustaceans that make up some of our most productive fisheries. The sea-grass is also the favoured food of the shy dugong, and the beds are therefore a critical habitat for the survival of this animal. The sea-grass is commonly found in quiet waters of less than ten metres depth, but it may form dense meadows many kilometres wide, stabilizing the seabed through its vast shallow root systems, in much the same way as a vegetated paddock reduces erosion on land.

A possibly unexpected habitat near the coast occurs around the *turbid-zone reefs*, which comprise corals especially adapted to waters with high sediment loads and low light conditions. These reefs have little relief, being only a few metres high, but they may be hundreds of metres wide. Unlike the more familiar reefs offshore which grow on a base of solid limestone, they grow on a base of loose coral fragments. They may be easily destroyed by wave action during cyclones, but continue to exist because of their particular coral species that can tolerate much disturbance and sediment transported along the near-shore zone.

Eastwards from the inner shelf the seabed gradually deepens to below 20 m, but is interrupted in places by channels of ancient rivers that meandered across the exposed shelf during lower sea-levels. Today, these ancient river channels are mostly infilled with the sediment that sweeps along the coast. Occasionally, depressions many metres wide and a few metres deep are found in the seabed, where freshwater springs emerge from underground channels which follow the ancient rivers. These so-called *'wonky holes'* look like a string of small holes that cross the shelf, and they are associated with localised communities of soft corals growing at their edges.

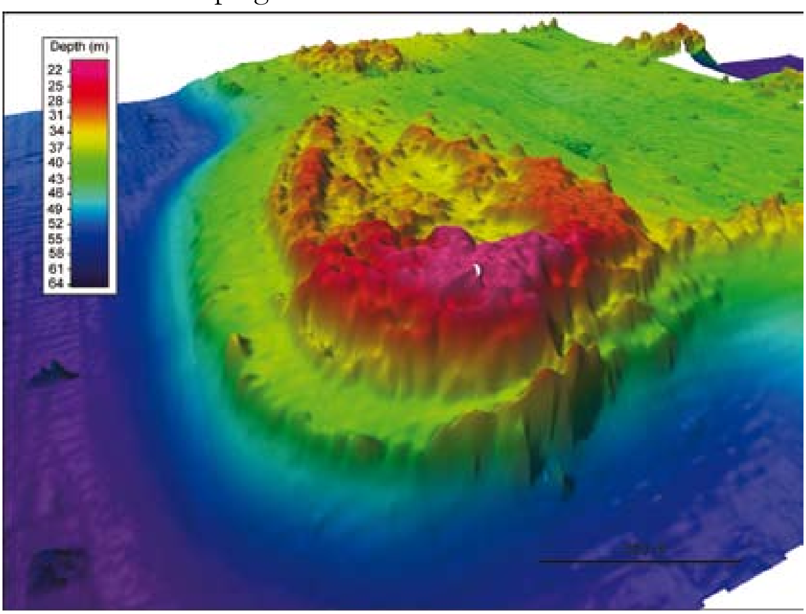


Bathymetry model of 'wonky holes' on the inner shelf. The depressions follow the line of an ancient river, which is now filled in.

Fringing reef at Cape Tribulation.

The middle shelf – a patchwork of reefs

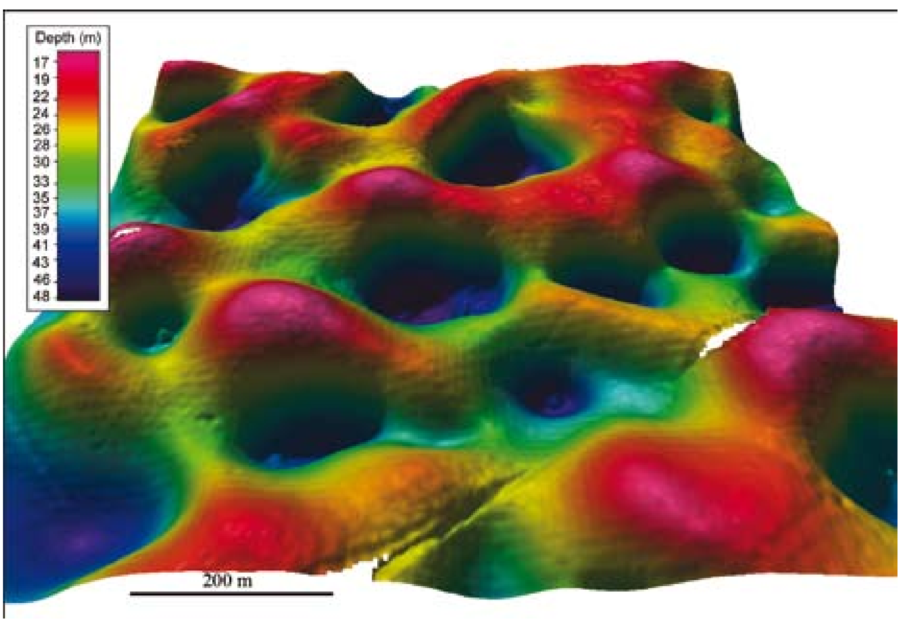
As we cross towards the middle shelf, depths drop to below 30 m and the water becomes clearer, due to reduced disturbance of the seabed by winds and tides and the greater distances from sediment-laden rivers. Here we arrive at the first of the *patch reefs,* which make up the majority of the coral reefs visited by travellers to the Great Barrier Reef today. While we only see the top ten metres or so of living coral when snorkelling, these patch reefs actually rise about 30 to 40 m above the surrounding seabed. They have been constructed by successive layers of coral building on older reefs that were left behind from earlier high sea-level phases. The deeper and older parts of these reefs show up as a series of eroded terraces that ring the modern reefs. These terraces provide the habitats of deep-water, hard corals and waving stands of soft corals that feed on the plankton drifting in the currents sweeping around the bases of the reefs.



Bathymetry model of a patch reef. Note the deeper and older terraces that ring the red-coloured modern reef.

Patch reef from the air.

Coral is not the only organism that forms reefs on the Great Barrier Reef. To the north of Port Douglas, vast areas of the seabed have unusual ridges and mounds tens of metres in height, which have formed through the very productive growth of a green algae called *Halimeda*. This coralline algae forms branches of small segments which break off once dead, and provides a huge proportion of the calcareous sediment that accumulates on the seabed of the Great Barrier Reef. The ridges and mounds of these *Halimeda* reefs may be tens of kilometres in width and rival the area covered by the nearby coral reefs. The *Halimeda* reefs owe their existence to the presence of nutrients from deep oceanic waters that upwell onto the continental shelf during the tides that daily ebb and flow across the outer shelf.



Bathymetry model of a *Halimeda* reef. Note the large (~200 m) mounds that have built up through algal growth. (White gaps result from missing data).

The outer shelf – gateway to the Great Barrier Reef

Forming a great rampart along the very edge of the continental shelf are the *outer barrier reefs*. The best known are the Ribbon Reefs that run for over 100 km north of Port Douglas. Here, diving or snorkelling is at its most spectacular as the coral is bathed by the clear oceanic waters of the South Subtropical Current. In the protected lagoons leeward of these reefs coral and clam gardens shelter enormous schools of colourful fish, while on the windward exposed sides, vertical walls are interrupted by deep chasms cleft into the reef through wave action and erosion.

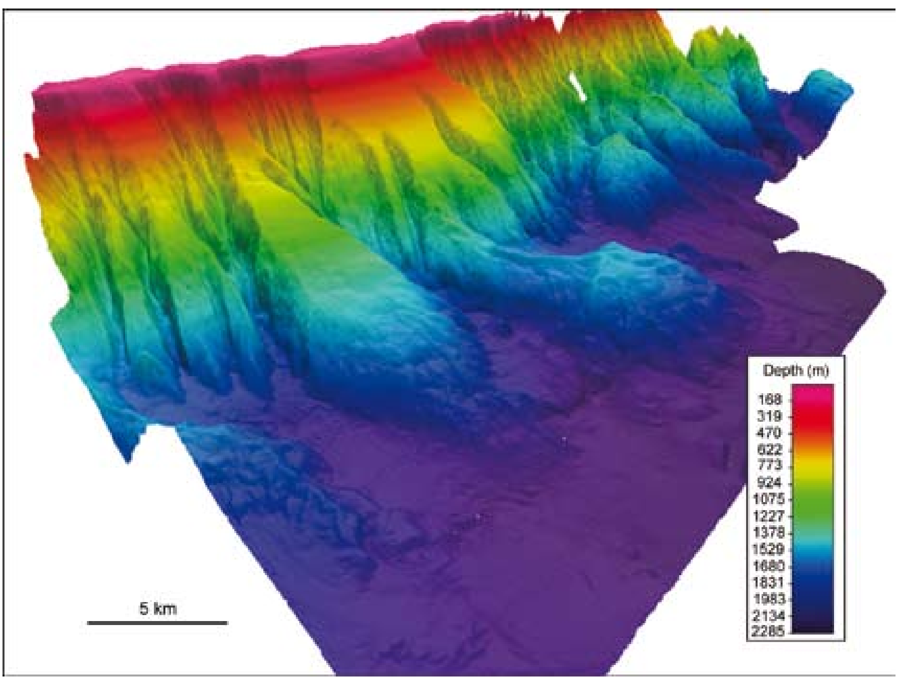
Separating each individual outer barrier reef are wide inter-reef passages about 40 to 50 m deep, which allow tides to flush the Great Barrier Reef each day. Some deeper ones, over 70 m deep, are actually the floors of the ancient river channels that have repeatedly cut into the shelf at lower sea-levels. These passages provide a pathway for large fish migrating between the deep ocean and the Great Barrier Reef lagoon, as well as the countless plankton that nourish the animals and plants on the shelf.

Two views of the outer barrier reefs.

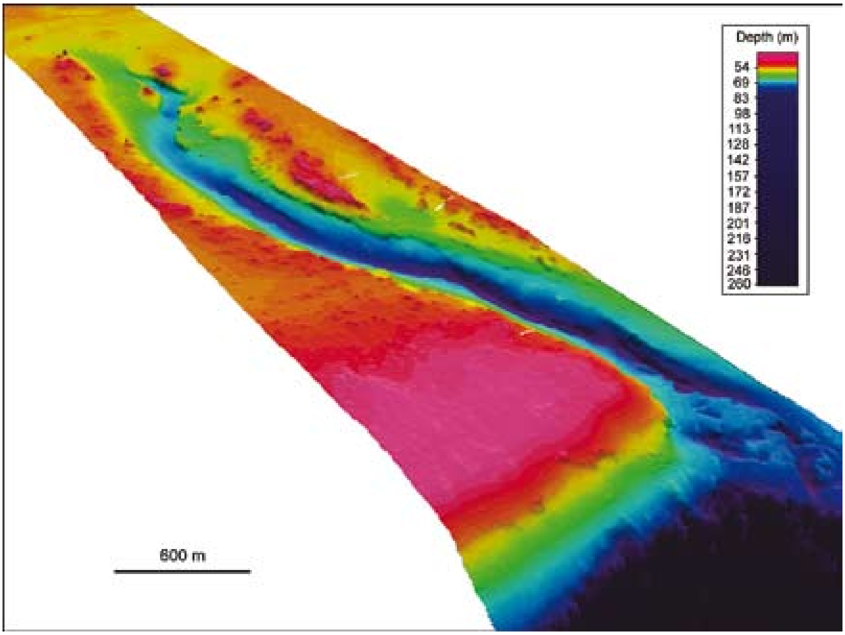
The continental slope – into the abyss

Seaward of the outer barrier reefs in about 100 m of water, the seafloor begins the steep drop that marks the start of the *continental slope*, which does not flatten out until reaching the abyssal plain at depths of over 1000 m. On the northern Great Barrier Reef the continental slope has an underwater terrain that is just as rugged as any of the mountain ranges lying to the west of Cairns. Cutting deeply into the slope are dozens of submarine canyons which carry sediment shed from the continental shelf into the deep abyss. The canyons are the conduits for the enormous debris slides and slump deposits found at the base of the continental slope which spread for tens of kilometres across the flat, abyssal plain.

The continental slope and its submarine canyons are habitats for strange deep-sea fish and plankton that migrate vertically into the shallower waters at night, before swimming back to the dark depths by daytime. Great oceanic fish, such as the famous blue marlin and the whale shark, feed at the heads of these canyons at different times of the year, cued into the vertical migration patterns of their prey food. Another discovery is the presence of cold-water coral ecosystems on huge blocks which have broken off the Great Barrier Reef margin, and slid down the slope to finally come to rest in the deep abyss. These mounds which are over 100 m high and several kilometres long, have cold-water corals, molluscs and polychaetes clustered on their surfaces, living in absolute darkness. What new and amazing underwater habitats remain to be found in the deep Great Barrier Reef?



Bathymetry model of the continental slope and the abyssal plain seaward of the Ribbon Reefs.



Bathymetry model of an ancient river channel cutting through the outer shelf.

Interconnected habitats

Recognising that the Great Barrier Reef World Heritage Area is not just the beautiful coral reefs, but is actually a vast collection of interconnected, broad-scale habitats or bioregions, the Australian Government commenced a Representative Areas Program in 2004 that culminated in over 30% of each bioregion being protected within 'no-take' zones. The people of North Queensland are therefore the custodians of one of the largest marine parks on the planet, which will protect the magnificent wildlife and resources for generations into the future.