Coral reef case study: Andros Barrier Reef, Bahamas

The Andros Barrier Reef is part of an extensive coral reef system in the Bahamas, off the south-east coast of Florida, USA (Figures **6** and **7**). The entire reef is the third most extensive coral reef system in the world. A 'barrier reef' is so-called because it forms a linear feature parallel to the shoreline separated from it by a wide lagoon.

The Andros Barrier Reef stretches for approximately 200 km and is separated from the land by a shallow lagoon with mangrove forests. The outer edge of the reef is marked by a steep drop to a depth of over 2000 m known as the 'Tongue of the Ocean'.

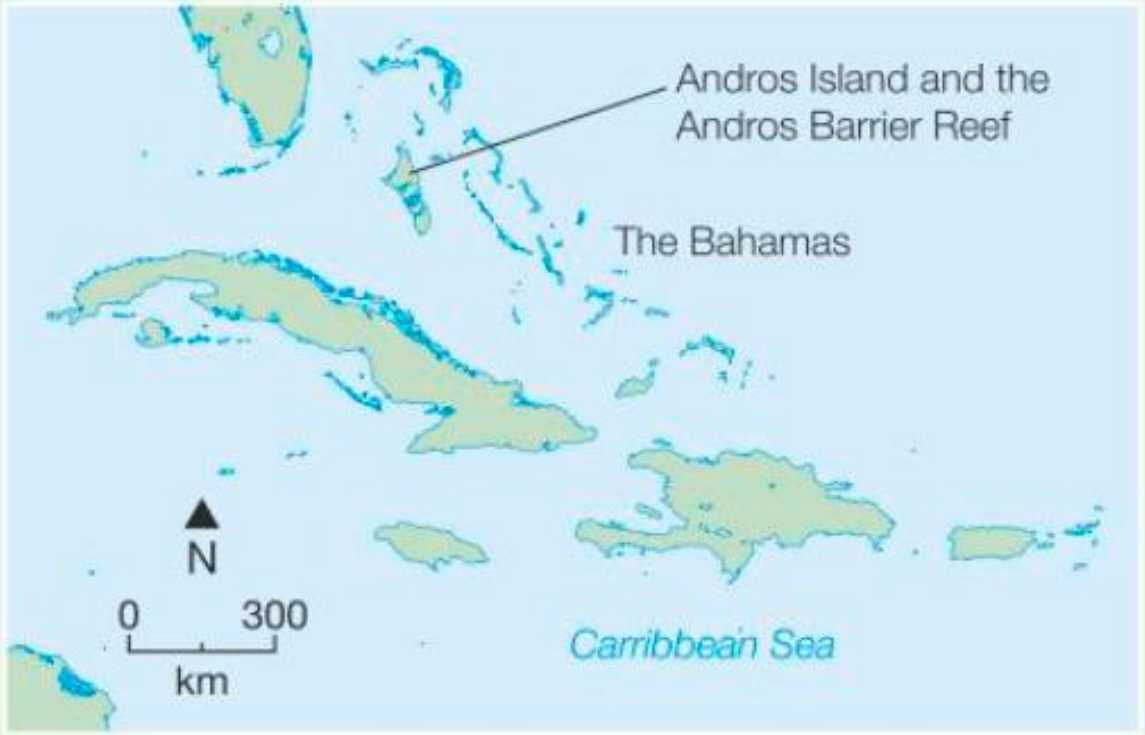

Figure 6 *Location of the Andros Barrier Reef, Bahamas*

1. **Where is the Andros Barrier Reef?**
2. **Why is it so important?**
3. **What is the Tongue of the Ocean?**
4. **Do some research on the Tongue of the Ocean? What is happening there?**

https://www.youtube.com/watch?v=a39XvoB7_Vo&t=21s

Ecological characteristics of the Andros Barrier Reef

The warm tropical Bahamian climate is ideal for coral reef formation. The waters are relatively free from pollution and silt and there are no significant rivers discharging into the sea to upset the balance of salinity. The clear water enables maximum penetration of sunlight so that zooxanthellae and phytoplankton can flourish and photosynthesise effectively. Remember that the ecosystem would not survive without phytoplankton.

As a result of its favourable environmental conditions, the Andros Barrier Reef is extremely biodiverse and recognised as one of the healthiest reef systems in the world. Scientists estimate that over 160 species of fish and coral make up the reef community. They include red snapper, reef shark, rock lobster, sharp nose puffer and green turtle, together with many colourful species of coral (Figure **8**).

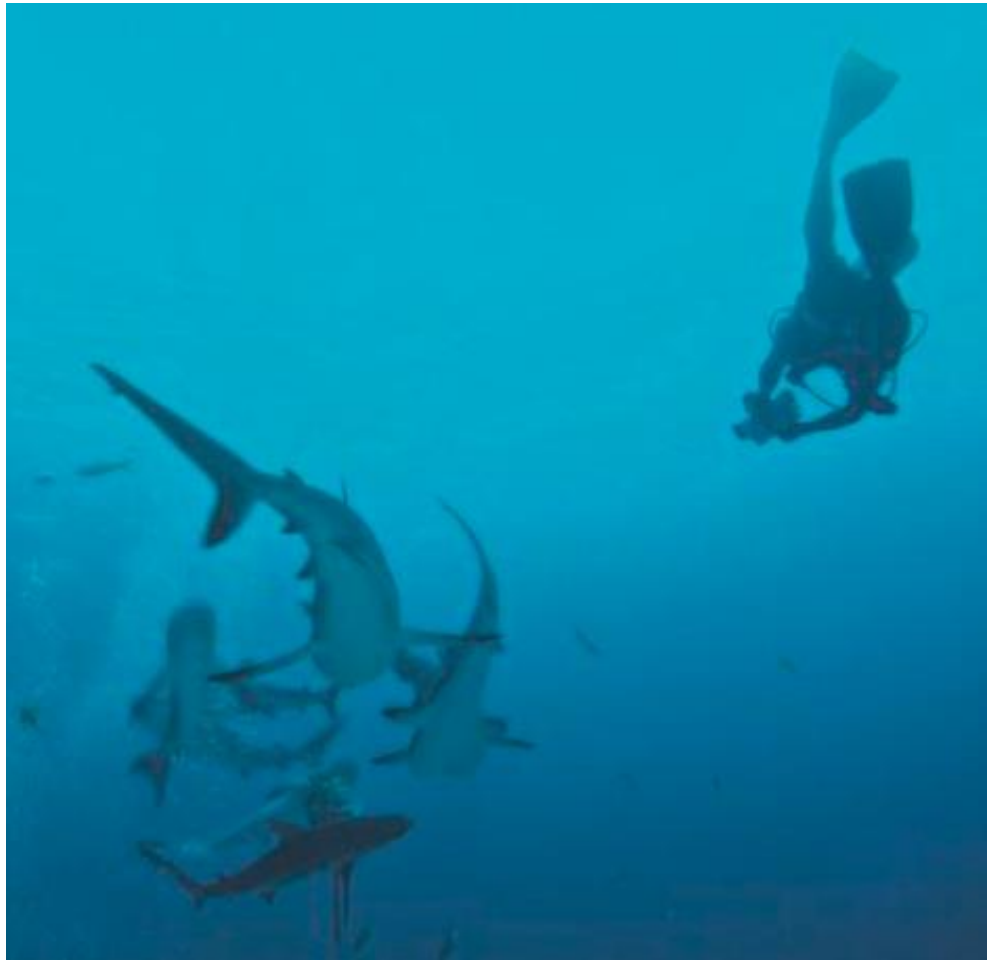

Figure 8 *Diving with Caribbean reef sharks*

1. Why is the Andros Barrier Reef recognised as one of the healthiest reef systems in the world.

What are the values of the Andros Barrier Reef?

The Andros Barrier Reef is important for several reasons.

- Coastal protection – acts as a buffer zone, providing vital shoreline protection from storms and tsunami, for example Hurricane Sandy in 2012. The shallow water above the reef forces waves to break early before reaching the islands. While this reduces coastal erosion and the risk of flooding on land, it can be quite destructive to the coral reef itself.
- Fish breeding grounds – creates sheltered conditions for the growth of mangrove forests, which themselves are important breeding grounds for fish. Fish are important commercially and for tourism, as well as being vital elements in the reef ecosystem. In the Bahamas, local and export markets for snapper, grouper, lobster and conch generate millions of dollars.
- Tourism – commercial and recreational activities such as fishing, sports-fishing, cruising, snorkelling and scuba diving bring in over US$150 million per year. The vertical wall of the 'Tongue of the Ocean' and sunlight penetration due to its east-facing aspect makes Andros Barrier Reef one of the most spectacular diving experiences in the region (Figure **9**).
- Healthy coral reef – widely recognised as being one of the healthiest reefs in the world, the Andros Barrier Reef is a superb outdoor laboratory for scientific research. In particular, it acts as a useful control in assessing environmental changes taking place in coral reef ecosystems elsewhere in the world.

Figure 9 *Scuba diving the Tongue of the Ocean off the Andros Barrier Reef*

1. Make a mind-map showing why the Andros Barrier Reef is so valuable.

Impacts of human activity on the Andros Barrier Reef

Climate change

Perhaps the most significant, although indirect, human impact on coral reefs involves climate change. The increased quantities of carbon dioxide in the atmosphere have been counterbalanced to some extent by increased absorption (sequestration) in the oceans. While this may appear to be a good thing in helping to reduce climate change (less carbon dioxide in the atmosphere means less enhanced greenhouse effect), it has led to an increase in ocean acidification, which scientists believe is a key factor in the decline of coral reef ecosystems.

When carbon dioxide is absorbed in the ocean, it reacts with seawater to increase acidity. If the water becomes too acidic it dissolves the calcium carbonate corals that molluscs and creatures such as crabs and lobsters need to build their shells and stony skeletons. It has been estimated that in the Andros Barrier Reef, coral calcification may decline by as much as 10 per cent by 2040 due to ocean acidification.

Higher water temperatures resulting from climate change can trigger a stress reaction in corals, causing them to expel the zooxanthellae. This has a huge effect on nutrient flows and causes the coral to become 'bleached', literally turning white (Figure **10**). Eventually the coral dies. Projections from climate models suggest that the coral reefs in the Bahamas may experience sufficient thermal stress to lead to severe bleaching after about 2040.

Figure 10 *Coral bleaching*

1. Make a mind map showing the impacts of human activity on the **Andros Barrier Reef**

Overexploitation

Commercial fishing and intensive tourism can cause immense harm to the coral reef ecosystem. The depletion of herbivorous fish can lead to problems in that they help to keep competitors, such as seaweed, under control, preventing it from becoming invasive.

Grouper is a very popular fish to eat. However, their removal in some cases has led to an increase in damselfish, which groupers feed upon. Damselfish, in turn, create pockets in coral, ideal habitat for the algae upon which damselfish feed. In time, these algae can take over a reef, essentially smothering it. Overfishing of herbivorous (plant-eating) fish can also lead to high levels of algal growth.

Figure 11 *Sponge farmers trim the harvest for shipment, Andros Island, Bahamas*

Corals can be killed by physical contact with anchors, fishing nets, boat hulls and even people's feet. This is certainly an issue in the coastal waters around the Bahamas, where thousands of divers, fishermen and sightseers are attracted every year. Although the harvesting of sponges (Figure **11**) is an important local industry in the Bahamas (its origins stretch back to the 1840s when Greek divers first exploited the reef for its sponges), it can create a harmful imbalance in the ecosystem.

1. **Describe the impacts of over exploitation on the coral reef.**
2. **What is the impact of the removal of Grouper?**
3. **What is the impact of the harvesting of sponges.**

Pollution

Pollution can involve agricultural chemicals, sewage and silt eroded from hillslopes and discharges by rivers. Silt causes the water to become cloudy, restricting the penetration of sunlight used by zooxanthellae to photosynthesise. Coastal developments (particularly for tourism) have led to the clearance of vegetation, which has increased soil erosion and coastal silt deposition.

Between 1950 and 1980 there was considerable logging of the natural pine forests on North Andros Island, which led to significant quantities of silt washing into the sea, smothering some areas of the coral reef. Algal blooms in the Caribbean and the Florida Keys have also smothered parts of the coral and blocked the sunlight required by the zooxanthellae to complete photosynthesis.

Deep-sea fishing takes place off the Andros Barrier Reef. Marine-based oil and chemical pollution from trawlers and other ships can be harmful to both corals and fish.

Hurricanes

The Bahamas is often affected by tropical storms and hurricanes, particularly from September to November, the so-called 'hurricane season'. While the Andros Barrier Reef provides important protection for the coastline, the coral can be severely scoured by strong currents and powerful waves and damaged by the snapping of branching corals and removal of sponges. Storms can also disturb the seabed sediments, clouding the water and potentially clogging up the corals' feeding systems.

Interestingly, hurricanes can cause an upwelling of cold water from the ocean depths, thereby cooling the surface waters and mitigating the impact of coral bleaching. In cooling the surface waters, this also makes subsequent hurricane formation less likely. This is a good example of a negative feedback loop.

1. What is the impact of a) Pollution b) Hurricanes