19. Status of Coral Reefs of the Lesser Antilles: The French West Indies, The Netherlands Antilles, Anguilla, Antigua, Grenada, Trinidad and Tobago

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Abstract

- The marine environments of these small and predominantly mountainous islands are all threatened by similar stressors: sediment runoff from the steep volcanic slopes; rapid development, particularly from the tourism sector; nutrient pollution from inadequately treated wastes and excessive use of fertilizers; over-fishing, especially from subsistence fishers; hurricanes and storms; and particularly climate change related coral bleaching and disease.
- The coral reefs remained relatively healthy until the early 1980s, but since then coral cover has been decreasing and algal cover increasing, with most of the reefs having lost more than half of their corals;
- Very severe coral bleaching affected all these islands in 2005, when abnormally warm water temperatures exceeding 29°C and up to 31°C sat over the coral reefs from mid May to mid November. Many island states reported that more than half of their corals bleached with a large proportion of these subsequently killed;
- In 2006 many corals were still bleached or were infected with coral disease, such that coral losses continued, with many countries reporting losses of about 50% of their previous coral cover;
- Reef fish communities were not affected by the bleaching but have progressively declined through over-fishing and habitat destruction;
- Most of these eastern Caribbean Islands lack sufficient capacity for coral reef monitoring and effective management, and many of the MPAs have remained as ‘paper parks’;
The most active monitoring and management is in the Netherlands Antilles and the French West Indies, following recognition that well managed tourism will support reef conservation in the long-term; the Caribbean Challenge is aimed at rectifying these problems by the countries cooperating to conserve 20% of their coastal resources in networks of MPAs by 2020.

INTRODUCTION

The first observations on the Lesser Antilles report idyllic conditions, for example, Father du Tertre described Guadeloupe in 1670 as “I am very certain that during the first ten years after the isle was inhabited, we pulled out (from the sea) every year more than three to four thousand turtles, a very large number of manatees and we still pull out every day quantities of them, and it will continue until the end of the world without depleting them.” The first scuba divers to Guadeloupe in the early 1950s suggested that the reefs were in ‘pristine’ condition.

The Lesser Antilles are a semi-circular chain of islands from 18°N to 11°N and 59°W to 70°W and form the western boundary to the Caribbean Sea. Anguilla is the most northerly at 18°35’N; the French West Indies (FWI) lie between 18°00’ and 14°20’N and consist of the islands of Martinique, Guadeloupe, La Désirade, Marie-Galante and Les Saintes, St. Barthélémy and the French part of St. Martin/Sint Maarten; Barbados is the most easterly at 13°10’N and 59°30’W; Tobago is the most southerly with coral reefs at 11°10’N to 60°49’W; and the main Netherlands Antilles are between 70°03’W and 68°10’W.
Most of these islands are volcanic and mountainous with a narrow shelf before dropping into deeper water. Corals grow as fringing reefs on the eastern, oceanic sides and as broader fringing reefs with occasional platforms. These reefs are, however, subject to considerable input of sediments and nutrients from the erosion of the volcanic soils. In contrast, Anguilla, one of several islands on the Anguilla Bank in the far north, is an uplifted fossil coral reef surrounded by fringing and patch reefs and offshore cays.

Tourism is a major economic contributor in the Lesser Antilles, developed mainly on the basis of clean water and coral reefs. The other major economic activity is fishing, both subsistence and commercial for grouper, snapper, lobster and conch. Thus the economies of these islands are heavily dependent on the maintenance of their coral reefs and other coastal resources.

The following sections will cover these islands and reefs on the map in from north to south along the pearl-like chain of the Lesser Antilles.

**Stress and Damage to Reefs of the Lesser Antilles**

The same Caribbean-wide stresses threaten the reefs on these islands, especially inappropriate watershed modification which has resulted in increased erosion of sediments and release of nutrients from these mountainous islands. Over-fishing and unsustainable coastal development occur on all islands as human populations increase and tourism expands. There have also been major disease outbreaks, hurricanes, increased seawater temperature, and changes in sea level and water chemistry. The magnitude of these stresses and the responses by the island governments vary but not to a great extent. The major natural and human stresses that have resulted in the decline of Lesser Antilles reefs are:

- **Human stresses:** excess sediment and nutrient discharges into coastal waters is occurring from deforestation for agriculture, poorly managed coastal development and mangrove clearing. This is particularly affecting enclosed bays and lagoons. Elevated nutrient loads also result from poor wastewater treatment and overuse of fertilizers; the results are seen in the proliferation of the brown algae *Dictyota* and *Lobophora* in sheltered areas and *Sargassum* and *Turbinaria* on exposed outer slopes. Contamination of coastal waters by various pesticides is now evident in many areas, especially in Martinique and Guadeloupe, but the potential impacts are unknown.

- **Sea surface temperature increases:** Most years it is low level, except in September when chronic coral bleaching occurs when temperatures exceed 29°C for a short time. There was minor coral bleaching in 1984, 1987 and 1998 when other regions in the Caribbean had severe bleaching. But corals in the Lesser Antilles were severely damaged during the hot summer of 2005.

- **Hurricanes:** There have been 5 hurricanes since 1989 that have directly affected the region: Hugo in 1989 in Guadeloupe; Luis and Marilyn (1995) and Lenny (1999) damaged Saint-Barthélemy and Saint-Martin; Dean in 2007 devastated the reefs of Martinique but caused little damage to Guadeloupe. Damage results from the huge waves and massive quantities of sediments and nutrients washed out by torrential rains. Often there are short-lived algal blooms after hurricanes.
**Anguilla**

We have not reported previously on the reefs of Anguilla; the only previous study was by the Bellairs Institute of Barbados in 1990; since 2004 new data have been collected by the Department of Fisheries and Marine Resources. Prior to 1980, the reefs around Anguilla were largely pristine with high coral cover, although there are no quantitative data. Anguilla suffered a massive *Acropora palmata* die-off in the 1980s, probably caused by white band disease. The Bellairs group reported coral cover between 4% and 23% at 8 sites around Anguilla in 1990 with the highest cover on the offshore cays. Hurricane Luis in 1995 caused an almost total loss of mangroves, halved seagrass cover and severely damaged corals. Octocoral cover went from 25% to less than 5% (83% loss); *Monstastreae* sp. cover dropped from more than 25% to less than 2% (95% loss) and losses in other corals ranged from more than 15% to less than 3% (89% loss). The offshore banks still retained some intact coral communities but hurricane Lenny in 1999 caused further damage. The current threats to reefs include: the loss of *Diadema antillarum*; over-fishing; nutrient enrichment; coastal development; coral bleaching; and coral diseases.

**CORAL REEF STATUS IN 2008**

Anguilla sat in the 2005 ’hot spot’ from June to October, however, the extent of coral bleaching is unknown. Local dive operators reported bleaching but monitoring in 2007 was too late to identify specific bleaching impacts. Baseline data collected in 4 Marine Parks showed coral cover between 0.5% and 24.5% across a variety of reef habitats but low coral cover was more common, averaging 9.5%. Offshore sites had the highest cover, with lower macro-algal cover and higher relative biomass of fish. The coastal Shoal Bay – Island Harbour Marine Park had high cover of fleshy macro-algae, mostly *Dictyota* sp. The low coral and high algal cover are presumed to be due to over-fishing of herbivores and low *Diadema antillarum* populations, as well as increases in the nutrient loads from coastal developments. In late 2007 the existing corals were predominantly healthy with 73% to 95% of coral tissue being healthy, and 45% to 84% of coral colonies showing dead areas. There was 7% of coral tissue bleached at one site. Thus in 2008 reefs on the south coast of Anguilla have very low coral abundance, with some areas having high cover of macro-algae. Coral recruitment appears low in all locations. *Diadema antillarum* populations seem to be recovering, although distribution is still rather patchy. Expert opinion considers that the Anguilla reefs are continuing to decline from the status reported in the 1990s.

**Socioeconomic Impacts and Management Responses:** Coral reefs are recognised as important in Anguilla’s economy, especially through fishing and tourism. Thus the Government has developed a long-term marine monitoring program to assist in developing coastal management plans that will include sections with strong coral reef protection including no-take zones in shallow reef areas, and a review of the fisheries legislation.

**Antigua**

There have also been no detailed reports on Antigua and Barbuda reefs in previous Status reports. These reefs were described previously as ‘extensive’ and ‘exceptional in their variety’, but little quantitative information was reported previously. The following information follows rapid assessments between 2006 and 2007 of patch and bank-barrier reefs.
Coral Reef Status in 2008

Reefs were assessed at 2–10 m depth on 16 reefs in Antigua (13 in the NE of Antigua; 3 at Cade’s Reef, SW); and also at 20–25 m in the NE and SW. Much of the reef structure consists of large, interlocking branches of dead elkhorn coral (*Acropora palmata*), indicating previous luxuriant growth. There are 32 species of stony corals covering 2–19% of the reef benthos (mean 6.7%; ± 4.6 s.d.); cover on deep reefs was less than 3%. The most abundant corals were *Porites astreoides* (25% of all colonies), *Agaricia* spp. (12%), *Montastraea faveolata* (9%), *M. annularis* (8%) and *M. franksii* (7%). *Acropora* corals (mean cover 1.5% ± 3.3) were observed at 8 of 16 sites, including *A. palmata*. *A. cervicornis* and *A. prolifera* observed together at 2 sites in the North Sound region. A few colonies of both *A. palmata* and *A. cervicornis* were found at 22 m depth in the NE section of Antigua. There was low abundance of recruits and juvenile corals (< 2 cm in diameter; 0.9 recruits/m²), mostly *Porites* (25% of juveniles), *Montastraea* (14%) and *Agaricia* (12%).

There was high cover of fleshy (*Dictyota, Lobophora*) and calcareous (*Halimeda*) macro-algae, ranging from 9–58% (mean of 33.3% ± 16.4). Other dominant groups included turf (31.5% ± 12.7), crustose corallines (6.2% ± 6.8) and cyanobacteria (5.8% ± 7.3). The cover of cyanobacteria reached more than 25% at 2 sites with mats of *Lyngbya* smothering *A. cervicornis*.

Average recent mortality was 1.1% (± 0.9), which is lower than the regional average (2.6%) from >800 sites in the AGRRA database. However, this was nearly double the 0.6% value recorded in 2005. Only 1.1% of colonies showed any disease, with yellow blotch being most common (on more than 20% of *Montastraea* colonies) in December 2006. Similarly, bleaching in 2007 was rare with 2.5% of colonies affected, compared to 22.3% of colonies in August 2005. The 2005 bleaching appears to have seriously reduced coral cover from 16% to the 6.7% coral covered recorded in 2007 (2005 data from Brandt et al).

Reef Conservation in Antigua

Coral reefs and their associated resources are essential to the economic sustainability and growth of Antigua and Barbuda. Several MPAs have been established: Diamond Reef Marine Park; Palaster Reef Marine Park (both gazetted in 1973); the Cades Bay Marine Park (gazetted in 1999); and the Codrington Lagoon and the North Sound (gazetted in 2005). However, there is little active management of the resources.

Stress and Damage to Reefs

The government of Antigua and Barbuda is aware of risks and is developing resource management and sustainable development plans. A Global Environment Facility project in 2008 is developing a Sustainable Island Resource Management strategy for ‘ecosystem functionality and biodiversity conservation within a landscape that enhances sustainable livelihood options and opportunities for sustained economic development’. Stresses causing the largest impacts on coral health are: macro-algal, cyanobacterial, and sponge competition; coral diseases; and sedimentation/nutrients. Algal overgrowth of shallow water corals by *Caulerpa, Lobophora, Dictyota, Halimeda* and the cyanobacterium *Lyngbya* is clearly evident. Crustose coralline algae were also out-competing corals, especially *Millepora* spp. Bioeroding (*Cliona*) and encrusting sponges are also out-competing corals on patch, shallow and deep bank reefs. In
late 2006 there was >20% prevalence of coral disease (mainly yellow blotch and white plague) on shallow, massive *M. faveolata* and *M. annularis* colonies >50 cm, probably a consequence of the 2005 bleaching event. Increased sedimentation is also damaging shallow corals with many colonies covered by a thin layer of fine, clay-like sediment, especially near dredged areas. There were parallel signs of recent coral death and coral recovery on remnant branches of dead *A. palmata* which provides good habitat for corals, fishes and reef invertebrates.

**Conclusions**

Corals on Antigua have been recently damaged by local and regional disturbances, but there are still healthy corals and the species richness is high. These reefs will recover provided surviving parent corals that can provide larvae are protected and the important algal grazers, especially fishes, are not further reduced. Finally, there are surviving populations of the 3 Caribbean *Acropora* species in NE Antigua. These corals have been drastically reduced everywhere in the Caribbean and have been recently listed as a threatened species in the USA. Previous large stands of *A. palmata* are gone, but surviving colonies of *A. palmata* occur on shallow and deep reefs, including new recruits. *A. cervicornis* is ubiquitous on shallow and deep bank reefs and is actively recruiting in many habitats. This may indicate a good chance for recovery as these branching corals grow quickly and can expand through fragmentation.

**Grenada**

Most of the data from Grenada have been collected from the 1980s on reefs on the southwest coast close to Grand Anse and St. George’s; the ‘tourist belt’. However, not all these data are available. Tourism is a major contributor to the economy and continues to grow rapidly with increasing infrastructure development. Reefs on the south-west side are heavily used by locals and visitors with more than 80% of all recreational diving occurring there.

Surveys in 2006 and 2007 identified 33 hard coral species, with the most common being *Porites porites* followed by *P. astreoides* and *Montastraea annularis*. Macro-algae, especially *Dictyota* and *Halimeda*, comprise the largest component on the bottom at 9 sites in south-west Grenada with mean cover from 36.5% (± 0.8%) to 53.2% (± 1.2%). Hard corals were the second most common component, ranging from 23.8% (± 0.9%) to 38.1% (± 1.2%); and the sea urchin, *Diadema antillarum* was either rare or absent.

Indiscriminate anchoring by boat operators and spear fishing pressures on algal-grazing fish were considered as the two biggest human threats to coral reefs on Grenada’s southwest coast; storm surges and hurricanes were the largest natural threats. The major threats to coral reefs are coastal development and poor land use practices on the east and south-east coasts.

**Coral Reef Status in 2008**

Macro-algae remain the largest component of benthic cover on south-west reefs, followed by hard coral cover, which declined at some sites from 23% to 38% in 2007 to 6% to 20% in 2008. There is an urgent need to manage spear fishing on reefs along the south-west coasts; and ensure that developers engage in good land use practices on the east and south-east coasts. The Government of Grenada is attempting to strengthen management of Grenada’s near shore marine resources and declared a new MPA in September 2008 on the Grenadian sister island of Carriacou. The addition of the Sandy Island Oyster Bed MPA brings the total of MPAs in Grenada to three.
The French Caribbean Islands
The French West Indian islands of Martinique, Guadeloupe (including Désirade, Marie-Galante and Les Saintes), Saint-Barthélemy and French Saint-Martin all have coral reefs. There are two barrier reefs along the east coast of Martinique and the north coast of Guadeloupe, and other coasts have fringing reefs on the windward and leeward coasts. The small islands near Saint Barthelemy and Saint-Martin have poorly developed fringing reefs, but extensive seagrass beds on the shallow, sandy island shelf. The largest area of mangroves in the Lesser Antilles is in Guadeloupe, but these have been largely destroyed by land reclamation.

There are 834 000 people in the French West Indies and an additional 1.2 million tourists every year; thus tourism is the important economic activity based largely on ‘healthy’ coastal resources. The tourists come to use glass-bottomed boats and kayaks, go water skiing, surfing, sailing, fishing and particularly go scuba diving with one of 80 scuba clubs in Guadeloupe and Martinique. Most diving is on the Caribbean side, for example, about 100 000 divers visit the Îlets Pigeon in Guadeloupe each year. There are 3 MPAs in Guadeloupe and one each in St. Barthelemy and St. Martin, as well as several non-permanent no-take zones in Martinique.

The cover of live corals on French West Indies reefs combined shows a steady decline since 2001 with an apparent initial baseline around 20–25%; in parallel there have been increases in total algal cover (turf and macro-algae). Occasional monitoring in 1987 and 1995 indicate that 20 years ago coral cover was above 40%, indicating that coral losses are more serious than recent monitoring shows. The corals are being replaced principally by bare rock covered with unattractive low turf algae.

Coral Reef Status in 2008
The first scientific observations of the coral reefs of Martinique and Guadeloupe Islands in the 1970s showed that reef health was beginning to decline due to a combination of natural and human stresses. When these two islands were mapped in 1996, only 15–20% of their reefs contained flourishing coral communities, and coral cover on Guadeloupe was assessed at 14% on reef flat areas and 45% on outer slopes. For example, coral cover on Îlets Pigeon dropped from 46% in 1995 to 26% in 1999, 11–56% of coral colonies showed some disease, and 11–56% of the surviving corals had some dead areas. There were similar observations on Martinique. The graph below shows the steady decline in coral cover and parallel increase in algal cover from monitoring program (every 6 months) established in 2001 as part of the GCRMN.
An exceptional increase of sea surface temperatures in the Caribbean caused massive coral bleaching on the reefs of the FWI in 2005, and significant delayed mortality due to coral diseases throughout 2006. This is seen in the sharp drop in the graph below. Surveys also show a decline in the health of the corals; for example the incidence of diseased coral colonies has been steadily increasing since 2003.

The incidence of coral diseases has remained relatively high over the last 7 years in proportions of species with necrotic tissues, the number of colonies with diseased patches and the average surface of necrotic tissues per colony. The incidence of disease has risen steadily from the lowest point in 2003.

This graph shows the numbers of new coral recruits which is an effective measure of coral reef health. There was a drop in recruits after the bleaching losses in late 2005, but by 2007 the numbers were approaching pre-bleaching levels (average of 9 reef sites). The number of species recruiting per season is very stable (8 to 11 species per 30m²).
Fish populations have remained largely stable since 2001 with similar numbers of species, total biomass and a consistent fish community structure. This is probably because the three-dimensional structure of the reefs has not changed significantly. However, species richness has increased in the Saint-Barthélemy MPA; similarly fish biomass has increased in the Pigeon Island MPA. A worrying trend is a significant decrease in the populations of algal grazing fishes (herbivores) which indicates over-fishing with traps and nets.

**Status of Mangroves, Seagrasses and Fisheries 2008**

There has also been degradation of seagrass beds and mangrove forests throughout the FWI. The extensive seagrass beds are nursery areas for many commercial species of invertebrates and fishes, but they are paying a heavy price from continued development of harbours, marinas, artificial beaches for hotels, sand mining and especially anchor damage from yachts and cruising and freighter ships. Guadeloupe has prohibited the use of seine nets to protect the shallow seagrass habitats of juvenile fishes. There are extensive mangrove forests in the bays of Martinique and Guadeloupe has the largest forest area in the Lesser Antilles. However, only a few trees remain in St-Martin and St-Barthélemy. The mangrove forests have also been devastated by economic development, especially through land reclamation for airports, industrial areas, hotels, marinas, etc. The 2500 registered professional fishermen land about 8000 tons of seafood in Martinique and 10 000 tons in Guadeloupe, with 60–75% taken from the reefs. Ciguatera (fish toxin) has significantly limited commercial fishing in St-Martin/St-Maarten and St-Barthélemy. Parrotfish (scarids) constitute the most important fish family captured by traps or nets, however, this is a potentially worrying sign as algal grazing fish play a major role in controlling macroalgal domination of coral communities; this will affect most reefs in the French West Indies.

**Conclusions and Recommendations**

The corals reefs of the FWI have shown a long-term decline of their coral communities, shifting from coral to algal dominated communities. This phenomenon is probably due to multiple causes: eutrophication of coastal waters; high rate of sedimentation; chemical pollution; and over-fishing. Trends in biotic indices like the importance of necroses on the coral colonies and the recruitment of juveniles are also not encouraging. After several alerts in 1984, 1987 and 1998, the 2005 bleaching had a major impact on the coral communities of FWI resulting in a decrease of about 40% of the coral cover on the reefs. If such events are repeated too frequently the consequences will be a dramatic decline of the reefs. The most impacted coral communities were those which were also subjected to high levels of anthropogenic stress. Rapid action against these various local human threats on the coral communities is recommended to retain coral resilience to bleaching effects. Such control would not only suppress the continuous slow decline of reef health, but also diminish the impact of the temperature anomalies due to global warming and favour the recruitment of new coral settlers. It is recommended that the long term monitoring program be continued to ensure that management is provided with valid information to make sound decisions to conserve these reefs, which were severely damaged during the 2005 bleaching event, with losses of 30–50% in coral cover.

**The Netherlands Antilles**

There are two distinct island groups in the Netherlands Antilles. The small oceanic islands of Bonaire and Curaçao 70 km north of Venezuela are in the path of persistent trade winds,
hurricanes are rare, and the islands have an arid climate. Bonaire and Curacao have continuous fringing reefs around them especially on the leeward coasts. The wetter, volcanic Windward Islands (St. Maarten, Saba and St. Eustatius) form the second group, and are often affected by hurricane swells and winds. They have narrow shelves and limited reef growth along their windward coasts. St. Eustatius has true calcareous reefs plus corals growing on volcanic rock, whereas the only true reefs on Saba are on the east of the island. St. Maarten (half Dutch and half French) has rapid and seemingly unmanaged tourism expansion, and as a consequence, the reefs have been damaged by pollution, deforestation, sedimentation, eutrophication from sewage, recreational boating and anchors. The Saba Bank is a very large submerged atoll with actively growing reefs, to the south-west of Saba.

Tourism is the main economic activity on all islands, especially Bonaire, which is almost completely dependent on dive tourism. Tourism is growing rapidly on Curacao. All islands support small-scale artisanal reef fisheries, and the Saba Bank has a major lobster fishery. All unprotected reefs of Bonaire and Curacao suffer from over-fishing, and recently Bonaire established no-fishing zones as a measure against over-fishing.

Although considered healthy compared to other Caribbean reefs, the reefs of Bonaire and Curacao have been steadily deteriorating since the early 1980s (and even longer according to anecdotal evidence); the other islands also appear to be deteriorating. Bleaching in 2005 severely damaged the Windward Islands reefs, but spared the reefs of Bonaire and Curacao. The most important threats to the reefs on the islands are coastal development and over-fishing for Bonaire, Curacao and St. Maarten, and sedimentation from land erosion due to bad land management on St. Eustatius and Saba. A Netherlands Antilles coral reef monitoring node was established in 2005 building on the efforts of the island MPA managers and the help of volunteers. Water quality monitoring was added around Bonaire and Curacao in 2006 to assess nutrient enrichment from coastal development.

**Coral Reef Status in 2008**

The reefs of Bonaire and Curacao remain predominantly healthy, with relatively stable coral cover; but strong declines were reported in the 1980s and 90s when disease and the loss of *Diadema antillarum* killed many corals. The last major impact was from the large waves of hurricane Lenny in 1999, which smashed corals down to about 10 m depth; subsequent coral diseases compounded the damage. Recent measures of nutrient concentrations on Bonaire point to threats of eutrophication and macro-algal overgrowth; the situation on Curacao is worse with nutrient levels beyond accepted threshold values and higher cover of macro-algae.

Monitoring on Bonaire by AGRRA indicates that the reefs remain among the best in the Caribbean, with nearly 50% average coral cover and increasing juvenile coral densities (from 20 in 2005 to 39 individuals per m² in 2007). However, there are some potentially troubling trends, as macro-algal cover has doubled from about 4% in 2003 to 8% in 2007, while parrotfish biomass and bite rates declined. In addition, there are increases in damselfish populations and declines in coralline algae. These point to possible reduced recruitment of reef corals and increasing macro-algal abundance. Some carnivorous fish populations (lutjanid snappers) are stable but there is a continual loss of groupers and barracuda. Abundance of the algal grazing urchin, *Diadema antillarum*, is increasing with densities of up to 1.79 individuals per m² at one site.
Curacao experienced large declines of coral cover during the 1990s; but cover has been relatively stable over the last 10 years at about 40% at 12 m depth. The incidence of coral disease dropped below 10% in the late 1990s, and has generally been below 5% since 1998. There are no clear trends in macroalgae cover or coralline algae. Large Acropora cervicornis stands covering hundreds of square metres are reappearing; for example, one stand established itself in 3–4 m depth after hurricane Lenny cleared the cemented base-rock in 1999. This stand re-established itself again after being completely levelled during hurricane Ivan in 2004: the colonies are about 60 cm high. Diadema antillarum abundance is increasing, particularly in lagoon entrances, with densities of up to 3 individuals per m².
**St. Eustatius:** The reefs were hard hit by the 2005 bleaching event, with 70–80% of coral colonies bleached. Subsequent mortality resulted in a loss of the original live coral cover from about 30% to less than 15% in 2008; a 50% decrease. Macro-algal cover increased from about 40% in 2005 to almost 60% in 2008.

There are no recent data for Saba and St. Maarten, however, there are reports of large coral cover losses in 2005. There are established species lists of hard and soft corals, macro-algae, and fishes for the extensive and rich reefs on the windward eastern and southern edges of the Saba Bank, but no recent monitoring data. Comparison of photographs taken on the Bank in 2002 and 2007 show at least an 80% decline in coral cover, probably due to losses during the 2005 bleaching event.

**Status of Mangroves, Seagrasses and Fisheries: 2008**

The main mangrove and seagrass areas on Bonaire are in Lac Bay, a Ramsar site. An island government decision to allow development adjacent to this area was overturned in 2007 to protect these wetlands of international importance. These protected mangroves are home to a thriving, carefully guided, kayak tour industry. Mangroves on Curaçao remain under threat and are slowly being reduced by coastal development. St. Maarten has some mangrove stands, but these are being quickly eradicated by uncontrolled tourism development. The situation with seagrass beds is similar. St. Eustatius has significant seagrass beds which are essential food for visiting populations of nesting turtles.

**Fisheries:** Bonaire established two no-take fish reserves within the Bonaire National Marine Park in 2007 in response to declining predatory fish like groupers. The Curaçao 2008 fisheries law plans to establish fish reserves; but no reserves have been designated. The reefs appear seriously over-fished and groupers and other larger predators are extremely rare; but there are no quantitative data.

**Conclusions and Recommendations**

The reefs of Bonaire and Curaçao are still relatively healthy, compared to other parts of the world, which increases their value as a dive tourism destination. This presents an opportunity for Bonaire and Curaçao, provided they safeguard these delicate resources with effective wastewater and fisheries management. In Curaçao, a reduction in pollution at the most polluted sites is necessary as well as introducing nature conservation legislation for effective coral reef management. Currently there is increasing pressure by developers to cash in on the booming tourism industry.

Saba and St. Eustatius have good coral reef management systems, whereas St. Maarten urgently needs to pass legislation to manage their coral reefs so as to improve resilience for better recovery after the large coral declines in 2005. There is an urgent need to manage the fishery resources of the Saba Bank with effective monitoring and enforcement, and so that it can be used as a model to study coral reefs that are remote from coastal influences.

**Trinidad and Tobago**

These are the most southerly of the eastern Caribbean islands, on the edge of the South American continental shelf. Trinidad has marginal coral communities due to the influence of the Orinoco
River, with only sediment tolerant coral species (*Siderastrea* and *Porites*). Tobago, however, is more remote from the large rivers and has patch and fringing reefs along about 90 km of the coastline. The threats to Tobago reefs are primarily nutrient and sediment runoff from land clearance and coastal development, sewage pollution and climate change. Many coral colonies were damaged during the 2005 mass bleaching event; and many of those that recovered were subsequently affected by coral disease. The Buccoo Reef Trust and the University of the West Indies, with funding from the Global Environment Facility, started monitoring in 2007 at the Buccoo Reef Marine Park; designated in 1973, it has also been a Ramsar site from 2005. The Marine Park covers approximately 13 km² with a complex mix of seagrass beds, mangrove forests and patch reefs.

There are many regulated tourism activities as well as illegal fishing and reef-walking. A management plan was developed in 1995 but was never implemented. Although the Buccoo Reef Management Committee was established in 2004 to implement the management plan of Park activities, the Committee has been largely ineffective at controlling damaging activities. The International Coral Reef Action Network, with funding from the United Nations Foundation, has now implemented a management and education program to improve management capacity by facilitating training, exchange and networking opportunities.

**Coral Reef Status in 2008**

Coral cover at the 11 permanent monitoring stations ranged from 26% at Sisters Rocks in the Caribbean to 3% on Bulldog Reef in the Atlantic. Caribbean reefs are primarily hard coral-gorgonian dominated, while macro-algae and sponges dominate the Atlantic side. Coral species diversity is higher on the Caribbean side (Kariwak to Pirates Bay) than on the Atlantic coast. Mean coral cover at 10 m depth was 15%, with macro-algae (18%), gorgonians (12%) and zoanthids (6%). Massive species constituted the largest proportion of corals (*Montastrea faveolata*, 35%; *Siderastrea siderea* 10%; *Diploria strigosa* 9%, and *Millepora* 15%).

Mean coral cover at 7 and 12 m depths dropped from 21% in 2005 to 15% in 2008 on the north-western side; most likely due to disease outbreaks following the 2005 bleaching event. Large swells in March 2008, damaged the shallow reefs on the Caribbean coast, and there is widespread coral disease, especially yellow band and dark spot diseases. Aspergillosis is infecting more than a third of all gorgonians (sea fans). White plague levels are particularly variable in summer, whereas black band disease is generally low. The few remaining elkhorn coral (*Acropora palmata*) stands are susceptible to white pox and patchy necrosis. The reefs on Tobago have become dominated by macro-algae, particularly downstream of the major towns on the Atlantic side where algal cover was high (34–65%) and apparently associated with nutrient and sewage pollution, especially during the rainy season.

**Reef Fish and Invertebrates**

Grouper (*Serranidae*) densities were generally low (<90 fish/hectare) with only two species (*Cephalopholis cruentatus* and *C. fulva*) comprising nearly 90% of all sightings on the north-western side. Nassau Groupers (*Epinephelus striatus*) are considered to be locally extinct and snapper (*Lutjanidae*) densities were also low (70 fish/ha). The total biomass of the 3 targeted families, groupers, snappers and grunts (*Haemulidae*), was 276 kg/ha on reefs between Buccoo and Castara. In the north-west, parrotfish densities (~950 fish/ha) and surgeonfish (~575 fish/
ha) are less depleted than elsewhere in the region. Like Curaçao, *Diadema antillarum* were not observed at 10 m monitoring stations, however, *Diadema* densities (75 urchins/ha) at 7 m and 12 m on the north-western side of the island suggest populations are increasing. Coral recruitment appears to be limited by low levels of macro-algae, a predominance of unstable rubble substrata and possibly other environmental factors. Densities of queen conch and spiny lobster numbers remain low (<2–3 individuals/ha); and there are no management policies to protect existing populations.

**Conclusions and Recommendations**

The prevalence of algae on Tobago’s reefs has been increasing since the 1980s, in parallel with significant coastal development and population growth. Sewage treatment is inadequate and facilities are not maintained, and sedimentation rates are increasing. These stresses are probably the cause of reduced live coral cover and high macro-algal cover. Although the Reefs at Risk assessment regarded Tobago’s reefs as over-fished, relatively high grazing levels by parrotfish and surgeonfish are controlling algal growth in the north-west. These results are encouraging, but there have been insufficient studies. The reefs are also affected by sediment from inland development and deforestation in the watersheds. There has been little coral bleaching since 2005, but there are high levels of coral disease on the reefs, especially yellow blotch disease affecting the dominant *Montastrea faveolata*.

The World Resources Institute estimated that the coral reefs on Tobago provided approximately US$120 million or 42% of the island’s GDP in 2006, through tourism, recreation, fisheries, and shoreline protection. This highlights the economic need to maintain coral reef health on Tobago. For example, baseline mapping is being extended to other parts of the island.

- A long-term monitoring program is needed to build on baseline mapping surveys and increase monitoring from the current 12 fixed stations; agencies are re-establishing Reef Check surveys around the island.

- Damage from land-based sources of pollution should be reduced through more effective watershed and coastal management, especially by raising public awareness of the damage and encouraging behavioural changes. Some communities are replanting a major watershed to protect downstream reefs on the north-western coast.

- Poor management capacity is hindering reef conservation, therefore a park manager and sufficient reef patrol officers are urgently needed to enforce regulations in the Marine Park. Draft legislation for Environmentally Sensitive Areas that has been dormant for 4 years needs to be ratified, and the Management Committee given greater authority and financial autonomy to control damaging activities and implement the recommended zoning plan.

- Finally, extensive public education and awareness campaigns are needed to ensure that all users appreciate and understand the value of these important coastal resources, and consideration should be given to establishing community managed marine protected areas elsewhere on the island.
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REFERENCES (a more detailed list is on the attached CD)


Caribbean countries have taken up the challenge from Micronesia and launched the ‘Caribbean Challenge’ to conserve biodiversity. The Government of Grenada announced a plan to protect 25% of its land and sea areas by 2020 at the Convention on Biological Diversity meeting in Brazil in 2006. Following this, the Prime Minister of the Bahamas, Hubert Ingraham, launched the Caribbean Challenge at the CBD 9th Conference of the Parties in Germany in May 2008 with the Dominican Republic, Jamaica, Grenada, St. Vincent and the Grenadines also joining. Other Eastern Caribbean countries are considering joining, as well as the French and Netherlands Caribbean territories. The signatory countries have all pledged to conserve 20% of their marine and coastal habitats by 2020 because they contain enormous biodiversity with 65 coral and 1,400 fish species, 6 of the 7 species of endangered sea turtles, and more than 300 endemic birds and mammals within an area containing 21,000 km² of coral reefs. Moreover, much of the Caribbean economy depends on the Challenge region, with 10 million people and 50% of the Caribbean national incomes based on ‘nature’ tourism. However, this tourism paradise is now threatened by over-fishing, invasive species, and unsustainable development on the land, with the countries having insufficient funding to protect these resources. This was the catalyst for the Challenge, which is designed as a $70 million project to be implemented over the next 6 years, with each country proposing Challenge activities, such as:

- developing effectively managed protected areas by hiring, equipping and training park managers and associated staff;
- creating new protected areas during the next 6 years, that will ensure the effective management of a minimum of 2 million hectares of new and existing protected areas;
- decreasing unsustainable fishing practices;
- finding protection strategies to reduce the impacts of global climate change on the area;
- developing and capitalizing protected area trust funds, and seeking other funds such as tourist user fees; and
- creating demonstration sites which will serve to showcase best practice.

The major difficulty, however, for a large, multi-country project is finding reliable, long-term funding. These Caribbean island nations are asking the world community to assist with funds to establish many more MPAs and strengthen the management of existing parks. For example, new funds will promote sustainable tourism, such as whale watching, in the Parque Nacional del Este and Samana Bay in the Dominican Republic, as well as assisting in the protection of coral reef resources. A key component will be the creation of more than US$45 million national-level protected area Trust Funds to fund rangers, patrol boats, scientific expertise and education programs. The Nature Conservancy has pledged US$20 million and the German Government has pledged approximately US$8.6 million. These funds will be used to match upwards of US$18 million in Global Environment Facility national and sub-regional projects to implement the Challenge. These Caribbean countries lack the capacity and economic base to tackle programs to ensure the long-term sustainable use of their natural resources without this Challenge and the promised funds. Plans should also include a monitoring program to assess progress in conserving the coral reefs and in raising awareness.