

19. STATUS OF CORAL REEFS IN THE FRENCH CARIBBEAN ISLANDS AND OTHER ISLANDS OF THE EASTERN ANTILLES

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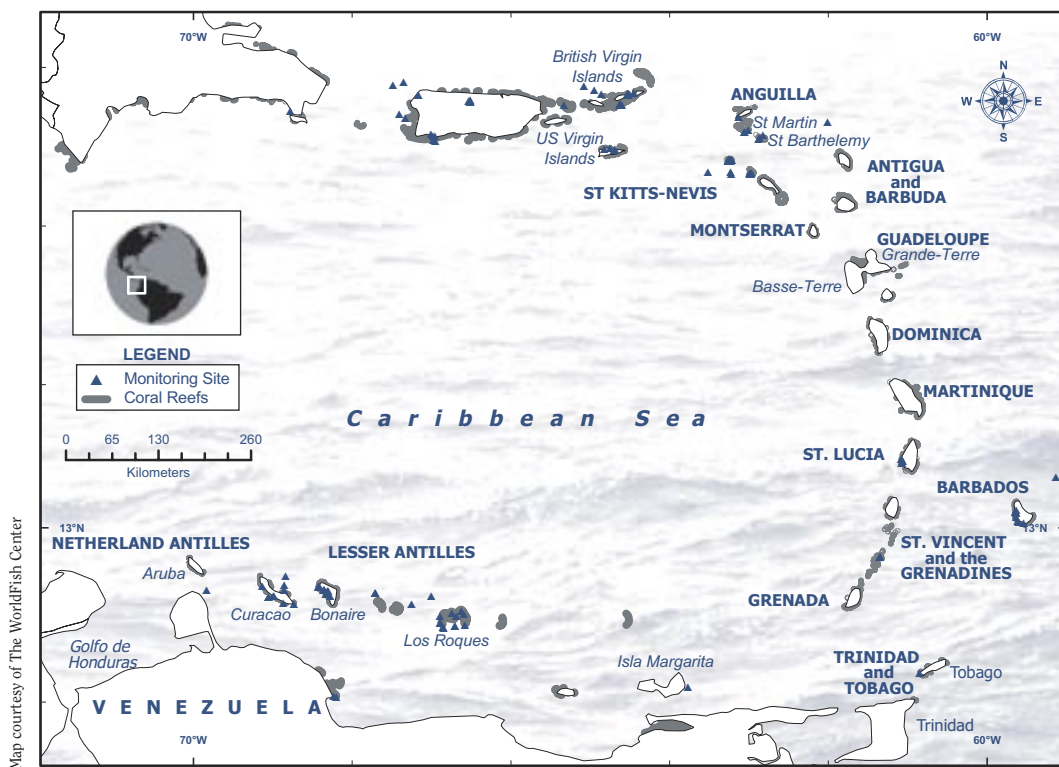
ABSTRACT

The coral reefs surrounding the islands of the French West Indies and nearby islands have shown a slow, but progressive decline since the early 1980s. Recent surveys and mapping efforts of the coastal areas have confirmed that this phenomenon is applicable on most of the reefs of the area. This stimulated a long-term monitoring project at 10 sites in Guadeloupe in 1999 and Martinique in 2001. These sites are monitored twice a year in the dry and the rainy seasons, and 5 years of monitoring data of coral and fish communities do not show any obvious negative or positive trends. The reefs of these islands have faced a common set of threats: high rates of sedimentation due to deforestation and bad land management, which affect mainly the reefs in the enclosed bays; algal proliferation due to an overload of nutrients in the coastal waters from excessive use of fertilizers and poor wastewater treatment; and chronic over-fishing and harvesting of reef resources.

The UNEP Regional Coordinating Unit in Jamaica and the Barbados Coastal Zone Management Unit have supported the Reef Check Eastern Caribbean Project for fish and benthic monitoring on St Vincent, Grenada, Dominica, Antigua, St Kitts and Tobago. These were designed as rapid assessments of coral reefs, where there were no current data. The assessments were accompanied by considerable training of local fisheries and dive operator staff, along with the provision of basic monitoring equipment.

100 Years ago: Although there are no data, the reefs were presumably in a pristine state with healthy coral and fish populations. The small human populations were not exerting strong pressures on the resources, although some easy prey, like turtles, may have been depleted. The first scuba divers in the early 1950s, report that the reefs were pristine.

In 1994: The decline of the reefs that started in the 1980s continued on most islands, with increases in sediment and nutrient pollution on the reefs and clear examples of over-fishing taking out the key target species. Management was not particularly effective and most MPAs were not well managed.



In 2004: The situation is very similar to 1994, with a slow degradation in the areas of high sedimentation and nutrient input. Fortunately, the reefs of the French West Indies and nearby islands were not too severely impacted by coral bleaching in 1997 and 1998 and exhibited good recovery. There are more MPAs (4 marine reserves and 9 no-take zones) around the different French islands. Awareness is increasing in all sectors of the community, government and the tourist industry on the need for more coral reef management and monitoring.

Predictions for 2014: In spite of the existence of these protected areas, substantial efforts need to be made to control the main forms of pollution of the coastal waters. Without such efforts, the health of the reefs will continue to decline.

Note: This chapter contains reports on just some of the islands previously detailed in the Status of Coral Reefs of the World: 2002 report. No information was received from the other island states; readers are directed to the 2002 report for more information.

INTRODUCTION

The French West Indies

The French West Indies are in the Lesser Antilles between 14°20 and 18°00 N with: fringing coral reefs that border the coast; barrier reefs, separated from the coast by a lagoon; and non reef-building coral communities which are mainly on the Caribbean coasts and are often more diverse and flourishing than those of the Atlantic coast reef formations.

Martinique Island

Martinique is the most southern island of the French West Indies, and is approximately elliptical with a maximum elevation of 1,397 m. It is 65 km by 30 km and covers 1,075 km² with a 350 km coastline. **The Caribbean coast** of Martinique has rich coral communities, although on the northern end of the island, the particularly steep slopes and abundance of volcanic ash from the Montagne Pelée have inhibited coral growth on both Caribbean and **Atlantic coasts**. The 25 km Atlantic barrier reef is a mix of coralline algae and corals, and protects the shore where fringing reefs have developed on the rocky coasts, with mangroves in the bays. The **southern coast** of Martinique is very different from other parts of the island, as there is an almost continuous line of shoals between the Pointe du Diamant and Sainte-Luce growing on a wide 10 m deep platform, cut by valleys in front of the river mouths. The most active coral growth is on the outer edge of the platform to form reefs growing up to the surface or 'cayes', which resemble a barrier reef. There are extensive seagrass beds (4,000 ha) behind the barrier along with mangrove forests near the coast (1,850 ha).

Guadeloupe Archipelago

Guadeloupe is a large island approximately in the centre of the West Indies with 2 islands covering 1705 km²: Basse Terre (848 km²; 1,467 m highest point) and Grande Terre (590 km²; 135 m highest point), separated by a narrow channel (La Rivière Salée). There is a barrier reef off the Grand Cul-de-Sac Marin 29 km long, which encloses an 11,000 ha lagoon with a maximum depth of 30 m. There are fringing reefs along the Atlantic coast of Basse-Terre, but only coral communities grow on the rocky seafloor on the Caribbean coast. However, these communities contain the highest biodiversity of the island, particularly around La Pointe Lézarde and Les îlets Pigeon. There is a discontinuous line of small fringing reefs on the southern coast of Grande-Terre, but there are almost no reefs on the northeast and northwest coasts, because the island ends as steep cliffs. There are also large areas of mangroves (3,000 ha) and seagrass beds (9,726 ha).

Marie-Galante (158 km²) is 43 km south of Grande-Terre, and has a few poorly developed fringing reefs on the east, southeast and southern coasts of the island. Flourishing coral communities are found below 20 m on the west coast where seagrass beds are patchily distributed on sandy bottoms.

Les Iles des Saintes (13 km²) has no coral reefs, but the rocky bottoms are colonized by corals and seagrasses on the sandy areas.

La Désirade (20 km²) has some small fringing reefs in the south, and seagrasses grow but are limited by strong wave action.

Petite-Terre (1.7 km²) has 2 islands surrounded by poorly developed fringing reefs.

Saint-Barthelemy and Saint-Martin Islands

The islands of Saint-Barthelemy and Saint-Martin are the most northern in the French West Indies. **Saint-Barthelemy** (21 km²; 302 m highest point) is surrounded by numerous small islands. **Saint-Martin/Sint-Maarten** are respectively under French and Dutch control. The northern French part is 50 km² (highest point: 424 m). The fringing reef formations are poorly developed around these 2 islands, but the seagrass beds are very extensive on the shallow continental shelf, and mangroves are limited.

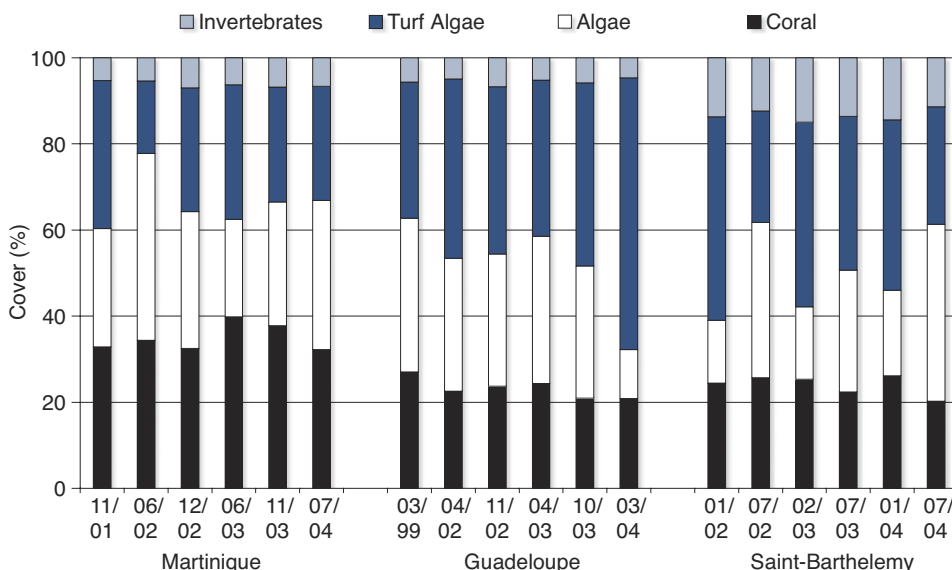
STATUS OF MARINE ECOSYSTEMS

The French West Indies

The consensus of many studies is that there has been a slow degradation of coral reef ecosystems in the West Indies, due largely to demographic and economic expansion on the islands. These small islands of the Antilles are particularly fragile, as most are mountainous with narrow shelves and often contain a high content of endemic marine flora and fauna.

There is very clear evidence of coastal ecosystem degradation throughout the French West Indies, not only of the coral reefs, but also of the seagrass beds and mangroves. Satellite mapping of Guadeloupe and Martinique show that only 15 to 20% of the reefs on both islands still have thriving coral growth. This has been confirmed by recent mapping, combined with underwater observations on Guadeloupe and Saint-Barthelemy. The live coral cover varied between 11 to 17 % on the reef flats, and 20 to 49 % on the outer slopes. At one site (îlets Pigeon) the cover declined from 46 % in 1995 to 26 % in 1999. Another alarming sign is that between 11% and 56 % of the coral colonies at one site had diseased tissues. The average rate of dead tissue fluctuates between 19% and 53% of the surface of the colonies. There have been similar observations on Martinique, with clear signals of reef decline since the 1980s.

Similar patterns of coral reef decline have been evident on the **Guadeloupe Archipelago** and on **Saint-Barthelemy** and **Saint-Martin** since the 1980s, with coral communities being progressively replaced by algal assemblages consisting mostly of *Sargassum* and *Turbinaria* on Atlantic coasts and *Dictyota* and *Lobophora* on Caribbean coasts. There are often short-lived algal blooms after Hurricanes have passed, due to a transient eutrophication of the coastal waters from massive



The cover of corals, macro-algae and other invertebrates has remained relatively stable in the 5 years of coral reef monitoring on the French islands. The monitoring, however, started after a series of destructive events (hurricanes, coral disease and some coral bleaching) reduced coral cover on many of these islands.

amounts of sediment and nutrients running off the land. The lagoons on the rainy Atlantic coast of Guadeloupe are particularly susceptible to heavy sedimentation pressures.

In **Martinique**, algal proliferation is a major factor contributing to the deterioration of the reefs. This was first evident on the Atlantic coast in the early 1980s, and spread to the Caribbean coast from 1984. Half of the land area of Martinique drains into Fort-de-France Bay that had the highest coral diversity on the island because it had a wide diversity of different habitats (reefs, seagrass beds, shoals, rocky shores). These communities in Fort-de-France Bay are polluted by urban wastes and high sediment loads such that the entire eastern part of the Bay is covered by silt and colonized only by seagrass beds. Industrial, urban and agricultural development continues with increasing levels of pollution. The prediction is that the coral communities in Fort-de-France Bay are doomed in the near future. A similar situation occurs in nearby Bay Du Marin. The same signals of algal proliferation in reef areas and high rates of sedimentation in lagoons and closed bays occur on other French Islands contributing to the degradation of the coral reefs.

Other Eastern Antilles Islands

Antigua: There are extensive shallow-reef systems on Antigua with some areas remote from the land between Long Island and Bird Island, where navigation is particularly difficult. Recent monitoring was a collaborative operation between the local dive operator, the Fisheries Division and the Reef Check team from Barbados. There are extensive *Acropora palmata* beds on top of most reef crests. During the last 6 years, 2 major hurricanes have passed over the island and these have detached many *A. palmata* colonies from the shallow areas and deposited some in the deeper areas, where there are many thriving colonies of the more robust corals *Diploria* sp, *Siderastrea siderea*, *M. annularis*, *P. asteroidea*. There were also many new coral recruits on the skeletons of the dead *A. palmata*. Macro-algal cover is relatively high, and probably linked more to a lack of adult algal grazers than to nutrient enrichment. The monitoring was insufficient to assess the condition of the reefs on Antigua and Barbuda, and there is a need to establish more monitoring sites; this will require a higher level of political will and more financial support.

There are no MPAs, but staff of the Fisheries Division are concerned about the lack of management and mechanisms to conserve the coral reef resources, especially the fisheries. The partnership between Dive Antigua and the Fisheries Division is effective in establishing some management. Dive tourism is increasing; however spearfishing is banned on the islands and is enforced by the coastguard and Fisheries staff. Antigua recently started a Reef Ball and coral transplantation project.

Dominica: Dominica has an impressive record in coral reef conservation for the region. Staff of the Soufriere-Scotts Head Marine Reserve and the Fisheries Division have been particularly active in conserving the reefs. The monitoring sites are in the MPA, where the Park staff negotiate carefully with fishers, requesting them to fish outside the park and use mooring buoys. Potential poachers know that they should not fish in the park, but the staff need more assistance to implement effective enforcement.

There are few well-defined offshore bank reefs, as the shelf can drop steeply within 30 m of the shore. The most productive coral reefs are within 250 m of the shore. The sites surveyed had high hard and soft coral abundance, very low algal cover, no observable diseases, no bleaching,

and no anchor damage because the mooring buoys are in place. These sites are typical of the Dominican reefs. Sediments from heavy rains have smothered some reefs on the southern coast nears Scotts Head. The low algal cover is probably linked to high populations of *Diadema* and parrotfish/doctorfish (algal grazers) and there are some large groupers, which is rare for the Caribbean. The commercial diver operators collaborate with the Fisheries Division and assist in patrols and monitoring.

Grenada: The monitoring sites are close to Grand Anse, which is the tourist capital. There is evidence of significant damage from Hurricane Lenny (and damage from recent Hurricane Ivan is suspected) at many shallow offshore bank and patch reefs, where large stands of *Acropora palmata* have fallen and are breaking up. This was also evident on the north of the island. Carriacou and Sandy Island lost a very high percentage of branching corals in last 5-7 years due to storms. Grenada has extensive shallow banks that are covered with large robust corals (*Siderastrea*, *Montastrea*). The deeper, low profile reefs are, however, quite healthy; algal cover appears to be very seasonal and not strongly linked to eutrophication as considerable growth of macro-algae was observed off uninhabited islands. Parrotfish abundance is quite healthy, however most fish are small, and *Diadema* are predominantly found in deeper areas.

The best reefs in Grenada are off the north coast with some healthy, large, dense stands of *A. palmata*; however these may not have survived Hurricane Ivan. Several offshore bank reefs have large populations of reef fish and lobsters; these do not appear to have been fished. A series of wrecks off Grenada diverts some of the diver damage away from the coral reefs. Most of the conservation work is done by private dive operations, with some involvement of St Georges University.

St Kitts and Nevis: St Kitts has fringing reefs, offshore bank reefs, like Ponds Bar, and near vertical walls similar to those on Dominica, but not as steep. Monitoring was restricted to the leeward side of island, where fish populations of both predatory and grazing species were relatively high. However *Diadema* populations were relatively low. The Kenneth Dive Centre has maintained observations of fish abundance for 30 years and report a significant decline, although the numbers are comparable with other Caribbean islands. Dive tourism is not well developed; however live aboard boat tourism from other islands visit the good diving sites off Brimstone Hill, where there are populations of large fish. Nevis Island has proportionally more dive sites, but was not monitored. The Chief Fisheries Officer is a dive master, which increases the awareness in the government of the status of the resources, however, there are limited budgets for coral monitoring. This is the case for many of the small island states, where monitoring is considered as a novelty. The Fisheries Department and the dive operator are cooperating on conservation projects, including installing artificial reefs.

St Vincent and Grenadines

The 'ole timers' readily confirm that fish populations, especially in the south of the island, have decreased dramatically since 1950s. Three monitoring sites were assessed within 8 km of the capital; 2 sites were reported by locals to be indicative of the other reefs. There was relatively high coral abundance, which ended at the sharp drop-off. There are large areas (100s of metres) dominated by the branching *Madracis mirabilis*. There are also healthy populations of *Diadema* sea urchins and the 'West Indian sea egg', which is not consumed locally. The high abundance of *Diadema* and parrotfish probably accounts for the low algal cover and high coral abundance at some sites. The west coast has numerous bays with extensive coral growth on the headlands.

Despite the perceived decrease in fish catches, large schooling predator fishes were observed in deeper water at the base of the reef. Coral diseases were minimal and restricted to black spot disease, and bleaching was absent at all sites monitored. The Fisheries Department and the Caribbean Regional Fisheries Mechanism Secretariat are active in fisheries management, and are continuously monitoring fish catches. Their staff took part in the Reef Check training, and it is anticipated that they will continue to monitor the reefs. The only MPA is on Tobago Keys (middle of the Grenadines), and is relative inaccessible to poachers; therefore it is anticipated to have healthy fish populations. The lobster fishery is tightly managed with closed seasons and good compliance, whereas fishing pressure is heavy in most other areas.

MARINE PROTECTED AREAS

Guadeloupe

The **Grand Cul-de-Sac Marin Natural Reserve** in Guadeloupe was created in 1987 to enclose 2,115 ha of territorial waters and 1,622 ha of forested lands. In 1993, the reserve was designated as a Ramsar wetland site of international importance and was also declared as a Man and Biosphere reserve. This natural reserve includes coral reefs, seagrass beds and mangroves areas, and is managed by Guadeloupe's National Park.

Petite-Terre: the Natural Reserve of the Islands of Petite-Terre was created in September 1998, covering 990 ha of land and waters to 10 m depth. It is managed by the ONF (Office National des Forêts).

Les îlets Pigeon: this is currently a no-take zone, where both commercial and sport fishing are prohibited and more formal designation as a reserve is planned.

Saint-Barthelemy: a Natural Marine Reserve was created in 1996 to cover 1,200 ha of ocean, excluding the small islands. Management of the reserve is through a non-profit association, including the municipality, the public users and a few private individuals.

Saint-Martin: a marine and terrestrial reserve of 3,060 ha was created in September 1998 on the northeast of Saint-Martin. The area includes coastal reefs and lagoons and is also managed by a non-profit association.

Martinique

There are no permanent marine reserves in Martinique, but 8 temporary no-take zones exist where commercial and recreational fishing is prohibited. They were originally created for 5 years, but have not been reopened and management is by the Direction des Affaires Maritimes of Martinique.

Resource Use

The population in **Guadeloupe, Martinique, Saint-Barthelemy** and **Saint-Martin** was 830,000 people in 1999, with an average density of 290 inhabitants per km². Of these, there were 2,200 registered fishermen. Fishing on **Guadeloupe** is predominantly artisanal, with 1,200 registered fishermen using 947 boats (mostly small-scale fishing from 6 to 8 m open boats, with only 10 vessels equipped for offshore fishing). There are probably 1,000 unregistered fishermen. About 8,800 tons of fish and 650 tons of crustaceans and shellfish are caught annually by these fishermen. A small benthic fishery contributes about 5,200 tons annually and imports (from

The known biodiversity on the reefs in the French West Indies. The source of the information is in the 1999 reference of Bouchon et al. at the end of the chapter.

Major Group	# of Species	Location
Algae	90	Guadeloupe
Phanerogams	6	Martinique/Guadeloupe
Sponges	73	St-Barthelemy/St-Martin
	70	Martinique
	42	Guadeloupe
Gorgonians	35	Martinique
	66	Guadeloupe
Corals	52	Guadeloupe
	45	Martinique
	47	St-Barthelemy/St-Martin
Annelids	33	French West Indies
Molluscs	570	Guadeloupe
	370	Martinique
	179	St-Barthelemy
	166	St-Martin
Crustaceans	60	French West Indies
Ascidians	93	French West Indies
Fish	400	French West Indies
Turtles	5	French West Indies

Venezuela, Europe, French Guiana etc.) make up more than 40 % of the estimated demand of 15,800 tons.

Fishing on **Martinique** is traditionally artisanal. In 2002, there were 1,052 registered fishermen, including 949 involved in coastal fishing. More importantly there are many unregistered fishermen, who could bring the total fishing population to 2,500. The fishing fleet consists of 914 boats with 98% being open boats averaging 7 m. The total fish catch was about 5,500 tons between 1991 and 1993, with pelagic species contributing 3,500 tons. However, no fishery data have been collected since 1993, so recent trends are unknown. It is probable that pelagic fish catches have increased with the recent development of anchored fish aggregation devices. All fish products are sold fresh in Martinique, but are not sufficient to satisfy the great seafood demand, so 7,000 tons of seafood are imported.

Tourism is a major industry in Guadeloupe with 623,000 tourists visiting in 2000. Hotel capacity is over 8,500 rooms, supplemented by other forms of accommodation including rural cottages. There were 736,000 visitors to Martinique in 2002 making tourism 10 % of the GDP;

this is a growth of 3 times in 15 years. Hotel room capacity is 4,900 with an additional 335 rural cottages. The major marine tourist activities are: glass-bottomed boats, kayaks, water skiing, surfing, sailboat rentals, sport fishing and especially scuba diving. There are 40 scuba diving clubs in Guadeloupe and similar numbers in Martinique. Most diving is on the Caribbean coast e.g. there are 80,000 divers annually around Les îlets Pigeon.

There are 2 marine research centres in the French West Indies: the Station Marine du Robert de l'IFREMER (Institut Français de Recherche pour l'Exploitation de la Mer) in Martinique, specialising in aquaculture and fisheries research; and the Laboratory of Marine Biology, Université Antilles-Guyane in Guadeloupe, devoted to tropical marine ecology.

LONG-TERM MONITORING SITES

Long-term quantitative monitoring of corals and fish fauna is undertaken twice a year, during the dry and the rainy season at 10 coral reef sites in Martinique, Guadeloupe and Saint-Barthelemy. These sites were chosen to include all major habitats and include marine reserves and areas where fishing is permitted. More sites will be added to develop a network of sites to include Saint-Martin and Petite-Terre.

Coral cover varies between 32 - 40% in Martinique, 21 - 24% in Guadeloupe and 20 - 26% in Saint-Barthelemy. Algal turf is the most important component of the benthic community, and there are also extensive areas covered by brown macro-algae, which can be an indicator of organic or nutrient pollution of the environment. These data show neither a negative nor a positive trend over these 5 years. The most important changes have been in the amount of brown macro-algae, which appear to be controlled by inputs of nutrients from the land as well as seasonal temperature changes and wave action. The cover of brown macro-algae on Saint-Barthelemy has regularly increased since the start of monitoring survey in parallel with increases in dead coral cover, which has varied between 17 % and 46 %. There is a direct correspondence between dead coral and proximity to and amount of pollution source; but there is no clear trend. The recruitment of juvenile corals fluctuates between 0.4 and 2 per m², and similarly there is no obvious trend seen in the 5 years of monitoring.

The average number of fish species in 600 m² areas varies from 45 species in Guadeloupe, to 46 in Martinique, and 48 in Saint-Barthelemy. The average fish biomass is also very similar in these sites: Saint-Barthelemy 751 kg ha⁻¹; Martinique, 788 kg ha⁻¹; Guadeloupe: 807 kg ha⁻¹. There appears to be no specific trends in the fish communities, although there are seasonal variations of fish biomass on Saint-Barthelemy.

STRESS AND DAMAGE TO CORALS REEFS

Sediments and Nutrients

There are high levels of rainfall in the French West Indies, which result in considerable erosion of deforested lands on Guadeloupe and Martinique. This began in the 17th century for agriculture, and is now compounded by injudicious coastal development, which all add to the input of sediments and nutrients into the marine environment. In addition, there is inappropriate use of fertilizers and poor wastewater treatment. Mangrove forests were destroyed throughout the 20th century, thereby removing these mechanisms for natural filtration of sediments and nutrients for the coral reefs. This has resulted in a deterioration

of coastal water clarity and high rate of sediment accumulation inside the bays and lagoons. There has been a parallel deterioration of coral reef communities due to intense macro-algal competition linked to nutrient overload. There has been a progressive invasion of reefs by algae in Guadeloupe since the beginning of the 1980s, predominantly by *Sargassum* and *Turbinaria* on the exposed outer slopes on the Atlantic coasts, and by *Dictyota* on more sheltered areas in lagoons and reefs on the Caribbean coasts. The corals on the islands of Saint-Martin and Saint-Barthelemy have also been colonized by *Dictyota*, which compete actively for space with corals and other benthic animals. *Turbinaria* and *Sargassum* are very resistant to Hurricane wave action, whereas *Dictyota* are removed by each passing Hurricane. However, they recolonise the reefs rapidly after the storms, including the coral areas devastated by the waves.

Damaging Fishing Methods

Techniques used in commercial fisheries vary widely, with some being very destructive, both to habitats and to fish stocks. Caribbean trap nets are particularly damaging, as individual fisherman may have up to 150 traps. They also use gill nets, trammel nets and seine nets.

Coral Bleaching

Coral bleaching generally occurs in the West Indies when water temperatures exceed 30°C for long periods. Bleaching is observed on some corals almost every year during September. In 1984 and 1987, a long-term elevation in surface water temperature caused mortality among certain species on the French islands. This was linked to the El Niño phenomenon, which also affected Indo-Pacific reefs in those years. These bleaching events had minimal effects on the reefs in the French West Indies. The first significant bleaching episode occurred in September and October 1998, when the sea surface temperature exceeded 29°C over several weeks. There was large-scale bleaching of corals (Scleractinians and Hydrocorals) and also other symbiotic animals such as Actinarians, Zoantharians and some Gorgonians. In Martinique, 59% of coral colonies bleached, with an average of 69% of tissues being bleached. There was similar bleaching in Guadeloupe, with 56% of corals affected and 80% of tissue area bleached. However, there was little mortality compared to other regions in the Caribbean over the next year, with tissue death in 20 to 30% of coral colonies, with the exception being *Diploria labyrinthiformis*, where mortality reached 80%. In September 1999, there was another bleaching episode confined to reefs in the Guadeloupe Archipelago, which affected almost 50% of the corals, but the Hurricane Lenny which followed, cooled the waters and reversed the bleaching. There has been no significant coral bleaching in the French West Indies since 1999.

Hurricanes

The French West Indies are affected by major Hurricanes every 10 years on average, which cause serious damage to the coastal ecosystems. There have been 4 recent Hurricanes: Hugo (1989) hit Guadeloupe; and Hurricanes Luis and Marilyn (1995) and Lenny (1999) hit Saint-Barthelemy and Saint-Martin very hard and also caused damage in Guadeloupe. The coral reefs of Martinique suffered significant damage after the passing of Hurricanes David in 1978 and Allen in 1980. Tropical storms are usually accompanied by torrential rains, resulting in massive runoff of sediments and nutrients to the nearshore reefs. Hurricane waves are the principal factor limiting coral reef growth in the Eastern Antilles. Hurricane Hugo smashed branching corals on the outer reef slopes down to 15 m (*Acropora palmata*, *A. cervicornis*, *Madracis mirabilis*), and there was delayed coral mortality in all species during the following months. The *Acropora palmata* populations never re-established themselves. After Hugo however, *Madracis mirabilis* quickly recolonised the area. Hurricanes Luis, Marilyn and Lenny damaged Guadeloupe's coral reefs even more severely than Hugo, mainly through large waves

up to 13 m high, which destroyed corals, sponges and gorgonians to depths of 25 m on the reefs. This was compounded by torrential rains and major soil erosion. There have been a few signs of recolonisation of *Acropora palmata*, which was the most common coral species on the outer reef slopes. On Saint-Martin and Saint-Barthelemy, hurricane Luis caused direct damage to the coral reefs, but the most significant impact was the disturbance of sediments on the shallow continental shelf. Fine particles remained in suspension for several months and smothered many organisms. Hurricanes David and Allen also damaged the *Acropora palmata* and *A. cervicornis* populations on the upper reef flat of Martinique, especially in the Sainte-Luce region. These populations have never re-established themselves, even though there has been no major Hurricane damage on Martinique since then.

POTENTIAL THREATS TO CORAL REEFS

The major natural and human factors threatening the coral reefs are summarised in the Table below. Two threats stand out: macro-algal proliferation in all the reef habitats; and high rates of sedimentation, especially in the bays and lagoons.

The summary of potential threats to the coral reefs of the French West Indies as assessed by local scientists and resource managers. These are probably the same level of threats applicable for other island states in the Eastern Caribbean. These show that the major threats are sediment and organic pollution from land-based activities, followed by over-fishing and coral bleaching.

Threat	Martinique	Guadeloupe	St-Barthelemy	St-Martin
Hurricanes	3	3	3	3
Coral bleaching	3	3	3	3
Algal proliferation	4	4	3	3
Organic pollution	4	4	4	4
Chemical pollution (pesticides)	4	4	1	1
Fertilisers	4	4	0	0
Hydrocarbon pollution	1	1	1	1
Sediment run-off	4	4	4	4
Land reclamation and dredging	3	3	1	4
Overfishing	4	4	1	3
Tourism impact	2	2	3	3

Risk : 0 = no threat; 1 = low; 2 = average; 3 = important; 4 = major threat.

CONCLUSIONS AND RECOMMENDATIONS

Mapping surveys of the coral reefs in the French West Indies Islands have shown that anthropogenic pressures have affected most of them. These pressures have mainly developed since the 1980s, nevertheless the 5 years of monitoring were initiated after most of the damage and have not shown any subsequent decline in the composition of the corals and fish communities. The major steps for the reestablishment of healthy reef systems depend on creating suitable environmental conditions by effectively treating sewage and other wastewater and controlling land erosion.

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DIREN : Direction Régionale de l'Environnement, Chemin des Bougainvilliers, 97100 Basse-Terre, Guadeloupe; Contact : Frank Mazeas, frank.mazeas@guadeloupe.ecology.gouv.fr

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ICRAN

BONAIRE NATIONAL MARINE PARK, NETHERLANDS ANTILLES – ICRAN DEMONSTRATION SITE

The Bonaire National Marine Park (BNMP), 100 km north of Venezuela, was established in 1979 and now has comprehensive legislation covering 27 km² of coral reefs, seagrass beds, and mangrove-lined bays. Over 390 fish species have been identified in the park. An annual fee for SCUBA divers (US\$10 per annum) is used for park maintenance, to provide information and education, research and monitoring programs, and for law enforcement activities. Despite initial concerns from the dive industry, the admission-fee system has been successful and within a year the marine park was entirely self-supporting. Coral-friendly diving ethics have been promoted and dive operators support the park by collecting fees and providing compulsory orientations and check-out dives, leading to a high level of compliance with rules and regulations. Unfortunately, the marine park is currently financially challenged by expansion to include Klein Bonaire, requiring increases in staffing levels, as well as inflation and a general unwillingness to consider other funding options. These problems complicate the close partnership with the dive and tourism industry but recently progress has been made with alternative financing systems. There is a successful public-private partnership with the local marina to collect visitors mooring fees, and an annual fee for private boat moorings. Establishing a donor base and the promotion of souvenir sales have not proved viable, but plans for a fee for all visitors to Bonaire are underway.

Ecological Monitoring: Although still considered some of the best reefs in the Caribbean, monitoring has revealed a steady decline in coral cover and diversity related to competition from algae, repeated bleaching events, coral disease, and substantial increases in tourism and associated development within the coastal zone. Reef Check monitoring is conducted annually and mangrove and seagrass studies have been undertaken. Fish stocks are now facing collapse and plans are underway for no-take marine reserves.

Socio-economic Monitoring: Dive site visitation data are collected from the dive operators on a monthly basis. The number of yachts and dive operators and fishermen using the park is monitored. Studies have also been undertaken to assess the reasons for success of diver ‘willingness to pay’ and in particular the carrying capacity and economic impact of the MPA. Some dive sites were found to be at or beyond capacity in 1991. A full time Nature and Environment officer works to increase public awareness, and islanders are soon to be surveyed on perceptions of turtle conservation.

Contact: Ramón de León, (marinepark@stinapa.org)

Coral reefs are 85% of the natural resources.

Ecological Monitoring is occasional.

Socio-economic Monitoring is occasional.

ICRAN

SOUFRIERE MARINE MANAGEMENT AREA, ST. LUCIA – ICRAN SITE

The Soufriere Marine Management Area (SMMA) extends along the Southwest coast of Saint Lucia, in the Eastern Caribbean. The site is managed by the Soufriere Marine Management Association, a non-profit stakeholder company. The SMMA is valuable for scientific study, improved the status of coral reefs and fish stocks in the marine reserves, and increased fishers catches. Initially however, a decline in fish catches, a lack of human and financial resources, inadequate legislation/enforcement and representational deficiencies resulted in misunderstandings and infringements of SMMA regulations. A Technical Advisory Committee comprising government organisations, NGOs, community members, and resource users was formed to address these concerns. An intense consultative and participatory review resulted in a more effective management structure with a stronger legal basis, clearly defined roles for all contractual parties and an evaluation process. As a result, conflicts have reduced among users, as their ownership and commitment to the initiative increased.

Under the new arrangement, the SMMA mission is ‘to contribute to national and local development, particularly in the fisheries and tourism sectors, through the management of the Soufriere coastal zone, based on the principles of sustainable use, cooperation among resource users, institutional collaboration, active and enlightened local participation, and equitable sharing of benefits and responsibilities among stakeholders’. User fees have made the reserve effectively self-financed. Furthermore, the government of St Lucia and donor organisations have improved infrastructure and training for the fishers, and established an investment fund. School visits to the site are increasing as a result of presentations and a newsletter and documentary were produced to show the impacts of terrestrial activities on marine resources. Alongside 5 Public Service Announcements, beach clean ups are well attended, with less garbage documented than in previous years.

Ecological Monitoring: The SMMA and other organisations monitor coral reefs, fish landings and levels of salinity, turbidity and sedimentation. Monitoring is particularly important as storms have resulted in up to 50% coral death, a problem exacerbated by alteration of the river course. There are now attempts to manage the catchment areas to prevent rapid runoff of sediments. Studies have shown a spillover of larvae to areas outside of the reserve as well as increased fish densities inside the reserve. Fish catches outside the reserve have almost doubled, and the species richness has also increased.

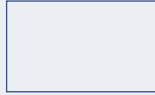
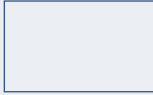
Socio-economic Monitoring: The increased fish stocks benefit tourism, and the fishers, who lost prime fishing grounds during establishment of the SMMA.

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Coral reefs are 20% of the natural resources.

Ecological Monitoring is effective.

Socio-economic Monitoring is occasional.



**ARCHIPEL DE LA GUADELOUPE,
FRANCE – MAN AND THE BIOSPHERE RESERVE**

The French Archipel de la Guadeloupe in the eastern Caribbean, includes the islands of St. Barthélemy, St. Martin, Les Saintes, La Désirade, Marie-Galante and Guadeloupe itself. The archipelago contains three marine reserves, one located in Saint-Barthelemy, and two in Guadeloupe (Petite-Terre and Grand Cul-de-Sac Marin). Its coastal areas have rich mangrove forests, wetlands and coral reefs, while inland there are dense tropical forests. More than 52 coral species, 59 crustacean species, 157 species of molluscs and more than 250 species of fishes have been identified inside the reserve. This site is a tourist destination throughout the year; over 10,000 visitors annually come to the marine reserve, mostly on weekends and holidays. The Guadeloupe National Park Authority is responsible for managing the Grand Cul-de-Sac Marin marine reserve and it also initiates and funds various scientific studies. The management plan was initiated in 1998 and focuses on maintaining biodiversity and good water quality. The marine reserve is divided into different zones, each with its own specific objectives.

There are several unions for fishermen in Guadeloupe involved in solving problems related to the use and management of marine resources. Monitoring of coral and fish populations is carried out by the Université des Antilles et Guyane and a variety of other organizations conduct research in this area. Current research topics have focused on coral reef ecology, cyclone impacts on mangroves, and distinguishing human effects from natural fluctuations. Reintroduction of manatees is an additional challenge for the marine reserve. Educational booklets and movies are available and school visits can be organised. Hurricanes, water pollution, land runoff and damage (anchor, construction, deforestation) are the main threats.

Ecological Monitoring: Three coral reef sites are monitored in the Grand Cul-de-Sac Marin on a long-term basis by the Marine Laboratory of the University des Antilles et de la Guyane.

Socio-economic Monitoring: No monitoring takes place.

Coral reefs are 20% of the natural resources.

Ecological Monitoring is effective.

Socio-economic Monitoring is not planned.

