THEMATIC REPORT FOR THE INSULAR CARIBBEAN SUB-REGION

Prepared for the CLME Project

by

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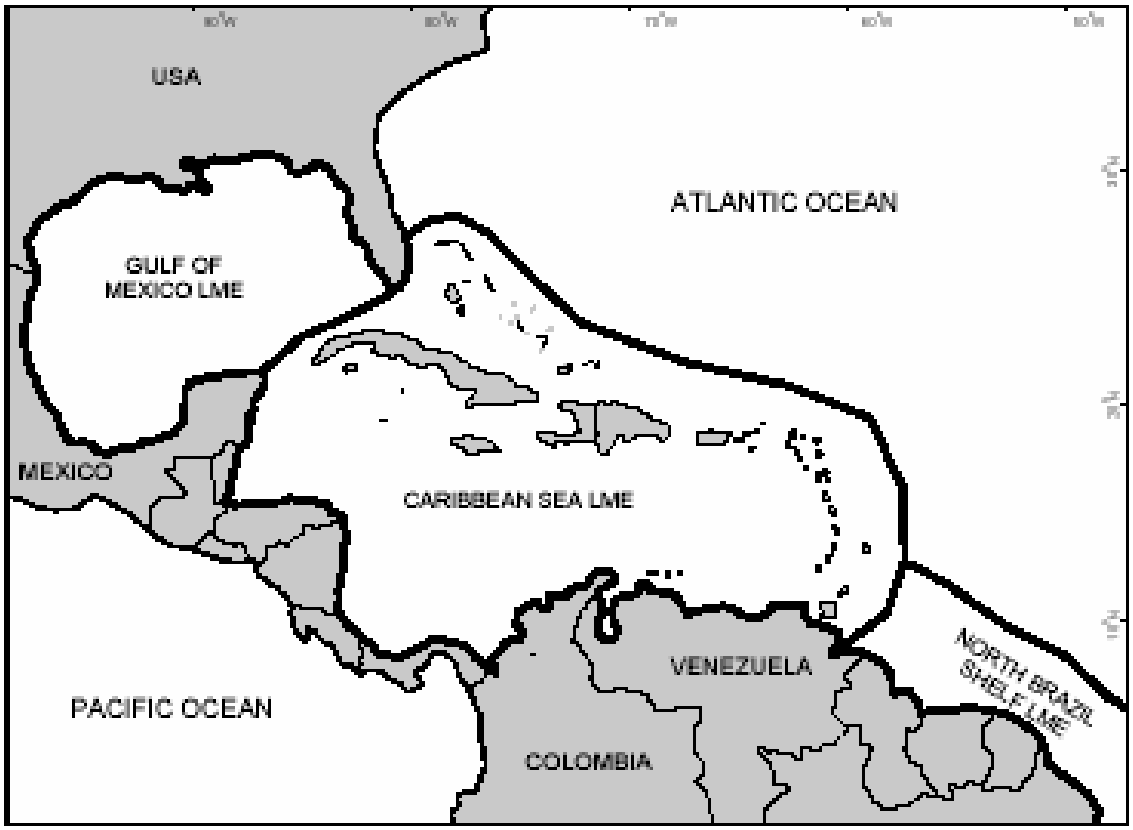

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1. INTRODUCTION

The Insular Caribbean is represented by three distinct groups of islands: The Bahamas; the Greater Antilles, consisting of the larger islands of Cuba, Dominican Republic, Haiti, Jamaica, and Puerto Rico; and the Lesser Antilles, composed of the smaller islands (Figure 1). Politically, the sub-region is comprised of 13 independent nations and several French, British, U.S. and Dutch overseas territories (Table 1). Among the countries are the 16 Caribbean Small Island Developing States (SIDS) included in the United Nations official list of SIDS. Twelve of the countries belong to the Caribbean Community and Common Market (CARICOM) and nine to the Organization of Eastern Caribbean States (OECS). There are three 'twin-island' States – Antigua and Barbuda, St. Kitts and Nevis, and Trinidad and Tobago, as well as the archipelagic States of St. Vincent and the Grenadines, and the Bahamas. The latter consists of 700 low-lying islands and cays, only about 22 of which are inhabited.

While these countries vary in a number of respects, for instance, in terms of physical size, political status, and cultural background, they show several similarities in terms of geography, climate, and colonial history. Furthermore, as small islands, they face similar environmental and socio-economic challenges that are characteristic of SIDS. A notable feature is the general high social and economic dependence on the marine environment and associated living resources. Almost every aspect of sustainable development in the Insular Caribbean is intricately linked to living marine resources, which places intense pressures on these resources. As a result, increasing resource depletion, as well as a wide range of problems affecting the coastal habitats, is among the major challenges confronting the Insular Caribbean, with grave consequences for sustainable development. With a limited and narrow resource base, sustainably exploiting and effectively managing their coastal and living marine resources are a major imperative for these countries.

Not only is this of utmost importance for the individual countries, but also for neighbouring, and indeed for the entire Caribbean Large Marine Ecosystem (CLME), given the high connectivity within the LME owing to the shared nature of many of the fish stocks, the high potential for the transboundary dispersal of fish and invertebrate larvae, as well as of pollutants, as a result of the general ocean circulation pattern within the Caribbean Sea. In this light, the goals set forth at the 2002 World Summit on Sustainable Development (WSSD) related to the marine environment and fisheries resources have major significance for sustainable development of the Insular Caribbean countries.

2. THE INSULAR CARIBBEAN

2.1 Geography and oceanography

The countries and territories of the Insular Caribbean sub-region are spread across an extensive area of ocean space, from the southern tip of Florida to northeastern Venezuela (Figure 1). The geography of this sub-region is characterized by an archipelago formed from the tectonic activity of the Caribbean plate, and marks the geomorphologic and climatic transitional zones between the Caribbean Sea, the Gulf of Mexico, and the Atlantic Ocean. Stretching from St. Kitts to Grenada, the mountainous inner arc of the Lesser Antilles consists of volcanic cones, some still

active. The outer arc, which runs from Anguilla to Barbados, is made up of low, flat islands, whose limestone surface overlies older volcanic or coralline rocks. In contrast, the islands of the Greater Antilles are composed of continental rock.

The islands exhibit substantial variation in physical size, which range from 110,860 km^2 (Cuba) to 100 km^2 (Montserrat). Great variation also exists between countries in terms of the size of the land mass relative to the Exclusive Economic Zone (EEZ) (Table 2). The ratio of coastline to land area is an indicator of 'islandness' or the proximity of the interior of the island to the coast: the larger the quotient, the more 'island-like' the country. The topography and hydrology determine the nature and extent of the land–sea interaction, which defines the coastal zone. 'Coastal zone' is considered as the area between the landward limit of marine influence and the seaward limit of terrestrial influence. Because of their small physical size, the entire landmass of some of these small islands can be considered as coastal.

Elevations range from over 3,000 m (the formerly glaciated summit of Pico Duarte) to a desert depression 40 m below sea level, both on the island of Hispaniola. Steep elevation and short, steep rivers characterize many of these islands, and not surprisingly, have important consequences for coastal areas. The islands are surrounded by narrow island shelves, with rocky and coralline formations. Most of the islands can be considered oceanic - with little shelf areas and steeply sloping seafloor that reaches great depths relatively close to shore. Exceptions to this include Trinidad and Tobago, which lie on the South American continental shelf, and as a consequence, is endowed with a relatively wide shelf area.

Water flows into the Caribbean Sea from the Atlantic Ocean mostly through the Grenada, St. Vincent, and St. Lucia Passages (Wust 1964, Johns *et al*. 2002). It then continues westward as the Caribbean Current, the main surface circulation in the Caribbean Sea. The source of the Caribbean Current is the Equatorial Atlantic Ocean via the North Equatorial, North Brazil, and Guiana Currents. The Guiana Current enters the Caribbean Sea along the northern coast of South America. Significant amounts of water is transported northwestwards by the Caribbean Current through the Caribbean Sea and into the Gulf of Mexico, via the Yucatan Current. The circulation in the Caribbean Sea experiences much variation in both space and time, some of it in the form of mesoscale eddies and meanders (Molinari *et al*. 1981).

The Caribbean Sea is greatly influenced by freshwater discharge from both the Orinoco and Amazon Rivers of South America (Müller-Karger *et al*. 1988, Müller-Karger *et al*. 1989). Satellite imagery has shown the Orinoco plume extending well into the Caribbean Sea (Figure 2). In addition to freshwater, the Orinoco River also contributes significant quantities of sediments and dissolved organic matter, the latter having been found to stimulate the growth of plankton far out in the Caribbean Sea (Müller-Karger *et al*. 1989). The Amazon River, the largest point source of fresh water to the ocean, also adds an enormous surface plume that extends hundreds of kilometres to the northwest (Müller-Karger *et al*. 1988). The influence of river runoff is strongly seasonal, with the strongest flow occurring between June and November, during the wet season.

Meteorologically, the sub-region is dominated by a tropical climate, with distinct wet (roughly June – November) and dry seasons (December – May), moderate air temperature ranges, and persistent trade winds. Annual rainfall varies between 50 - 1,250 mm. The seasonal variations of

the meteorological conditions are caused by north-south migrations of the Intertropical Convergence Zone, which is found near the equator in winter and at about 10°N at the end of summer. The wet season is associated with a continuous series of tropical waves that move westward, some developing into depressions, tropical storms, and hurricanes. A distinctive hurricane season extends from June to November.

2.2 Ecological features

On the whole, the Caribbean Sea is generally considered a 'desert', mostly comprised of clear, nutrient-poor waters. Based on SeaWiFS global primary productivity estimates, the Caribbean Sea is considered a low productivity ecosystem (<150 $gCm^{-2}yr^{-1}$) (NOAA 2003). Nonetheless, there is considerable spatial and seasonal heterogeneity in productivity throughout the sub-region. The complex interaction of open ocean waters, coastal and ocean processes, and riverine flows is reflected in geographically-varying ecosystem components that contribute to the sub-region's rich and valuable marine ecological and biological diversity. Areas of high productivity include the plumes of continental rivers, such as around the island of Trinidad where nutrients and silt from the Orinoco River (and to a lesser extent the Caroni River of Trinidad) support a rich and diverse fauna of demersal fish and invertebrates, typical of tropical, soft bottom habitats.

High productivity is also found in habitats such as coral reefs, mangrove forests, and seagrass beds, which naturally dominate the coastal margins in all the islands. These three types of habitats often exist together within a tightly-coupled ecological complex and provide important ecological services. For instance, coral reefs, mangroves, and seagrass beds function as spawning and nursery grounds for fish and invertebrates. They provide coastal protection against waves and storm surges, and coastal stabilization. Mangroves influence the productivity of coastal areas by contributing nutrients and acting as sediment traps in estuarine waters, thereby protecting coral reefs from sedimentation. Seagrass habitats are important for fishery production, and as a food source for certain threatened animal species. About 7% of the world's coral reef resources are located in the Caribbean LME (Sea Around Us 2007), particularly in the Greater Antilles and the Bahamas.

The Caribbean LME encompasses known biodiversity hotspots, the Caribbean Islands hotspot (Figure 3), which includes most of the islands of the Insular Caribbean sub-region, and part of the Mesoamerica hotspot (Conservation International 2007). Within these hotspots, the level of marine endemicity is high, with nearly a quarter of the 60 species of corals and 1,500 species of fish being endemic. Furthermore, the greatest concentration of fish species in the Atlantic Ocean Basin occurs in the northern part of the Caribbean Islands hotspot in waters shared by the Bahamas, Cuba, and the US (Mittermeier *et al*. 2000, Myers *et al*. 2000). The coral reef fauna in the Caribbean Islands are the most diverse in the world, in terms of higher taxonomic variety. The marine biodiversity of many of the islands, however, remains little studied.

The living marine resources include queen conch (*Strombus gigas*), spiny lobster (*Panulirus argus*), crabs, molluscs, and penaeid shrimps, as well as an immense variety of fish species associated with the range of habitats (e.g. reef fish, muddy bottom species, small and medium sized coastal pelagic species, large migratory pelagic species, and deep slope snapper and groupers), to turtles and marine mammals. Many of these resources form the basis of important

artisanal and commercial fisheries, both for the countries themselves and a number of foreign fishing nations.

Major swim-ways of turtles and marine mammals cross the Insular Caribbean waters regularly. Marine turtles, which nest on the beaches in several of the islands, include the hawksbill (*Eretmochelys imbricata)*, green (*Chelonia mydas*) and leatherback (*Dermochelys coriacea*). At least 34 species of marine mammals are known to inhabit the waters of the Caribbean Sea, seasonally or year-round (31 cetacean, 2 pinnipeds, and 1 sirenian) (UNEP/CEP 2001). The cetaceans include seven species of baleen whales and 24 species of toothed whales. Of the two pinnipeds, the West Indian monk seal (*Monachus tropicalis*) is now generally considered extinct. These animals use the Caribbean Sea as primary habitat for a range of critical activities such as feeding, mating, and calving. The West Indian manatee (*Trichechus manatus*) is the only sirenian species in the region, and is native to Cuba, Hispaniola, Jamaica, Puerto Rico, and Trinidad and Tobago.

It is becoming increasingly apparent that the sub-region's living marine resources continue to be unsustainably exploited and coastal habitats rapidly degraded because of escalating anthropogenic pressures superimposed upon natural local, regional, and global trends. Exacerbating these pressures are inadequate environmental, technological, and economic policies, and/or their poor implementation and enforcement. Throughout the Insular Caribbean, depletion of fish stocks, loss and degradation of coastal habitats and their biodiversity are threatening the livelihoods of thousands of persons and the income base of many of the countries.

2.3 Socio-economic background

The Caribbean Islands share some common socio-economic features, such as a concentration of racially and culturally mixed populations in the coastal zones, an emphasis on cash crops such as sugar cane and bananas, and the growth and importance of tourism. On the other hand, the countries show significant disparities regarding their political regimes, population distribution, and access to public services, economic stability, and priorities for economic development (UNEP 2004a, UNEP 2004b).

Table 3 presents some socio-economic statistics for the Insular Caribbean countries. The most populated country is Cuba (over 11 million), and the least populated is Montserrat (5,000), although the latter is partly a result of the mass emigration of inhabitants following the devastating eruption of the Soufriere Hills Volcano in 2004. High population densities, particularly in coastal areas, are a common feature of these small islands and place enormous pressure on the ecosystems. In several of the countries population density exceeds 200/km^2, reaching over 600/km^2 in Barbados. The proportion of urban population, which is concentrated in coastal areas, exceeds that in the Latin American and Caribbean region as a whole and has shown an increasing trend over the last few decades. Key health and social indicators have generally maintained a positive trend in the majority of the countries (UNEP 2005). The level of human development, as reflected by the UN Human Development Index (HDI) (UNDP 2006), is high for most of the countries, with only one country, Haiti, showing a low HDI (Table 3).

Significant variation exists among the countries with respect to poverty, with the highest proportion (65%) of population below the national poverty line being in Haiti (UNDP 2006).

The major economic sectors include tourism, export agriculture, and mineral extraction (bauxite and petroleum). Historically, the export earnings of many of the islands depended on agriculture (mainly sugarcane and bananas). This sector, which was once a major source of foreign exchange earnings, employment, and socio-economic stability in the Caribbean countries, is, however, in general decline. Although its contribution to GDP is relatively low, marine fisheries constitute a significant source of food, employment, and foreign exchange earnings in the Insular Caribbean countries.

Tourism, on the other hand, has become one of the principal industries and the fastest growing economic sector in the sub-region (CARICOM Secretariat 2003). According to the Caribbean Tourism Association, in 2004 close to 10 million tourist arrivals and a similar number of cruise ship passenger visits were recorded in 12 of the Caribbean SIDS. This represents an increase of between 13.4% (Cuba) and 106% (Dominica) over the previous year. There is a high dependence of the economies of some of the countries on tourism, which contributes an average of 35% of GDP and accounts for between 20% - 86% of earnings as a proportion of total exports (Commonwealth Secretariat 2000). In countries such as Antigua and Barbuda, US Virgin Islands, and the Bahamas, tourism contributes over 50% to GDP, reaching as high as 72% and 85% in Antigua and Barbuda and the US Virgin islands, respectively. The service industry, which includes tourism, is the main employment sector, except in Haiti. For instance, tourism and its related activities provide employment for approximately 50% of the Bahamian workforce. In the Insular Caribbean, tourism is dependent on the coastal and marine areas, and the concentration of tourism infrastructure and activities on the coast causes major environmental problems for coastal habitats.

2.4 Environmental and socio-economic vulnerability of SIDS

The Caribbean islands, like small islands worldwide, share a number of natural and anthropogenic features that make them particularly vulnerable to impacts from a wide range of internal and external forces (World Bank 2000, Kaly *et al*. 2002). Among these features are geographic isolation; scarce land resources; economic dependence on a limited range of natural resources (in most cases coastal and marine resources); ecological uniqueness and environmental fragility; exposure to external and global changes in trade and markets; poverty; and high susceptibility to natural disasters (particularly climate-related) and global environmental change.

Of particular concern is the effect of global warming, which is projected to lead to an increase in the frequency and severity of tropical storms (IPCC 2001). The Caribbean region has a long history of devastating tropical hurricanes and other natural disasters, with severe ecological, social and economic consequences. Global warming and climate change are also having detrimental effects on fragile coastal ecosystems such as coral reefs, for example, through coral bleaching and physical damage from storms and hurricanes. Based on global projections and studies in other regions, sea-level rise of 30 -55 cm for the Caribbean over the next 50 years has been considered a reasonable projection. A rise of this magnitude is expected to have severe implications for the social and economic development of many Caribbean states (IPCC 2001).

About 70% of the Caribbean's population inhabits cities, towns, and villages located in vulnerable low-lying coastal areas (UNEP 2000). It has been suggested that land loss from sea-level rise, especially on the low limestone islands, is likely to be of a magnitude that would disrupt virtually all economic and social sectors (Leatherman 1997).

A SIDS environmental vulnerability index, which integrates ecological fragility and economic vulnerability, has been developed by the South Pacific Applied Geoscience Commission (SOPAC), the United Nations Environment Programme (UNEP) and their partners. Preliminary results (Kaly *et al*. 2004) show that 17 of the countries can be classified as extremely vulnerable to highly vulnerable, four as vulnerable, and one at high risk, while none as resilient (Table 4).

The hurricane season of 2004 clearly demonstrated the extreme economic, socio-cultural, and environmental vulnerability of SIDS. In less than two months four extremely dangerous hurricanes (Charley, Frances, Ivan, and Jeanne) tore through the Caribbean. No island was left untouched. These hurricanes caused severe loss of life, dangerous flooding, damage to infrastructure and devastation to agriculture and critical habitats. A well-known example is Hurricane Ivan, which devastated nearly the entire island of Grenada and caused widespread damage in other islands such as Barbados, Jamaica, and Tobago. The economic cost of damage from hurricanes in 2004 amounted to about 2.8 billion USD in Cuba, Dominican Republic, Grenada, Haiti, and Jamaica (CRED 2005). Their limited financial and human resources, as well as narrow natural resource base implies that recovery of these small island states from disasters will be slow and long, and will rely to a large extent on external aid.

The high dependence of these countries on the marine environment and living marine resources, combined with their high environmental vulnerability underscores the importance of sustainably exploiting these resources, especially with regard to a changing global climate over which these countries have little or no control. It is imperative that the coastal habitats are maintained in healthy condition to increase their resistance and resilience to the impacts of internal and external anthropogenic and natural pressures. All the Insular Caribbean SIDS have adopted the Barbados Programme of Action for the Sustainable Development of SIDS (BPoA), which identifies actions required at the national, regional, and international levels for sustainable development in these countries and for reducing their vulnerability. Included in the priority areas identified in the BPoA are climate change and sea level rise, coastal and marine resources, tourism resources, and biodiversity resources.

3. PRIORITY TRANSBOUNDARY PROBLEMS

The GEF-supported Global International Waters Assessment (GIWA) has identified priority environmental problems in the Caribbean Islands from among five major concerns and related issues. The five concerns are Freshwater shortage, Habitat and community modification, Pollution, Unsustainable exploitation of fish and other living resources, and Global change. Further details on the GIWA concerns and issues, as well as on the GIWA methodology are available at http://www.giwa.net. The severity of the environmental and socio-economic impacts of these concerns and issues were ranked based on pre-defined criteria. For the Insular Caribbean, the large islands (Greater Antilles and the Bahamas)) and small islands (Lesser Antilles) were assessed separately (UNEP 2004a, UNEP 2004b). The priority concerns related to the marine environment were identified as:

- Unsustainable exploitation of fish and other living resources;
- Habitat and community modification;
- Pollution; and
- Global changes (particularly climate change and sea level rise).

In this report, climate change is not discussed separately, but rather treated as a cross-cutting issue because of its linkage with the other concerns.

3.1 Unsustainable exploitation of living marine resources

3.1.1 Description of the problem and justification of its transboundary importance

Throughout the Insular Caribbean, marine fisheries are an important source of food, employment, and income. A diverse array of resources characterizes the sub-region's fisheries. These include spiny lobster, queen conch, penaeid shrimps, a large number of reef, continental shelf demersal, deep slope and bank fish species, and large and small coastal pelagics such as king mackerel (*Scomberomorus cavalla*), Spanish mackerel (*S. maculatus*), dolphinfish (*Coryphaena hippurus*), and flyingfish (*Hirundichthys affinis*, *Exocoetus volitans*). Most of these resources have been conventionally fished throughout the sub-region. In recent years, several of the countries have developed fisheries for large oceanic migratory pelagic species such as yellowfin tuna (*Thunnus albacares*), albacore tuna (*Thunnus alalunga*), Atlantic blue marlin (*Makaira nigricans*), and swordfish (*Xiphius gladius*) (Chakalall and Cochrane 2004).

The majority of the fishery resources are coastal and intensively exploited by large numbers of small-scale fishers using a variety of fishing gears and landing their catch at numerous sites scattered around the islands. The region's highly migratory tuna and billfish resources are exploited by countries from within the region, as well as by foreign nations, the latter fishing particularly on the High Seas. In several of the islands, these species also form the basis of important recreational fisheries.

While the degree of exploitation varies by species and among countries, assessments have revealed generally high exploitation levels that have resulted in declining catches, particularly in inshore areas throughout the sub-region, as well as in a number of threatened species. The general consensus is that most of the coastal fisheries resources are fully or overexploited and there is increasing evidence that pelagic predator biomass has been depleted (Mahon 2002). Several species of sea turtles are threatened or endangered in many areas as a result of overexploitation.

Overexploitation is considered to be severe in both the Greater Antilles and the Bahamas, as well as in the Lesser Antilles (UNEP 2004a, UNEP 2004b). Specific resources that are overexploited, or exploited close to their maximum sustainable yield (MSY), include shrimp, spiny lobsters, conch, turtles, reef fishes, some of the small pelagic species such as flyingfish, and even some of the Highly Migratory Species and Straddling Stocks (HMS & SS) (FAO 1998, Mahon 2002, Die 2004).

Unsustainable exploitation of living marine resources in the Insular Caribbean is of major transboundary significance, not only for the sub-region, but very likely for the entire Caribbean LME and adjacent LMEs, owing to the shared and/or migratory nature of some of these resources. For instance, the stocks of some of the large and small coastal pelagic species are shared between neighbouring countries, while all of the large oceanic pelagic species are HMS & SS, moving in and out of all or most of the EEZs and extending into the High Seas. Reef organisms, lobster, conch, and small coastal pelagics are also likely to be shared resources by virtue of planktonic larval dispersal. In many species, larval dispersal lasts for several weeks or months, which could result in transport across EEZ boundaries. Long distance dispersal of lobster larvae in the Caribbean has been demonstrated (e.g. Silberman *et al*. 1994). In addition, owing to the close proximity and ecological similarity of the islands, dispersal of larvae across EEZs is not unlikely.

Unsustainable fishing has also threatened global biodiversity, in contributing to reduction in the population of species of global significance such as turtles and marine mammals, local extinctions, and possibly loss of endemic species.

Another transboundary dimension of unsustainable exploitation is illegal fishing by foreign countries. For example, depletion of queen conch, lobster, and Nassau grouper in the Bahamas occurs as a result of legitimate and illegitimate harvesting, including by foreign countries.

3.1.2 Environmental impacts

The major environmental impacts of unsustainable exploitation include:

i. Reduced abundance of fish stocks, as evident in declines in total catch and catch per unit effort (CPUE);
ii. Changes in trophic structure of fish populations, with a trend towards small, low trophic level species;
iii. Threats to biodiversity;
iv. Degradation of coastal habitats.

i. <u>Reduced abundance of fish stocks</u>

Trends in annual catches by countries for the period 1950 – 2003 are shown in Figure 4. These statistics were obtained from the Sea Around Us project, University of British Columbia Fisheries Centre (Sea Around Us 2007), and are based on fisheries landings statistics reported by the countries to FAO (Watson *et al*. 2004). Total annual catch increased steadily from 1950 to a peak of nearly 140,000 tonnes in the mid-1990s, following which it declined to below 110,000 tonnes in 2003. In most of the countries, total annual catch declined in the past decade. Increased catches in recent years, for example, in Antigua and Barbuda, probably resulted from geographic expansion of the fishery into offshore areas or from fishers switching to other species not conventionally exploited.

During the 1980s and 1990s, many islands experienced changes in the relative abundance of reef fish species. This is confirmed by informal reports from fishing communities of declines in overall catch per trip, reduction in individual sizes of fish caught, and changes in species

composition of the catch (Mahon 1990, Mahon 1993). A notable change is the reduced abundance of large-sized carnivorous reef fish such as snappers and groupers in several locations (e.g. in the Bahamas, Grand Cayman, Cuba, and St. Vincent) surveyed during the Atlantic and Gulf Rapid Reef Assessment (AGRRA) programme (Kramer 2003). In Haiti and Jamaica overexploitation has been particularly severe; the highly commercial snapper and grouper fisheries collapsed by the mid-1970s and fish landings are now made up of smaller herbivorous fishes such as parrotfish or grunts.

Of particular concern is the heavy exploitation of spawning aggregations of reef fish species, particularly Nassau grouper (*Epinephelus striatus*), and the resulting declines and even commercial extinction in a number of localities in the Bahamas, Cayman Island, Cuba, Dominican Republic, Puerto Rico, and the British and US Virgin Islands (Sadovy and Eklund 1999). This is of transboundary importance since there may be one panmictic population of Nassau grouper in the northern Caribbean, with a high gene flow in the region and larval dispersal over great distances (Hateley 1994, cited in Sadovy and Eklund 1999). Nassau grouper and yellowfin grouper (*Mycteroperca venenosa*) have both been placed on the IUCN (World Conservation Union) Red List of Threatened Species.

Recent assessments have indicated that the spiny lobster is being fully or overexploited throughout much of its range (FAO 2001a, FAO 2001b), although data are insufficient from some areas to reliably estimate the status of this resource. Annual catch of spiny lobster in the Insular Caribbean (23 countries) is shown in Figure 5. Catches rose steadily to over 20,000 tonnes in the mid-1980s, then levelled off, although with some instances of reduced catches, including between 2002 and 2003.

At the Second Workshop on the Management of Caribbean Spiny Lobster Fisheries in the Western Central Atlantic Fisheries Commission (WECAFC) Area (FAO 2002), a number of countries reported similar trends in the status of the spiny lobster within their waters. For instance, in the Bahamas, decline in landings, in abundance and in mean size, and steadily increasing fishing mortality were reported. Cuba also reported a decline in landings, abundance, and in recruitment over the past decade, thought to have resulted from a combination of fishing and unfavourable environmental conditions. In the Dominican Republic, there has been a decline in the size captured, which is below the legal minimum size. Fishing effort for spiny lobster has increased significantly over recent years in Jamaica, and the present level of fishing mortality appears to be greater than the optimum recommended for the fishery.

Overexploitation and depletion of the lobster resource has major transboundary implications for the entire Caribbean Sea LME, and indeed adjacent areas. With a 6 to 10 month ocean pelagic larval dispersal stage, many localities may depend on recruitment from other areas, and perhaps the EEZs of other countries. In most countries there is an urgent need to control or reduce fishing effort for this species.

In early 2000 annual landings of queen conch in the Insular Caribbean (22 countries) declined by more than 80%, from about 20,000 tonnes in mid-1990s (Figure 6). Queen conch populations in several countries in the sub-region have been reported as partially, fully, or severely overfished (Appeldoorn 1994, Chakalall and Cochrane 1996). Since 1992, the queen conch has been listed

in Appendix II of the Convention for International Trade in Endangered Species (CITES). In 2006 CITES placed an embargo on queen conch exports from three Caribbean countries: Honduras, Haiti, and the Dominican Republic, in an effort to promote sustainable trade in this species.

Trends in total annual catches of tunas and billfishes in a number of Insular Caribbean countries (Sea Around Us 2007) show a steady increase to about 7,000 tonnes in the mid-1990s, followed by a rapid decline to less than half this magnitude in 2003 (Figure 7). This is consistent with assessment of these species by the International Commission for the Conservation of Atlantic Tunas (ICCAT), which suggested that some of these HMS & SS are already considered to be overfished throughout the Atlantic (Die 2004). These include the Atlantic swordfish (ICCAT 2001a) and Atlantic blue marlin and white marlin (ICCAT 2001b). The abundance of Western Atlantic sailfish fell dramatically in the 1960s and has not increased much since. Current catches seem sustainable (ICCAT 2001b), but it is not known how far the current levels are from MSY. In the Eastern Caribbean, the wahoo and dolphinfish are considered to be overexploited and current fishing mortality not sustainable (CFRAMP 2001).

ii. Changes in trophic structure of fish populations

An indicator of the ecosystem impacts of unsustainable fishing practices is a change in the structure of the marine food web, as reflected in changes in the mean trophic level (MTL) of the catch (Pauly *et al*. 1998, Pauly 2005). This phenomenon - 'fishing down the food web'- occurs with depletion of large predators (high trophic level species) through fishing, leading to a predominance of smaller, low-trophic level species. Trends in MTL of the catch between 1950 – 2003 are illustrated in Figure 8, using data obtained from the Sea Around Us project (Sea Around Us 2007). In the last two decades, the MTL showed marked declines in five of the eight countries for which data were available (Figure 8). For the two countries with increasing (Cuba, St. Kitts and Nevis) or stable MTL (Dominican Republic) since 1983, MTL was nevertheless lower than that in previous decades, showing that these countries have also suffered from fishing down of the food web. The MTL declines could be more severe than shown, since they could be masked by increases in catches of large migratory pelagic fish.

iii. Threats to biodiversity

Unsustainable fishing also poses a threat to the biodiversity of non-target species, which are caught incidentally as bycatch, particularly in gear such as demersal trawls and longlines. Many shark species are particularly vulnerable to overfishing owing to their low reproductive rates. They are commonly taken as bycatch in longlines, thus raising concerns about their becoming inadvertently depleted to the point of extinction. Threats to biodiversity could also arise from the selective targeting of particular species of reef fish for the aquarium trade, but little is known about these impacts in the sub-region.

Direct and indirect threats of fishing to species of conservation importance such as turtles and marine mammals are well known, and populations of some of these species have been decimated, some even becoming locally extinct, in the Caribbean. Populations of sea turtles have been reduced through high harvesting pressure on eggs and adults. Turtles and marine mammals

are accidentally captured in active or abandoned fishing gear, and by hunting/poaching. The hawksbill, green, and leatherback turtles are classified as endangered by IUCN, and the loggerhead as vulnerable. Sea turtles were harvested throughout the sub-region for meat, shell, oil, skins, and eggs. Today very few persons depend on the capture of turtles for a significant portion of their livelihood, but the fishery has persisted in some areas, and opportunistic capture has been reported.

Fishing for marine mammals has traditionally been carried out in a number of the islands such as Dominica, St. Lucia, and St. Vincent and the Grenadines. The Caribbean monk seal is now considered extinct by the IUCN, largely through overhunting (Rice 1973). During the 18th Century the West Indian manatee once occurred along the nearshore coastal waters of Tobago. This species is now extinct from around Tobago, largely as a result of hunting (Khan 2002). The baleen whale, sperm whale, and West Indian manatee are all listed as vulnerable to extinction on IUCN Red List of Threatened Species.

iv. Degradation of coastal habitats

Commercial, subsistence, and recreational fishing, particularly of herbivores, are among the most widespread and greatest threats to coral reefs. In fact, overfishing has been identified as the most pervasive threat to Caribbean coral reefs (Burke and Maidens 2004), and has been one of the major causes of the deterioration of reef condition in the Caribbean in recent years. Overfishing, particularly of herbivorous species, has been identified as a key-controlling agent on Caribbean reefs, leading to shifts in species dominance (Aronson and Precht 2000). Overfishing of herbivores in coral reef systems has contributed to decreased coral cover and increase in algal abundance, which is thought to be widespread in the Caribbean (CARICOMP 1997). Fishing can also impact coastal habitats through direct damage by fishing gear, boat anchors, vessel groundings, and destructive practices such as the use of explosives and poisons. The threat levels from overfishing on Insular Caribbean reefs are shown in Figure 9.

3.1.3 Socio-economic consequences

Fisheries provide employment, income and protein for a significant fraction of the population of the Insular Caribbean countries. The number of persons employed in this sector range from a few hundred in the smaller countries (e.g. about 600 in St. Kitts and Nevis) to nearly 17,000 in Cuba and 20,000 in Jamaica (FAO 2007). The fisheries sector continues to act as a 'safety-net' for the economy in many of the countries, i.e., when there is a downturn in other sectors, such as tourism and construction, individuals re-enter or increase their activity in this sector. As a result, large numbers of part-time fishers exist in many of the countries. Fish is a major component of the diet and the primary source of protein in the Insular Caribbean. Annual per capita fish consumption reaches up to 20 - 30 kg (live wet weight) in several of the countries, for example, in Barbados, Dominica, and Jamaica (FAO 2003a). Fishing is also a traditional and cultural way of life for many island communities (e.g. the flyingfish fishery of Barbados), the cultural integrity of which may be altered by depleted fish stocks.

Although in some countries such as the Bahamas, Barbados, and Trinidad and Tobago, fisheries do not make a significant contribution to GDP compared to other sectors such as tourism and industry, this sector accounts for substantial foreign exchange earnings (FAO 2007). For

instance, in the Bahamas, spiny lobster and queen conch are the most highly demanded commodity for export, with spiny lobster alone generating about 79% - 80% of this sector's revenue. Exports of fish products from the CARICOM region were valued at over 250 million USD in 2000 (FAO Annual Yearbook Fisheries Statistics: Commodities 2000).

Considering the importance of the fisheries sector in the Insular Caribbean, the decline of fish stocks is likely to have serious socio-economic impacts in these countries. These include loss of employment, reduced food security in communities that depend on fishing, and reduced income. This is particularly significant in countries with a relatively high level of poverty, and considering that small-scale fishers are often among the most economically disadvantaged in society. In the past decade, the annual value of the catches has declined by about 100 million USD (Figure 10), reflecting the trend in reduction in landings.

Reduced inshore resources also lead to increasing operational expenses, since fishers have to extend their fishing range offshore. Overfished stocks can also lead to poaching, illegal fishing (e.g. catching of lobsters and conch below the minimum legal sizes), as well as in conflicts among fishers, and even between countries, for the scarce resources. The latter has been demonstrated in the recent conflicts between Barbados and Trinidad and Tobago over the flyingfish resources. At the international level, unsustainable exploitation could be seriously disruptive for trade, as demonstrated by the CITES trade embargo on queen conch.

3.1.4 Linkage with other transboundary problems

Overexploitation and destructive fishing practices are closely linked with habitat degradation, particularly of coral reefs, mangroves, and seagrass beds, which provide shelter, feeding and nursery grounds for fish and invertebrates of commercial importance. Apart from fishing pressure, fish stocks are also affected by pollution and climate change, although there is little data from the sub-region to show these linkages.

3.1.5 Immediate causes

The major immediate causes of unsustainable fisheries exploitation include:

- Harvesting of fish beyond the level of MSY;
- Catching of large quantities of immature and spawning individuals, leading to growth and recruitment overfishing;
- Destruction of habitats and loss of biodiversity (which could contribute to decline in fisheries resources and exacerbate the problems caused by overexploitation).

The key sector involved is the fisheries sector, although the tourism sector is also likely to contribute indirectly and directly, through high demand for seafood and recreational fishing. Among the major stakeholders are the fisheries sector (harvesting, processing, and marketing), tourism sector, national governments, fisheries research institutes, the general public, donor agencies, intergovernmental agencies, and non-governmental organizations (NGOs) (national, regional, and international). Other stakeholders at the sub-regional, regional and international levels, such as CARICOM, OECS, Intergovernmental Oceanographic Commission Regional

Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE), ICCAT, and UN organizations (see chapters on Governance and Stakeholders) are also included, in view of the transboundary nature of the region's living marine resources.

3.1.6 Underlying causes

The underlying causes of unsustainable exploitation in the Insular Caribbean include:

- The open access nature of fisheries resources: This means that anyone can enter the fishery, and there are no set limits on the number of fishers (although unprofitable catches could eventually force fishers out or discourage others from entering). This is exacerbated by the limited employment opportunities in other sectors;
- Excessive fishing effort, beyond that required for MSY: Fishing effort (as measured by number of fishers, number and horsepower of boats, number of fishing trips, etc.) has increased considerably in the Insular Caribbean countries, with large numbers of small-scale fishers in inshore areas. Excessive fishing effort ultimately results in decreased CPUE, an indication of reduced stock abundance;
- Government subsidies to the fisheries sector: Effectively, this has helped to increase fishing effort and promote fishing overcapacity;
- Changes in technology: Improvements in technology, for instance, more efficient vessels and gear, modern fish-finding equipment, and navigation systems, serve to increase pressures on fish stocks, especially those in previously inaccessible offshore areas;
- Destructive fishing methods: Use of explosives and poisons, as well as non-selective fishing gear (e.g. small-meshed nets and fish traps) and demersal trawls can accelerate resource declines. The deliberate catching of immature or spawning individuals (e.g. conch, lobsters, spawning aggregations of groupers) is also an underlying cause of stock declines in the region.

3.1.7 Socio-economic, legal, and political root causes

The above-mentioned causes of unsustainable exploitation have identifiable socio-economic, legal, and political root causes, which are well recognized in the Caribbean, and which are characteristic of overexploited fisheries in most developing countries. Among the major root causes are:

- Increasing demand for food and employment by growing human populations, as well as high demand for seafood by the tourism industry;
- The relatively high poverty level in some of the countries, which means greater pressures on the fish stocks from people who have little alternatives for food and employment;
- Limited financial resources and human capacity to devote to fisheries assessment and management, resulting in non-existent or limited monitoring, surveillance, and enforcement of existing national policy and legislation, and limited implementation of the relevant Multilateral Environmental Agreements (MEAs) and non-binding agreements;

- Limited scientific information on the status, distribution, and sustainable yield levels of the commercially important fisheries resources, at the sub-regional, regional, and ecosystem levels. Where scientific knowledge is available, it is often poorly communicated to, and understood by policy-makers and the public;
- Low priority accorded to fisheries on the political agenda in several of the countries, owing to its low importance relative to other sectors such as tourism and industry;
- Poor stakeholder involvement in resource management, as well as limited public responsibility;
- Low level of public awareness of the importance of marine ecosystems and the impact of transboundary influences;
- Weak and ineffective legal, regulatory, and institutional frameworks;
- Illegal, unregulated, and unreported (IUU) fishing;
- Lack of regional harmonization of regulations;
- Lack of long-term planning and political will;
- Government policy in many countries to expand fisheries as a means of generating jobs and foreign exchange, most often without adequate knowledge about the resources;
- Failure to integrate environmental considerations in development strategies;
- Cultural and language barriers, which can constrain dialogue, communication, and data and information exchange, and hinder regional cooperation and collaboration in the management of shared resources;
- Lack of a regional fisheries management organization for management of shared stocks (apart from those resources under ICCAT);
- Natural phenomena that may adversely impact fish stocks, for example, environmental changes brought about by El Niño, and rising sea surface temperatures.

3.1.8 Knowledge gaps

Although the Insular Caribbean countries have shown major improvement in research and assessment of their living marine resources in recent years, considerable knowledge gaps still exist, particularly with respect to transboundary resources. Management of these resources should be based on the status of the stock evaluated at the scale of the entire stock (Die 2004). There is a high degree of uncertainty in the spatial oceanic dynamics of migratory species, and there is a need for standardized indices of abundance, sustainable yield, and fishing effort for these resources.

Significant gaps still exist on the biology and population dynamics of individual species. The move towards more integrated, holistic (e.g. ecosystem) approaches to living marine resources management has revealed major gaps in the knowledge required to implement these approaches. For instance, there is limited knowledge about ecological interactions within fish communities, on the impacts of fishing and other pressures on ecosystem structure and function, and threshold levels at which the ecosystem could collapse. These gaps are significant within national boundaries, and even more so at the sub-regional and regional scales. Holistic, multisectoral approaches require knowledge, for example, about the synergies among the various sectors and their combined pressures on living marine resources.

Global climate change is expected to have grave impacts on small islands. While the Insular Caribbean countries have little control on this issue at the global scale, they could be better prepared to deal with some of the likely consequences, for example, by taking adaptive measures. In terms of fisheries, knowledge on the response of the sub-region's marine ecosystems and fish populations to global climate change (e.g. changes in productivity, migratory patterns) would help in developing and implementing appropriate management measures.

The establishment of Marine Protected Areas (MPAs), marine reserves, no-take fishery zones, etc. is widely advocated, including in the WSSD plan of Implementation. However, in order to derive maximum benefits from these areas, their establishment and management must be based on relevant scientific knowledge, much of which is lacking in the sub-region. This includes knowledge on the distance and direction of dispersal of larvae, patterns of movement during the juvenile and adult phases of fisheries species, knowledge of the ecosystem impacts of fishing, and knowledge of the behavior and temporal variability of water masses in the vicinity of complex coastlines. The most crucial questions concern connectivity and the anticipated recruitment subsidy that this should make possible. There are also gaps in socio-economic knowledge required for effective management of MPAs.

Since fisheries management is as much about people as about fish stocks, political leaders and policy-makers must be made aware of the linkages between socio-economic issues such as poverty and unemployment, governance issues, and environmental issues, information on which is currently limited.

3.1.9 Proposed options

The WSSD fisheries targets include maintaining or restoring stocks to levels that can produce the MSY, with the aim of achieving these goals for depleted stocks on an urgent basis and where possible not later than 2015. A wide range of options exists for addressing unsustainable exploitation, several of which have been adopted in the Insular Caribbean countries. Numerous options and guidelines that are relevant for the management of the sub-region's fisheries resources have been proposed in a number of reports and at many national, sub-regional and regional fora, as well as in the WSSD plan of implementation. The need for improved regional collaboration and cooperation, and appropriate institutional, legislative, and policy frameworks has also been extensively discussed (e.g. Chakallal *et al*. 1998, Mahon and McConney 2004, FAO/WECAFC 2005). Therefore, these will not be discussed here and only some specific options are highlighted.

- The current overexploited status of the fisheries of the Insular Caribbean requires major reduction in fishing effort and eliminating unsustainable fishing practices. This option has complex socio-economic implications, and must be accompanied by creation of alternative employment opportunities, as well as the provision of alternative sources of protein for the communities that depend on these resources for employment and food. For those resources that are already overexploited or depleted, co-operation in management would allow for rebuilding of the resources, resulting in increased revenues/yields and fisheries sustainability;

- Wider ratification and effective implementation of the relevant UN and regional and sub-regional fisheries agreements or arrangements, in particular the Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Species, the FAO Code of Conduct for Responsible Fisheries, and the relevant FAO international plans of action and technical guidelines;
- Implementation of more holistic management approaches:
  i. Ecosystem approaches, possibly at the regional and sub-regional scale;
  ii. Establishment of and effective management of a sub-regional/regional network of marine parks and protected areas, based on sound science. No-take reserves can become an effective fishery management tool that provides fishery benefits as well as important biodiversity conservation benefits;
  iii. Integrated Watershed and Coastal Area Management;
- Clear delimitation of EEZs.

Countries should manage their fisheries with the best available scientific information and adopt a conservative precautionary and adaptive approach to management. Filling knowledge gaps needs a significant investment in targeted research, chiefly in the context of adaptive management, and will require the development of strong collaborations among the scientific, management, and stakeholder communities.

3.2 Habitat degradation and community modification

3.2.1 Description of the problem and justification of its transboundary importance

Virtually all the nearshore areas of the Insular Caribbean experience multiple threats that act simultaneously to degrade coastal ecosystems and reduce the ecosystem services they provide. Threats originate both at the site of degradation and far away - from land, as well as from distant regions. Coral reefs, mangroves, and seagrass beds are closely linked by complex ecological interactions between them, and degradation of one or more of these ecosystems could adversely affect the functioning of the others. Physical destruction and removal, sedimentation, over-extraction of living resources, and introduction of exotic species and disease contribute to degradation and loss of these essential coastal habitats.

In the low productivity Caribbean Sea 'desert', the highly productive coral reefs, mangroves, and seagrass beds are among the few 'oases', that are responsible for nutrient cycling and carbon and nitrogen fixation in this nutrient-poor environment. Coastal habitats have important transboundary significance in that they harbour high genetic and biological diversity and serve as feeding and nursery grounds for fish and invertebrate species with transboundary distribution as larvae or adults. Among these are lobsters, conch, turtles, and manatee. The transboundary importance of the sub-region's mangrove forests extends beyond the borders of the Caribbean LME. These forests serve as over-wintering habitat for a number of species of neo-tropical migrant birds, whose populations could be threatened should these important habitats cease to exist. Since the oceans are the ultimate sink for land-based pollution, and the fate of coastal waters is strongly tied to the condition of coastal lands, rivers, and estuaries, successful

conservation requires addressing not only the use of the marine environment, but land use as well, far up into the watersheds.

3.2.2 Environmental impacts

The major environmental impacts of habitat degradation and community modification include:

i. Loss of ecosystem structure and function;
ii. Reduction/loss of biodiversity;
iii. Reduction in fisheries productivity.

i. Loss of ecosystem structure and function

Degradation and loss of essential coastal habitats are becoming increasingly common in the Insular Caribbean. Much of the coral reefs throughout the Caribbean are subjected to multiple sources of stress operating over several spatial and temporal scales, with overfishing being the most pervasive threat. Burke and Maidens (2004) integrated four major threats to Caribbean reefs (coastal development, marine-based threats, overfishing, land-based sediment and pollution) into the Reefs at Risk Threat Index, which showed that nearly two-thirds of the region's coral reefs are threatened by human activities, with overfishing being the major threat. High threat levels were found in the Insular Caribbean (Figure 11).

Recent studies have revealed a trend of serious and continuing long-term decline in the health of the region's coral reefs (Wilkinson 2002, Gardner *et al*. 2003, Kramer 2003). In some areas, up to 80% of shallow-water reefs have been destroyed. Overall, about 30% of Caribbean reefs are now considered to be either destroyed or at extreme risk from anthropogenic pressures (Wilkinson 2000). In the absence of greater efforts to manage and protect these reefs, another 20% or more are expected to be lost over the next 10 - 30 years.

Diseases are emerging as a significant cause of reef degradation in the Caribbean, and the incidence of an unprecedented array of new coral diseases has been reported with increasing frequency in the region (Woodley *et al*. 2000, Burke and Maidens 2004). In fact, most reported observations of diseases affecting coral reefs and associated organisms worldwide have been in the Caribbean (Burke and Maidens 2004). Prominent among these reports have been the Caribbean-wide die-off of the long-spined black sea urchin (*Diadema antillarum*) (Lessios *et al*. 2001); widespread losses of major reef-building corals (staghorn and elkhorn) due to white band disease; the widespread occurrence of Aspergillosis, a fungal disease of some species of sea fans; and numerous outbreaks of white plague. Observations of diseases on coral reefs in the Caribbean are illustrated in Figure 12.

Since the early 1980s repeated coral bleaching incidents as a result of elevated sea surface temperatures have caused widespread damage to reef-building corals and contributed to overall decline in reef condition throughout the Caribbean (Spalding 2004). Monitoring of live coral cover by the Caribbean Coastal Marine Productivity Programme (CARICOMP) between 1993 and 2001 revealed declines in live coral on nearly two-thirds of the sites investigated. Coral bleaching observations in the Insular Caribbean are shown in Figure 13. Coastal ecosystems also

suffer extensive damage from tropical hurricanes. In recent years, the Insular Caribbean has been buffeted by a quick series of hurricanes, which left many reefs shattered, covered with sediment, and vulnerable to disease.
The problems of algal infestation, coral diseases, and near extinction of the sea urchin occurred simultaneously during the 1970s, 1980s, and early 1990s (USGS 2000). Each event coincided with increases in warm water associated with El Niño weather patterns and peaks in African dust production and transport across the Atlantic. Based on data recorded in Barbados, the years of highest cumulative dust flux occurred in 1983 - 1985 and 1987 (Figure 14). This has been linked to increasing aridity and desertification in Northern Africa, which began in the mid-1960s, peaked in the 1970s and 1980s, and began to decline in the 1990s. Various peaks in the dust record at Barbados and elsewhere in the western Atlantic (Prospero and Nees 1986) coincide with benchmark perturbation events on reefs throughout the Caribbean (Figure 14). The spread of African dust cloud over the Caribbean Sea is shown in Figure 15. As can be seen, the Insular Caribbean is one of the first areas where this cloud 'makes landfall'.

Over the past two decades most of the Insular Caribbean countries have experienced mangrove loss (FAO 2003b), in some cases quite severe, as occurred in Antigua and Barbuda, Barbados, Dominica, Dominican Republic, Haiti, and Jamaica (Table 5). Mangroves are threatened by altered drainage, agricultural and urban expansion, and construction of shrimp farms, which has also exacerbated erosion, sedimentation, and nutrient enrichment in coastal waters. In some countries including the Bahamas, Dominican Republic, and Jamaica tourism development has occurred at the expense of seagrass beds and mangroves. This has also led to a corresponding increase in the quantity of sediments in coastal waters, which has adversely affected coral growth. Seagrass beds in some areas are affected by chronic sedimentation. In some areas sandy foreshores and beaches have been severely destroyed or modified due to coastal construction, sand mining, and poorly-devised shoreline protection structures.

Degradation of these habitats not only compromises their ecosystem structure and functioning, which reduces their resistance and resilience to external perturbations, but also leads to reduction or loss of the ecosystem services they provide to humans.

ii. Reduction/loss of biodiversity

Dramatic changes in the community structure of Caribbean coral reefs have taken place in recent years. For example, prior to the 1980s, scleractinian (stony) corals dominated these reefs and the abundance of macroalgae was low. Over the past two decades, a combination of anthropogenic and natural stressors has caused a reduction in the abundance of hard corals and an increase in macroalgae cover. This has been exacerbated by the mass mortality of the sea urchin. The overfishing of algae-grazing fishes has also contributed to this problem, which is thought to be widespread in the Caribbean (CARICOMP 1997). This is well illustrated in Jamaican coral reefs, where a "phase shift" occurred in which the coral reefs were largely replaced by algal communities. Between 1977 and 1993, live coral cover declined from 3% to 52%, and fleshy algae cover increased from 4% to 92%. The reasons for the change are complex and multiple: overfishing, disease, and hurricanes, perhaps exacerbated by nutrient pollution (Hughes *et al*. 2003).

The West Indian manatee feeds on seagrass and algae. However, its population has dramatically declined as a result of hunting and habitat degradation, and the distribution of the remnant population is fragmented due to local extinction or habitat unsuitability (Khan 2002). In Trinidad, most coastal wetlands that are a major habitat for the manatee have already been severely damaged, and are further threatened by expanding urbanization, agricultural pesticide runoff, and silting of drainage channels. Turtle populations have also declined, not only because of over-harvesting, but also as a result of the loss of nesting sites.

iii. Reduction in fisheries productivity

As previously described under unsustainable exploitation, habitat degradation contributes to declines in certain fisheries resources through loss of shelter, nursery, and feeding areas. While overfishing is the principal cause of declines in coral reef fisheries, destruction of reef and adjacent mangrove and seagrass habitats could exacerbate this situation. It is well recognized that fisheries catches are relatively higher in areas adjacent to mangrove forests. Some heavily overfished species such as conch and lobster spend part of their early life cycles in seagrass beds. Conch pelagic larvae require specific habitats such as seagrass beds to settle, which if absent, results in death of the larvae. Mangroves and seagrass beds also help to maintain productivity of coastal waters by contributing nutrients to these otherwise nutrient-poor areas and serving a water purification role.

Habitat modification is thought to be responsible for unusual reef fish mass mortalities that occurred simultaneously in several countries in the southeast Caribbean in 1999. Siung-Chang and Lum-Kong (2001) suggested that these events were associated with freshwater outflow from the South American mainland. Stress from prolonged exposure to low salinity water could have increased the susceptibility of fish to bacterial infections and other diseases. Another hypothesis is that the fish kills were caused by an algae bloom associated with an increase in the influx of nutrient-rich water from the Orinoco and Amazon Rivers, an increase of water temperature, and oxygen depletion (PAHO 2000).

3.2.3 Socio-economic consequences

Habitat degradation and community modification affect most of the islands, whose social and economic welfare depend on the services provided by marine and coastal ecosystems. With limited opportunities for economic diversification, habitat degradation can have severe socio-economic consequences in these small islands (UNEP 2004a, UNEP 2004b). As mentioned, one of the consequences of habitat degradation is reduced fisheries productivity, the socio-economic impacts of which have been previously discussed. The mass fish mortalities of 1999 resulted in economic losses of tens of thousands of dollars and a decline in fishing and fish vending activities (PAHO 2000). Habitat degradation and community modification are likely to have even more severe socio-economic consequences for those islands that depend heavily on tourism for their social and economic viability. Furthermore, loss of the coastal protection function of these ecosystems increases the vulnerability of coastal land, infrastructure, and humans to damaging waves and storm surges.

Tourism revenues are often directly impacted by habitat degradation because of the loss of amenity value for activities such as fishing, swimming, and diving. Habitat degradation

represents loss of income and employment opportunities in the tourism sector in the medium and long-term. Estimates of economic losses from coral reef degradation in the Caribbean range from 350 million - 870 million USD/yr by 2015, compared to current benefits valued collectively at 3 billion - 4 billion USD/yr (Burke and Maidens 2004). The continued loss and degradation of the sub-region's coastal habitats will therefore impose serious economic consequences for not only the tourism industry, but the economy of the entire region.

Habitat degradation and community modification has also reduced existing income and foreign exchange from other sectors, inhibited investment, and created a loss of educational and scientific values. Other socio-economic impacts of habitat and community impacts are degraded land due to loss of physical protection, costs of responding to risks, affected cultural heritage, increased costs of controlling invasive species, and costs of restoration of modified ecosystems.

3.2.4 Linkage with other transboundary problems

Habitat degradation and community modification are closely linked with unsustainable exploitation, in contributing to declines of fish populations through loss of shelter, nursery, and feeding grounds. This problem is also linked with pollution, which is likely one of the major causes of degradation of coastal habitats in the sub-region. In turn, degradation of mangroves and seagrass beds results in reduction in the ecosystem service of water purification and nutrient cycling, thus increasing the impact of pollution in adjacent coral reefs and exacerbating their degradation. Habitat degradation and community modification is also linked with global climate change. In addition to the direct impacts of climate change (e.g. coral bleaching), degraded habitats are less resilient to external perturbations such as climate change. Widespread loss of habitats such as seagrass beds and mangroves could also exacerbate climate change by reduction in their carbon sequestration function.

3.2.5 Immediate causes

The principal immediate causes of habitat degradation and community modification include:

- Overfishing and excessive harvesting (e.g. of mangrove trees);
- Diseases and coral bleaching;
- Physical and biological alteration, damage and destruction, including removal and burial.

Almost all the key sectors contribute to habitat degradation and community modification in the Insular Caribbean, including fisheries, tourism, agriculture and aquaculture, urbanization, industry, construction, shipping, and energy production. The major stakeholders include the tourism and fishing industries, other users of marine and coastal areas and resources, national governments, as well as the general public, donor agencies, intergovernmental agencies, and NGOs (national, regional, and international). Stakeholders at the sub-regional and regional levels are also included, in view of the transboundary impacts of habitat degradation and community modification.

3.2.6 Underlying causes

The major underlying causes of habitat degradation and community modification in the Insular Caribbean are diverse, with complicated interactions and synergies. Some of the underlying causes are the same as for unsustainable exploitation, for example, destructive fishing methods and rising demand for food (see above), as well as excessive harvesting of mangrove trees. Among the other underlying causes are:

- Unsustainable tourism practices: Activities related to tourism impacts on coral reefs include both direct and indirect impacts. Activities with direct physical impacts include snorkelling, diving, reef walking, boating, fishing, and collecting, which can contribute to over-exploitation of reef species and threaten local survival of endangered species. Indirect impacts relate to the development, construction, and operation of tourism infrastructure as a whole (resorts, marinas, ports, airports, etc.). Tourism-related sources of sewage pollution include hotels and resorts and, to a lesser extent, recreational vessels;
- Improper land use and poor agricultural practices: Deforestation, especially on hillsides, coastal construction in fragile and sensitive areas, and poor agricultural practices are among some of the underlying causes of degradation of coastal habitats in the Insular Caribbean. Land degradation has increased the quantity of sediments entering coastal areas through surface-runoff, increasing turbidity and sedimentation. In fact, sedimentation is one of the major threats to the reefs in the sub-region (Burke and Maidens 2004). Improper land use in coastal watersheds is a major cause of pollution from agrochemicals, pesticides, and other toxic substances;
- Poorly planned coastal development (e.g. tourism and urban development, industrialization, maritime transport): Increasing tourism and urbanization is a dominant feature throughout the sub-region, particularly in coastal areas. As a consequence, coastal habitats experience a range of pressures, including outright removal and land filling, dredging, and pollution. Coastal areas are also the focus of industrial development, which coupled with maritime transport, is an increasing threat to the sub-region's coastal habitats. In some countries the growth of mariculture and aquaculture, particularly shrimp farming in coastal areas, is also contributing to degradation and loss of essential coastal habitats. Burke and Maidens (2004) considered coastal development to be a major threat to coral reefs in the Caribbean, with high threat levels for a significant percentage of the reefs in a number of the islands (Table 6);
- Inadequate waste management: Waste management and disposal capability is very limited in the Insular Caribbean countries, and as a result, pollution of coastal areas especially from land-based sources is a major threat to coastal habitats. Of particular concern is the disposal of untreated or partially treated sewage into coastal areas;
- Natural causes: The bleaching of corals as a result of rising sea surface temperature and physical damage from storms and hurricanes are likely to increase, in light of predicted continued global warming and increases in the frequency and intensity of tropical storms and hurricanes (Figure 13);
- Invasive species: Eighteen invasive or exotic species have been reported in the Insular Caribbean (Kairo *et al*. 2003). These include clownfish, dragonet, bamboo shark, American oyster, sea nettle, and yellow-green microalga (Bahamas), green mussel (Jamaica, Trinidad), and Australian spotted jellyfish (Puerto Rico). The threat from invasive species arises from various pathways and sources, with ship ballast water being

among the major threats. Another pathway is through the introduction of exotic species for aquaculture.

3.2.7 Socio-economic, legal, and political root causes

Some of the socio-economic, legal, and political root causes of this problem are similar to those of unsustainable exploitation. Added to these are:

- The lack of economic valuation of ecosystems and their services (except perhaps for fisheries resources);
- Poor integration of environmental considerations into economic development;
- Limited integrated watershed and coastal area management.

3.2.8 Knowledge gaps

Knowledge gaps include:

- Ecosystem structure and function, and inventory of marine species;
- Spatial extent and distribution of habitats (habitat mapping);
- Economic value of coastal and marine ecosystems and the ecosystem services they provide;
- Social and economic cost of degradation (including the cost of addressing habitat degradation);
- Linkage between habitat degradation and increasing fish and coral diseases;
- The degree of connectivity and interdependence among the habitats in the different countries in the sub-region and within the Caribbean LME as a whole;
- Ecosystem carrying capacity with respect to tourism;
- Response of ecosystems to global environmental changes.

3.2.9 Proposed options

Several options are available to address habitat degradation, including restoring degraded ecosystems and protect healthy ones. This will require a range of measures such as establishment of MPAs and biodiversity corridors in the region, multiple use areas, reduction of threats from both marine and land-based sources, and adoption of integrated watershed and coastal area management. National legislation, as well as regional and global MEAs should be better implemented and enforced.

3.3 Pollution

3.3.1 Description of the problem and justification of its transboundary importance

Waste management is considered to be one of the major environmental issues in the CARICOM region (CARICOM Secretariat 2003). Although encouraging progress has been made in some areas, for instance, management of solid and liquid waste, overall progress has been slow, largely

because of the high costs of installing and maintaining appropriate waste management systems. Growth in urban population, industrial activity, and tourism continues to outstrip infrastructural capacity to handle waste. Land-based pollution is among the major threats to the coastal and marine environments of the Caribbean SIDS (Heileman and Corbin 2006). This is compounded by the fact that, because of their small physical size and 'islandness', activities far inland could have serious effects on the coastal areas. Pollution from increasing petroleum exploration and extraction in the sub-region is an immediate emerging concern.

Pollution from marine-based sources is also of concern. For example, the Old Bahamas Channel, which is heavily used for shipping, acts as a conduit for pollutants. Reports have shown that tankers, private vessels, and other ships that use this channel clean their bilges and tanks, and discharge the residual oils into the water, which form tar balls (BEST 2002).

Throughout the sub-region, pollution by a range of substances including sewage, nutrients, sediments, petroleum hydrocarbons, and heavy metals is increasing. Several coastal hotspots have been identified in some of the larger industrialized islands (Siung-Chang 1997). These include heavily contaminated bays such as Havana Bay (Cuba), Santo Domingo (Dominican Republic), Kingston Harbour (Jamaica), and Point Lisas Bay (Trinidad). Other hotspots may be related to direct point or non-point discharges.

Pollution has significant transboundary implications, as a result of the high potential for transport across EEZs in wind and ocean currents. Not only can this cause degradation of living marine resources in places far from the source, but it can also pose threats to human and animal health by the introduction of pathogens.

The sub-region is also impacted by extra-regional influences. For instance, the islands in the southern Caribbean are heavily influenced by continental river run-off. As already mentioned, the plume of the Orinoco River, as tracked by satellite imagery, seasonally penetrates across the Caribbean Basin, potentially exerting a region-wide influence, particularly in the southern Insular Caribbean (Figure 2). An example of the transboundary impact of this phenomenon are the fish kills in the Windward Islands in 2000, which were linked to bacteria introduced in sediments as a result of flooding in the Orinoco Basin (Hoggarth *et al*. 2001).

There is increasing concern about the influence of atmosphere/ocean linkages on the marine environment (GESAMP 2001). This influence has been demonstrated in the Caribbean region in the atmospheric transport of dust from North Africa, as shown in Figure 14 (USGS 2000, UNEP/GEF 2002). Data from Barbados, Trinidad and Tobago, and Jamaica suggest that persistent organic pesticides (POPs) originating outside the region reach the Caribbean in air currents (UNEP/GEF 2002). The countries of North Africa in the Sahel region apply large amounts of pesticides, including those banned in the Caribbean and the USA. These pesticides are present in the dust cloud reaching the Caribbean and southern USA from North Africa. Dust may also affect the marine environment through direct fertilization of benthic algae by iron or other nutrients and by broadcasting of bacterial, viral, and fungal spores.

3.3.2 Environmental impacts

i. Deterioration of environmental quality;
ii. Degradation of coastal ecosystem;
iii. Threats to living marine resources.

i. Deterioration of environmental quality

The presence of a range of pollutants is evident in coastal areas throughout the Insular Caribbean, with levels varying from trace in offshore areas to very substantial in some coastal hotspots (Heileman and Corbin 2006). These pollutants can all be placed into the source categories of the Global Programme of Action for Protection of the Marine Environment from Land-based Activities (GPA): Sewage, POPs, nutrients, sediment mobilization, radioactive substances, heavy metals, oils (hydrocarbons), and litter. In a regional priority ranking of the GPA categories in the Wider Caribbean, sewage was found to be of first priority, with nutrients, sediments, and POPs ranked as second (GESAMP 2001). Sewage is regarded as one of the most important and widespread causes of deterioriation of the coastal environment in the Caribbean (Siung-Chang 1997, CAR/RCU 2000). Rapid population growth and tourism, urbanization, and the increasing number of ships and recreational vessels result in the discharge of increasing amounts of poorly treated or untreated sewage into coastal waters.

In a regional overview of land-based sources and activities affecting the marine, coastal, and associated freshwater environment in the Wider Caribbean Region, several Caribbean SIDS reported high nutrient levels (including from sewage) in coastal areas to be of concern (UNEP 1999). The predominant source of nutrients is untreated sewage, as well as non-point agricultural run-off. Aquaculture facilities as well as industrial activities and atmospheric emissions also contribute nutrients to the marine environment.

Several Caribbean SIDS have included high levels of sediments in the coastal zone among the major environmental problems they face (UNEP 1999). In fact, in the OECS sediment mobilization was ranked as the first environmental priority. In some islands, the development of steeper terrain in combination with short steep slopes terminating in sensitive wetlands and marine environments has increased erosion and the input of sediments to coastal areas. Large quantities of pesticides are extensively used in agriculture and reach the coastal and marine environments via rivers and atmospheric transport. Cultivation on steep slopes promotes soil erosion and the movement of pesticides to coastal areas. Although organochlorides are banned throughout most of the Caribbean, sites with heavy organochloride pollution loads have been reported, for example, Kingston Harbour and Hunt's Bay in Jamaica (Dasgupta and Perue 2003). Studies in the Caribbean documented in UNEP/GEF (2002) showed that POPs have been detected in sediments in Portland and Kingston Harbour, the southwest coast of Cuba, and coastal areas of St. Lucia.

Major industrial centres within the sub-region are concentrated in a few areas, including Kingston Harbour, Point Lisas Bay (Trinidad), and Havana Bay (Cuba). Industrial pollution is a particularly pressing problem for Trinidad and Tobago given its high level of industrialization. Coastal areas near to these industrial centres show significant petroleum and heavy metal

concentrations in water and sediment, for example, in Cuba, Dominican Republic, Jamaica, and Trinidad (Beltrán *et al*. 2002). Data from UNEP-IOC/IOCARIBE CARIPOL Programme indicate that the concentration of dissolved or dispersed petroleum hydrocarbons are generally low in offshore waters, while relatively high levels are found in semi-enclosed coastal areas.

As a result of inadequate solid waste collection and disposal systems in most of the countries, waste is disposed of in mangrove swamps, drainage channels, and along riverbanks, eventually reaching the coastal waters. Poorly managed landfills in coastal areas can contribute litter to the marine environment, especially in the rainy season. The composition of solid waste continues to change from mostly organic to inorganic, non-biodegradable material. For example, in Trinidad and Tobago, the amount of organic waste dropped from 44% in 1980 to 27% in 1994, while plastic grew from 4% to 20% (UNEP 2000).

ii. Ecosystem degradation

Deterioration of environmental quality (water and sediments) through pollution can impair the functioning of coastal ecosystems and affect the health of living marine resources. Sedimentation, as well as pollution from both land and marine based sources, poses high levels of threat to coral reefs in the Insular Caribbean (Burke and Maidens 2004) (Figure 16). High inputs of nutrients from sewage and agricultural fertilizers have promoted hotspots of eutrophication, increased algal and bacterial growth, degradation of seagrass and coral reef habitats, changes in community structure, decreased biological diversity, fish kills, and oxygen depletion in the water column in some localized areas throughout the sub-region (UNEP 2004a, UNEP 2004b). For example, Kingston Harbour has experienced increasing eutrophication for decades as a result of sewage pollution, mainly from surrounding towns and from ships (UNEP/CEP 1998, Webber and Clarke 2002). Similarly, Havana Bay, which receives about 300,000 m^3/day of urban/industrial non-treated sewage is strongly influenced by algal blooms, including frequent red tides (Beltrán *et al*. 2002).

Elevated nutrient input into coastal areas have also contributed to overgrowth of coral reefs by algae in several localities throughout the sub-region. This has been compounded by the reduced abundance of algal grazers, as previously discussed. Herbicides in agricultural runoff can also cause damage to seagrass beds. Smothering of coral reefs, seagrasses, and associated filter feeders and other benthic organisms by high sediment loads is also of concern throughout much of the sub-region. The increase in turbidity has caused changes in benthic or pelagic biodiversity in some areas. In Antigua and Barbuda, for example, the high turbidity of inshore water and elevated algal cover on reefs are linked to the impacts of coastal development, with sedimentation having a major influence on reef condition (Smith *et al*. 2000). The impact of sedimentation in coastal areas is exacerbated by the destruction of mangrove forests and seagrass beds, which act as natural filters.

iii. Threats to living marine resources

Apart from degradation of coastal habitats, some pollutants can have more direct impacts on living marine organisms themselves because of their toxicity and bioaccumulation in animal tissue. Occurrences of fish kills caused by pollution are commonly reported in the sub-region. A

serious but unseen threat to living marine resources is the bioaccumulation of pollutants such as POPs and heavy metals in their tissue. Contamination of tissue has been demonstrated in shrimp from Jamaica (UNEP 2002) and mussel from Cuba (Dierksmeir 2002). This is of greater concern in higher trophic level animals and ultimately humans, due to the bio-magnification of these pollutants in the food chain. Solid waste such as plastics can cause considerable harm to marine fauna such as turtles, marine mammals, and sea birds, as reported in the Bahamas. Floating debris in Bahamian waters contributed to unsuccessful reproduction and death of sea turtles, marine mammals, and sea birds in this country's waters (BEST 2002).

3.3.3 Socio-economic consequences

The socio-economic impacts of pollution in the sub-region are described in UNEP (2004a, UNEP 2004b), and range from moderate to severe. One of the major impacts is on human health, through the propagation of disease vectors (microbiological pollution) promoted by the discharge of untreated sewage (UNEP 2000). HABs are frequently the cause of very serious human illness when the biotoxins produced are ingested in contaminated seafood. The illnesses most frequently associated with marine biotoxins include paralytic shellfish poisoning and ciguatera poisoning, which frequently occur in the sub-region. High bacterial counts have been detected in some bays in the sub-region (UNEP 2004a), especially where there are large coastal populations and large concentrations of boats.

Emissions of heavy metals pose a serious risk to human health and living marine resources (UNEP 1999). Bioaccumulation of some pollutants such as POPs and heavy metals in the tissue of marine organisms that are consumed by humans can also have serious impacts on human health. Pollution has also diminished the aesthetic value of some areas, impacting on recreational activities and reducing revenue from tourism (UNEP/CEP 1997).

3.3.4 Linkages with other transboundary issues

Pollution is linked with habitat degradation and overexploitation by causing deterioration of environmental quality and ecosystem degradation, and as a result, reduction in overall productivity. It can also be linked to decline of marine resources by causing direct mortality of marine living organisms.

3.3.5 Immediate causes

The principal immediate causes of pollution of marine and coastal areas include:

- Point and non-point discharge of industrial and urban waste (including from tourism) from land-based sources;
- Operational spills in ports and marinas;
- Runoff of agricultural fertilizers and pesticides;
- Dumping of solid waste;
- Land degradation;
- Atmospheric deposition.

Almost all the key sectors contribute to pollution of coastal and marine areas in the Insular Caribbean, including fisheries, tourism, agriculture and aquaculture, urbanization, industry, shipping, transport/infrastructure, and energy production. The major stakeholders include the tourist and fishing industries, other users of the marine and coastal environment, national government, as well as the general public, and donor agencies. Similar stakeholders at the sub-regional and regional levels are also included, in view of the transboundary impacts of pollution.

3.3.6 Underlying causes

The underlying causes of pollution include poor agricultural practices (including excessive use of fertilizers and pesticides), unsustainable tourism practices, poorly planned coastal development, and inadequate waste management and disposal. Other underlying causes include limited cleaner production technologies in industry.

3.3.7 Socio-economic, legal, and political root causes

Among these root causes are:

- Weak and ineffective legal, regulatory, and institutional frameworks;
- General lack of environmental quality standards and legislation, or poor surveillance and enforcement, and limited compliance;
- Lack of regular monitoring and assessment: Because of limited financial and human resources, monitoring, control, and assessment activities are weak and insufficient. Scientific activities are not integrated, and there is insufficient certification of laboratories. While numerous studies have been conducted in localized areas, most are sporadic and limited in scope;
- Limited financial resources for infrastructure maintenance and renovation: Many of these small countries lack the necessary financial resources to maintain their sewage treatment plants and to improve industrial and other waste treatment infrastructure;
- Limited use of appropriate, efficient and cost-effective pollution prevention technologies;
- Poor data quality: In general the quality of regional environmental data is low, as few countries have the necessary systems in place to collect quality-assured environmental data on a regular basis.

3.3.8 Knowledge gaps

Very little quantitative data exist on the transboundary dispersal of pollutants in the sub-region and the Caribbean region as a whole. There is an urgent need for regular and long-term monitoring of pollution in the Caribbean Sea, both at the source and in the coastal and marine environment, including areas that may be affected far from the source. Focus should be on the monitoring of key parameters in regional hotspots, and using a standard set of indicators and methods, to allow spatial and temporal comparisons. Knowledge gaps still exist on the impacts of pollution on sensitive habitats, on living marine resources, and on human health. For instance, data on bioaccumulation of pollutants in marine organisms and impacts on human health (including bioaccumulation in humans) when consumed are limited. The absence of clear targets

and indicators makes it difficult to assess the impacts of marine pollution, as well as progress in addressing this problem, in concrete terms.

There are no developed indicators to measure economic losses caused by pollution on fisheries, the tourism industry, and other economic activities. Correspondingly, there is a lack of data for economic valuation of environmental damage from pollution.

3.3.9 Proposed options

Options to address marine and coastal pollution should include greater focus on improved implementation of existing, rather than development of more policies, strategies, and action plans. For example, there should be better implementation of the Cartagena Convention, particularly the Protocols related to oil spills and land-based pollution. Implementation could be improved by ensuring that existing policies, strategies, and action plans are realistic and accompanied by a strategic planning and financing strategy. Environmental standards need to be developed and enforced and the 'polluter pays' principle better implemented and enforced at national and regional levels. This would require the development of appropriate legal and institutional frameworks, as well as knowledge on the economic and social costs of habitat degradation and loss from pollution.

There should be less of a sectoral approach in dealing with pollution, and a move towards an integrated, ecosystem approach where feasible. Since most of the pollution in the marine environment originates from land-based sources, integrated watershed and coastal area management needs to be more widely adopted.

4. GOVERNANCE OF TRANSBOUNDARY LIVING MARINE RESOURCES

4.1 Institutional and legal

In recent decades, important institutional, legislative, and policy reforms related to marine environmental issues have taken place in the Insular Caribbean countries. A number of institutional and policy frameworks relevant to management and conservation of living marine resources have been established at the national, sub-regional, and regional levels. At the national level, almost all the countries have established authorities and government ministries whose mandate extends to living marine resources (e.g. Ministry of Environment/Fisheries, Fisheries Department). Resource assessment, research, management, and regulation fall under the authority of the relevant Environment/Fisheries Ministry or Fisheries Department. At the sub-regional level, the CARICOM Regional Fisheries Mechanism (CRFM) undertakes resource assessment. Research and monitoring capacity also exists in national (e.g. University of Havana) and regional universities (University of the West Indies) and national (e.g. Institute of Marine Affairs, Trinidad and Tobago), and intergovernmental organizations (e.g. Caribbean Environmental Health Institute - CEHI). Most research conducted is, however, limited to resources and/or ecosystems within national borders.

Within each country, the integrated approach for living marine resource management is still in its infancy. In addition, in general there is no mechanism for communication and collaboration

among relevant sectors on a national, as well as on the sub-regional and regional scales regarding transboundary issues and related governance frameworks.

While most of the countries have legislation related to the exploitation and management of living marine resources, few have provisions specifically related to large pelagic fish species (McConney 2004). Fisheries management initiatives are partly governed by international frameworks such as the Law of the Sea Convention (LOSC), the UN Fish Stocks Agreement, and the FAO Code of Conduct for Responsible Fisheries. Several of the countries are currently trying to initiate coastal zone planning within an integrated coastal area management framework. Almost all the countries have established MPAs and/or national parks with marine components (Table 7), although these are generally not effectively managed because of limited human and financial resources.

4.2 Transboundary cooperation

A number of inter-governmental agencies engage in projects and programmes related to the conservation of marine areas and living resources. Among these are UNEP Caribbean Regional Coordinating Unit, CARICOM, CARIFORUM, Caribbean Conservation Association, CEHI, and the OECS Environment and Sustainable Development Unit. Participation of countries in collaborative management of transboundary resources is generally low, with most collaboration being in the area of stock assessment, particularly for lobster and conch. There are initiatives underway, however, that will address this deficiency. These include current efforts to establish a Common Fisheries Policy and Regime at the CARICOM level. It has been proposed that the main elements of a common fisheries regime should include the following: i) the acceptance of a common fisheries policy and strategy; ii) demarcation of its fisheries zone; and iii) an appropriate regional organization for administering, implementing, and enforcing the policy (CARICOM 2004).

In 1989 the Heads of Government of CARICOM agreed to deepen the economic component of the integration process into a CARICOM Single Market and Economy (CSME). One of the key objectives of the CSME is the development of common policies in several areas including management of fisheries. However, management of the fisheries resources of the Insular Caribbean is complicated by factors such as the absence of delimited EEZ boundaries, multiple user conflicts arising from marine-based tourism, land and sea-based pollution, and unregulated fishing (Cadogan 2006). Competition for these resources is likely to increase with the entry into force of the CSME. Under the CSME, CARICOM States are expected to have preferential rights of access to each other's EEZs.

Common fishing zone provisions are also being pursued at the sub-regional level through the Environment and Sustainable Development Unit of the OECS. The harmonization of legislation by the OECS in the 1980s was followed by various initiatives towards the establishment of a common fisheries zone or zones and efforts at joint surveillance. Otherwise, there has been little activity regarding cooperation in management at the regional level, either within CARICOM or among the countries of the sub-region or wider Caribbean. This is largely due to the absence of a Regional Fisheries Management Organization with a mandate to manage shared fisheries resources, despite a recognized need.

The best established and operational fisheries management organization with relevance to the Caribbean Sea LME is ICCAT, which has the mandate to manage all tuna and tuna-like species in the Atlantic. Currently, however, only three Insular Caribbean countries (Barbados, Trinidad and Tobago, St. Vincent and the Grenadines) are contracting parties to ICCAT (Table 8). A number of other Bodies are involved in assessment, provision of advice, and fisheries management at the sub-regional and regional level (Table 8). These are broad in scope, covering resources that range in distribution from coastal/national to HMS & SS (Table 9). Among them are CRFM, WECAFC, the Caribbean Fisheries Management Council, and IOCARIBE. In addition to ICCAT, operating at the international level is the International Whaling Commission. The countries have increasingly been ratifying or approving MEAs and non-binding agreements related to the marine environment and living marine resources (Table 10).

Regional programmes related to marine environmental and biodiversity issues include UNEP's Regional Seas Programme, the Caribbean Coastal Marine Productivity Programme, and the Caribbean Environment Programme (CEP), a sub-programme of UNEP's Regional Seas Programme. The aim of CEP is to promote regional cooperation for the protection and development of the marine environment of the Wider Caribbean Region. CEP is facilitated by the UNEP Caribbean Regional Coordinating Unit located in Jamaica. Marine environmental policy frameworks at the regional level include the 1981 CEP Caribbean Action Plan and the Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (Cartagena Convention) and its three protocols (Protocol Concerning Cooperation in Combating Oil Spills in the Wider Caribbean Region; Protocol Concerning Specially Protected Areas and Wildlife in the Wider Caribbean Region; and Protocol Concerning Marine Pollution from Land-Based Sources and Activities). Unique to the region, the Cartagena Convention and its three protocols constitute the first regional framework convention for the protection of the region's marine and coastal areas and wildlife.

The 13 independent states are members of the Association of Caribbean States (ACS), while Aruba, Guadeloupe and Martinique (France), the Netherlands Antilles, and Turks and Caicos are associate members. The ACS was established in 1994 with the aim of promoting consultation, cooperation, and concerted action among all the countries of the Caribbean. The objectives of the ACS are based on the following: strengthening of the regional co-operation and integration process, with a view to creating an enhanced economic space in the region; preserving the environmental integrity of the Caribbean Sea; and promoting the sustainable development of the Greater Caribbean.

In September 2006 the ACS established the Caribbean Sea Commission, with a view to promoting and achieving the preservation and sustainable use of the Caribbean Sea, through the formulation of guidelines for coastal and marine management. On 20 December, 2006, the United Nations General Assembly adopted a resolution entitled: "Towards the Sustainable Development of the Caribbean Sea for present and future generations". This resolution is a culmination of efforts made almost a decade ago by organizations in the region including the ACS and CARICOM to secure the recognition by the international community of the Caribbean Sea as a special area in the context of sustainable development.

A number of regional and sub-regional projects supported by international funding organizations such as the Global Environment Facility (GEF) and foreign donors are currently being conducted. This includes the Caribbean LME project and 'Integrating Watershed and Coastal Areas Management' project for 13 Caribbean SIDS. This project, which is funded by GEF and other collaborating agencies, will focus on demonstration activities on waste management, groundwater protection, watershed management, with the potential for replication across the region and in other SIDS regions. Through this project, Barbados, Dominica, Grenada, Haiti, and St. Vincent and the Grenadines will also benefit from regional project activities including the review and development of policy and legislation, training, and environmental monitoring. Another relevant project is 'Scientific Basis for Ecosystem-Based Management in the Lesser Antilles including Interactions with Marine Mammals and other Top Predators' (LAPE), which is supported by FAO and the Government of Japan, with participation by the countries of the Lesser Antilles. Like the CLME, the LAPE project is of particular relevance to transboundary living resources in that it focuses on an ecosystem approach to management of pelagic fisheries, particularly the large migratory pelagics.

For stakeholder involvement in living marine resources management, see chapter 5 on Stakeholders.

4.3 Constraints

The Insular Caribbean countries have made considerable progress in improved governance of their living marine resources at the national level. However, management of transboundary resources at the national, sub-regional, and regional levels has been constrained by a number of factors including:

- Institutional and legal deficiencies;
- Limited co-ordination and collaboration among the numerous players and programmes, at all levels;
- Low level of data and information exchange among the countries;
- Inadequate financial resources;
- Limited human capacity and financial resources for research, assessment, management, surveillance, enforcement, and monitoring ;
- Gaps and overlaps in the legislative framework for coastal and marine management;
- Low level of implementation of regional and sub-regional MEAs;
- Limited participation by stakeholders in the management of living marine resources;
- Language and cultural barriers, which can often constrain dialogue and interaction, as well as of the sharing of data and information at the sub-regional and regional levels;
- Overlap of living marine resource management goals throughout the Caribbean, which could result in conflicts if these goals are incompatible with each other.

These constraints need to be addressed for effective management of the transboundary living marine resources of the CLME.

5. STAKEHOLDER ANALYSIS

The major stakeholders related to living marine resources of the Insular Caribbean, within the framework of the policy cycle, are shown in Table 11. Groups of citizens and NGOs are playing an increasingly important role in development and conservation activities that concern the marine environment. A number of regional and international NGOs participate in environmental programmes and in the inter-governmental decision-making process, including Caribbean Conservation Association, Island Resources Foundation, Caribbean Programmes of WWF-USA, The Nature Conservancy, Caribbean Natural Resources Institute (CANARI), and Conservation International. Stakeholder organizations (fishery cooperatives or associations) with some relevance to pelagic fisheries exist in most of the countries, but none of these national bodies is concerned only with shared fisheries resources (McConney 2004).

As seen in Table 11, the main users of the living marine resources of the Insular Caribbean (fisheries sector, tourism, etc.) are generally not involved in any phase of the policy cycle. At the national level, there is minimal stakeholder participation in decision-making, national legislation/regulation changes, and evaluating compliance with agreed regulations. Greater involvement of stakeholders is needed for effective management of transboundary living marine resources in the Insular Caribbean.

6. SUMMARY AND CONCLUSIONS

The living marine resources of the Insular Caribbean sub-region is of major transboundary significance, not only for the sub-region, but for the entire Caribbean and adjacent LMEs, owing to the shared and/or migratory nature of some of these resources. Some of the coastal pelagic stocks are shared between neighbouring countries, while all of the large oceanic pelagic species are transboundary or HMS & SS. Reef organisms, lobster, and conch are also of transboundary importance, owing to their long planktonic larval stage and transboundary dispersal by ocean currents.

Living marine resources are of considerable socio-economic importance in the sub-region, with fisheries being an important protein source, and together with tourism, providing employment for a substantial number of people and significant national income. Human pressures, superimposed on global threats, are causing widespread declines in living marine resources and degradation of critical coastal habitats in the sub-region.

Throughout the Insular Caribbean, inshore fish stocks are heavily overexploited, and stocks of some offshore migratory pelagic species are already beginning to show signs of overexploitation, despite the recent development of fisheries for these species. Catches of all the major exploited groups of fish and invertebrates have declined in the past decade. Overexploitation is also being manifested at the ecosystem level, with declining mean trophic levels in the fish catch, an indication of depletion of top predator biomass. Not only have fish and invertebrate stocks suffered from unsustainable exploitation. Populations of a number of other species such as turtles and marine mammals have also been decimated through over-harvesting and habitat degradation. Unsustainable exploitation of living marine resources has grave implications for sustainable development of the Insular Caribbean countries, which are heavily dependent on coastal and living marine resources for socio-economic development.

Critical coastal habitats, particularly coral reefs, mangroves, beaches, and seagrass beds have been severely degraded throughout the sub-region, as a consequence of a range of anthropogenic and natural pressures, including land-based pollution and increasing sea surface temperatures. Ecosystem structure and function has been impaired and essential ecosystem services reduced in several areas. Habitat degradation and reduction of environmental quality from pollution have serious consequences for the sustainability of living marine resources and for human health as well. Furthermore, these problems also have serious socio-economic impacts in the sub-region, owing to the dependence of these countries on living marine resources, as well as to the vulnerability of these countries to climate-related disasters. Global climate change could exacerbate these problems, but to what degree is unknown. Left unattended, these problems are predicted to become worse in the future.

Unsustainable exploitation of living resources, habitat degradation and community modification, and pollution of the marine environment are interlinked, not only because of their synergistic impacts on living marine resources, but also because in general they have the same underlying and socio-economic, legal, and political root causes. Some of these underlying and root causes are also manifested at the regional level, for example, deficiencies in institutional, policy, and legislative frameworks for transboundary management of the living marine resources of the CLME.

This situation presents the opportunity to address these problems collectively, at the national, sub-regional, and regional levels, for multiple benefits. It also shows the need for integrated approaches. The transboundary implications call for greater collaboration and coordination at sub-regional and regional levels. However, these problems also have overlaps in the sectors that contribute to them, as well as in the range of stakeholders. The complexity of the group that makes up the users, other stakeholders, as well as the key actors responsible for planning, decision-making, and financing development in the coastal zone and exploitation of living marine resources, makes it difficult to coordinate management and to develop effective management strategies and communication tools at the national level, and more so at the regional level.

Considerable progress has been made by the countries of the Insular Caribbean to manage their living marine resources, at the national level and sub-regional levels. However, this progress continues to be outweighed by the growing pressures on these resources, compounded by slow implementation and enforcement of existing policy frameworks. While a range of options are available to the Insular Caribbean countries to restore and sustainably exploit their living marine resources, they have little control over external threats such as climate change. Their best hope lies in protecting coastal ecosystems and their living marine resources so that they are resistant and resilient to these perturbations. The marine resources of the Caribbean Sea are largely shared resources, and the effectiveness of any management initiative will depend on collaborative and cooperative actions at the regional level, or other appropriate scale, depending on the issue and the resource. As previously indicated, a number of regional initiatives and organizations already exist, and the establishment of an appropriate governance mechanism or framework for management of Caribbean transboundary living marine resources should be urgently pursued.

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ACRONYMS AND ABBREVIATIONS

ACS	Association of Caribbean States
BPoA	Barbados Programme of Action for the Sustainable Development of Small Island Developing States
CANARI	Caribbean Natural Resources Institute
CARICOM	Caribbean Community and Common Market
CARICOMP	Caribbean Coastal Marine Productivity Programme
CEHI	Caribbean Environmental Health Institute
CEP	Caribbean Environment Programme
CITES	Convention for International Trade in Endangered Species
CLME	Caribbean Sea Large Marine Ecosystem
CPUE	Catch per unit effort
CRFM	CARICOM Regional Fisheries Mechanism
CSME	CARICOM Single Market and Economy
EEZ	Exclusive Economic Zone
GEF	Global Environment Facility
GIWA	Global International Waters Assessment
GPA	Global Programme of Action for Protection of the Marine Environment from Land-based Activities
HDI	Human Development Index
HMS & SS	Highly Migratory Species and Straddling Stocks
ICCAT	International Commission for the Conservation of Atlantic Tunas
IOCARIBE	Intergovernmental Oceanographic Commission Regional Sub-Commission for the Caribbean and Adjacent Regions
IUCN	World Conservation Union
IUU	Illegal, Unregulated and Unreported (fishing)
LAPE	Lesser Antilles Pelagic Ecosystem Project
LME	Large Marine Ecosystem
LOSC	Law of the Sea Convention
MEA	Multilateral Environmental Agreement
MPA	Marine Protected Area
MSY	Maximum Sustainable Yield
MTL	Mean Trophic Level
NGO	Non-governmental Organization
OECS	Organization of Eastern Caribbean States
POPs	Persistent Organic Pesticides
SIDS	Small Island Developing States
SOPAC	South Pacific Applied Geoscience Commission
UN	United Nations
UNEP	United Nations Environment Programme
USD	United States Dollar

WECAFC Western Central Atlantic Fisheries Commission
WSSD World Summit on Sustainable Development

TABLES

Table 1. States and overseas dependent territories in the Insular Caribbean

Independent countries	Dependent territories
1. Antigua & Barbuda (SIDS, CARICOM, OECS) 2. Bahamas (SIDS, CARICOM) 3. Barbados (SIDS, CARICOM) 4. Cuba (SIDS) 5. Dominica (SIDS, CARICOM, OECS) 6. Dominican Republic (SIDS) 7. Grenada (SIDS, CARICOM, OECS) 8. Haiti (SIDS, CARICOM) 9. Jamaica (SIDS, CARICOM) 10. St Kitts & Nevis (SIDS, CARICOM, OECS) 11. St Lucia (SIDS, CARICOM, OECS) 12. St Vincent & the Grenadines (SIDS, CARICOM, OECS) 13. Trinidad & Tobago (SIDS, CARICOM)	<u>Dutch Overseas Departments</u> 14. Aruba (SIDS) 15. Netherlands Antilles (SIDS) <u>French Overseas Departments</u> 16. Guadeloupe 17. Martinique <u>US Territories</u> 18. Puerto Rico 19. US Virgin Islands (SIDS) <u>British Overseas Departments</u> 20. Anguilla (OECS) 21. British Virgin Islands (OECS) 22. Cayman Islands 23. Montserrat (CARICOM, OECS) 24. Turks & Caicos Islands

Table 2. Land and EEZ area of countries and territories of the Insular Caribbean

Caribbean countries and territories	Total land area (km^2)	*EEZ (km^2)
Anguilla	102	91,000
Antigua & Barbuda	440	110,000
Aruba	190	31,000
Bahamas	13,880	655,000
Barbados	430	187,000
British Virgin Islands	150	81,000
Cayman Islands	260	123,000
Cuba	110, 860	351,000
Dominica	750	29,000
Dominican Republic	48 730	256,000
Grenada	340	27,000
Guadeloupe	1,710	96,000
Haiti	27,750	127,000
Jamaica	10,990	258,000
Martinique	1,100	47,000
Montserrat	100	8,000
Netherlands Antilles	800	52,000
Puerto Rico	8,950	206,000
St Kitts & Nevis	360	10,000
St Lucia	620	16,000
St Vincent & the Grenadines	390	36,000
Trinidad & Tobago	5,130	75,000
Turks & Caicos Island	430	149,000
US Virgin Islands	340	6,000

(*Sea Around Us 2007)

Table 3. Selected socio-economic parameters of Insular Caribbean countries
(sources: [1]UNDESA 2003, [2]UNDP 2006)

Country/Territory	[1]Total pop projected 2002 (000)	[1]Pop density (persons/km^2)	[1]GDP/cap (USD)	[2]HDI level L, M, H (*rank)
Antigua and Barbuda	65	152	10,204	(H) 59
Aruba	108	489		
Bahamas	312	22	14,856	H (52)
Barbados	269	622	9,255	H (31)
Cuba	11,273	101	2,545	H (50)
Dominica	70	95	3,367	M (68)
Dominican Republic	8,639	172	2,500	M (94)
Grenada	94	270	4,682	M (85)
Haiti	8,400	293	431	L (154)
Jamaica	2,621	234	2,990	M (104)
Netherlands Antilles	219	269	12,149	
St. Kitts & Nevis	46.7	149	6,396	H (51)
St. Lucia	151	238	4,994	M (71)
St Vincent & the Grenadines	115	289	1,940	M (88)
Trinidad & Tobago	1,306	252	6,817	H (57)
Virgin Islands (US)	124	271		

*out of 177 countries

Table 4. Vulnerability of some Insular Caribbean countries according to the SOPAC Environmental Vulnerability Index (*countries with insufficient data)
(source: Extracted from Kaly *et al*. 2004)

Extremely vulnerable	Highly vulnerable	Vulnerable	At risk	Resilient
*Barbados *Guadeloupe Jamaica *St Lucia Trinidad & Tobago *Virgin Islands (British) *Virgin Islands (US)	Cuba *Cayman Is Dominican Republic *Grenada Haiti *Montserrat *Netherlands Antilles *Puerto Rico *St Kitts & Nevis St Vincent & the Grenadines	*Anguilla *Antigua & Barbuda *Aruba *Turks & Caicos	*Bahamas	None

Table 5. Change in mangrove area in Insular Caribbean countries (1980 -1990) (n.s. – not significant) (source: FAO 2003b)

Country	1980 (ha)	1990 (ha)	Total change 1980-1990 (%)	2000 (ha)	Total change 1990-2000 (%)
Anguilla	90	90	-	-	-
Antigua & Barbuda	1,570	1,200	-23.6	900	-25
Aruba	420	420	n.s.	420	n.s.
Bahamas	170,000	145,000	-14.7	140,000	-3.4
Barbados	30	16	-46.7	10	-37.5
British Virgin Islands	660	630	-0.5	590	-0.6
Cuba	530,500	529,800	n.s.	529,000	n.s.
Dominica	40	13	-67.5	9	-30.8
Dominican Republic	33,800	26,300	-22.2	18,700	-28.8
Grenada	295	262	-11.2	230	-12.2
Guadeloupe	3,900	2,500	-3.5	2,300	-0.8
Haiti	17,800	15,000	-16.5	10,000	-33.3
Jamaica	23,000	10,800	-53.0	9,300	-13.9
Netherlands Antilles	1,140	1,138	n.s.	1,130	n.s.
Puerto Rico	6,500	6,400	-0.2	6,400	n.s.
St. Kitts & Nevis	84	80	-4.8	75	-6.3
St. Lucia	200	200	n.s.	200	n.s.
St. Vincent & the Grenadines	60	52	-13.3	45	-13.5
Trinidad & Tobago	9,000	7,200	-20.0	6,600	-8.3
US Virgin Islands	978	978	n.s.	978	n.s.

Table 6. Percentage of coral reefs at medium and high risk from four individual threats in Caribbean SIDS; Reefs at Risk Threat Index (L: low; M: medium; H: high; VH: very high) (source: Burke and Maidens 2004)

Country	**Coastal development**	**Sedimentation & pollution from inland sources**	**Marine-based pollution**	**Overfishing**	**Reefs at risk Threat Index (%)**			
					L	**M**	**H**	**VH**
Antigua & Barbuda	71	29	29	100	0	39	50	11
Aruba	100	0	74	100	0	0	85	15
Bahamas	5	0	1	22	75	24	2	0
Barbados	100	60	15	100	0	0	86	14
Cuba	21	28	8	68	32	32	33	3
Dominica	96	100	14	100	0	0	63	37
Dominican Republic	59	45	10	79	18	8	63	10
Grenada	85	57	23	100	0	20	41	40
Haiti	92	99	7	100	0	0	45	55
Jamaica	55	61	31	69	32	2	34	32
Netherland Antilles	43	0	45	36	37	15	39	9
St. Kitts & Nevis	95	100	26	100	0	0	77	23
St. Lucia	99	100	40	100	0	0	39	61
St. Vincent & the Grenadines	64	16	29	100	0	38	48	14
Trinidad & Tobago	99	87	1	100	0	0	99	1
Virgin Islands (US)	58	34	44	61	0	9	73	18

Table 7. Number of MPAs (or parks and reserves with marine components) in the Insular Caribbean (source: MPA Global: A database of the world's Marine Protected Areas http://www.mpaglobal.org/home.html)

Country/Territory	**No. MPAs, national parks, marine reserves, or with marine component**
Anguilla	5
Barbados	1
Antigua and Barbuda	11
Aruba	1
Bahamas	31
Cuba	20
Dominica	2
Dominican Republic	15
Grenada	1
Guadeloupe	13
Jamaica	12
Martinique	18
Montserrat	6
Netherlands Antilles	6
Puerto Rico	11
St Kitts & Nevis	1
St Lucia	29 (marine reserves)
St Vincent & the Grenadines	19
Trinidad & Tobago	13
British Virgin Islands	32
US Virgin Islands	15

Table 8. Membership of countries of the Insular Caribbean countries in organizations relevant to large pelagic fisheries management and development

Country/territory	ICCAT	CARICOM	OECS	WECAFC	IOCARIBE
Antigua and Barbuda		x	x	x	
Bahamas		x		x	x
Barbados	x	x		x	x
Cuba				x	x
Dominica		x	x	x	
Dominican Republic					x
France (Guadeloupe, Martinique, St. Barthelemy, St Martin)				x	x
Grenada		x	x	x	
Haiti				x	x
Jamaica		x		x	x
Netherlands (N. Antilles)				x	x
St. Kitts & Nevis		x	x	x	
St. Lucia		x	x	x	x
St Vincent & the Grenadines	x	x	x	x	
Trinidad & Tobago	x	x		x	x
UK (Anguilla)			x	x	x
UK (British Virgin Is)			x	x	
UK (Cayman Is)				x	
UK (Montserrat)		x	x	x	
UK (Turks & Caicos)				x	
USA (Puerto Rico, US Virgin Is)				x	x

Table 9. Review of the important resources in the WECAFC region and relevant regional and international organizations (resources are not presented in order or importance or priority) (source: FAO 1998)

Resource	CARICOM	OECS	WECAFC	CFMC	ICCAT	IOCARIBE
Soft-bottom groundfish	x		x			
Shallow reef fish	x	x	x			
Deep shelf fish	x	x	x			
Large coastal pelagics	x	x	x		x	
Large oceanic pelagics	x	x	x		x	
Sharks						
Small coastal pelagics	x	x	x			
Flyingfish	x	x	x			
Lobster	x	x	x	x		
Shrimp	x		x			
Conch	x	x	x	x		
Other resources			x			
General Fisheries Mgt issues	x	x	x			x, turtles, LME
No. member countries	12	9	31		24	22
Organizational Status	IGO	IGO	IGO	Gov't	IGO	IGO
Scope	Fisheries, policy, research cooperation	Fisheries, policy, co-operation	Fisheries, policy, research, co-operation	Fisheries management,	Fisheries	Research
Primary mandate	Technical, management	Technical, management	Technical	Management	Technical, management	Technical

Table 10. Some relevant global and regional Multilateral Environmental Agreements (MEAs) in the Insular Caribbean and their status (R: Ratified; A: Acceded; S: Signed; X: Ratified/Acceded/not specified)

Country	Global MEAs									Regional MEA Cartagena Convention		
	UNCLOS	SS & HMS	CBD	CITES	BASEL	UNFCCC	MARPOL	LONDON	IWC	Oil spill	SPAW	LBS
Antigua & Barbuda	R		R	A	A	R	X	X	X	R/A	S	
Bahamas	R	R	R	A	A	R	X					
Barbados	R	R	R	A	A	R	X	X		R/A	R/A	
Cuba	R		R	A	A	R	X	X		R/A	R/A	
Dominica	R		R	A	A	R	X		X	R/A		
Dominican Republic			R	A	A	R	X	X		R/A	R/A	S
Grenada	R		R	A		R			X	R/A		
Haiti	R		R			R		X				
Jamaica	R	S	R	A	A	R	X	X		R/A	S	
St Kitts & Nevis	R		R	A	A	R	X		X	R/A		
St Lucia	R	R	A	A	A	R	X	X	X	R/A	R/A	
St Vincent & the Grenadines	R		A	A	A	R	X	X	X	R/A	R/A	
Trinidad & Tobago	R	R	R	A	A	R	X	X		R/A	R/A	R/A

UNCLOS: United Nations Convention on the Law of the Sea; **SS&HMS:** Agreement for the Implementation of the Provisions of UNCLOS Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks; **CBD:** Convention on Biological Diversity; **CITES:** Convention on International Trade in Endangered Species of Wild Fauna and Flora; **Basel:** Convention on the Transboundary Movements of Hazardous Wastes and their Disposal; **UNFCCC:** United Nations Framework Convention on Climate Change; **MARPOL:** International Convention for the Prevention of Pollution from Ships; **London:** Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter; **IWC:** International Convention for the Regulation of Whaling; **Cartagena:** Convention on the Protection and Development of the Marine Environment in the Wider Caribbean**; Oil Spill:** Protocol Concerning Cooperation in Combating Oil Spills in the Wider Caribbean Region; **SPAW:** Protocol Concerning Specially Protected Areas and Wildlife in the Wider Caribbean Region; **LBS:** Protocol Concerning Pollution from Land-Based Sources and Activities.

Table 11. Major stakeholders and their role in the governance cycle with respect to the management of transboundary living marine resources in the Insular Caribbean

Stage of governance cycle	NAT'L	SUB-REGIONAL	REGIONAL	GLOBAL
Decision-making	Gov't, Commissions, Ad hoc Committees, Environmental Management Authorities	OECS	Regional conventions (Cartegena)	ICCAT, IWC, Int'l conventions (e.g. LOSC, Fisheries agreements, CBD, IWC), Global Action Programmes (e.g. GPA)
Analysis & advice	Gov't, Academic and research institutions, Advisory commissions, Ad hoc committees, Expert groups	CARICOM, CRFM, OECS	Regional conventions, regional bodies (CFMC, IOCARIBE, WECAFC, CEHI, ACS), UN regional bodies (UNEP CAR/RCU), Expert working groups (lobster, conch), Regional NGOs (e.g. CANARI, CCA)	ICCAT, IWC, Int'l conventions, Global Action Programmes (GPA), World Bank, UN organizations (e.g. FAO, UNEP), GEF, ICCAT, Int'l NGOs
Implementation	Gov't	OECS	At national level by Gov't	At national level by Gov't
Review & evaluation	Gov't, Academic and research institutions, Advisory commissions, Expert groups	CARICOM, CRFM, OECS	Regional conventions, Regional bodies (CFMC, IOCARIBE, WECAFC), UN regional bodies (UNEP CAR/RCU), Expert groups (lobster, conch), Regional NGOs (e.g. CANARI, CCA)	ICCAT, IWC, Int'l conventions, Programmes of Action (GPA), World Bank, UN organizations, GEF, Int'l NGOs
Data & Information	Gov't, Academic and research institutions, Civil society	CARICOM, CRFM, OECS	Regional conventions, regional bodies (e.g. CRFM, CARICOM, OECS, WECAFC), UN regional bodies, Expert groups (lobster, conch), Regional NGOs (e.g. CANARI, CCA)	ICCAT, Int'l conventions, Int'l Action Programmes (GPA), World Bank, UN organizations, GEF, Int'l NGOs

FIGURES

Figure 1. Map showing the Insular Caribbean sub-region

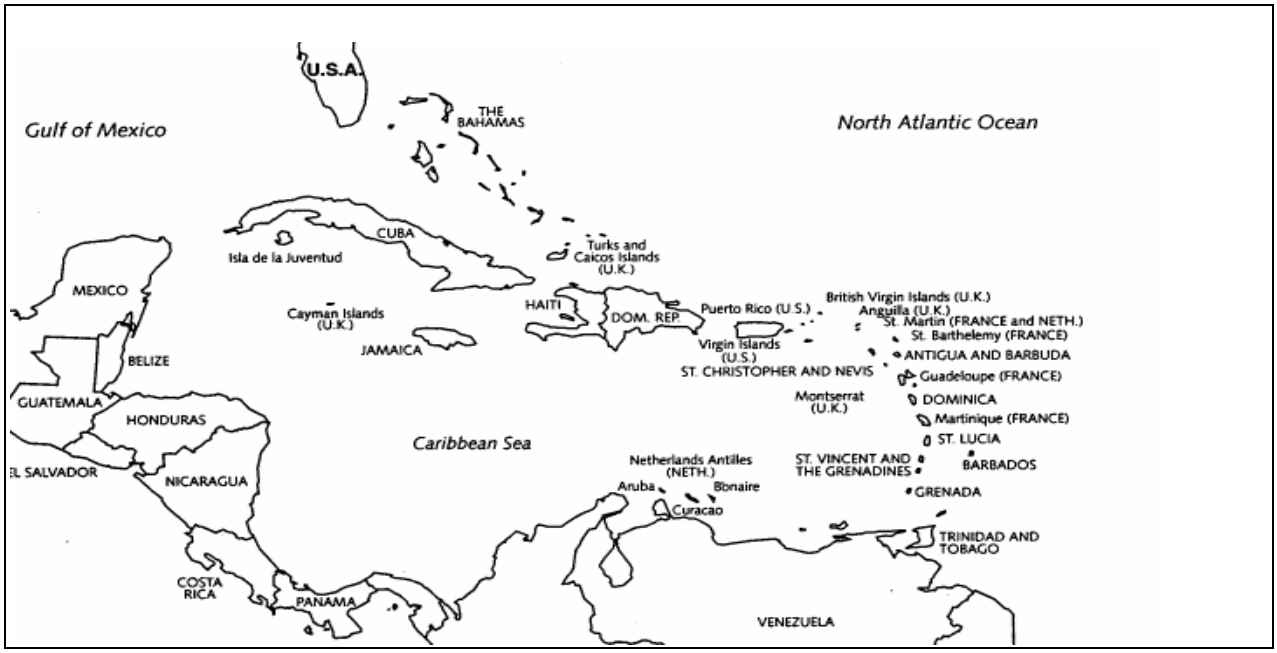


Figure 2. Satellite image showing the Orinoco River plume in the Caribbean Sea (source: Müller-Karger *et al*. 1989)

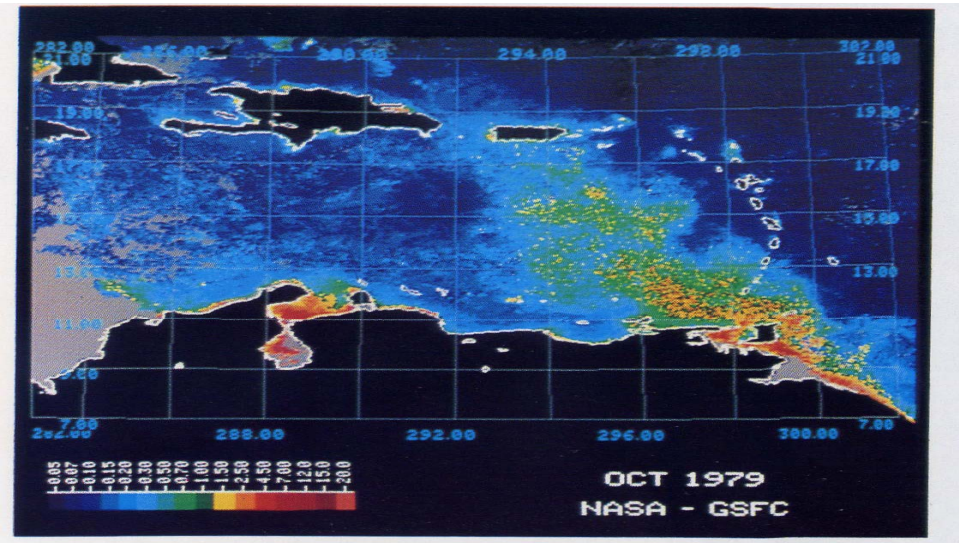


PLATE 5. October 1979. CZCS composite of 9 overviews of the Caribbean Sea in October 1979. The Orinoco plume occupied the eastern Caribbean and flowed northwestward past Puerto Rico. A small plume veering offshore near 10° N, 59° W was evidence of an anticyclonic eddy east of Trinidad.

Figure 3. Caribbean biodiversity hotspot
(source: Conservation International, http://www.biodiversityhotspots.org/xp/Hotspots/caribbean/)

Figure 4. Annual fisheries landings in Insular Caribbean countries, 1950 -2003 (source: Sea Around Us 2007)

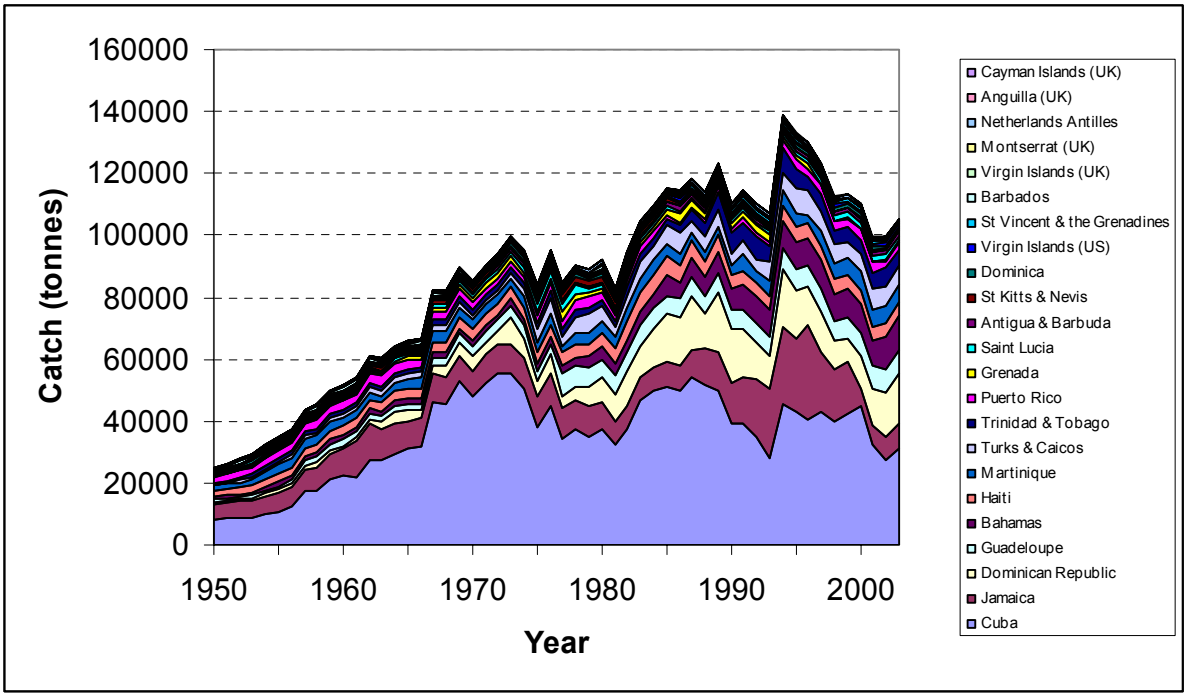


Figure 5. Annual catch of spiny lobster in the Insular Caribbean, 1950 -2003
(source: Sea Around Us 2007)

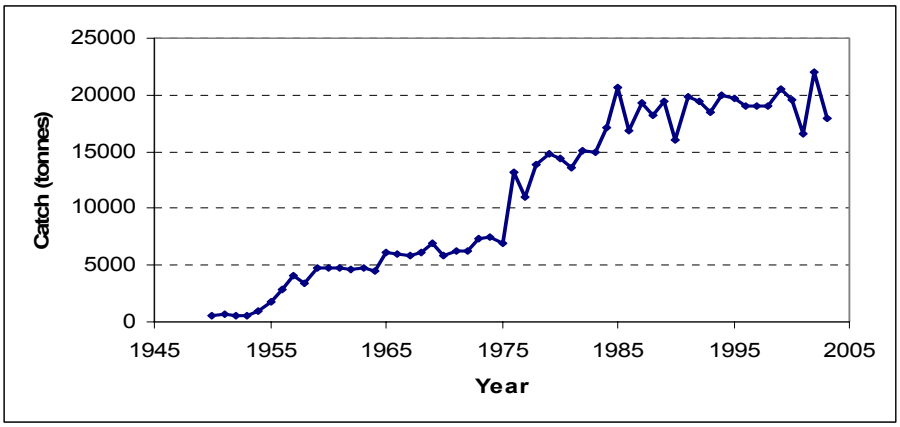


Figure 6. Annual catch of queen conch in the Insular Caribbean, 1950 -2003
(source: Sea Around Us 2007)

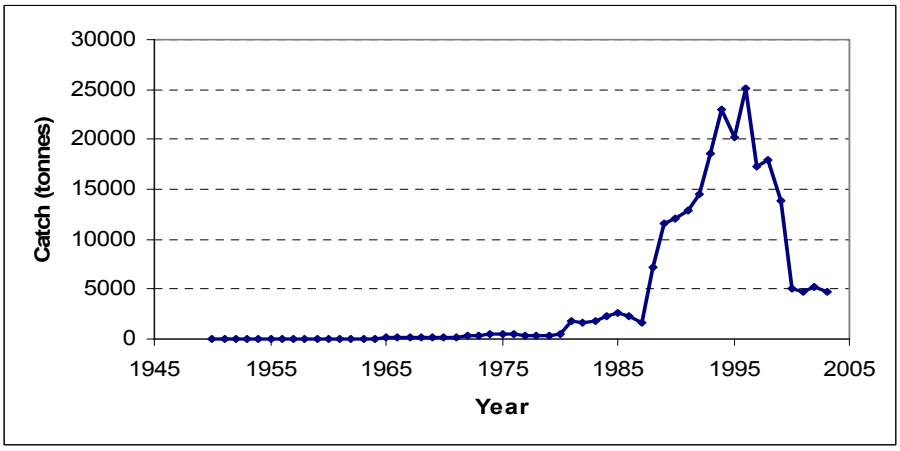


Figure 7. Annual catch of tunas and billfishes in the Insular Caribbean, 1950 -2003
(source: Sea Around Us 2007)

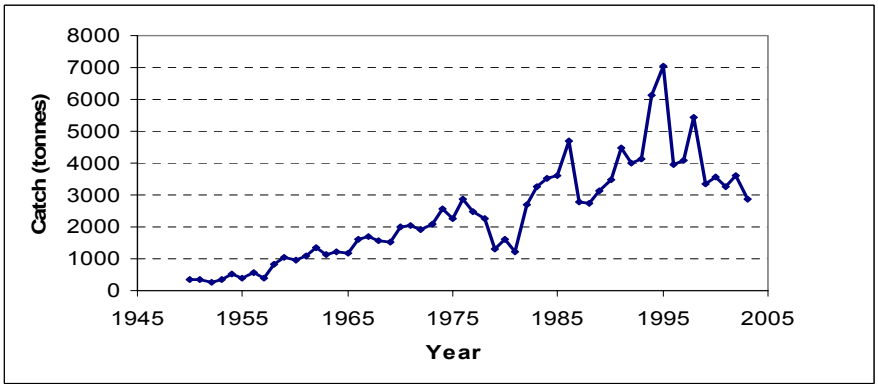
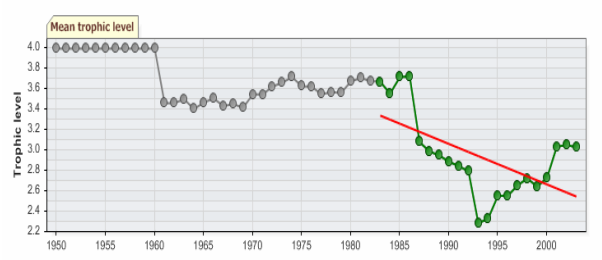
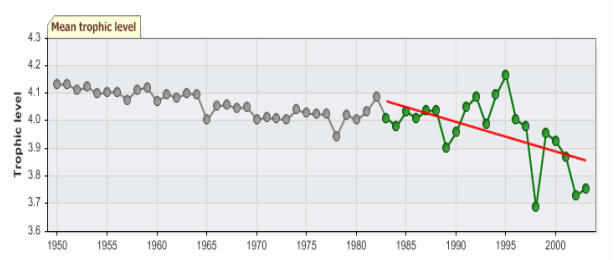


Figure 8. Mean Trophic Level of the catch in selected Caribbean Islands, 1950 - 2003
(Based on data from Sea Around Us 2007)

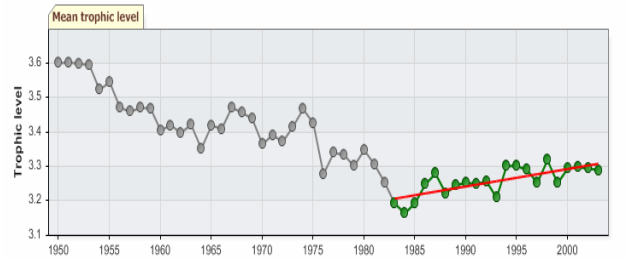
Antigua & Barbuda



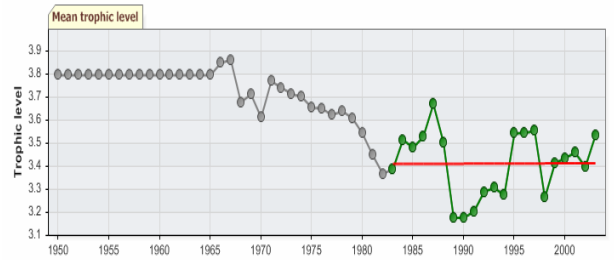
Barbados



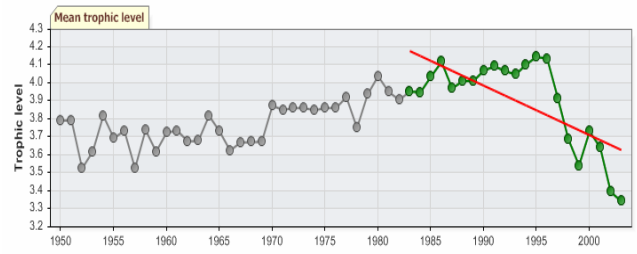
Cuba



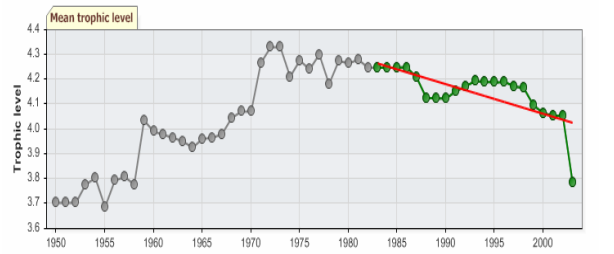
Dominican Republic



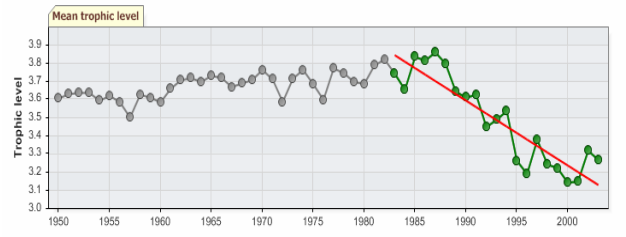
Grenada



Martinique



Puerto Rico



St. Kitts & Nevis

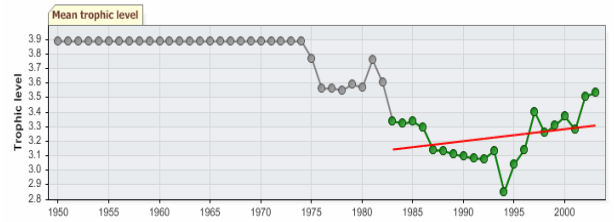


Figure 9. Threats to Caribbean coral reefs from overfishing (source: Burke and Maidens 2004)

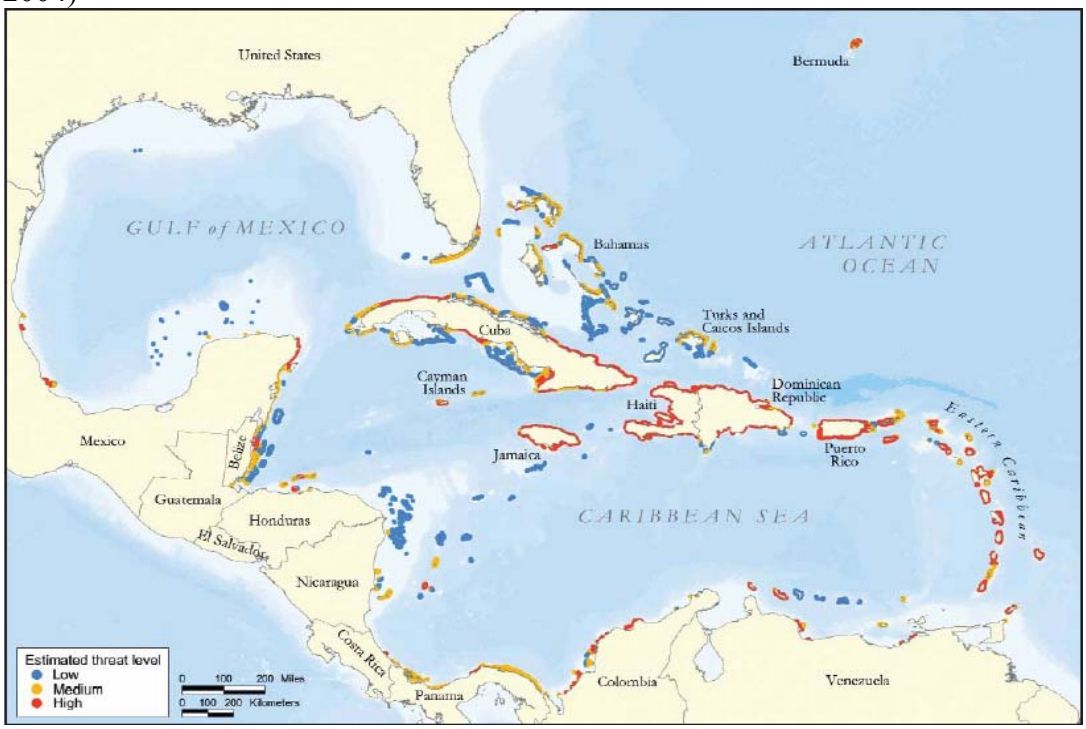


Figure 10. Value of the annual fisheries catch in the Insular Caribbean 1950 -2003 (source: Sea Around Us 2007)

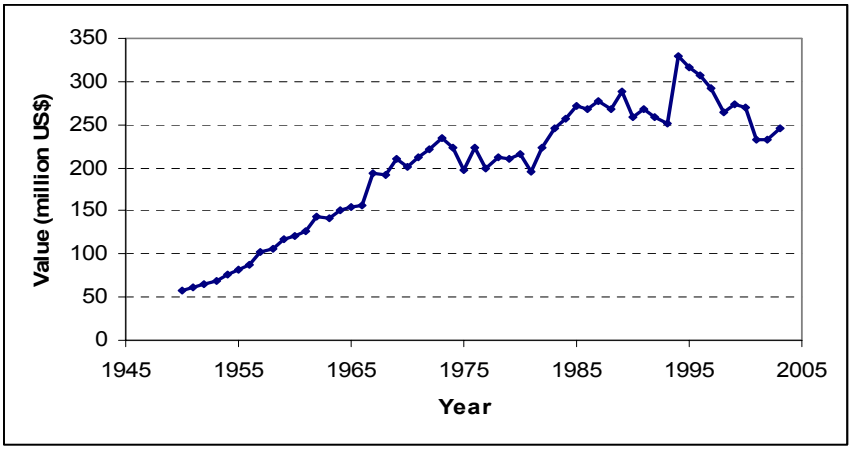


Figure 11 . The Reefs at Risk Threat Index in the Caribbean (source: Burke and Maidens 2004)

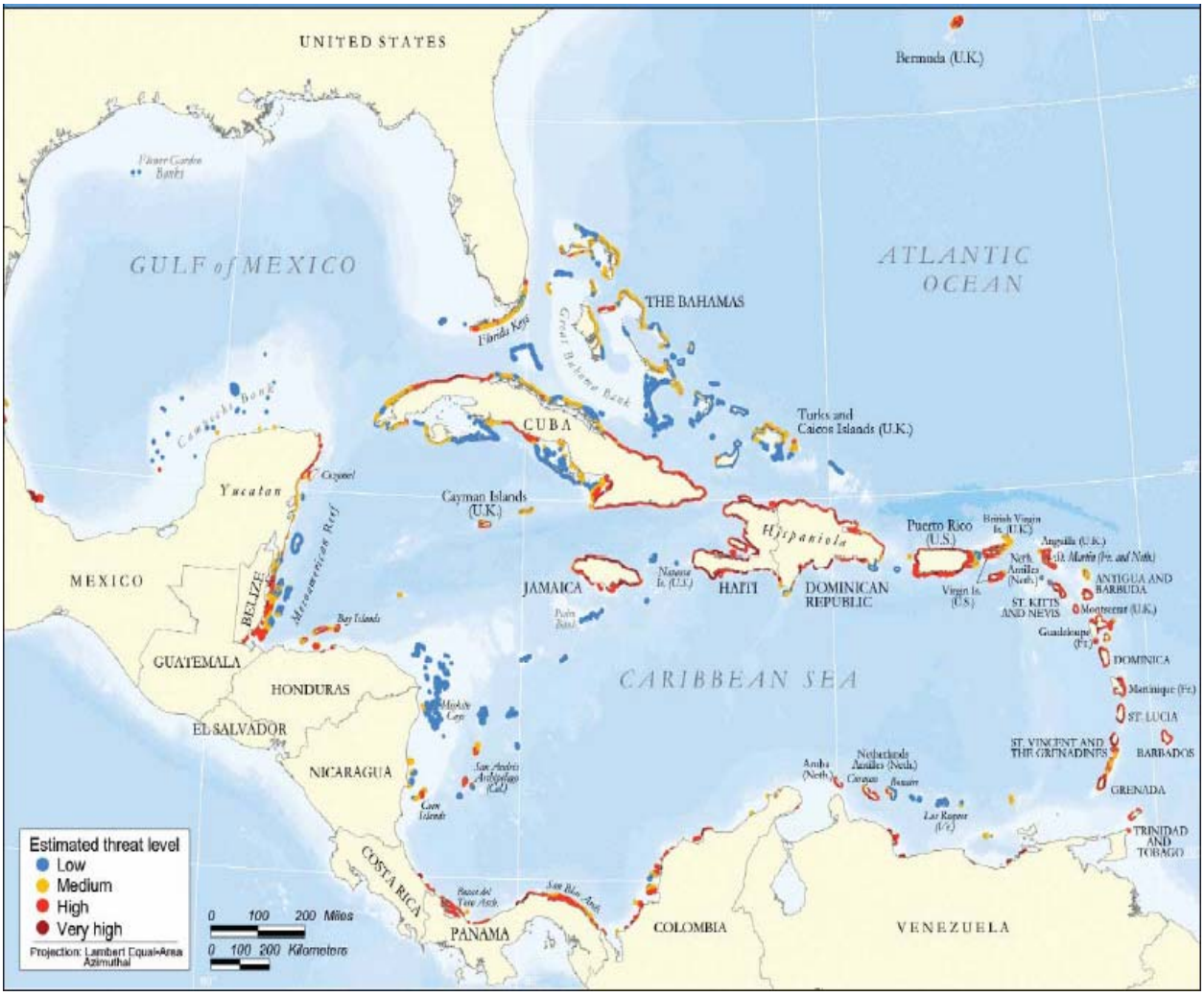


Figure 12. Coral disease observations in the Caribbean (source: Burke and Maidens 2004)

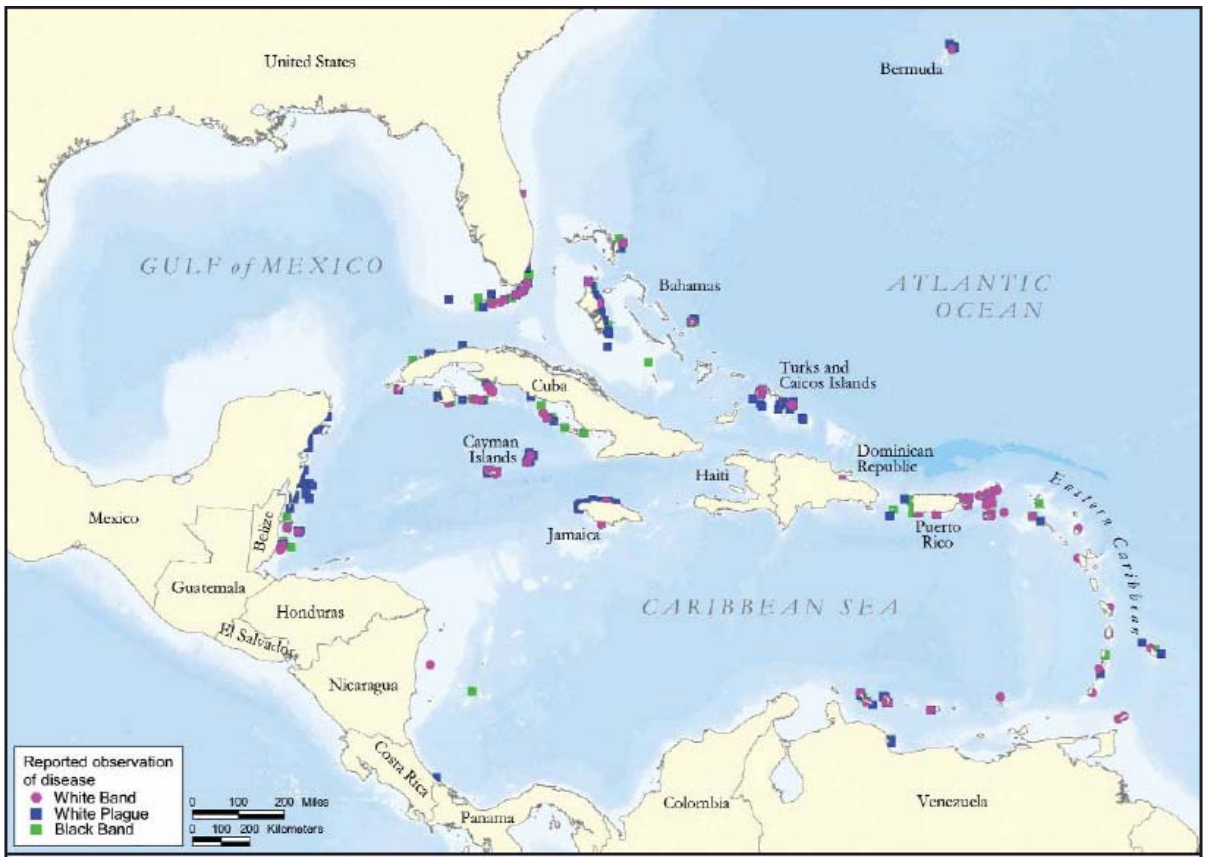


Figure 13. Coral bleaching observations in the Caribbean (source: Burke and Maidens 2004).

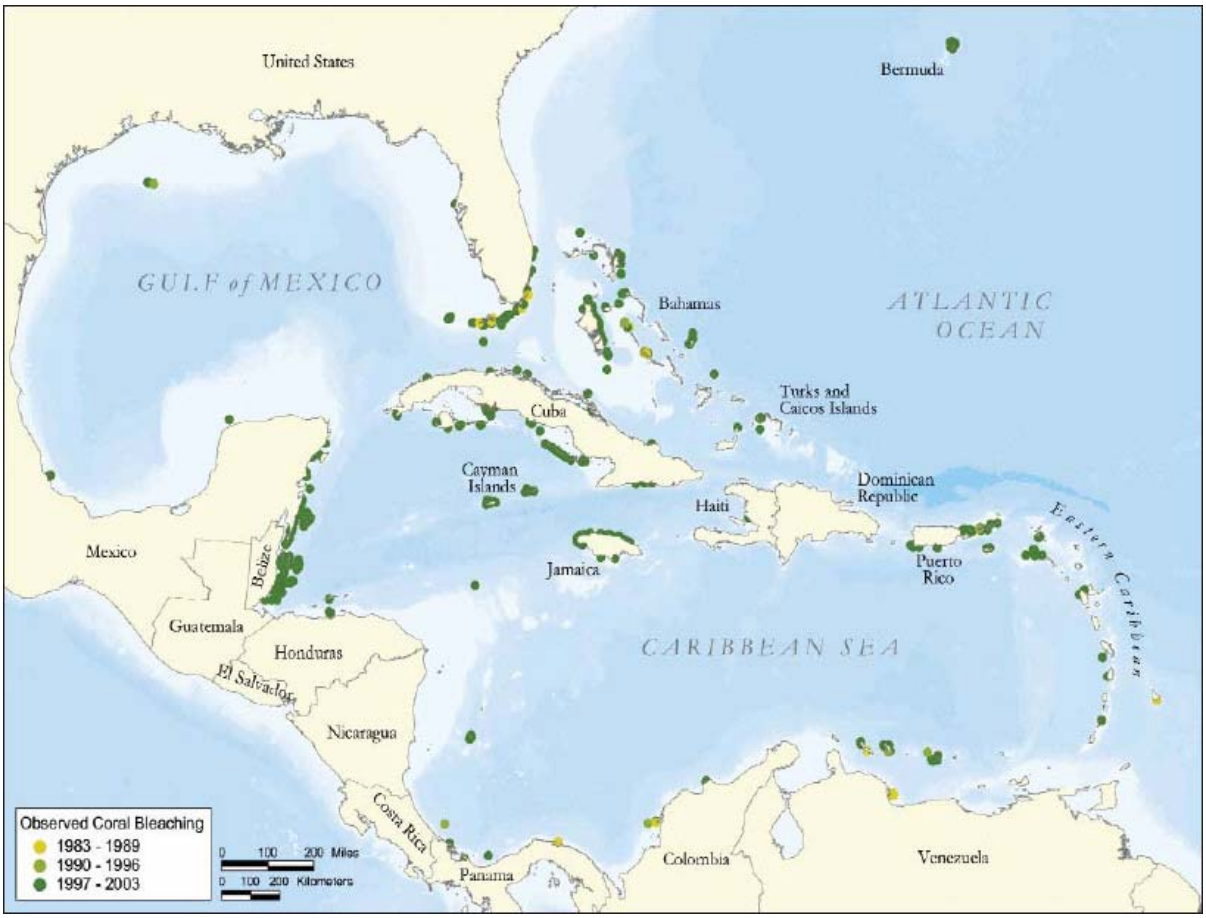


Figure 14. Overall increase in African dust reaching Barbados since 1965. Peak years for dust deposition were 1983 and 1987. These were also the years of extensive ecological change on Caribbean coral reefs. (source: USGS 2000, Courtesy of Dr. J. Prospero, University of Miami)

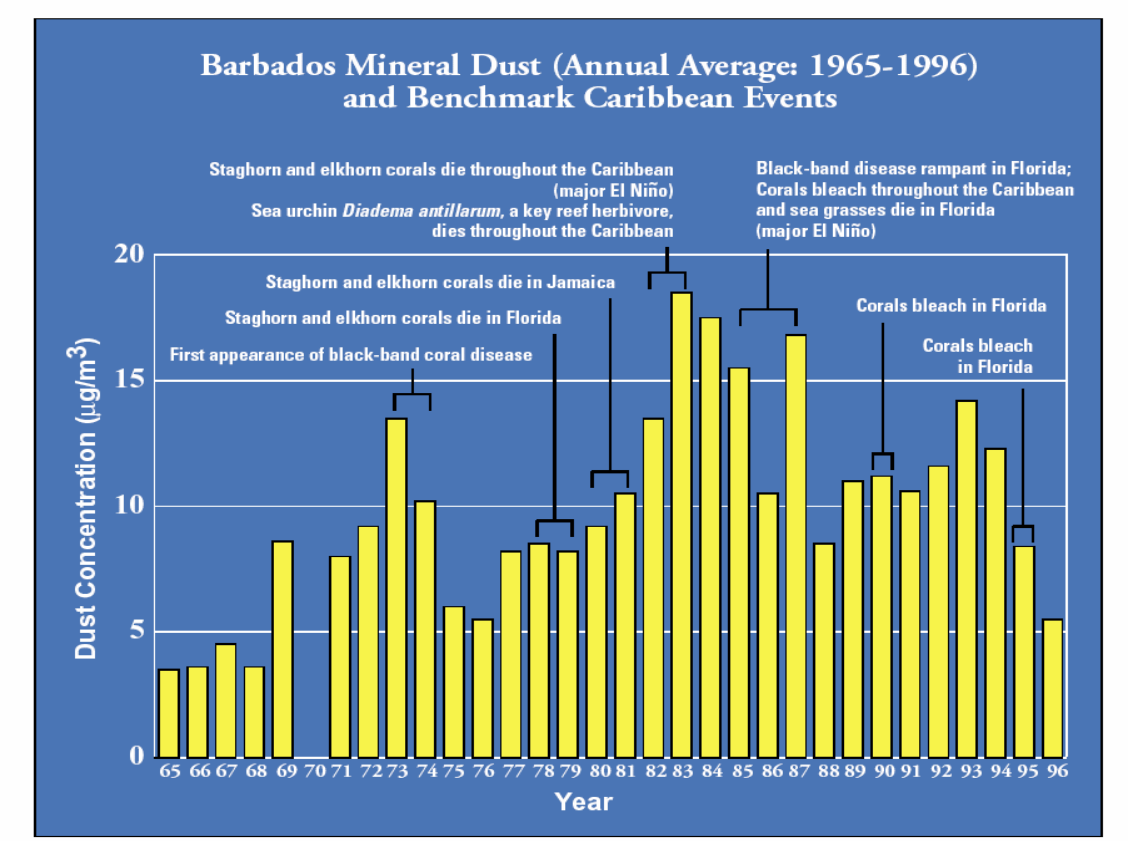


Figure 15. May 28, 1999 satellite image of SE United States, Central America, and the Amazon region showing an African dust cloud over the Caribbean (source: USGS 2000)

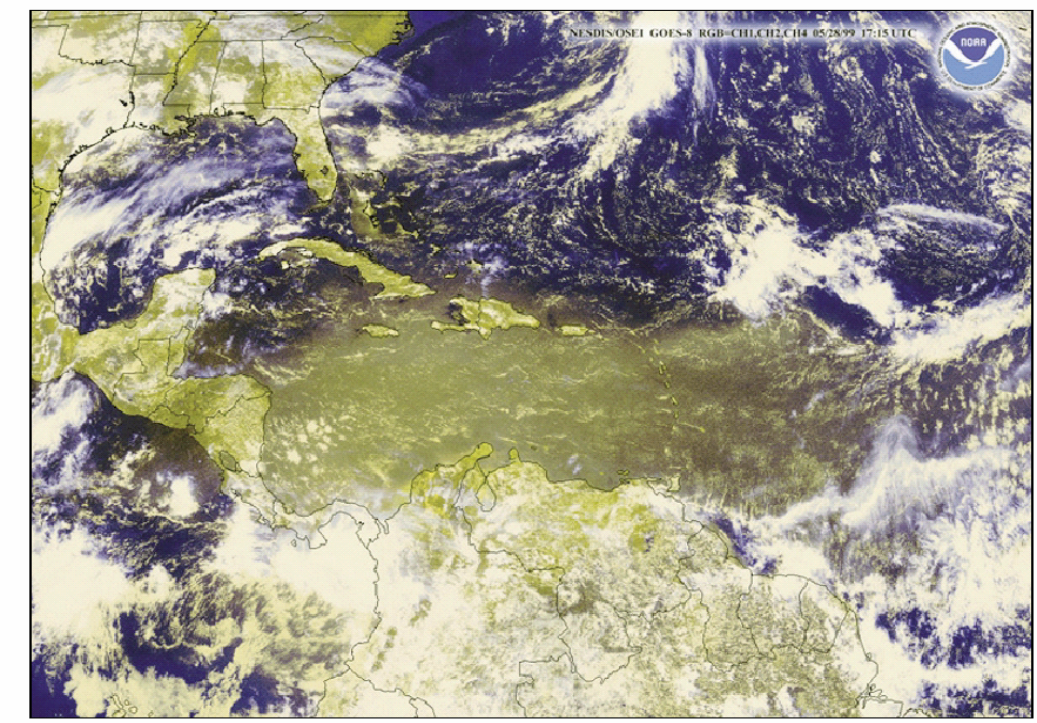


Figure 16. Threat to coral reefs by sedimentation and pollution from inland sources in the Caribbean (source: Burke and Maidens 2004)