Chapter 1. INTRODUCTION

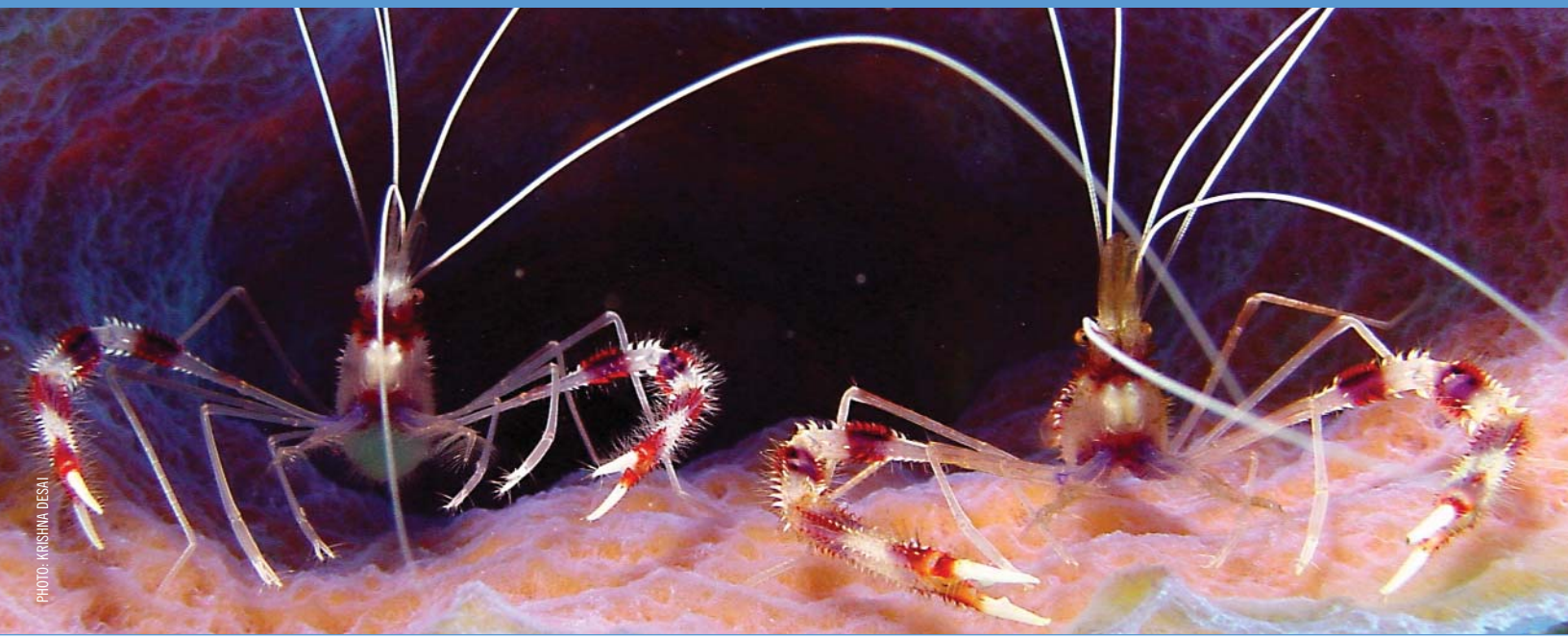


PHOTO: KRISHNA DESAI

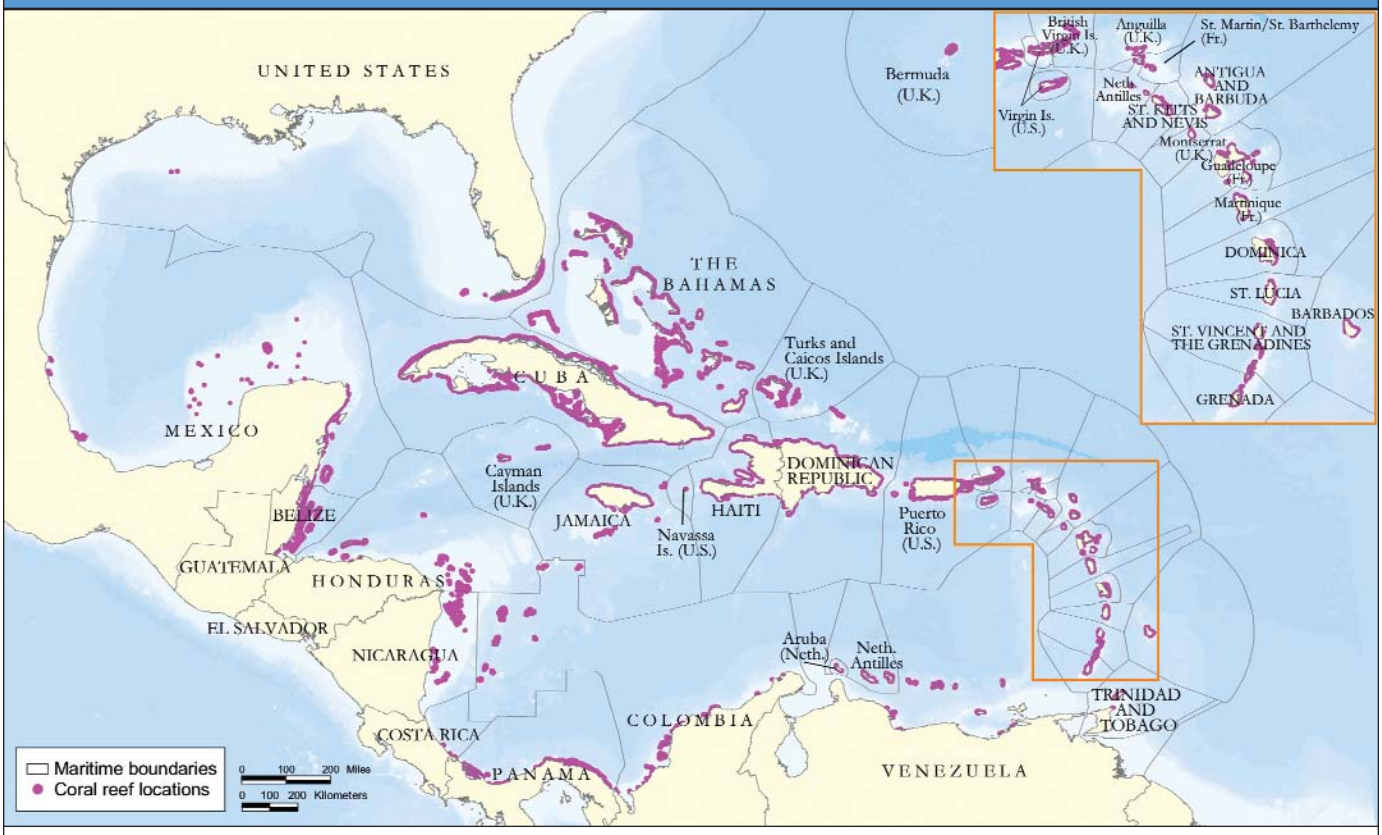
The Wider Caribbean (hereafter called the Caribbean) is a large marine realm encompassing the Caribbean Sea, the Gulf of Mexico, and part of the northwestern Atlantic Ocean extending out to the tiny island of Bermuda. *(See Map 1.)* Richly endowed with biological treasures, it is also a region of tremendous cultural and political diversity shaped by a vivid history. The wide coastal shelves and warm tropical waters create ideal conditions for the formation of an estimated 26,000 square kilometers (sq km) of coral reefs.[1] Separated from other coral reefs, these have evolved in isolation, and remarkably few of the many thousands of species in these waters are found anywhere else in the world.[2]

More than 116 million people live within 100 km of the Caribbean coast *(see Appendix A, Table A3),* and many livelihoods depend strongly on the marine environment. Coral reefs contribute significantly to nutrition and employment, particularly in rural areas and among island communities, where there may be few employment alternatives. The reefs are also a major draw for tourists to the region. Coral reefs provide shoreline protection, notably during storms and hurricanes, and generate white sand for many beaches. The biodiversity of coral reef ecosystems has enormous value as a provider of potentially life-saving pharmaceuticals.

Despite their value, coral reefs in the Caribbean are under threat.[3] Growing coastal populations and rising tourist numbers exert increasing pressure. Land-based activities, including construction, deforestation, and poor agricultural practices, are depositing an increasing load of sediment and nutrients in coastal waters, smothering some corals and contributing to overgrowth by algae. Current levels of fishing pressure are unsustainable in most areas and have already led to species loss and the collapse and closure of fisheries in some countries.[4] Increasing pressures are undermining the resilience of reefs to threats from global climate change.[5] In addition, extensive areas of corals have succumbed to diseases in recent years. The origins of these diseases remain poorly understood, but corals across the region are susceptible.[6]

Understanding the effects of human activities on specific reefs, including the economic consequences of these disturbances, is key to future conservation and planning efforts. Within the region numerous studies are underway to assess and monitor particular coral reefs *(see Appendix C for details)*. In a few places, such as Jamaica and the Florida Keys, changes in coral condition are well documented, but in most other places, the availability of detailed information is limited, inhibiting effective management.

MAP 1. THE CARIBBEAN REGION



The Caribbean region, as defined by this analysis, encompasses 35 countries and territories bordering the Gulf of Mexico and Caribbean Sea,[a] including the oceanic island of Bermuda (*see Map 1*). Politically, and socioeconomically, these countries are highly diverse, from the world's richest nation to some of the poorest; from long-established democracies to totalitarian systems; and from industrialized countries with intensive agricultural systems to countries with little industry and largely natural landscapes.

The nearly 7.8 million sq km of land that drains into the Caribbean [b] stretches from the Upper Mississippi Basin in southern Canada to the Orinoco Basin of Colombia and Venezuela. The total population within this drainage area was estimated at 290 million in 2000,[c] of whom some 41 million people lived within 10 km of the coastline.[d] Average population density within this coastal strip increased by 14 percent between 1990 and 2000. (*See Appendix A, Tables A2 and A3 for detailed physical and population statistics.*)

Over the last three decades, tourism has surpassed fishing as the most important economic activity for many coastal localities. In 2000, more than 40 million people visited the region (excluding the United States), generating over US$25 billion in revenue.[e] Between 1990 and 2000, tourist (stay-over) arrivals grew at an average annual rate of 4.7 percent.[f] Cruise-based tourism grew even faster, at an average of 6.5 percent per annum between 1990 and 2000.[g] (*See Appendix A, Table A4, for detailed economic statistics.*)

Notes:

a. Within the Caribbean region, there are 35 distinct political units, including 24 sovereign nations (14 island nations and 10 continental), five overseas territories of the United Kingdom, two overseas departments of France, two self-governing units of the Netherlands, one territory of the United States, and the U.S.-associated commonwealth of Puerto Rico.
b. Caribbean drainage area was calculated at WRI using watersheds developed from USGS HYDRO1K and NASA SRTM elevation data.
c. Population in Caribbean drainage areas was calculated at WRI using population data from the Center for International Earth Science Information Network (CIESIN), *Gridded Population of the World, Version 3* (Palisades, NY: CIESIN, Columbia University, 2003).
d. Caribbean coastline is based on World Vector Shoreline. For continental countries, Pacific coastlines were excluded. Population data are from CIESIN (2003).
e. See Appendix A, Table A4.
f. CTO (2002), p. 21.
g. Ibid, p. 21.

Map Sources:

Maritime boundaries: Derived at WRI using data from the Global Maritime Boundaries Database (Veridian - MRJ Technology Solutions, 2002). Reef locations: See Appendix B. Bathymetry: Developed at WRI from depth point data from the Danish Hydrologic Institute's (DHI) C-MAP data product, interpolated at 1-km resolution.

ABOUT THE PROJECT

The Reefs at Risk in the Caribbean project was initiated to improve coral reef management by giving resource managers and policymakers specific information and tools to help manage coastal habitats more effectively. The project is designed to raise awareness about the nature and extent of the threats facing the region's coral reefs and to draw attention to the considerable value of these resources.

Achieving these aims by building up new information from surveys and monitoring would be prohibitively expensive. Rather, the project focuses on compiling existing information from a broad range of sources and putting this information together in a standardized, regionally consistent format. Some of this information relates directly to coral reefs, such as the locations of the reefs themselves. However, the project also entails gathering information on other natural and human features that can be developed into proxy measures, or indicators, of human threats to reefs. In addition, the project brings together social and economic data on the region, supporting an analysis of the economic value of the region's coral reefs and underpinning a series of policy and management recommendations.

The indicators developed by the Reefs at Risk in the Caribbean project enable detailed comparative analyses of threats to coral reefs on many scales. The Reefs at Risk indicators are a simplification of human activities and complex natural processes. The approach and methodology used to create the indicators, and their limitations, are described in Chapter 2. In Chapter 3, we examine in detail the main categories of threat to coral reefs, discuss the effects of these threats, and suggest remedies for mitigating threats. Chapter 4 explores reef status and threats in nine sub-regions of the

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Coral polyps filter feeding at night.

BOX 1. CARIBBEAN CORAL REEFS

A coral reef is both a physical structure and a highly productive ecosystem. The physical structure is built over centuries by the piling up of skeletons deposited by reef-building corals, which are colonies of tiny animals. Each animal within the colony is known as a polyp and has a simple tubular body with a ring of stinging tentacles around a central mouth. Within these polyps are even smaller single-celled plants (*zooxanthellae*). Corals filter food from the water using their tentacles, but they also rely heavily on their zooxanthellae, which use the sun's energy to synthesize sugars, some of which are taken up and used by the polyps. These corals, then, must have sunlight to grow, reproduce, and build their limestone (calcium carbonate) skeletons. Of the roughly 800 species of reef-building (*Scleractinian* or stony) corals that have been described worldwide, about 65 are found in the Caribbean.[a] Although these species are the great architects of the coral reef, their numbers are dwarfed by a great diversity of other life forms—turtles, fish, crustaceans, mollusks, urchins, sponges, and others—which make coral reef ecosystems the most diverse on Earth.

The Caribbean region possesses about 26,000 sq km of shallow coral reefs,[b] about 7 percent of the global total.[c] Reefs dominate shallow marine habitats over wide areas of the Caribbean, especially around islands. They are more sparsely distributed through the Gulf of Mexico. Far out in the Atlantic, the coral reefs of Bermuda are the most northerly in the world.

Notes:

a. Spalding et al. (2001).
b. Although estimates of coral reef area will change with advances in mapping, the best data currently available support this estimate. See Appendix B for sources used for this estimate, and Appendix A, Table A1 for comparison of different estimates of reef area by country.
c. G. Paulay, "Diversity and Distribution of Reef Organisms," in *Life and Death of Coral Reefs*. C. Birkeland, ed. (New York: Chapman & Hall, 1997), p. 303; Spalding et al. (2001).

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About 65 species of reef-building coral are found in the Caribbean. The major reef building species, which are typically large (>25 cm diameter) and fast growing, are Elkhorn (*Acropora palmata*), Staghorn (*Acropora cervicornis*) and Star Coral (*Montastraea* spp.). Coral reefs are a valuable asset to coastal communities — offering a source of food, popular locations for tourism and recreation and a potential source of bioactive compounds for new medicines.

Caribbean. Chapter 5 offers an estimation of the economic value of three key goods and services provided by Caribbean coral reefs—fish catch from reef fisheries, dive tourism, and shoreline protection services—and presents an evaluation of economic losses that could result as coral reefs degrade. Finally, Chapter 6 formulates broad management and policy recommendations based on the findings of the analysis.

Reefs at Risk in the Caribbean is part of a series that began with a global analysis, *Reefs at Risk: A Map-Based Indicator of Threats to the World's Coral Reefs,* released in 1998.[7] Subsequently, region-specific projects have refined the original model, have incorporated a much higher-resolution analysis, and have provided an improved tool for analyzing the impacts of human activities on reefs. The first in the regional analysis series, *Reefs at Risk in Southeast Asia,* was released in 2002. The Reefs at Risk in the Caribbean project, a two-year collaborative effort involving more than 20 partner institutions, has compiled and integrated far more information than can be presented in this report. More detailed information, including all maps and statistics, country-level results, and details of the analytic methods are available at http://reefsatrisk.wri.org/ and on the accompanying *Reefs at Risk in the Caribbean* data CD.