

## EarthTrends Featured Topic: Reefs at Risk in the Caribbean

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Coral reefs are an integral part of the Caribbean fabric, threading along thousands of kilometers of coastline. Rich in life and beauty, they serve a multitude of purposes to the Caribbean people. Their fisheries provide food for millions of people, their structure protects shorelines from tropical storm swells, and they lure divers and snorkelers from around the world, bringing with them valuable tourism dollars for local Caribbean economies. In addition, pharmaceutical companies have begun to express interest in coral reefs as potential sources of new drugs and life-saving medical treatments.

Unfortunately, these valuable ecosystems are degrading rapidly under the mounting pressure of many human activities. Coastal development, sedimentation, overfishing, disease, global warming, and marine pollution each pose a threat to coral reefs, and while they are tremendously resilient ecosystems, these cumulative threats are taking an alarming toll on coral reefs throughout the Caribbean.

The Reefs at Risk in the Caribbean project was conducted to assess the status of coral reefs throughout the Caribbean with respect to these six threats individually and collectively. A region-wide analysis was performed, consolidating both physical and socioeconomic datasets within a geographic information system (GIS), which produced multiple maps showing the distribution of human pressure on coral reefs in the Caribbean.

The threats examined were subdivided into “low,” “medium,” and “high” categories. Two broad threats, those of disease and abnormally high sea surface temperatures, were not included in this analysis due to the lack of spatial detail in the datasets and the degree of uncertainty about the contributing factors. Both of these threats are important however, and should not be discounted when considering the health and management of coral reefs.

The following article will provide information on each of the six threats facing coral reefs in the Caribbean, quantify and illustrate the current threat levels, and discuss necessary steps to reverse the decline in the health of the region’s coral reefs.

### Key Findings

Nearly two-thirds of coral reefs in the Caribbean are threatened by at least one form of human activity.

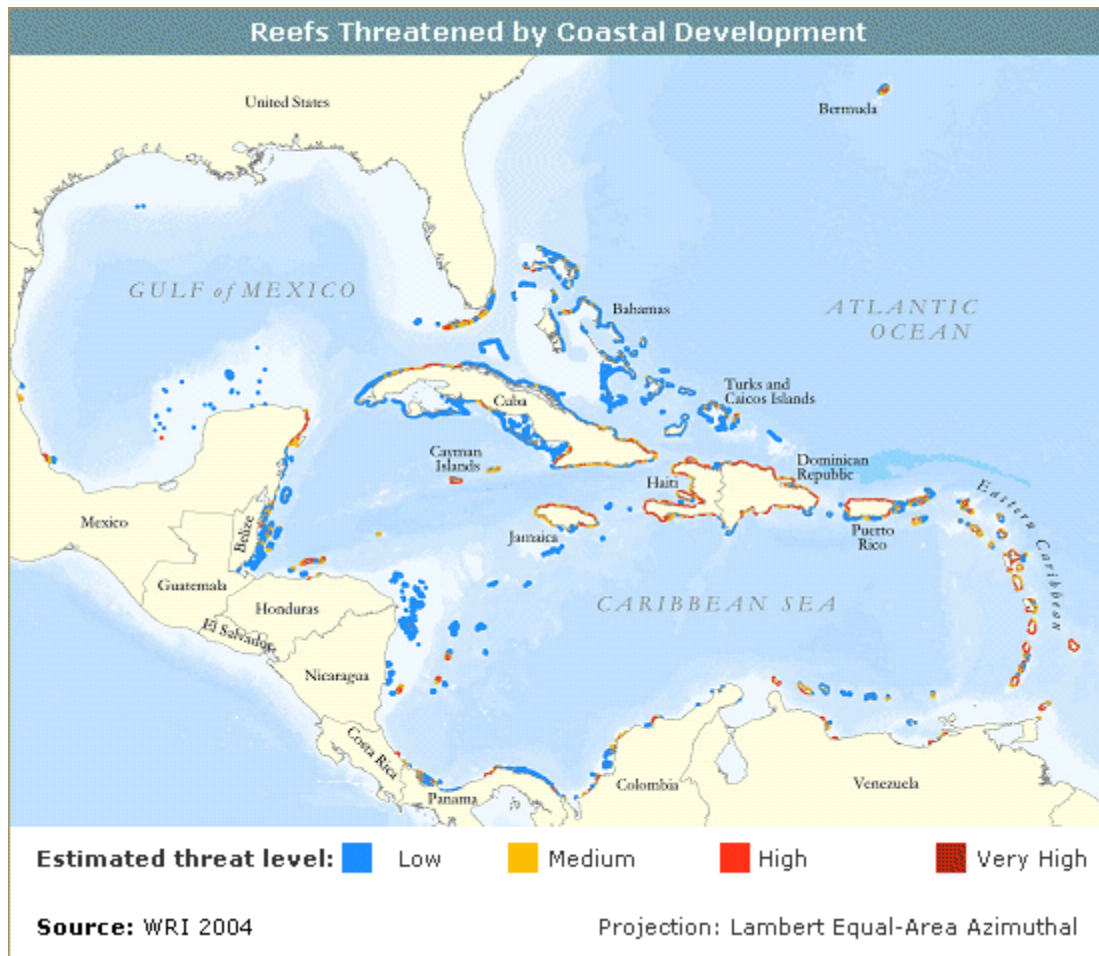
- An estimated one-third of coral reefs in the Caribbean are threatened by coastal development, sediment, and pollution from land-based sources.
- Overfishing threatens 60 percent of Caribbean coral reefs.
- Disease and rising sea temperatures threaten to damage coral reefs across the Caribbean region.
- The coastal communities and national economies of the

Caribbean region are poised to sustain substantial economic losses if current trends in coral reef degradation continue.

### Coastal Development

Approximately 36 percent of Caribbean coral reefs lie within 2 km of the coast, making them highly susceptible to pressures arising from coastal populations. Direct damage can occur to the reefs through dredging and mining, and indirect damage can occur from run-off and pollution generated by industrial structures, construction sites, and roads. Traditionally, sediments and nutrients coming from the land were filtered by mangrove forests and seagrass, however the loss of these important areas is widespread throughout the Caribbean (Jameson et al. 1995).

In addition to the threats created by human activities, our biological presence also poses a threat to the Caribbean reef systems. It is estimated that less than 20 percent of sewage water generated in the Caribbean region is treated before entering the ocean. Coral reefs thrive in traditionally nutrient free waters. Untreated sewage is a major source of nutrients entering coastal waters which, under normal circumstances, would be devoid of nutrients. These conditions favor algal growth at the expense of the corals (Souter and Linden, 2000). The tourism industry, a sector of major importance to the regional economy, also threatens the reefs in a number of ways. Dive boats can damage reef structure with



their anchors, and resort development and operation increase pollution and sewage, as does the construction of tourism infrastructure (roads, marinas, airports).

The Reefs at Risk analysis estimates that one-third of the Caribbean's coral reefs are threatened by pressures arising from coastal development (at medium and high threat). Specifically, the analysis identified Greater Antilles, Eastern Caribbean, the Bay Islands in Honduras, and parts of the Florida Keys, the Yucatan, and the Southern Caribbean as areas where the reefs were under significant pressure. The areas where coastal development pressure was identified as the lowest were the Bahamas, Turks and Caicos Islands, and Cuba (*See Map 1*). Pressure from coastal

development is rising and continues to rise as population expands in the region. Between 1990 and 2000, the estimated population living within 10 km of the Caribbean coast grew from 36 million to 41 million.

### Agricultural Sedimentation and Pollution

The conversion of land to agriculture increases soil erosion and sediment delivery to coastal waters, bringing with it pesticides and nutrients. Nearly a quarter of all the land area draining into the Caribbean is agricultural land, with the highest erosion risks occurring in Mexico, Guatemala, Honduras, Colombia, Eastern Jamaica, Haiti, and Puerto Rico.

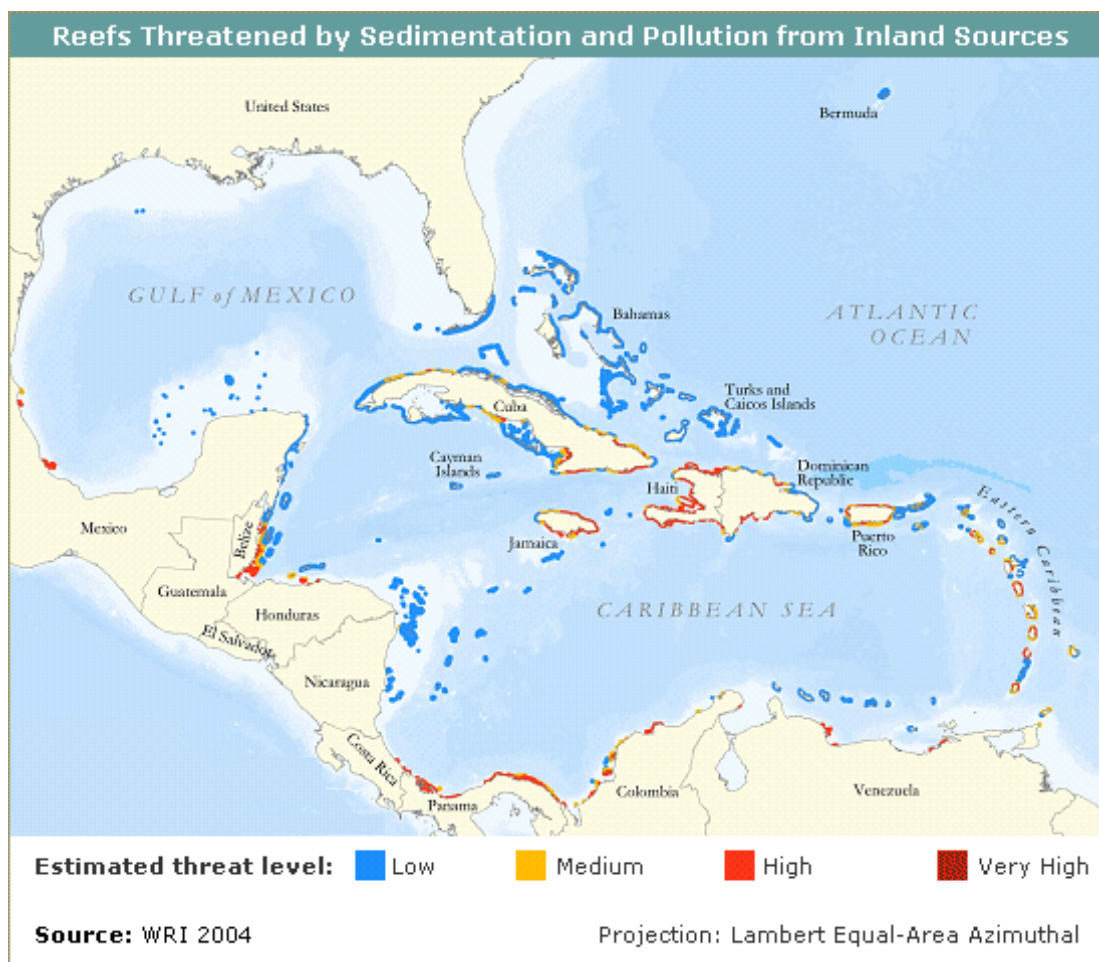
Increased sediment causes stress on coastal ecosystems in a variety of ways. It screens out the light needed for photosynthesis, decreases the amount of suitable substrates for juvenile corals, and in extreme cases, can completely smother corals. This type of damage has been documented off the coasts of Panama, Costa Rica, and Nicaragua (Guzman, 2003; Cortes and Jimenez, 2003; Ryan and Zapata, 2003). The fertilizers used in agriculture increase the amount of nutrients in the water when they are transported by runoff, and can lead to algal blooms, changes in the aquatic community structure, and decreased biological diversity. High levels of nutrients can also produce dead zones--areas devoid of oxygen--and such events can be devastating to coral reefs. Similarly, agricultural runoff delivers pesticides to coastal waters

which damage seagrass beds and cause the loss of coral cover which in turn increases algae and sponges.

The Reefs at Risk project identified close to one-third of the coral reefs in the Caribbean as threatened by sediment and pollutant delivery related to land-use activity. Areas with a large proportion of threatened reefs were Jamaica, Hispaniola, Puerto Rico, Panama, Costa Rica, and Colombia. In addition, some reefs were identified as threatened in Belize, Venezuela, and reefs near the high islands of the Eastern Caribbean (*See Map 2*).

sewage, ballast and bilge discharge, and the dumping of other human garbage and waste from ship, are a cause for great concern in the Caribbean region. Much of this threat is related to the high amount of marine transportation in the Caribbean. For example, ship anchors can extensively damage the seafloor; discharge from ships releases a toxic mix of oil, nutrients, invasive species, and other pollutants. The routine maintenance and washing of oil tanks, drilling rigs, and pipelines releases a significant amount of oil into the environment. Oil damages coral reproductive tissues, harms

Cruise ships are also a significant source of marine pollution in the Caribbean. A typical cruise ship generates over 2,000 gallons of oily bilge water a day (Sweeting and Wayne, 2003), and one megaton of garbage each day (Mohammed et al, 1998). Solid waste and marine debris from many sources has proven to be a major threat to marine environments across the world. The Caribbean is no exception. In 2003 a clean-up event sponsored by The Ocean Conservancy removed 1,200 metric tons of waste along just 2,100 km of coastline.



### Marine-Based Sources of Threat

Marine-based sources of pollution, including oil discharge and spills,

zooxanthellae (algae that lives symbiotically inside corals), inhibits juvenile coral recruitment, and reduces the resilience of reefs to other stresses (Dubinsky and Stambler, 1996).

The Reefs at Risk analysis identified that about 15 percent of the reefs in the region are threatened by marine-based sources of pollution. Many of the region's small islands, such as St.

Lucia, Montserrat, St. Kitts and Nevis, the Netherlands Antilles, Bermuda, and the Virgin Islands had threat levels estimated at high (See Map 3).

even after they have been lost and their connection severed from the surface.

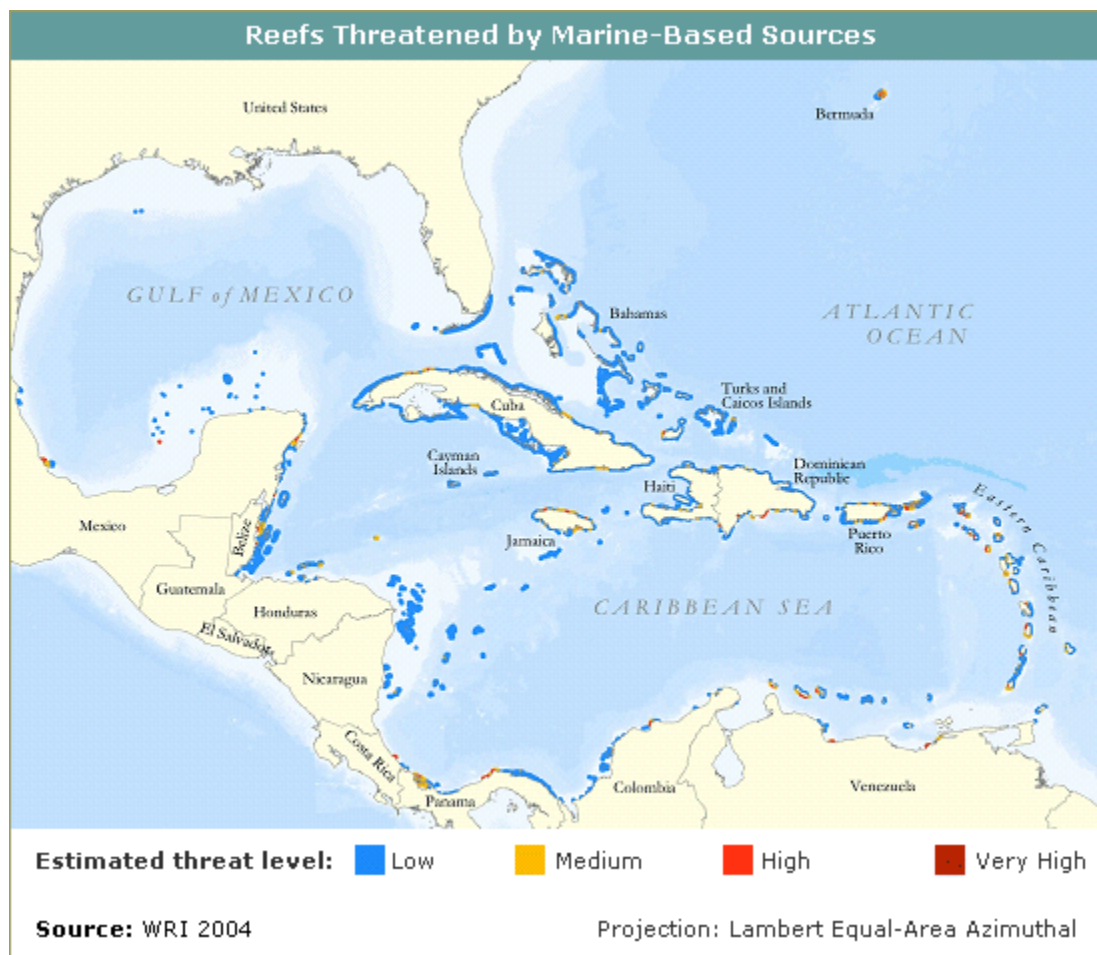
Fishermen typically target the largest fish on the reef as these have the highest market value. The

region's reefs as being threatened by overfishing (See Map 4). Reefs that are located close to shore, such as in the Eastern Caribbean, are often the most threatened systems,

as there are often a number of fisheries competing in a small area. Reefs located far from shore, such as in parts of the western Caribbean and Cuba, were assigned a low threat level.

### Climate Change and Disease

While the Reefs at Risk project did not quantify the level for threat to coral reefs from climate change and disease, it is important to note the existence of these issues, as they are affecting the structure and health of the



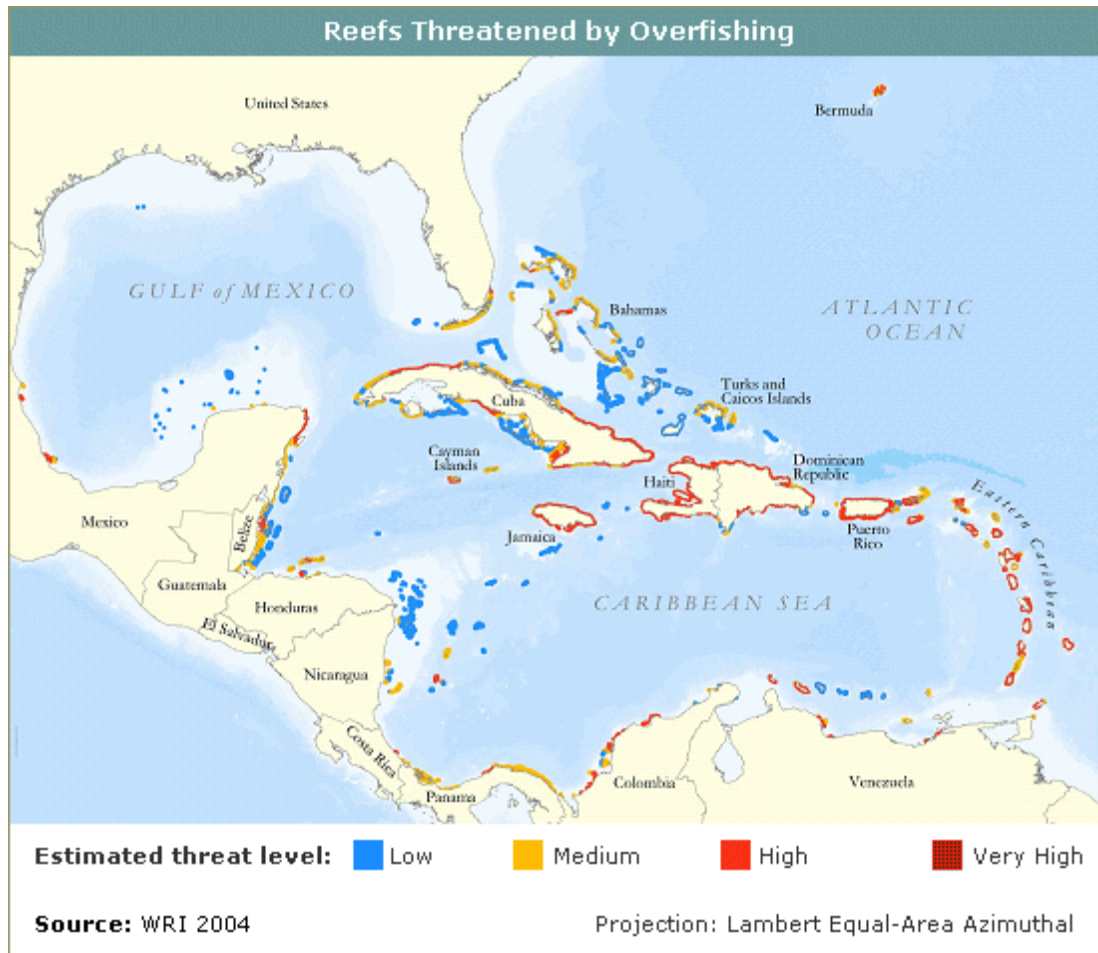
### Overfishing

Fishing has long been a mainstay of the Caribbean economy, supplying food to the region and exported fish products that contribute millions of dollars to national economies. However, Caribbean coral reefs are particularly susceptible to overfishing. Fisheries in the Caribbean are open access with very few regulations and the location and distribution of the fish are highly predictable. The gear used by fishermen, such as traps and fishing line, can damage reefs through breaking up corals and by continuing to catch fish

depletion of larger fish leads to a reduction in the average size of the targeted species, and can cause fishermen to fish for lower valued species, removing even more components of the coral reef food web (McManus et al, 2000). The removal of certain species can also significantly alter the reef structure. For example, herbivorous fish are responsible for controlling algae growth on the reef. If these fish are removed from the system, algae can flourish and reduce coral cover (Bohnsack, 1993).

The Reefs at Risk analysis identified 60 percent of the

region's coral reefs. The most direct evidence of climate change's impact on coral reefs comes in the form of coral bleaching, which refers to the loss of a coral's natural color due to expulsion of the zooxanthellae. In the absence of the zooxanthellae, corals lack the necessary nutrients for reef building and growth. As small an increase as 1.0 degree C can trigger a bleaching event. Based on current data, it is believed that coral bleaching will become an annual event by the year 2020 (Hoegh-Guldberg 1999). Another consequence of global climate change will be an increase of carbon dioxide levels in the ocean.



This will increase the acidity of the sea water and reduce the solubility of other compounds, such as aragonite, that are used by corals in reef building.

While the most profound and widespread changes in Caribbean coral reefs in the past 30 years have been attributed to disease, the reasons for this sudden emergence and rapid spread are not well known. 23 diseases and syndromes affecting corals have been identified in the Caribbean, and in most cases, the pathogen causing the disease is not known (Global Coral Disease Database). Three of these diseases - black band disease, white band disease, and white plague - account for two-thirds of the reports in the database and affect at least 38 species of corals across the Caribbean.

### Cumulative Threat

The Reefs at Risk Threat Index integrates all four of the quantified threats. This is an important tool because when reefs are exposed to multiple threats, the combined pressure can drive reefs into steep decline. The Threat Index identifies nearly two-thirds of the region's reefs as threatened by human activities, with about 20 percent at medium threat, one-third at high threat, and 10 percent at a very high threat (*See Map 5*). Areas with high threat levels include the Eastern Caribbean, most of the Southern Caribbean, Greater Antilles, Florida keys, Yucatan, and the nearshore portions of the Mesoamerican Barrier Reef and the Southwest Caribbean.

### Conclusions and Recommendations

The coastal communities and national economies of the Caribbean region are poised to sustain substantial economic losses if current trends in coral reef degradation continue. Coral reef-associated fisheries in the Caribbean region provide net annual revenues valued at an estimated US\$310 million. Further degradation of the region's coral reefs could reduce these net annual revenues by an estimated US\$95 million to US\$140 million per year by 2015. A decrease in dive tourism could also significantly affect annual net tourism revenues. Currently the net benefits from dive tourism total an estimated US\$2.1 billion per year, with divers typically spending 60-80 percent

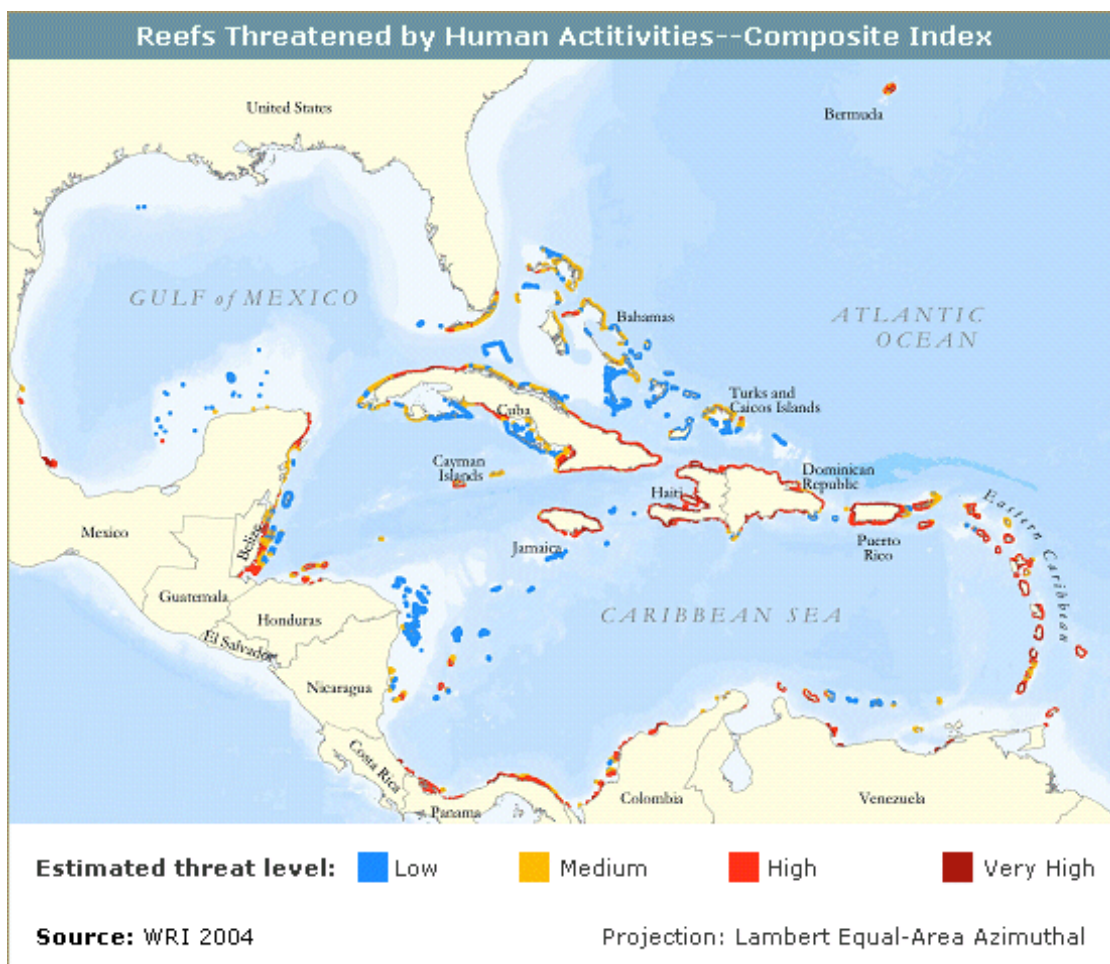
more than other tourists. By 2015, coral reef degradation could result in annual losses of US\$100 million to US\$300 million. In addition to being a source of revenue in the region, coral reefs also protect coastal shorelines in the Caribbean by dissipating wave and storm energy. The estimated value of this protection is between US\$70 million and US\$2.2 billion per year. If coral reef degradation continues, within 50 years the Caribbean could experience annual losses totaling US\$140 million to US\$240 million.

Despite the level of threat Caribbean coral reefs are facing, actions to reverse the threats can often be undertaken at very low cost, with very high financial and societal returns. The Reefs at Risk project recommends a number of actions, both regional and international, to achieve this end. Such actions include the establishment of better management practices to encourage sustainable fisheries, to protect reefs from direct damage,

and to integrate the sometimes conflicting approaches to management in the watersheds and adjacent waters around coral reefs. Fundamental to supporting these actions is wider involvement of the public and stakeholders in the management process, as well as an improved level of understanding of the importance of coral reefs. Better understanding of the economic value of coastal ecosystems and of

the linkages between human activities and changes in coral reef condition will further support and underpin the necessary changes in management and will strengthen and political and societal support for these changes.

*For more information please consult the complete Reefs at Risk in the Caribbean report at <http://reefsatrisk.wri.org>*



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