WORLD RESOURCES INSTITUTE

Coastal Capital: Jamaica

The Economic Contribution of Jamaica's Coral Reefs

Coral reefs provide a diverse array of goods and services to the people and economy of Jamaica. They help to build and protect Jamaica's beautiful white sand beaches, which attract tourists from around the world. Reefs provide critical habitat for Jamaica's artisanal and industrial fisheries, and they also protect Jamaica's coastline—including coastal communities and tourist hotels—from the destructive force of tropical storms.

Unfortunately, these benefits have been frequently overlooked or underappreciated in coastal investment and policy decisions. As a result, overfishing, poorly planned coastal development, sedimentation, and pollution have combined to threaten Jamaica's reefs. These local threats are compounded by the growing global threats from climate change, including warming seas and ocean acidification. This suite of threats, coupled with Jamaica's high reliance on coral reefs, highlights the urgent need for improved coastal and fisheries management to reduce local pressures on reefs and preserve the benefits coral reefs provide to Jamaica.

Economic valuation—a tool which assigns a monetary value to the goods and services provided by ecosystems—gives policy makers important information to help set priorities and improve decision-making regarding natural resources. This summary first quantifies the relationship between coral reef degradation, beach erosion, and potential losses of tourism revenue in Jamaica. We then assess the economic contribution of coral reef-associated fisheries. Finally, we examine the role of coral reefs in reducing coastal flooding during storms.

Tourism, fisheries, and shoreline protection are just three of the many culturally and economically important services provided by reef ecosystems in Jamaica. Even without a complete economic valuation of other ecosystem services, the country's coral reefs are clearly valuable. Investing in the maintenance and enhancement of these reef-related benefits—and preventing future losses—is thus an important investment in the health and sustainability of Jamaica's economy. For the full technical reports, including the valuation methodology, please visit *www.wri.org/coastal-capital.*

Protecting Beaches and Tourism Dollars

The travel and tourism sector plays a critical role in the Jamaican economy. Projections suggest that this sector will account for nearly 24 percent of Jamaica's gross domestic product in 2011. The industry is also projected to directly support 82,000 jobs (7 percent of total employment), while the wider tourism economy (including supporting industries such as food, infrastructure, and communications) supports 262,000 jobs (23 percent of total employment). In 2009, Jamaica drew 1.8 million overnight visitors and an additional 900,000 cruise tourists.

Jamaica's white coralline beaches represent a primary draw for international tourists, and thus provide a critically important contribution to Jamaica's economy. We estimate that between 70 and 80 percent of tourists care strongly about the presence of beaches in their visits to Jamaica, as the vast majority of "tourist days" are spent in one of the three major beach destinations in the country—Negril, Montego Bay, or Ocho Rios.

Map 1 Jamaica's reefs are at risk from overfishing, coastal development, watershed-based pollution, and marine-based pollution

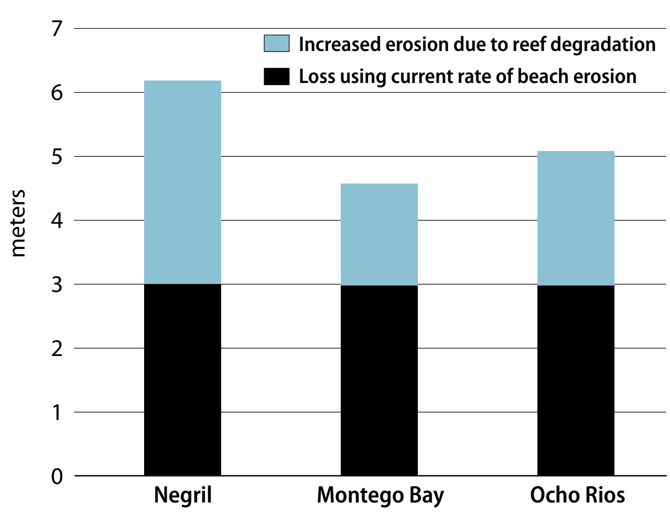
Source: Burke, L., K. Reytar, M. Spalding, and A. Perry. 2011. Reefs at Risk Revisited. WRI.

However, all three tourist destinations are affected by beach erosion, which threatens to reduce visitation to Jamaica and thus critical tourism revenue. The degradation of Jamaica's coral reefs, which supply sand to beaches and also dissipate wave energy, is an important factor contributing to beach erosion. Jamaica's coral reefs have suffered significant mortality in recent decades as a result of many human pressures, including overfishing, pollution, and coastal development (Map 1). These threats are compounded by coral bleaching and disease, hurricanes, and a decline in *Diadema* sea urchin populations (*Diadema* are herbivores that help maintain the balance between coral and algae on reefs).

To assess the role of coral reefs in preventing beach erosion, we estimated how the further degradation of coral reefs would lead to increased wave heights and thus increased beach erosion.[1] Drawing on available data, we used a base (current) erosion rate of 0.3 m/yr at the three sites. We found that if further reef degradation occurs, erosion rates could increase significantly above the current rates at all three sites, by more than 50 percent for Montego Bay, 70 percent for Ocho Rios, and more than 100 percent for Negril over a 10-year period (Figure 1).

We then determined the loss in tourists' enjoyment associated with a decline in beach quality due to increased erosion at each site. We estimate that at the end of 10 years, current erosion rates at the beaches in Negril, Montego Bay, and Ocho Rios will cause an annual loss in value of US$19 mil-

Figure 1 Comparison of predicted beach loss over a 10-year period



1. The modeled scenario involved the loss of friction from live, standing coral cover, followed by the slower erosion of coral substrate (6 mm over 10 years).

Table 1 Annual loss in consumer satisfaction (US$) at beaches due to coral reef degradation *(after 10 years of erosion)*

Location	Loss in value due to current rates of beach erosion	Loss per tourist	Loss in value if the beach erodes faster due to reef degradation	Loss per tourist	Difference due to further reef degradation
Negril	$5.5 million	$15	$10.9 million	$30	$5.3 million
Montego Bay	$7.1 million	$15	$10.7 million	$23	$3.6 million
Ocho Rios	$6.5 million	$15	$11.1 million	$26	$4.6 million
Total:	**$19.2 million**		**$32.7 million**		**$13.5 million**

Note: The loss in consumer satisfaction was calculated using a per meter value of $5.11 per visitor (based on Edwards 2009), coupled with the average number of overnight visitors a year for each site: Negril (360,927), Montego Bay (466,075), and Ocho Rios (425,026) (Jamaica Tourist Board 2009).

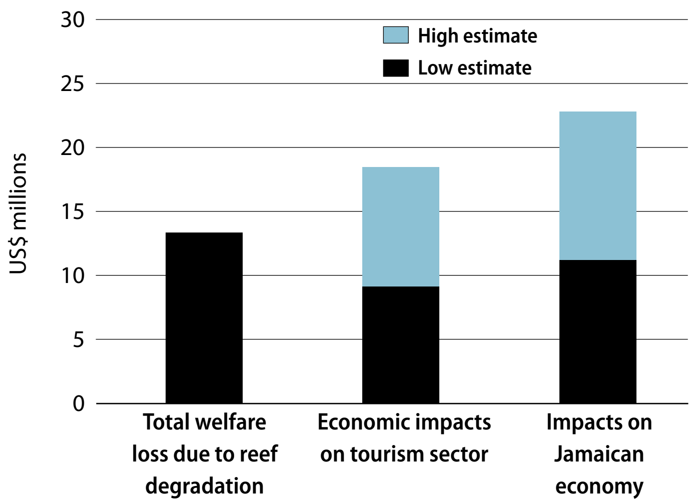
lion.[2] If reefs degrade further, we estimate that the additional beach erosion will increase this annual loss to US$33 million that year (Table 1). This represents an additional US$13.5 million per year—a 70 percent increase in the annual loss of value from the base scenario if the reef degrades further. This loss of value is projected to have knock-on impacts by reducing tourist visitation to Jamaica by 9,000–18,000 visitors annually, costing an estimated US$9 million to US$19 million per year to the Jamaican tourism industry and US$11 million to US$23 million per year to the entire Jamaican economy (Figure 2).

The economic risks to the Jamaican tourism industry are large. Beach erosion due to reef degradation will reduce visitor demand, and the costs from beach engineering solutions (such as sand replenishment) will likely increase in the future. In order to promote reef protection, it is crucial that key stakeholders take full account of the economic value of reef-based ecosystem services. This requires that the economic benefits of coral reefs be publicized and leveraged to build national political will for greater reef conservation. Environmental policy should also be strengthened to address the drivers of coral reef degradation (overfishing, poorly planned coastal development and pollution). Furthermore, new opportunities for long-term conservation funding—such as new markets, payments for ecosystem services, and charging polluters for damages—should be explored.

This summary is based on:

Kushner, B., P. Edwards, L. Burke, and E. Cooper. 2011. ***Coastal Capital: Jamaica. Coral Reefs, Beach Erosion and Impacts to Tourism in Jamaica.*** **Working Paper. Washington, DC: World Resources Institute.**

Figure 2 Losses from beach erosion due to further reef degradation
(annual losses during the tenth year of erosion)



2. This calculation is based on Edwards, P. 2009. *Measuring the Recreational Value of Changes in Coral Reef Ecosystem Quality in Jamaica: The Application of Two Stated Preference Methods.* Doctor of Philosophy in Marine Studies thesis, University of Delaware. Edwards looked at tourists' willingness to pay for environmental quality to determine the loss in value per meter loss of beach width.

Jamaica's Reef-Associated Fisheries: Diminished, Yet Vital

Coral reef-related fisheries—defined as fisheries that involve the capture of fish that depend directly on coral reefs, mangroves, or reef-protected habitat such as seagrasses for at least a portion of their life cycle—are socially and economically important in Jamaica. Reef-related fisheries support between 15,000–20,000 active fishermen, most of whom are artisanal. Fisheries provide coastal communities an important "safety net" of food and employment in times of need. Jamaica's fisheries also provide a wide range of employment—including wholesale and retail vendors, processors, gear makers, boat builders, and ice suppliers—and contribute directly and indirectly to the livelihoods of more than 100,000 people island-wide, or nearly 5 percent of the population.

Unfortunately, Jamaica's nearshore waters are among the most overfished in the Caribbean. Many artisanal fishermen have few alternative sources of income, creating a high level of dependence on Jamaica's nearshore fisheries. Use of fish pots or traps with small mesh sizes, mechanization and subsidies to the fishing industry, along with a rapid increase in spear-fishing and compressor diving have all exacerbated the overexploitation of Jamaica's reef fisheries.

For a long time, the Pedro Bank—located 80 km offshore—had remained a healthier fishery thanks to lower pressure from land-based pollution and fishermen alike. With Jamaica's mainland fishing grounds degraded, fishing pressure is increasing on the Pedro Bank, and illegal poaching (both foreign and domestic) and inadequate enforcement threaten the ecological sustainability of this offshore fishery as well. Likewise, the conch fishery—Jamaica's most strictly regulated fishery—is threatened by poaching and underreporting of catches. A further threat to the country's fisheries has been the recent explosion in the population of the lionfish—an invasive carnivorous species—in Jamaican waters.

Despite these pressures, Jamaica's fisheries continue to provide valuable jobs and revenue for the country. From 2001 to 2005, gross revenue from the sale of reef-related fish averaged US$33.1 million per year, including US$24.2 million per year from domestic sales and US$8.9 million per year from exports (Tables 2 and 3). We also estimate the value of the subsistence catch (consumed domestically and not sold on the market) to average US$1.2 million per year during that time period. Combined, these fish sales contribute US$34.3 million per year, a value equivalent to 0.3 percent of Jamaica's annual GDP.

While official data show that overall national trends in fish catch volume and value have been relatively stable in recent years, studies also show that the quality and average size of fish landed are declining, and that fishermen are having to travel further out to sea to maintain their level of catch. In

Table 2 Value of fish catches in Jamaica in US$ millions, 1996–2005

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Finfish	46.6	20.8	15.6	23.5	17.1	16.3	26.2	17.2	32.9	26.6
Conch	10.5	13.4	12.5	10.0	–	6.9	6.9	3.7	4.0	4.7
Lobster	7.2	2.4	1.5	3.0	4.7	8.5	3.2	2.7	1.2	2.7
Shrimp	1.4	0.5	0.1	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Total Value	**65.8**	**37.2**	**29.7**	**36.5**	**22.1**	**32.0**	**36.6**	**23.9**	**38.5**	**34.3**

Source: STATIN 2007 in ECOST 2007. (Adjusted to US$ 2011.)

Table 3 Average annual revenues from reef-related fisheries, 2001–2005

	Avg. annual Catch (MT)	% sold domestically	Gross revenues (local sales, US$ millions)	% exported	Gross revenues (exports, US$ millions)	Avg. sale price (US$)/kg	Total gross revenues (US$ millions)
Finfish	6,383	90%	$21.4	10%	$2.4	$3.73	$23.8
Conch	717	5%	$0.3	95%	$5.0	$7.35	$5.3
Lobster	269	60%	$2.2	40%	$1.5	$13.71	$3.7
Shrimp	198	100%	$0.3	0%	–	$1.55	$0.3
Total Value	**7,566**	**NA**	**$24.2**	**NA**	**$8.9**	**NA**	**$33.1**

Source: ECOST 2007, STATIN 2007 in ECOST 2007 and Murray 2008.[3] (Adjusted to US$ 2011.)

3. Murray, A. 2008. *Jamaica National Report*. Belize City: Caribbean Regional Fisheries Mechanism Secretariat; ECOST Project. 2007. *Case Study 2: Jamaica*; STATIN. 2007. Statistical Institute of Jamaica. Online at: http://statinja.gov.jm.

fact, due in large part to decreasing Jamaican fish stocks, the country now has to import from abroad most of the fish eaten on the island. These trends indicate that the current level of fishing effort is not ecologically sustainable and that, should this level of effort continue, yields will decline in the future—along with the economic value of Jamaica's reef-related fisheries.

In recent decades, the Jamaican economy has incurred high losses from the decline of its reef fisheries. A 2003 study found that overfishing at landing sites on Jamaica's north coast led to a 13 percent decline in total fish catch volume and a 17.3 percent decline in fish catch value between 1968 and 2001. Scaling this up to the national level suggests that Jamaica's failure to effectively manage its fisheries cost the country US$1.6 billion in lost revenues over the period from 1975 to 2000, not counting the Pedro Bank fishery.[4]

Recent positive steps taken by the Jamaican government—including the drafting of a National Fisheries Policy beginning in 2003, the establishment of the National Fisheries Advisory Board in 2008, the creation of new fish sanctuaries in 2009 and 2010, and initiatives to control the lionfish invasion—could all eventually help to restore fish stocks in Jamaica and thereby mitigate a key threat to the country's coral reefs. Passage of a new fisheries law based on the draft National Fisheries Policy—which aims to achieve sustainable fisheries yields—is therefore essential. Adequate funding for implementation and enforcement of fisheries regulations—as well as the political will for effective law enforcement—will be critical if these initiatives are to curb the decline of Jamaica's fisheries.

Jamaica's fisheries are in a troubling state of decline, but they are not beyond repair. Further investment in maintaining coastal habitat, protecting coral reefs, and managing fisheries sustainably to restore fish stocks is greatly needed. If Jamaica's fisheries were restored, they could make an even greater contribution toward the country's economy and to the well-being of its people.

This summary is based on:

Waite, R., E. Cooper, N. Zenny, and L. Burke. 2011. *Coastal Capital: Jamaica. The Economic Value of Jamaica's Coral Reef-Related Fisheries.* Working Paper. Washington, DC: World Resources Institute and The Nature Conservancy.

4. Sary, Z., J. Munro, and J. Woodley. 2003. *Status Report on a Jamaican Reef Fishery: Current Value and the Costs of Non-management*. Gulf and Caribbean Fisheries Institute (GCFI).

Past economic valuations of coastal and marine resources in Jamaica

WRI reviewed 14 previous economic valuation studies of Jamaica's coastal resources. These studies used a variety of techniques to assess the values of tourism, fisheries, shoreline protection, and other coastal ecosystem services. Three of the studies were national in scope; the remaining local-level studies focused on the three main tourist destinations of Montego Bay, Negril, and Ocho Rios, as well as Discovery Bay and Portland Bight.

The studies provide a rationale for increased investment in the protection of Jamaica's coastal ecosystems, and many also explore sustainable ways to finance coastal and marine conservation. However, these studies have had limited success in influencing Jamaica's policy makers. In some cases, the studies were not made publicly available; in others, results were not effectively communicated to decision makers. A full list of the studies is available at *www.wri.org/coastal-capital.*

Buffering Waves, Protecting Resources

Coral reefs play an important role in protecting the shoreline by reducing wave energy, during both routine conditions and storms. This is apparent where waves break on the edge of a coral reef and much calmer water is found inside the reef. Coral reefs can reduce wave energy by more than 75 percent. In this way, coral reefs lessen coastal erosion and reduce inundation during storms. The effectiveness of a coral reef in reducing wave energy varies with the type of the reef, continuity and size of the reef, distance from shore, depth below the surface, and complexity (roughness) of the live coral structure on the reef, as well as the wave height. Fringing, patch, and barrier reefs protect an estimated 60 percent of Jamaica's shoreline.[5]

To assess the importance of coral reefs in reducing wave energy and inundation in Jamaica, WRI worked closely with partners in Jamaica to select three representative sections of coastline and apply a hydrodynamic model for three pilot sites (Negril, Discovery Bay, and the Kingston / Port Royal Cays area). At the three pilot locations, we estimated inshore wave heights, water level at the shoreline, and coastal inundation both for current coral reef conditions and with a severely eroded coral reef for two storm scenarios (a 1-year and a 25-year storm event).

As the reef degrades, larger inshore waves will result in increased erosion and higher water levels at the shore. The difference in water level at the shoreline between the "current reef" and "severely degraded reef" scenarios were highest at Discovery Bay, with a difference of 0.8 m for the one-year return period storm and 0.6 m for the 25-year storm. Smaller differences were seen in Negril and Kingston/Port Royal (Table 4).

In order to extrapolate from these three pilot sites to the national level, we classified each segment of the Jamaican shoreline according to five coastal characteristics to identify the pilot site it most closely matches. The coastal segments identified as having high levels of shoreline protection from reefs—similar to the Discovery Bay site—include Coral Gardens, Falmouth, Discovery Bay, St. Ann's Bay, Morant Point, Savanna-La-Mar, and Southern Negril (shown in dark blue in Map 2).

Using this classification scheme, along with our modeling results, allows us to estimate areas—and identify valuable buildings and infrastructure—that are likely to be inundated if the reef erodes severely. Map 3 provides an example of the mapping of change in inundated areas for the 25-year storm event for the central north coast near Discovery Bay. Areas in yellow have an elevation under 1.4 m and are expected to be inundated despite the wave attenuation by the current reef. Areas in red are between 1.4 and 2.0 m elevation and are projected to be inundated (during the 25-year event) if the reef becomes severely degraded. The additional inundated area includes over 100 structures, including two hotels, a church, and an airfield.

Table 4 Modeled change in water level at shoreline for current and degraded reef condition

		Water level at shoreline *(in meters)*		
Study Site	**Storm Scenario**	**Current reef**	**Degraded reef**	**Difference**
Negril	1-year	0.8	1.3	0.5
	25-year	1.3	1.7	0.4
Discovery Bay	1-year	0.6	1.4	0.8
	25-year	1.4	2.0	0.6
Port Royal/ Kingston	1-year	1.0	1.4	0.4
	25-year	2.7	2.9	0.2

Source: All wave height and shoreline water level results are from: Houser, C. 2010. *2-D Analysis of Wave Attenuation and Run-Up for Select Sites in Jamaica*. Unpublished analysis summary for WRI. Texas A&M University.

Note: A 1-year storm event is the largest storm that occurs during a typical year. A 25-year storm event is the largest storm likely to occur during a 25-year period.

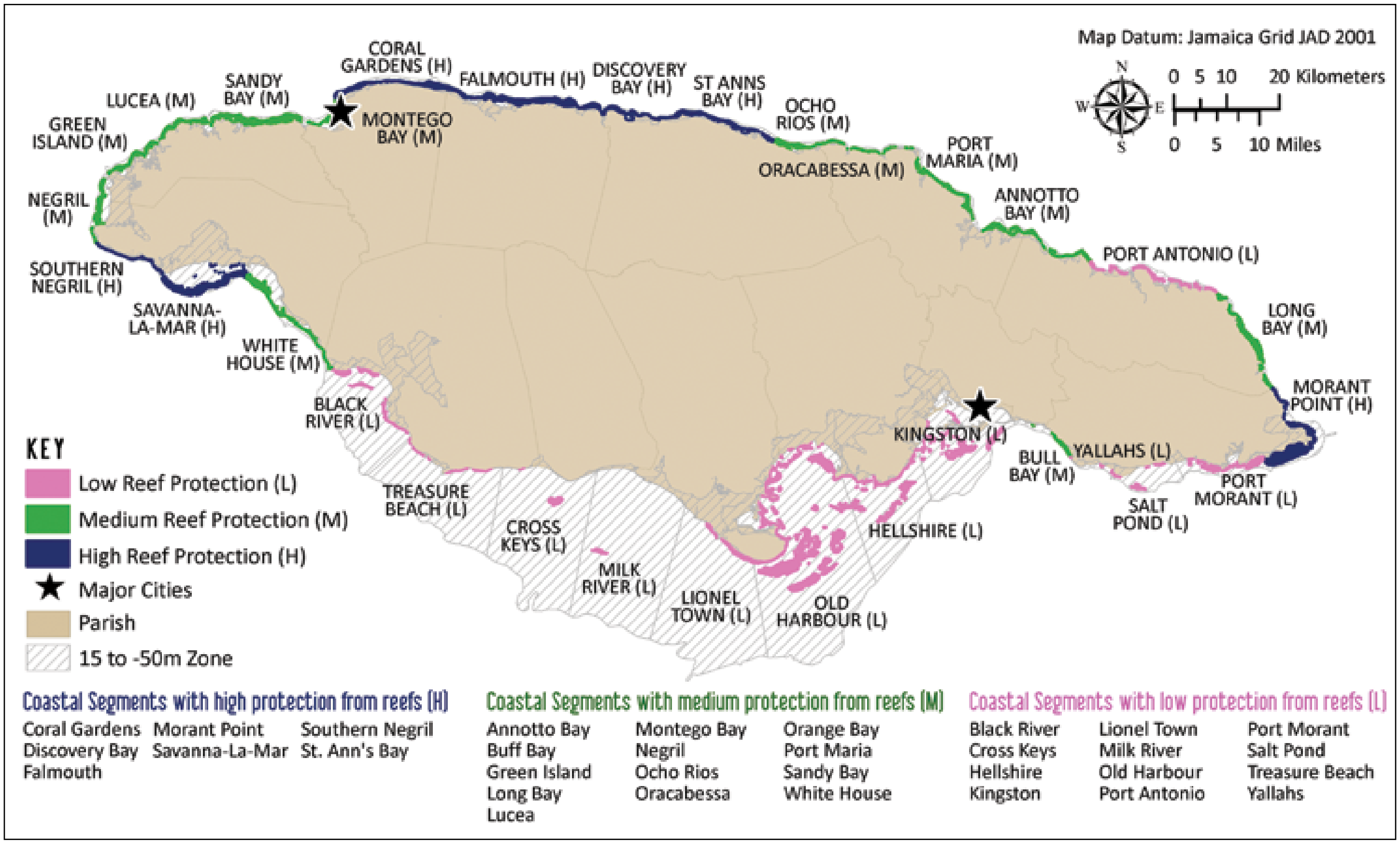
Classifying the relative protection afforded by reefs has implications for strategies to rehabilitate and preserve reef structure. This is particularly crucial on the north coast, where fringing reef systems afford a high degree of protection and where a great deal of exposure exists in the form of major hotels, mining and manufacturing infrastructure, along with burgeoning population centers such as Montego Bay, Falmouth, and Ocho Rios. Jamaica's south coast—dominated by shelf marginal and patch reef—is generally afforded the least amount of protection from its reefs. These results support the case for targeted conservation of reef structures along parts of the coastline where they offer the greatest protection—to people, infrastructure, and valuable assets.

This summary is based on:

Maxam, A., P. Lyew-Ayee, and K. McIntyre. 2011. *A Classification of the Protection given by Reef Systems in Jamaica - Utilizing GIS and Oceanographic Methods of Analysis.* Working Paper. Kingston, Jamaica: Mona Geoinformatics Institute (MGI).

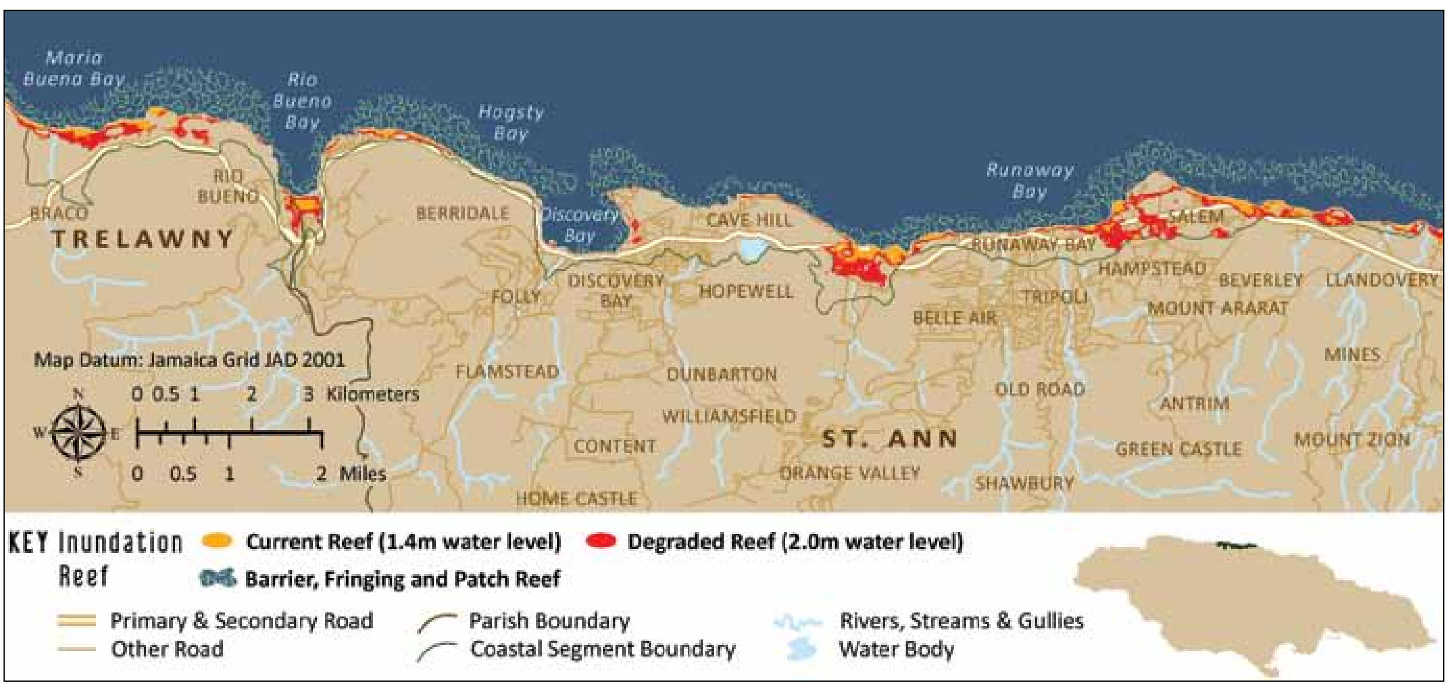
5. Shoreline within 500 m of a coral reef was classified as protected. (From Burke et al. 2011.)

Map 2 Relative shoreline protection from coral reefs in Jamaica



Source: MGI 2011. (The shoreline characterization is based on coral reef type, slope and orientation, distance from shore, and the complexity of the reef shape.)

Map 3 Modeled coastal inundation for a 25-year storm event near Discovery Bay, Jamaica



Source: MGI 2011.

Actions Needed

Coastal Capital: Jamaica shows that coral reefs provide real benefits to Jamaica's economy. Many critically important and economically valuable ecosystem services that reefs provide could be lost—including reef-associated tourism, shoreline protection, and habitat for fisheries—resulting in losses of jobs, revenue, and increased erosion and property damage during storms.

Jamaica's reefs are already threatened by overfishing and pollution, and are increasingly threatened by global changes—especially warming seas. Jamaica's reefs can survive and recover, but this will require effective management and protection. It is in the long-term economic interest of Jamaica to:

Promote sustainable fishing:

- *Improve fisheries management.* Enact legislation and regulations aimed at sustainable yields, and invest in improved monitoring, enforcement, research and data collection.
- *Strengthen marine protected areas*. Develop long-term funding for integrated management efforts, including the expansion of protected area networks and fish sanctuaries.
- *Provide for alternative livelihoods for artisanal fishermen.* This will help to ease the intense pressure on Jamaica's reef fisheries.

Manage coastal development wisely:

- *Improve wastewater management*. Enhanced management of sewage, as well as runoff from construction would improve coastal water quality, benefiting both coral reefs and fish.
- *Protect mangroves*. Mangroves serve as important fish habitats, and also act as buffers, reducing agricultural runoff that reaches coral reefs. The government should seek to protect remaining mangroves from clearance for beach and coastal development.
- *Improve land-use planning and zoning.* Reassessment of the government's current setback regulations would establish a more adequate buffer zone between beaches and coastal infrastructure, protecting both coastal ecosystems and beachside hotels.

Reduce watershed-based sedimentation and pollution:

- *Promote improved agricultural techniques*. Improved soil conservation (using terracing) and reduced use of chemicals would reduce flows of sediment and pollutants to coastal waters.
- *Retain and restore vegetation*. Reforestation—using local species—would help reduce erosion, especially on steep slopes and in riparian areas.

History demonstrates that conserving ecosystems begins with widespread awareness of the benefits they provide and the political will to act. It will therefore be important to publicize and disseminate the key findings of *Coastal Capital: Jamaica* to the Jamaican government, business community, citizens, conservation groups, and development agencies. Increased political will, new business initiatives and grassroots advocacy will all be necessary to overcome the barriers to conserving Jamaica's coral reefs, ultimately allowing reefs to continue to provide benefits to Jamaica's economy—and people—for generations to come.

WRI and Economic Valuation of Coastal Resources

The World Resources Institute (WRI) launched the *Coastal Capital* project in the Caribbean in 2005. The project works with local partners to produce national and subnational assessments of the economic contribution of coral reefs and mangroves. WRI aims to increase local capacity to perform ecosystem valuations, to raise public awareness of the economic and social benefits of marine resources, and to provide estimates of the monetary value that can be used to inform planning and decision making.

For more information

Please visit **www.wri.org/coastal-capital** or contact:

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Photo Credits

Beach erosion: Emily Cooper
Fishermen: Edward Robinson
All others: Krishna Desai

Coastal Capital Project Partners

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