Resilient Islands

Mangroves in the Dominican Republic's Samaná Bay protect coasts and support alternative livelihood opportunities like kayak tour guiding. © Tim Calver

Valuing Benefits
of Mangroves and Coral Reefs in the Caribbean

Coastal ecosystems such as mangroves and coral reefs provide multiple ecosystem services, including benefits for fisheries, recreation, tourism, and carbon sequestration. But values of these services are often not fully accounted for in policy and management decisions, and these ecosystems continue to be lost at alarming rates. This policy brief reviews current knowledge on the ecosystem service benefits provided by coral reefs and mangroves, except for flood protection, which is researched and addressed in a companion brief. The analysis of this brief is focused geographically in the Caribbean, with an emphasis on Jamaica, Grenada and Dominican Republic. A comprehensive assessment of the monetary and non-monetary benefits provided by these coastal ecosystems helps to understand how they contribute to human well-being and increase resilience in coastal areas. This understanding helps inform policies for improving coastal resilience, conservation and restoration.

Coastal mangrove forest in the area of the Sandy Island Oyster Bay Marine Protected Area (SIOBMPA) at Carriacou, Grenada. © Marjo Aho

Overview

BACKGROUND

This brief is part of a collaboration between The Nature Conservancy and the University of California, Santa Cruz (Nadine Heck, Siddharth Narayan, Michael Beck). This project is part of International Climate Initiative (IKI) and is supported by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU).

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KEY POINTS:

- Today, mangroves, coral reefs and other coastal ecosystems in the Caribbean provide an estimated value of nearly **$15 billion** annually in fisheries, tourism recreation and carbon sequestration.
- Mangroves and seagrass beds together provide around **$6.7 billion** in ecosystem service benefits.
- Coral reefs provide nearly **$6.2 billion** in benefits.
- Of these benefits, **carbon sequestration** by mangroves (~$6.7 billion) and **tourism** by coral reefs (~$5.7 billion) are the most valuable.
- Other important but less understood services include biodiversity protection & fisheries.
- There is large variability in the estimates and methods used to value different benefits like tourism, fisheries or carbon sequestration, in contrast to flood reduction benefits which follow established guidelines for avoided damage assessments.
- There is limited knowledge of benefits that are more difficult to quantify but are important to local coastal communities, like pharmaceutical benefits, cultural ecosystem services, subsistence fisheries & water purification.
- Comprehensive understanding of multiple benefits can be used to inform, target and prioritize restoration efforts within National Adaptation Plans, Nationally Determined Contributions (NDCs), Marine Spatial Plans and even disaster recovery spending.

Figure 1 Marine Ecosystem Services[8]

PROVISIONING SERVICES

Products obtained from ecosystems

- Food provision (fisheries and aquaculture)
- Water storage and provision
- Biotic materials
- Fiber, timber and fuel

REGULATING SERVICES

Benefits obtained from the regulation of ecosystems processes

- Water purification
- Air quality regulation
- Flood/storm protection
- Erosion control
- Climate regulation
- Weather regulation
- Ocean nourishment
- Life cycle maintenance
- Biological regulation
- Human disease control

CULTURAL SERVICES

Nonmaterial benefits obtained from ecosystems

- Spiritural and religious
- Recreation and ecotourism
- Aesthetic
- Inspirational
- Educational
- Sense of place
- Cultural heritage

SUPPORTING SERVICES

Services necessary for the production of all other ecosystems services

- Photosynthesis
- Primary production
- Nutrient cycling
- Resilience and resistance
- Biologically mediated habitat

GLOBAL BENEFITS OF MANGROVES AND REEFS

Recent studies estimate that coastal ecosystems globally provide an estimated total value of $125 trillion per year[1], including around $35.8 billion generated annually by coral reefs for tourism world-wide[2]. These ecosystem services can be grouped into (1) provisioning services (2) regulating services (3) cultural services and (4) supporting services (Fig. 1)[3-6,7].

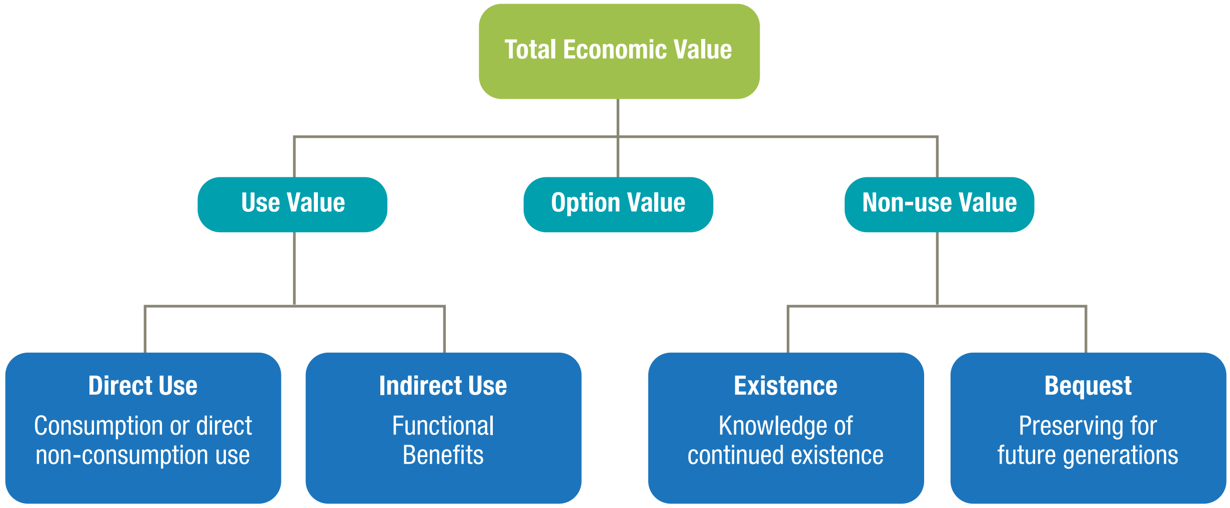
However, these ecosystems continue to disappear and, over the past 20 to 50 years, about 50% of salt marshes, 30% of coral reefs, and 35% of mangroves have been either degraded or lost[9-12].

Caribbean countries in particular are highly dependent on coastal ecosystems including coral reefs and mangroves for a variety of ecosystem services that contribute directly or indirectly to human welfare and well-being[7]. At the same time, coastal ecosystems that provide these services are under considerable threat[13]. Approximately 75% of the region's coral reefs are at risk from overfishing and pollution, and nearly one quarter of mangrove forests in the region were lost between 1980 and 2005, primarily due to urban and tourism development[14]. Government officials, businesses, community members, conservation organizations and other regional and national stakeholders in the Caribbean can use information on the value of these ecosystem services to support their coastal resilience and habitat conservation policies[13].

The total economic value of the multiple benefits provided by coastal ecosystems is rarely accounted for in coastal management decision and policies.

This lack of consideration encourages short-term over-exploitation and degradation of coastal ecosystems, further reducing the provision of critical ecosystem services. A better understanding of the benefits that these systems provide and what is at stake if we were to lose them is an essential part of coastal management[15, 16].

Figure 2 Total economic value of ecosystem services[20]



MEASURING ECOSYSTEM SERVICES

Assessing benefits can be challenging as not all services are easily and directly quantifiable[17] (Table 1). Direct-use values refer to direct use of ecosystems including consumptive uses (e.g., food) and non-consumptive uses (e.g., recreation) (Fig. 2). Indirect use values refer to services that provide benefits outside of the ecosystem itself (e.g., carbon sequestration, coastal protection). Ecosystems also provide non-use values such as existence and bequest values[18, 19]. Option value refers to the value placed on willingness to pay for preserving a service for future use[20].

Ecosystem service benefits can be measured in monetary and non-monetary units and their assessments typically requires the use of spatial and temporal models[17, 21]. Direct values can be assessed based on *market transactions* using a market price approach (MP) (Table 1). Non-market values can be calculated using *revealed preference methods* including travel cost method (TCM) and hedonic pricing (HP) or as *Stated preference methods* including contingent valuation method (CVM) and choice modeling (CM)[7]. If budgets and/or time are limited, another option is to estimate values using the *value transfer approach*, which spatially and/or temporally transfers benefits from other case studies to the case study at hand [22]. In many cases, more than one method can be used to calculate benefits[23].

Erosion, storm surge and flooding threaten coastal restaurants, bars and homes, Alligator Pond, Jamaica. © Tim Calver

Table 1 Ecosystem Service Valuation Methods

Sector	Valuation Method
Tourism	Market price (MP), Hedonic pricing (HP), Travel Cost (TC), Contingent valuation (CV), Choice modeling (CM)
Fisheries	Market price (MP), Production function (PF)
Timber	Market Price (MP)
Water filtration by wetlands	Replacement costs (RC)
Any ecosystem service	Benefits transfer, Meta-analysis

Adapted from[14]

Fishing boats line the shores of Pedro Bank, Jamaica. © Tim Calver

Methods

Review of Benefits in the Caribbean

The aim of our study was to develop a rigorous, comprehensive and replicable review of the existing literature on ecosystem service benefits applicable to the Caribbean islands, with an emphasis on Jamaica, Grenada and the Dominican Republic. To identify ecosystem service values for the Caribbean, we conducted a literature review of existing valuation studies, including academic and grey literature, using Google, Google Scholar and Web of Science. Keywords for the search included "ecosystem services," "fish," "fisheries," "marine protected area(s)," "marine resource(s)," "reef(s)," "tourism," "water quality," "nutrient cycling," "carbon sequestration" combined with "coral reefs" or "mangroves" and terms related to economic measures including "benefit(s)," "value," "valuation" and "willingness to pay" and "Caribbean," "Grenada," "Jamaica," "Dominican Republic." We included studies from 1995 up to 2019. Cited references were searched for leads on additional studies. We also looked at "cited by" and "related articles" featured in Google Scholar. We only included studies with explicit values for marine ecosystem services. We included 37 articles and reports on ecosystem services in the analysis, providing a total of 126 ecosystem service values. Across the Caribbean, studies used a mix of methods to value ecosystem service benefits, including direct estimates of market price, or indirect methods such as travel cost, replacement cost, willingness-to-pay, benefit-transfer, contingent valuation, choice modeling or econometric methods[24]. Of these, just under half the studies used a market-value based approach. Studies on specific ecosystem service benefits like carbon and fisheries are patchy in terms of regional coverage (see Annex). Where available, we used national data sets for ecosystem service values. If no national data was available, we used cases studies from sub-national sites that were summed up to provide approximate national values for selected ecosystem services. To avoid double counting, we either included national values or summed values for case studies for each country. If we had multiple values for an ecosystem service in the same location, we either took the mean or the most recent and/or most comprehensive study that provided the highest quality data. As the focus was on coral reefs and mangroves, we separated values for these ecosystem services if this information was available. A number of studies, however, did not separate economic values for specific ecosystems and these values are presented as benefits of multiple ecosystems. While coral reefs and mangroves were part of these combined ecosystem values, we excluded these numbers in the overall count for coral reefs and mangroves. Seagrasses values were extremely rare but were included for water purification estimates. For carbon sequestration values we calculated the total carbon stored above and below ground based on numbers provided by Sanderman et al[25] and multiplied this with a current carbon price of US $15/- based on the California carbon dashboard[26]. All monetary values were converted to USD$ 2019 values.

Coral outplant monitoring in St. Croix, Virgin Islands. © John Melendez

Results

Our study reveals that value estimates for some ecosystems and ecosystem services are more common than for others. The highest number of ecosystem service values was for coral reefs with 77 values, followed by 22 values for mangroves, and 27 values for multiple ecosystems. Across ecosystems, almost half the studies focused on tourism values, followed by income from fisheries and carbon sequestration values (Figure 3). Though limited in number, studies on recreational and subsistence fisheries suggest that these benefits can be very valuable as seen in the Dominican Republic. This is also true of non-use services, such as cultural services, pharmaceutical benefits, water purification, and research benefits which are relatively poorly studied. The numbers in this report thus might not reflect the full value of these ecosystem services in the Caribbean Islands.

Based on our review of existing data, ecosystems in the Caribbean provide multiple benefits (in addition to coastal protection) with an estimated annual economic value of approximately $15 billion. Ecosystem services with the highest assessed values include tourism and recreation, carbon sequestration, and biodiversity protection (Figure 4).

Figure 3 Proportion of values by ecosystem service (N=126)

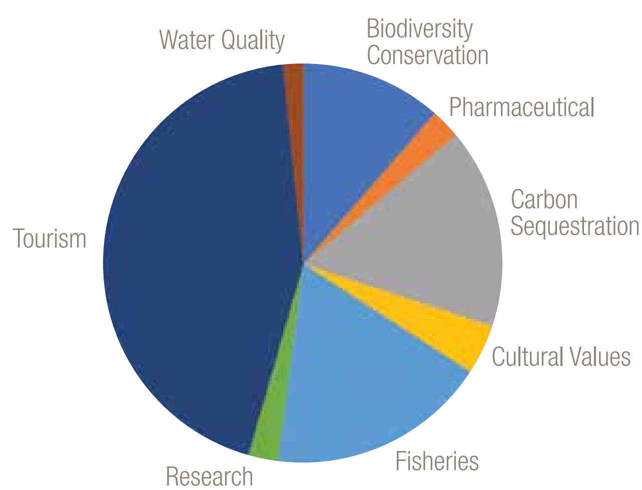


Figure 4 Economic value of key ecosystem services across Caribbean islands (mill. USD$; see Table 2 for list of islands).

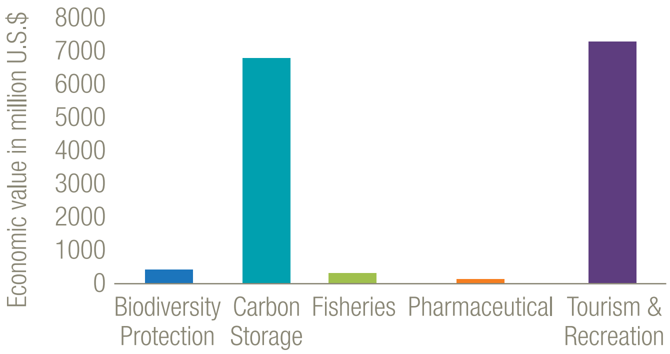


Table 2 National Ecosystem Service Values (see Annex for full list of studies and values by country)

Country	Million USD$	Country	Million USD$
Anguilla	20.22	Jamaica	2114.66***
Antigua	67.83	Martinique	91.75
Aruba	508.42	Puerto Rico	691.5
Bahamas	6149.81*	Saba	7.29
Barbados	184.94	Saint Martin	119.89
Bonaire	240.82	St Eustasius	12.6
British Virgin Islands	200.83	St Kitts & Nevis	16.68
Cayman Islands	434.83	St Lucia	354.94
Cuba	1706.94**	St Maarten	66.32
Curacao	406.14	St Vincent & Grenadines	25.3
Dominican Republic	689.56	Trinidad & Tobago	176.31
Grenada	62.78	Turks & Caicos	147.31
Guadeloupe	111.13	US Virgin Islands	283.51
Haiti	58.83		

*Carbon sequestration ~$5.2 billion; ** Carbon Sequestration ~$1.4 billion; ***Tourism ~$1.8 billion

Table 3 Ecosystem Service Values From Reefs And Mangroves Across The Caribbean

Ecosystem Service	Coral Reefs (Mill. USD$)*	Mangroves (Mill. USD$)*
Biodiversity protection	251	Not Available
Carbon Sequestration	1	6663
Fisheries	110	66
Pharmaceuticals	120	Not Available
Tourism & recreation	5747	12

* converted to USD$ 2019, rounded off to nearest million

Example of Elkhorn coral, Jardines de la Reina, Cuba © Ian Shive

Table 2 lists combined ecosystem service values across the Caribbean islands. High values for The Bahamas and Cuba are related to high values of carbon sequestration. The high ecosystem service value for Jamaica is mainly from tourism and recreation.

Our analysis indicates that coral reefs provide approximately $6.2 billion in ecosystem services, with the majority of this value (~$5.7 billion) coming from tourism and recreation (Table 3). Mangroves provide about $6.7 billion in benefits, with the majority derived from carbon sequestration. Degradation of these ecosystems could significantly lower their economic value. In Bonaire, for example, the quality of the coastal environment is a critical driver for tourism[e.g., 27] and a loss of quality in coral reef systems could potentially lead to the loss of millions of dollars. Lower values for other ecosystem services might be related, to some extent, to a lack of assessments of the benefits from these services.

Figure 6 Carbon Sequestration Value Of Mangroves (metric tons of soil organic carbon)

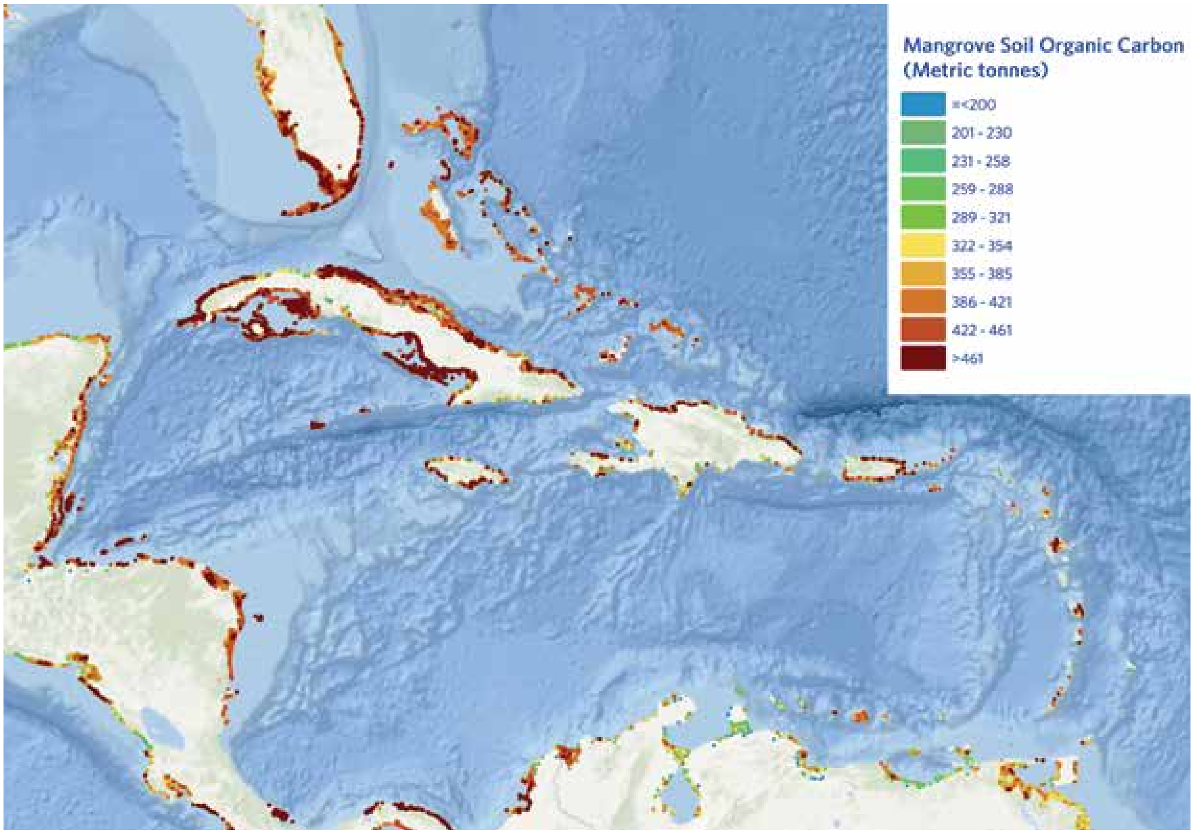
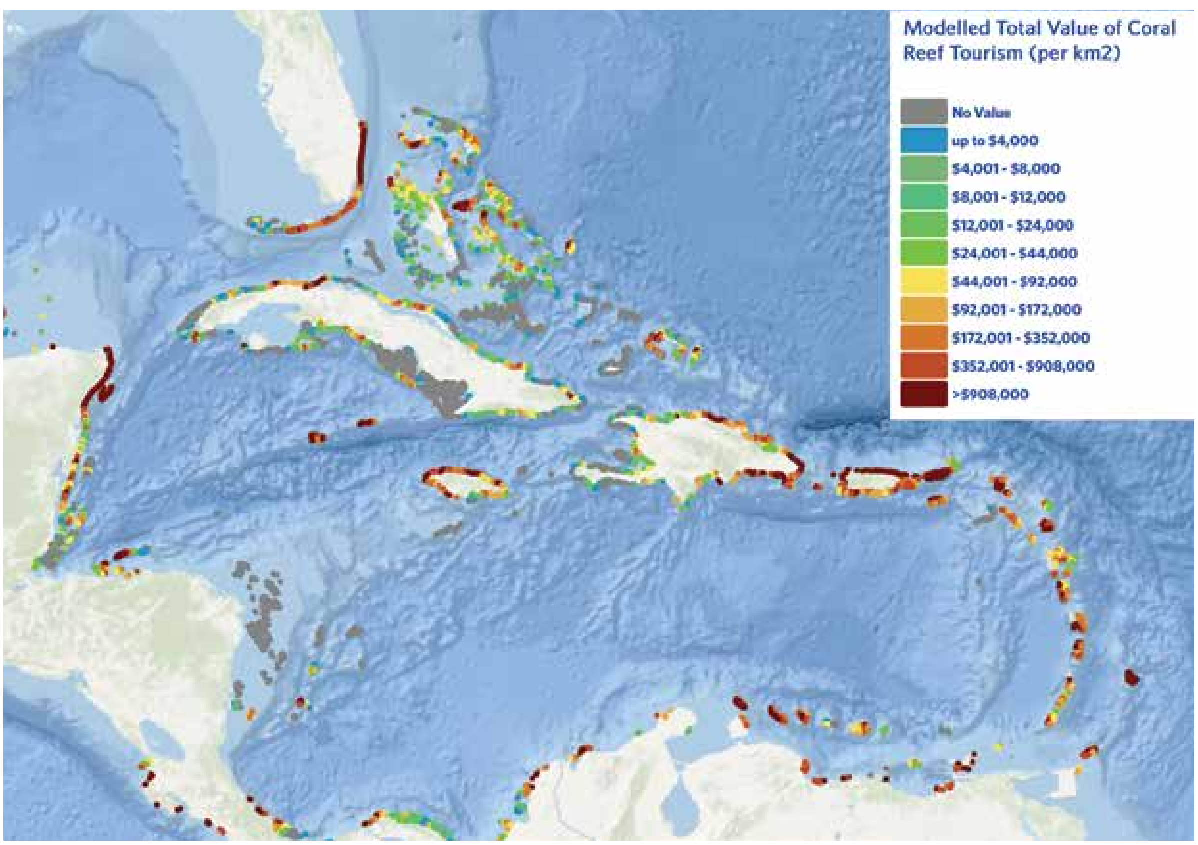


Figure 7 Tourism Values (USD$)



Ecosystem services are not distributed equally across countries, (Figs 6 & 7) which has implications for regional management of mangroves and coral reefs for their ecosystem services. Some geographic areas might benefit more than others. These geographic differences may be shaped by the spatial distribution of ecosystems but also other factors, like infrastructure and transport in the case of tourism. Comprehensive regional studies on multiple ecosystem services are needed to fully understand the factors causing spatial variations in values. Meanwhile, ecosystems in different locations may need to be managed differently depending on the type and value of ecosystem services they provide.

ECOSYSTEM SERVICE BENEFITS IN JAMAICA, GRENADA & THE DOMINICAN REPUBLIC

This Policy Brief estimated an overall value of ecosystem service benefits of approximately **$2.1 billion** for Jamaica, **$62 million** for Grenada, and **$690 million** for the Dominican Republic. **These benefits from existing ecosystems represent a significant portion of national GDPs especially for Jamaica (14.2%) and Grenada (55.8%). These benefits are still significant for the Dominican Republic (0.9%) which has a considerably higher GDP.** Jamaica has the highest number of studies and the highest value for mangrove and coral reef related tourism (~$1.4 billion) (Figure 8 & Table 4) including ~$6.9 million for the Portland Bight Protected Area[28] and almost $1.4 billion for Montego Bay[29,30]. The Dominican Republic also has the highest value for tourism followed by carbon sequestration and fisheries, with recreational fisheries (~$81.4 million) much more economically valuable compared to the commercial fishing sector (~$0.75 million)[31]. Grenada, on the other hand, has the highest values for reef related fisheries with the commercial fishing sector generating considerably higher cash flows (~$22.7 million) relative to the recreational fishing sector (~$15.7 million)[31].

Kids planting mangrove seedlings. © Marcos Lopez/TNC;

Healthy waters attract millions of tourists to the Caribbean. © Paul Selvaggio

Across the 3 countries, Jamaica is the most well-studied and Grenada the least, in terms of different ecosystem service benefits. While we only found quantitative studies on fisheries and tourism benefits in Grenada, studies in the Dominican Republic additionally looked at carbon sequestration and biodiversity. In Jamaica, in addition to all these benefits, there was also an estimate of non-use values in the form of pharmaceutical benefits from coastal ecosystems.

Figure 8 Ecosystem service values for Jamaica, Grenada & Dominican Republic. Note that these values do not include coastal protection benefits.
★: Value (vertical axis) scale is different for Grenada which has lower overall values

Table 4 Ecosystem service values in Jamaica, Grenada and Dominican Republic in millions USD$*

Ecosystem	Ecosystem Service	Jamaica	Grenada	Dominican Republic
Coral reefs	Biodiversity	36.8		
	Fisheries	37.0		19.2
	Pharmaceutical	106.0		
	Tourism	342.4	23.8	525.5
Mangroves	Carbon sequestration	66.00		80.4
Multiple	Tourism	1869.0		
	Fisheries		39.0	82.4
	Biodiversity			1.4
Total		**2114.7**	**62.8**	**689.6**

*converted to USD$ 2019, rounded to nearest 1,000; blank cells indicate data not available for that ecosystem service value.

Red Mangrove (Rhizophora mangle) grows along the edge of Baie Liberte, Haiti. © Tim Calver

The Way Forward

Opportunities for Integrating Ecosystem Service Benefits in Policy and Management Decisions in the Caribbean

Coastal ecosystems in the Caribbean provide significant economic value in terms of their ecosystem services. If these ecosystems are degraded or lost, billions of dollars could be lost in critical ecosystem services that help improve coastal resilience **and protect people and property**. More and more targeted efforts, are needed in terms of policies and measures to conserve and restore coastal ecosystems and mechanisms to account for the economic value of diverse ecosystem services. While coastal protection ecosystem services are increasingly rigorously measured, the same is not true for other ecosystem services that are crucial for long-term coastal resilience, **such as fish production or medicinal and pharmaceutical ecosystem services**. The findings of this review can inform the policy and practice of many Caribbean agencies, businesses and organizations as they seek to identify sustainable and cost-effective approaches for habitat conservation, risk reduction, national adaptation plans and climate mitigation goals, **as well as guide sustainable development and disaster risk reduction goals**.

The values of different ecosystem services could be used to identify and target conservation and restoration priorities for multiple coastal resilience, adaptation and climate mitigation outcomes. For example, it may be most optimal to manage urban reef and mangrove ecosystems for their coastal protection benefits. Tourism benefits from ecosystems in otherwise rural areas may also be critical for the resilience of local coastal communities. These benefits, rigorously quantified, could be included in National Accounts, to help consider the benefits of keeping these ecosystems in place, and in National Adaptation Plans of Actions, to identify **where actions for conservation and** restoration may be most beneficial. Similar analyses could help identify pristine coastal and marine ecosystems and associated marine protected areas for their climate mitigation ecosystem services like carbon sequestration. These values could be used to identify trade-offs between multiple management objectives in Marine Protected Areas and Marine Spatial Plans.

Comprehensive understanding of multiple ecosystem service benefits can also be used to identify where investments in restoration can best increase coastal resilience through a suite of relevant ecosystem services. These findings can be used to better inform disaster recovery spending allocated for ecosystem restoration efforts. For example, private and public flood risk insurance mechanisms like the Caribbean Catastrophe Risk Insurance Facility (CCRIF) and disaster recovery agencies and development Banks such as the World Bank, IDB and U.S. Federal Emergency Management Agency (FEMA) are looking at natural and nature-based solutions as cost-effective solutions for adaptation and risk reduction. Rigorous assessments of ecosystem services could also help identify areas where conservation or restoration can be cost-effective (i.e. have a benefit to cost ratio greater than one) by combining flood risk reduction and other ecosystem service benefits. A more comprehensive consideration of the combined natural capital

Healthy coral reefs help to absorb wave impact along shores which in turn helps to prevent beach erosion © Jennifer Adler

from coastal ecosystems, such as within National Accounts, could also lead to changes in management approaches. The inclusion of natural capital within standard accounting systems is being piloted for coastal protection benefits, but does not yet consider the combined value of multiple benefits.

Pilot hybrid or 'artificial' reef structures, built with steel cages and filled with stones and cement, to protect a vulnerable coastline from strong wave action and the impacts from climate change, such as severe erosion © Tim Calver

As demonstrated in this review, coastal ecosystems typically provide multiple benefits that are often jointly provided by multiple ecosystems. Many ocean and coastal sectors such as tourism and fisheries are currently managed in isolation, which leads to competition and trade-offs. Integrated assessments of natural capital on the other hand could help to identify joint management priorities across sectors. This review also finds that some services, like pharmaceutical benefits, cultural ecosystem services or other regulating services are less rigorously measured than services like carbon sequestration or tourism. This lack of information can hinder optimal management of coastal resources.

More rigorous spatial analysis of ecosystems combined with data collection on associated values for under-studied benefits, will help provide a complete picture of the total economic value of coastal ecosystems across the Caribbean. Ultimately, such analyses will help inform optimal allocation of resources for habitat conservation, risk reduction and climate adaptation and demonstrate the need for investment in coastal ecosystems for coastal resilience and human well-being.

Snappers swim through protected waters in The Bahamas. © Shane Gross

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Appendix 1

Country	Ecosystem Service	Million US$
Anguilla	Tourism and recreation	20.22
Antigua	Tourism and recreation	67.83
Aruba	Biodiversity protection	10.60
	Cultural values	3.70
	Tourism and recreation	494.12
Bahamas	Biodiversity protection	45.83
	Carbon sequestration	5212.02
	Cultural values	
	Fisheries	20.60
	Tourism and recreation	143.20
	Water quality	725.56
Barbados	Tourism and recreation	2.60
Bonaire	Biodiversity protection	184.94
	Carbon sequestration	206.13
	Cultural values	0.02
	Fisheries	4.81
	Pharmaceutical	1.33
	Tourism and recreation	0.77
	Research	25.69
	Water quality	1.66
British Virgin Islands	Tourism and recreation	0.41
Cayman Islands	Biodiversity protection	200.83
	Carbon sequestration	97.00
	Fisheries	20.73
	Pharmaceutical	2.40
	Tourism and recreation	14.00
Cuba	Carbon sequestration	300.70
	Tourism and recreation	1416.00
Curacao	Carbon sequestration	290.94
	Fisheries	1.29
	Tourism and recreation	12.61
	Research	391.80
Dominican Republic	Biodiversity protection	0.44
	Carbon sequestration	1.35
	Fisheries	80.36
	Tourism and recreation	82.37
Grenada	Fisheries	525.48
	Tourism and recreation	39.00
Guadeloupe	Carbon sequestration	23.78
	Tourism and recreation	18.23
Haiti	Carbon sequestration	92.91
	Tourism and recreation	43.22
Jamaica	Biodiversity protection	15.62
	Carbon sequestration	36.76
	Fisheries	66.00
	Pharmaceutical	37.00
	Tourism and recreation	106.00
Martinique	Tourism and recreation	1868.90
Puerto Rico	Carbon sequestration	91.75
	Tourism and recreation	25.11
Saba	Biodiversity protection	666.39
	Carbon sequestration	0.87
	Cultural values	0.00
	Tourism and recreation	0.04
Saint Martin	Tourism and recreation	6.38
St Eustasius	Biodiversity protection	119.89
	Carbon sequestration	0.48
	Cultural values	0.01
	Fisheries	0.07
	Tourism and recreation	0.20
St Kitts and Nevis	Tourism and recreation	11.85
St Lucia	Fisheries	16.68
	Tourism and recreation	0.94
St Maarten	Fisheries	354.00
	Tourism and recreation	2.12
St Vincent and the Grenadines	Tourism and recreation	64.19
Trinidad and Tobago	Biodiversity protection	25.30
	Fisheries	0.79
	Tourism and recreation	1.52
Turks and Caicos	Biodiversity protection	174.00
	Carbon sequestration	8.87
	Fisheries	33.42
	Tourism and recreation	4.80
US Virgin Islands	Tourism and recreation	100.22
		283.51

Appendix 2

WTP = Willingness to pay TC =Travel cost CM = Choice modeling
MP = Market price (Competitive and Simulated market price estimations)

Country	Ecosystem	Ecosystem service	Valuation method	Original Value	Value (Annual, 2019)	Source
Anguilla	Coral reefs	Tourism	TC	19,685,000	20,216,495	[36]
Antigua	Coral reefs	Tourism	TC	66,043,000	67,826,161	[36]
Aruba	Coral reefs	Tourism	TC	218,226,000	224,118,102	[36]
Aruba	Multiple	Tourism	MP	269,000,000	270,000,000	[1]
Aruba	Multiple	Biodiversity	WTP	$10,600,000	10,600,000	[1]
Aruba	Multiple	Cultural values	WTP	3,600,000	3,700,000	[2]
Bahamas	Coral reefs	Tourism	TC	526,058,000	540,261,566	[36]
Bahamas	Mangroves	Carbon sequestration	MP*	249120000	249,120,000	[37]
Bahamas: Androz	Coral reefs	Fisheries	MP	24,000,000	28,170,000	[3]
Bahamas: Androz	Coral reefs	Tourism	MP	$43,600,000.00	51,200,000	[3]
Bahamas: Androz	Mangroves	Carbon sequestration	BT	15,000,000	17,600,000	[3]
Bahamas: Androz	Mangroves	Fisheries	MP	56,000,000	65,730,000	[3]
Bahamas: Androz	Multiple	Biodiversity	BT	$28,531,259.00	32,934,935	[3]
Bahamas: Androz island	Coral reefs	Multiple	BT	$18,156,256.00	20,958,595	[3]
Bahamas: Exuma Cay	Mangroves	Carbon sequestration	BT	11,500,000	12,900,000	[4]
Bahamas: Exuma Cay	Multiple	Fisheries	BT	23,000,000	26,000,000	[4]
Bahamas: Exuma Cay	Multiple	Recreation	BT	105,800,000	118,400,000	[4]
Bahamas: Exuma Cay	Multiple	Biodiversity	BT	11,500,000	12,900,000	[4]
Bahamas: Exuma Cay	Multiple	Non-use value	BT	18,400,000	20,600,000	[4]
Bahamas: Exuma Cay	Multiple	Raw materials	BT	11,500,000	12,900,000	[4]
Bahamas: Exuma Cay	Multiple	Water quality	BT	2,300,000	2,600,000	[4]
Bahamas: MPAs	Multiple	Carbon sequestration		$5,000,000,000	5,000,000,000	[5]
Bahamas: MPAs	Multiple	Fisheries	MP	$23,500,000	23,300,000	[5]
Bahamas: MPAs	Multiple	Tourism	MP	$67,600,000	66,900,000	[5]
Barbados	Coral reefs	Tourism	TC	180,082,000	184,944,214	[36]
Bonaire	Coral	Carbon sequestration	MP	$15,422	16,908	[6]
Bonaire	Coral reefs	Tourism	WTP, TC	23,434,839	25,692,441	[7]
Bonaire	Coral reefs	Fisheries	MP	1,216,689	1,333,900	[8]
Bonaire	Coral reefs	Tourism (MPA)	CV	$758,173.00	875,194	[9]
Bonaire	Coral reefs	Tourism (diving)	CV	$949,072.00	1,095,558	[10]
Bonaire	Coral reefs	Biodiversity	CM	$176,315,288	206,131,237	[11]
Bonaire	Coral reefs	Tourism	TC	90,200,000	92,635,400	[36]
Bonaire	Mangroves	Carbon sequestration	MP	$4,670	5,120	[6]
Bonaire	Multiple	Cultural values	WTP	3,900,000	4,300,000	[12]
Bonaire	Multiple	Research	MP	1,485,000	1,658,000	[6]
Bonaire	Multiple	Medical and pharmaceutical	WTP, MP	$688,788	768,917	[6]
Bonaire	Multiple	Art	MP	$460,000	510,000	[6]
Bonaire	Sea Grass	Water quality	BT	$405,000	$405,000	[13]
British VI	Coral reefs	Tourism	TC	195,550,000	200,829,850	[36]
Caribbean	Coral reefs	Tourism	MP	2,100,000,000	3,100,000,000	[14]
Caribbean	Coral reefs	Fisheries	MP	310,000,000	450,000,000	[14]

Country	Ecosystem	Ecosystem service	Valuation method	Original Value	Value (Annual, 2019)	Source
Cayman Islands	Coral reefs	Fisheries	MP	2,300,000	2,400,000	[15]
Cayman Islands	Coral reefs	Pharmaceutical	MP	13,600,000	14,000,000	[15]
Cayman Islands	Coral reefs	Tourism	TC	292,794,000	300,699,438	[36]
Cayman Islands	Mangroves	Carbon sequestration	MP	290,000	298,000	[15]
Cayman Islands	Mangroves	Carbon sequestration	MP*	20730000	20,730,000	[37]
Cayman Islands	Multiple	Tourism	MP	69,000,000	71,000,000	[15]
Cayman Islands	Multiple	Biodiversity	WTP	94,000,000	97,000,000	[15]
Cuba	Coral reefs	Tourism	TC	283,290,000	290,938,830	[36]
Cuba	Mangroves	Carbon sequestration	MP*	1416000000	1416,000,000	[37]
Curacao	Coral reefs	Fisheries	MP, BT	11618000	12,185,000	[16]
Curacao	Coral reefs	Tourism	MP, BT	32028000	33,590,000	[16]
Curacao	Coral reefs	Research	MP, BT	392500	412,000	[16]
Curacao	Coral reefs	Carbon sequestration	MP, BT	1099000	1,153,000	[16]
Curacao	Coral reefs	Tourism	TC	116,169,000	119,305,563	[36]
Curacao	Mangroves	Research	MP, BT	27500	28,800	[16]
Curacao	Mangroves	Fisheries	MP, BT	407000	427,000	[16]
Curacao	Mangroves	Tourism	MP, BT	1122000	1,177,000	[16]
Curacao	Mangroves	Carbon sequestration	MP, BT	126500	132,700	[16]
Curacao	Multiple	Tourism	MP	$373,500,000	391,700,000	[16]
Curacao	Seagrass		MP, BT	$284,000	298,000	[16]
Dominican Republic	Coral reefs	Fisheries	MP	16,624,152	19,190,018	[17]
Dominican Republic	Coral reefs	Tourism	WTP	76,500	88,300	[17]
Dominican Republic	Coral reefs	Tourism	TC	511,669,000	525,484,063	[36]
Dominican Republic	Mangroves	Fisheries	MP	9,091,084	10,494,253	[17]
Dominican Republic	Mangroves	Carbon sequestration	MP*	80355000	80,355,000	[37]
Dominican Republic	Multiple	Biodiversity	TC	1,170,000	1,350,000	[17]
Dominican Republic	Multiple	Fisheries (commercial, recreational & supply chain)	MP	82,175,772	82,373,761	[18]
Grenada	Coral reefs	Recreation & Tourism	MP	4,661,789	5,659,400	[19]
Grenada	Coral reefs	Tourism	TC	23,150,000	23,775,050	[36]
Grenada	Multiple	Fisheries	MP	8,890,000	10,780,000	[19]
Grenada	Multiple	Fisheries (commercial, recreational & supply chain)	MP	38,000,000	39,000,000	[18]
Guadeloupe	Coral reefs	Tourism	TC	90,463,000	92,905,501	[36]
Guadeloupe	Mangroves	Carbon sequestration	MP*	18225000	18,225,000	[37]
Haiti	Coral reefs	Tourism	TC	15,206,000		[36]
Haiti	Mangroves	Carbon sequestration	MP*	43215000	43,215,000	[37]
Jamaica	Coral reefs	Biodiversity	WTP	25,149,406.74	36,761,948	[20]
Jamaica	Coral reefs	Tourism	TC	333,386,000	342,387,422	[36]
Jamaica	Mangroves	Carbon sequestration	MP*	32475000	32,475,000	[37]
Jamaica: Montego Bay	Coral reefs	Tourism and recreation	MP	315,000,000	475,000,000	[21]
Jamaica: Montego Bay	Coral reefs	Fisheries	MP	1,300,000	2,000,000	[21]
Jamaica: Montego Bay	Coral reefs	Biodiversity	WTP	19,600,000	29,500,000	[21]
Jamaica: Montego Bay	Coral reefs	Pharmaceutical bio-prospecting	MP	70,000,000	106,000,000	[22]

Country	Ecosystem	Ecosystem service	Valuation method	Original Value	Value (Annual, 2019)	Source
Jamaica: Montego Bay	Coral reefs	Fisheries	MP	33,100,000	37,000,000	[23]
Jamaica: Montego Bay	Multiple	Tourism	TC	1,182,000,000	1,387,000,000	[24]
Jamaica: Portland	Coral reefs & Mangroves	Tourism	BT	4,700,000	6,900,000	[25]
Jamaica: Portland	Coral reefs & Mangroves	Biodiversity protection	BT	2,000,000	3,000,000	[25]
Jamaica: Portland	Mangroves	Carbon sequestration	BT	45,000,000	66,000,000	[25]
Jamaica: Portland Bight Protected Area	Coral reefs & Mangroves	Fisheries	MP	6,780,000	9,770,000	[25]
Martinique	Coral reefs	Tourism	TC	89,337,000	91,749,099	[36]
Netherland Antilles	Coral reefs	Tourism (diving)	TC	19,000,000	32,000,000	[26]
Puerto Rico	Coral reefs	Tourism	TC	648,867,000	666,386,409	[36]
Puerto Rico	Mangroves	Carbon sequestration	MP*	25110000	25,110,000	[37]
Saba	Coral reefs	Tourism	WTP, MP	5,997,800	6,377,223	[27]
Saba	Coral reefs	Biodiversity protection	WTP	818,000	870,000	[27]
Saba	coral reefs	Carbon sequestration	MP	4,512.73	4,787	[28]
Saba	Multiple	Cultural values	CM	37,887.74	40,284	[28]
St Eustasius	Coral reefs	Tourism	CM	9,000,000	10,000,000	[29]
St Eustasius	Coral reefs	Biodiversity conservation	WTP	451,000	480,000	[30]
St Eustasius	Coral reefs	Tourism	CM, MP	909,995	967,562	[30]
St Eustasius	Coral reefs	Carbon sequestration	MP	6,034	6,416	[31]
St Eustasius	Coral reefs	Cultural values	WTP	64,590	68,676	[31]
St Eustasius	Coral reefs	Tourism	MP	1,737,190	1,847,085	[31]
St Eustasius	Coral reefs	Fisheries	MP, WTP	189,575	201,568	[31]
St Kitts and Nevis	Coral reefs	Tourism	TC	16,240,000	16,678,480	[36]
St Lucia	Coral reefs	Tourism	MP	194,000,000	227,000,000	[32]
St Lucia	Coral reefs	Recreation (local)	MP	109,000,000	127,000,000	[32]
St Lucia	Coral reefs	Fisheries	MP	800,000.00	935,000	[32]
St Lucia	Coral reefs	Tourism	TC	56,574,000	58,101,498	[36]
St Vincent and the Grenadines	Coral reefs	Tourism	TC	24,639,000	25,304,253	[36]
Trinidad and Tobago	Coral reefs	Tourism	MP	130,000,000	150,000,000	[32]
Trinidad and Tobago	Coral reefs	Recreation (local)	MP	44,000,000	51,000,000	[32]
Trinidad and Tobago	Coral reefs	Fisheries	MP	1,300,000.00	1,520,000	[32]
Trinidad and Tobago	Coral reefs	Biodiversity Protection	TC	559,014	793,064	[33]
Trinidad and Tobago	Coral reefs	Tourism	TC	44,958,000	46,171,866	[36]
Turks and Caicos	Coral reefs	Tourism and recreation	MP	18,200,000	23,400,000	[21]
Turks and Caicos	Coral reefs	Fisheries	MP	3,700,000	4,800,000	[21]
Turks and Caicos	Coral reefs	Biodiversity	WTP	4,700,000	6,000,000	[21]
Turks and Caicos	Coral reefs	Tourism (diving)	TC, WTP	8,300,000	10,700,000	[34]
Turks and Caicos	Coral reefs	Tourism	TC	97,587,000	100,221,849	[36]
Turks and Caicos	Mangroves	Carbon sequestration	MP*	33420000	33,420,000	[37]
Turks and Caicos	Multiple	Tourism	TC, WTP	45,500,000	47,700,000	[35]
Turks and Caicos	Multiple	Biodiversity	WTP	8,454,446	8,866,764	[35]
USVI	Coral reefs	Tourism	TC	276,056,000	283,509,512	[36]

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Snappers swim through protected waters in The Bahamas. © Shane Gross

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