2020

# The State of Nearshore Marine Habitats in the Wider Caribbean

United Nations Environment Programme - Caribbean Environment Programme (UNEP-CEP)
Caribbean Natural Resources Institute (CANARI), Technical Report No. 1

Catalyzing implementation of the
Strategic Action Programme for the Caribbean and
North Brazil Shelf LME's (2015-2020)

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Protecting the Caribbean Sea and its resources is vital to safeguarding the future of the countries that border it.

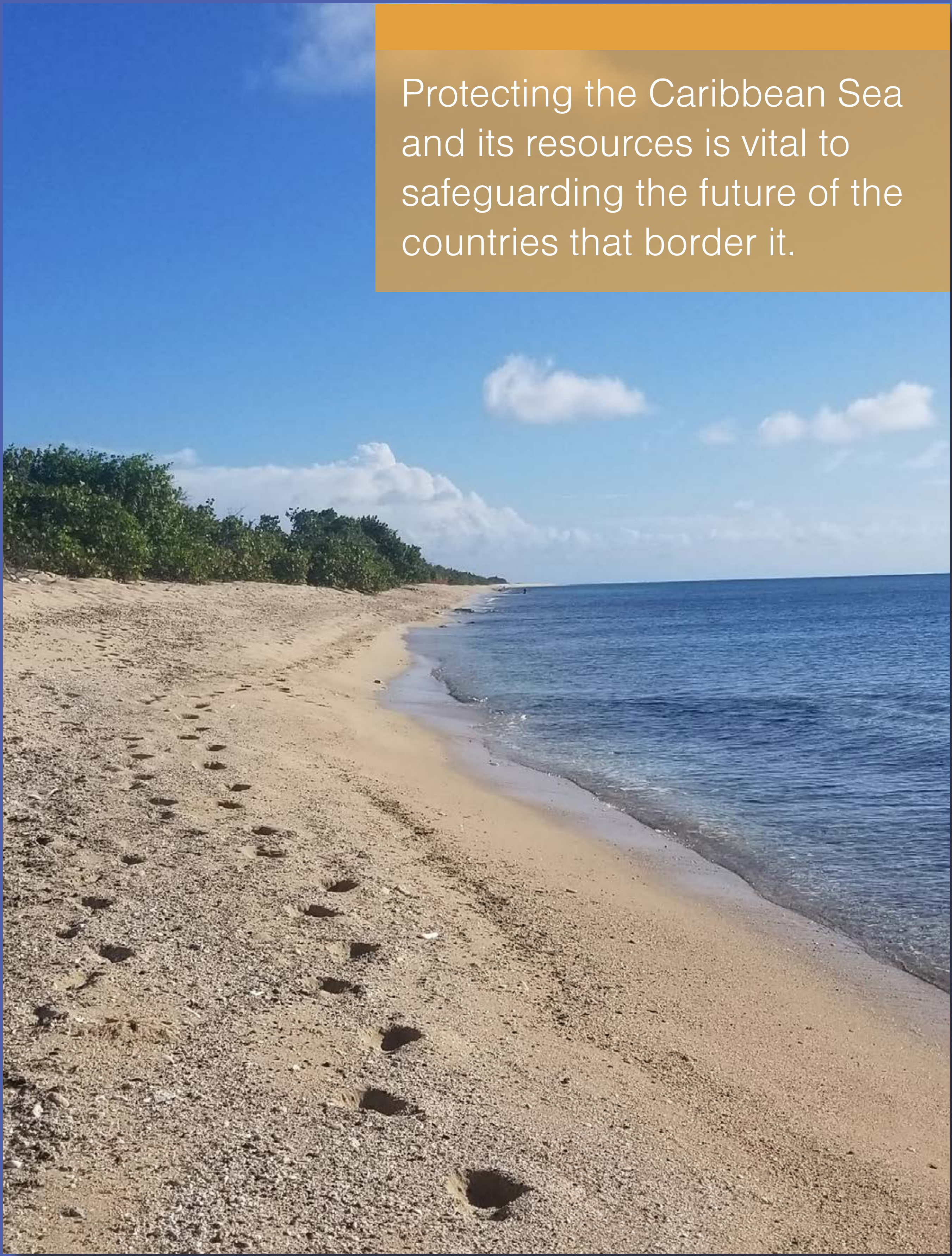

*Photo by L. Henderson*

# Preface

## Background

Protecting the Caribbean Sea and its resources is vital to safeguarding the future of the countries that border it. More than 134 million[1] people who live on or near the coast are supported by the Caribbean Sea's ocean economy. The area of the Caribbean Sea makes up just one percent of the global ocean but with its 2012 estimated value of US$407 billion it accounts for between 14 and 27% of the global ocean economy (Patil *et al*. 2016). The Caribbean Sea is biologically significant as well: it has the highest marine species richness in the Atlantic Ocean, represents two of the 34 identified biodiversity hotspots (Myers *et al*. 2000) and is considered the "high-diversity heart" of the Tropical West Atlantic, itself one of four global centres of tropical marine biodiversity (Robertson and Cramer 2014).

Periodic assessment of the state of the marine environment allows the Regional Coordinating Unit of the United Nations Environment Programme (UNEP) Caribbean Environment Programme (CEP) to track progress towards the goals of the protocols of the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention). This State of Nearshore Marine Habitats Report is prepared as an output of the Specially Protected Areas and Wildlife (SPAW) Sub-programme of the CEP as well as the five-year Caribbean and North Brazil Shelf Large Marine Ecosystems (CLME+) Project (2015-2020) as part of the effort toward implementation of the 10-year politically endorsed Strategic Action Programme (CLME+ SAP). The CEP Secretariat of the Protocol Concerning Specially Protected Areas and Wildlife in the Wider Caribbean Region (SPAW) is one of several inter-governmental organisations co-executing the CLME+ SAP.

The report supports the objectives of the SPAW Sub-programme component on Conservation and Sustainable Use of Coastal and Marine Ecosystems to:

- Mobilise the political will and actions of governments and other partners for the conservation and sustainable use of coral reefs and associated ecosystems such as mangroves and seagrass beds; and
- Effectively communicate the value and importance of coral reefs, mangroves and seagrass beds, including their ecosystem services, essential biodiversity[2] richness and biomass, threats to their sustainability, and the actions needed to protect them (United Nation Environment Programme [UNEP] 2019).

1 This includes the coastal population in the Caribbean Sea LME at 84,263,359; North Brazil Shelf LME at 9,550,602; and Gulf of Mexico LME at 40,522,728 (http://www.lmehub.net/).

2 Criteria 10. Although ecosystems are best protected by measures focused on the system as a whole, species essential to the maintenance of such fragile and vulnerable ecosystems/habitats, as mangrove ecosystems, seagrass beds and coral reefs, may be listed if the listing of such species is felt to be an "appropriate measure to ensure the protection and recovery" of such ecosystems/habitats where they occur, according to the terms of Article 11 (1) (c) of the Protocol.

Photo by L. Henderson

More than 134 million people who live on or near the coast are supported by the Caribbean Sea's ocean economy.

# Scope of the Report

## Thematic

The report focuses on three habitats that are characteristic of coastal ecosystems in the wider Caribbean, namely coral reefs, mangrove forests, and seagrass meadows. These three habitats are part of the reef fisheries ecosystem, one of the three focal sub-ecosystems of the CLME+ SAP. Although other sub-ecosystems, such as the mudflats of the North Brazil Shelf Large Marine Ecosystem (NBSLME), are part of the reef fisheries ecosystem, they are not included in this report as the focus is driven by the reporting needs of the SPAW Sub-programme.

The report highlights the status and trends of the three habitats, identifies the drivers and pressures, summarises the interventions to address the pressures, identifies gaps in response, identifies emerging challenges, and proposes actions to improve management of the target habitats.

The report also provides background information and context for the development of a Regional Strategy and Action Plan for the conservation of coral reef, mangrove, and seagrass habitats in the wider Caribbean, which is also being prepared by the SPAW Sub-programme of the CEP as an output of the CLME+ Project. The Regional Strategy and Action Plan will be presented to the Eleventh Meeting of the Conference of Parties (COP) to the SPAW Protocol in 2021.

The report is intended to contribute to the preparation of the report on the State of the Marine Environment and associated Economies (SOMEE) in the CLME+ region. In this context, the report is one of several aligned strategies, and plans that are intended to protect the integrity of coastal ecosystems and essential biodiversity in the wider Caribbean (see Appendix 1).

Although this report was prepared in the context of the SPAW Sub-programme and the CLME+ SAP, it supports other initiatives such as the Small Island Developing States Accelerated Modalities of Action (SAMOA Pathway), the 2030 Agenda for Sustainable Development, and the Convention on Biological Diversity. Of particular interest are Sustainable Development Goal 14 (Conserve and sustainably use the oceans, seas and marine resources for sustainable development) and the Aichi Biodiversity Targets 10 and 11 (conservation of valuable and vulnerable coastal ecosystems).

## Geographic

The geographic coverage of this report includes two overlapping programme areas: the SPAW Sub-programme area (Gulf of Mexico and Caribbean Sea) and the area covered by the CLME+ Project. The area comprises three adjacent large marine ecosystems (LMEs) with a combined area of approximately 5.9 million km2: – Gulf of Mexico (1,530,387 km2), Caribbean Sea (3,305,077 km2), North Brazil Shelf (1,034,575 km2).[3]

3 http://www.lmehub.net/

# Process of Preparing the Report

The report on the State of Nearshore Marine Habitats in the Wider Caribbean was developed by the Caribbean Natural Resources Institute (CANARI) upon request of UNEP-CEP in collaboration with, and guidance of, UNEP-CEP and the CLME+ Project Coordinating Unit. It is based on a review of literature gathered by CANARI, including publications shared by UNEP-CEP, CLME+ Project Coordination Unit, SPAW Protocol countries, regional inter-governmental organisations, regional academic institutions, and civil society organisations.

The first draft of the report was reviewed by experts and representatives of the UNEP-CEP National Focal Points, partners and experts as well as during a regional stakeholder workshop on 3-4 December 2018. The stakeholder workshop included members of the Scientific and Technical Advisory Committee (STAC) to the SPAW Protocol as well as other regional marine conservation experts and practitioners. The report was subsequently circulated to SPAW national focal points and selected subject experts for further review. The revised draft of the report was circulated in January and again in April 2020 to SPAW national focal points, collaborating regional institutions, and stakeholders for further review in preparation for submission to the Ninth Meeting of the STAC to the SPAW Protocol in 2021.

*Photo by L. Henderson*

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# Acronyms

| | |
|---|---|
| ACS | Association of Caribbean States |
| AGRRA | Atlantic and Gulf Reef Rapid Assessment |
| AIDA | Interamerican Association for Environmental Defense |
| BIOPAMA | Biodiversity and Protected Areas Management |
| BMF | Belize Marine Fund |
| CaMPAM | Caribbean Marine Protected Area Management Network and Forum |
| CANARI | Caribbean Natural Resources Institute |
| CARICOM | Caribbean Community |
| CARICOMP | Caribbean Coastal Marine Productivity Program |
| CARIWET | Caribbean Wetlands Regional Initiative |
| CARPHA | Caribbean Public Health Agency |
| CarSIF | Caribbean Sea Regional Innovation Fund |
| Cartagena Convention | Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region |
| CATS | Caribbean Aqua-Terrestrial Solutions |
| CBD | Convention on Biological Diversity |
| CBF | Caribbean Biodiversity Fund |
| CCAD | Central American Commission on Environment and Development |
| CCI | Caribbean Challenge Initiative |
| CEP | Caribbean Environment Programme |
| CEPF | Critical Ecosystem Partnership Fund |
| CERMES | Centre for Resource Management and Environmental Studies |
| CITES | Convention on International Trade in Endangered Species of Wild Fauna and Flora |
| CLME | Caribbean Large Marine Ecosystem |
| CLME+ CSAP | CLME+ People Managing Oceans: Civil Society Action Programme for Sustainable Management of the Shared Living Marine Resources of the Caribbean and North Brazil Shelf Large Marine Ecosystems |
| CLME+ Project | Caribbean and North Brazil Shelf Large Marine Ecosystems Project |
| CLME+ SAP | Strategic Action Programme (SAP) for the sustainable management of shared Living Marine Resources in the Caribbean and North Brazil Shelf Large Marine Ecosystems |
| $cm^2$ | Square centimetre |
| CNFO | Caribbean Network of Fisherfolk Organisations |
| $CO_2$ | Carbon dioxide |
| COP | Conference of Parties |
| CoRIS | Coral Reef Information System |
| CRC | Coral Restoration Consortium |
| CRCP | Coral Reef Conservation Program |

| | |
|---|---|
| **CRFM** | Caribbean Regional Fisheries Mechanism |
| **CROP** | Caribbean Regional Oceanscape Project |
| **ECMMAN** | Eastern Caribbean Marine Managed Areas Network |
| **EBSA** | Ecologically or Biologically Significant Area |
| **ECROP** | Eastern Caribbean Regional Ocean Policy |
| **EFJ** | Environmental Foundation of Jamaica |
| **EU** | European Union |
| **EU BEST** | Voluntary scheme for Biodiversity and Ecosystem Services in Territories of European Overseas |
| **FAO** | Food and Agriculture Organisation of the United Nations |
| **Fondo MARENA** | National Fund for the Environment and Natural Resources of the Dominican Republic |
| **GCFI** | Gulf and Caribbean Fisheries Institute |
| **GCRMN** | Global Coral Reef Monitoring Network |
| **GCRMN-Caribbean** | Global Coral Reef Monitoring Network – Caribbean node |
| **GDP** | Gross domestic product |
| **GEF** | Global Environment Facility |
| **GIS** | Geographic Information System |
| **GLISPA** | Global Island Partnership |
| **GNI** | Gross National Income |
| **GoM-LME** | Gulf of Mexico Large Marine Ecosystem |
| **ha** | Hectare |
| **HAB** | Harmful algal bloom |
| **IBA** | Important Bird and Biodiversity Area |
| **IMO** | International Maritime Organization |
| **IOC** | Intergovernmental Oceanographic Commission |
| **IPBES** | Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services |
| **IUCN** | International Union for Conservation of Nature |
| **IUU** | Illegal, unreported and unregulated |
| **JRC** | Joint Research Centre of the European Commission |
| **KBA** | Key Biodiversity Area |
| **kg C/m$^2$/year** | Kilogram of carbon per square metre per year |
| **km** | Kilometre |
| **km$^2$** | Square kilometre |
| **LBS Protocol** | Land-based Sources of Marine Pollution Protocol |
| **LME** | Large Marine Ecosystem |
| **MAR2R** | Integrated Transboundary Ridge-to-Reef Management of the Mesoamerican Reef |
| **MAR Fund** | Mesoamerican Reef Fund |
| **MARPOL** | International Convention for the Prevention of Pollution from Ships |
| **MBRS** | Mesoamerican Barrier Reef Systems Project |
| **MCE** | Mesophotic Coral Ecosystems |
| **MEA** | Multilateral Environmental Agreement |
| **mg** | Milligram |

| | |
|---|---|
| **MMA** | Marine Managed Area |
| **MPA** | Marine Protected Area |
| **NBSAP** | National Biodiversity Strategy and Action Plan |
| **NBSLME** | North Brazil Shelf Large Marine Ecosystem |
| **NFWF** | National Fish and Wildlife Foundation |
| **NOAA** | National Oceanic and Atmospheric Administration |
| **OA** | Ocean acidification |
| **OAS** | Organization of American States |
| **OECS** | Organisation of Eastern Caribbean States |
| **OSPESCA** | Central America Fisheries and Aquaculture Organization |
| **PAC** | Peyssonnelid algal crusts |
| **PACT** | Protected Areas Conservation Trust |
| **ppm** | Parts per million |
| **PSSA** | Particularly sensitive sea area |
| **RAC** | Regional Activity Centre |
| **RSAP** | Regional Strategy and Action Plan |
| **RHI** | Reef Health Index |
| **SAMOA Pathway** | Small Island Developing States Accelerated Modalities of Action |
| **SAP** | Strategic Action Plan |
| **SCTL** | Stony Coral Tissue Loss |
| **SICA** | Central American Integration System |
| **SIDS** | Small Island Developing States |
| **SocMon** | Socio-economic Monitoring for Coastal Management |
| **SOMEE** | State of the Marine Environment and associated Economies |
| **SPAW** | Specially Protected Areas and Wildlife |
| **SST** | Sea surface temperature |
| **STAC** | Scientific and Technical Advisory Committee |
| **TNC** | The Nature Conservancy |
| **UNEP** | United Nations Environment Programme, now referred to as UN Environment |
| **UNESCO** | United Nations Educational, Scientific and Cultural Organization |
| **UNOPS** | United Nations Office for Project Services |
| **US$** | United States dollar |
| **USA** | United States of America |
| **USVI** | United States Virgin Islands |
| **UWI** | University of the West Indies |
| **WCPA** | World Commission on Protected Areas |
| **WECAFC** | Western Central Atlantic Fishery Commission |
| **WHO** | World Health Organization |
| **WIDECAST** | Wider Caribbean Sea Turtle Conservation Network |
| **WWF** | World Wildlife Fund |

The report focuses on three habitats that are characteristic of coastal ecosystems in the wider Caribbean, namely coral reefs, mangrove forests, and seagrass meadows.

*Photo by L. Henderson*

# Executive Summary

This State of Nearshore Marine Habitats Report is prepared as an output of the Specially Protected Areas and Wildlife (SPAW) Sub-programme of the Caribbean Environment Programme (CEP) of the United Nations Environment Programme (UNEP) as well as the five-year Caribbean and North Brazil Shelf Large Marine Ecosystems (CLME+) Project (2015-2020) as part of the effort towards implementation of the 10-year politically endorsed Strategic Action Programme (CLME+ SAP). The report informs development of a Regional Strategy and Action Plan (RSAP) for the conservation of coral reef, mangrove, and seagrass habitats in the wider Caribbean.

The report focuses on three habitats that are characteristic of coastal ecosystems in the wider Caribbean, namely coral reefs, mangrove forests, and seagrass meadows. These are found across the 5.9 million km2 area of the wider Caribbean, which comprises three adjacent large marine ecosystems: Gulf of Mexico, Caribbean Sea and North Brazil Shelf.

The coral reef-mangrove-seagrass complex has been described as one of the most biologically diverse and productive systems in the world, with strong interlinkages between the three sub-ecosystems. These habitats host significant species diversity, including endemic and threatened species, as well as commercially valuable species. The Western Caribbean ecoregion has been identified as one of 10 marine biodiversity hotspots globally. There are 15 Ecologically or Biologically Significant Areas in the wider Caribbean. The Mesoamerican Reef along the coasts of Mexico, Belize, Guatemala and Honduras is the largest barrier reef in the Western Hemisphere and the second largest in the world.

These ecosystems provide essential ecosystem services and tangible and intangible benefits to adjacent coastal communities and countries. More than 134 million people who live on or near the coast benefit from the ocean for their livelihoods, recreation, health, well-being, culture and spirituality. For example, a 2016 study by the World Bank (Patil *et al*. 2016) put the economic value of the Caribbean Sea alone to the region – including all its services and support to fishing, transport, trade, tourism, mining, waste disposal, energy, carbon sequestration and drug development – at US$407 billion per year in total, of which US$54.55 billion can be directly linked to coastal and marine ecosystems. This estimated value, which is based on 2012 data, is projected to nearly double by 2050. Moreover, this figure is likely an underestimation because the region's ocean economy is still not well measured or understood. Indirect and intangible benefits are also not captured.

For many countries in the wider Caribbean, particularly the islands, the majority of the population, infrastructure, and economic activities are located in the coastal zone. That places great pressure on coastal ecosystems, which provide goods and services for economic development while simultaneously absorbing the wastes and other impacts from development activities. The direct human pressures on coastal ecosystems have continued unabated for many decades and in some cases have increased. The damage from human activities has compromised the abilities of natural systems to withstand stresses from other sources such as diseases, alien invasive species, intense weather events, and climate change.

The significant and mutually reinforcing anthropogenic drivers of change that are affecting the wider Caribbean's nearshore marine resources include population growth and urbanisation, coastal development, and over-exploitation of natural resources, including overfishing. These are occurring against the backdrop of climate change, which both adds pressures and exacerbates existing vulnerabilities. Fully understanding the impact of these is complicated as some threats are recently emerging and their impacts on habitats and species are not yet fully understood. Furthermore, the pressures and threats may interact with each other in ways not yet fully understood.

Decades of these anthropogenic and natural stresses on the three habitats has resulted in overall poor status based on key indicators, and worsening trends in almost all areas. Key indicators such as coral cover, recruitment, health, fish and invertebrate diversity are poor. The most recent comprehensive analysis of Caribbean coral data estimates that average coral cover has declined from an estimated 34.8% in the 1970s to just 16.3%. The shift from coral dominated to macroalgal dominated Caribbean coral reefs is also a concern. Recent Reef Health Index scorecards give islands in the eastern and northern Caribbean a score of "Poor" and the four Mesoamerican Reef countries a score of "Fair."

*Photo by L. Henderson*

For mangroves and seagrass, coverage is low and declining but data is lacking to assess the health of these two habitats. Obtaining accurate data on mangrove forest coverage using remotely captured images is difficult, but the picture is clear on continued mangrove loss across the region. While it is well known that mangroves provide a range of habitat and nursery functions for associated species, the status of the floral and faunal species associated with mangrove forests in the wider Caribbean is unclear. Apart from the structural damage from intense storms, it is also unclear how the natural and anthropogenic stresses will affect the capacity of mangrove ecosystems to maintain their habitat and associated functions. For seagrass, monitoring across the region has been piecemeal and sporadic so data on coverage and health across the region is inadequate. However, in general, seagrass beds are being degraded and lost across the region.

The importance of the habitats and the scale of threats they are facing have been well understood in the region, and numerous responses exist at the regional, national and local levels. These have been supported by the significant growth in the number of international environmental programmes, agreements and associated financing. However, management and conservation work in the region has been disjointed, carried out on a project-by-project basis, with limited consolidation of efforts and projects. Efforts are underway to establish a Coordination Mechanism that brings together countries and intergovernmental organisations, and to further enhance collaborative governance by engaging stakeholders from academia, the private sector and civil society. Establishment of coordination mechanisms among regional bodies and enhancing the effectiveness of engagement of non-state actors are key elements of this.

The designation of ecologically sensitive or biologically important areas under several different global frameworks has been a key management strategy used across the region, and many sites contain coral reefs, mangroves and seagrass. The wider Caribbean includes 15 Ecologically or Biologically Significant Marine Areas declared under the Convention on Biological Diversity, two Particularly Sensitive Sea Areas designated under the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78), nearly 100 sites under the Convention on Wetlands of International Importance especially as Waterfowl Habitat (the Ramsar Convention), 35 protected areas under the SPAW Protocol of the Cartagena Convention, six World Heritage Natural Sites under the Convention concerning the Protection of the World Cultural and Natural Heritage, approximately 330 Key Biodiversity Areas and many Important Bird and Biodiversity Areas in coastal areas. The number of protected areas designated under national laws and international programmes is also increasing and the area of marine and coastal habitat protected increased nearly 29-fold from pre-1983 to 2014. However, concerns persist about the effectiveness of management of these areas and there are numerous capacity building initiatives that aim to address this.

There are also several interdisciplinary and multi-sectoral initiatives and partnerships that are facilitating the collection of, and generating and analysing data on, marine habitats across the region. These include assessments on habitat extent, health, biodiversity, ecosystem services, resilience, economic and livelihood benefits, and policy, regulations and

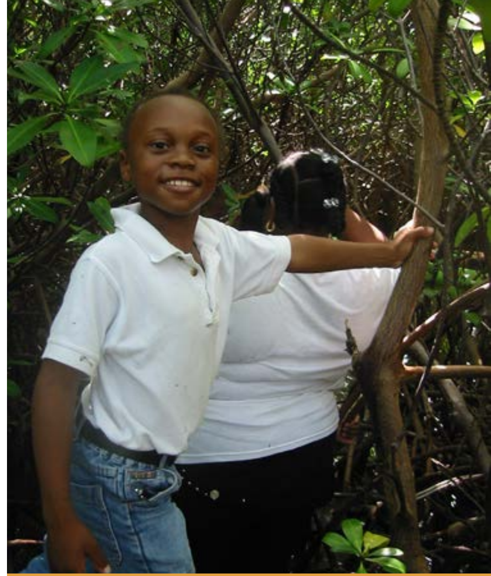


*Photo by P. Rothenberger*

Several regional and national environmental funds have been established to facilitate the flow of funds from multiple sources to support management initiatives on the three habitats.


Photo by P. Rothenberger

National institutional frameworks and arrangements need to be strengthened to guide strategic, information-based, long-term and comprehensive management approaches. Enhancing the completeness, consistency, compatibility, management and sharing of data and knowledge is also required.

financing. Many efforts are also focused on restoration of mangroves and coral reefs, which include a focus on development of methodologies, sharing knowledge and supporting collaboration.

Several regional and national environmental funds have been established to facilitate the flow of funds from multiple sources to support management initiatives on the three habitats. There are innovative tools for sustainable financing which could be tested in the region using blended finance approaches and public-private partnerships, including blue bonds, debt-for-nature swaps, Social Impact Bonds and Development Impact Bonds, crowdsourcing diaspora funding, contingently recoverable grant resources, blue levies and insurance investments. However, enhancing coordination and synergies across multiple funding streams is needed across the region. The potential for blue economy approaches to enhance support for protection and sustainable use of the three habitats is also being explored but ensuring that these are inclusive and environmentally sustainable is critical.

A plethora of national, sectoral and local policies, strategies and plans exist that are relevant to management, conservation and sustainable use of coastal ecosystems (e.g. national development plans, national policies on wetlands, integrated coastal zone management plans and individual protected area management plans). Among these, National Biodiversity Strategies and Action Plans are the main vehicles for national implementation of the Convention on Biological Diversity and often include targets for marine ecosystems/habitats in general. Some include specific coral reef targets; mangroves in many instances are included in targets for forest and/or wetlands. However, seagrasses are seldom addressed.

Despite these efforts and some progress in addressing threats and conserving critical coastal and marine ecosystems, this has not been enough to reverse the trend in continued degradation and loss of critical coastal ecosystems. National institutional frameworks and arrangements need to be strengthened to guide strategic, information-based, long-term and comprehensive management approaches. Enhancing the completeness, consistency, compatibility, management and sharing of data and knowledge is also required. Effectiveness of management actions can be enhanced through building capacity and knowledge, ensuring coordination and coherence, focusing on management effectiveness and outcomes, strengthening public engagement and collaborative governance, improving communication and using stewardship approaches that recognise the value of natural ecosystems to development.


Photo by L. Henderson

The coral reef-mangrove-seagrass complex has been described as one of the most biologically diverse and productive systems in the world.

*Photo by L. Henderson*

# 1 Introduction to the wider Caribbean and its nearshore habitats

## Key messages

- More than 134 million people who live on or near the coast are supported by the Caribbean Sea's ocean economy for their livelihoods, recreation, health and well-being.
- Coral reefs, mangroves and seagrass beds are found across the 5.9 million km2 area of the wider Caribbean, which comprises three adjacent large marine ecosystems: Gulf of Mexico LME, Caribbean Sea LME and the North Brazil Shelf LME.
- The coral reef-mangrove-seagrass complex has been described as one of the most biologically diverse and productive systems in the world, with strong interlinkages between the three sub-ecosystems.
- Coral reefs are generally found along insular and continental coastlines throughout the wider Caribbean, including the Mesoamerican Reef system which is the largest transboundary barrier reef and second largest barrier reef in the world. Few small reefs are found along the North Brazil Shelf coastline. Mangroves are widespread along the coasts of the wider Caribbean, especially in the North Brazil Shelf. Seagrasses are located throughout the wider Caribbean, growing in lagoons between beaches and coral reef or forming extensive meadows in protected bays and estuaries.
- These habitat host significant species diversity, including endemic and threatened species, as well as commercially valuable species.

4 This includes the coastal population in the Caribbean Sea LME at 84,263,359; North Brazil Shelf LME at 9,550,602; and Gulf of Mexico LME at 40,522,728 (http://www.lmehub.net/).

# 1.1 Understanding the coral reef-mangrove-seagrass complex

## Nearshore marine ecosystems are under threat from human activity

The people and economies of the wider Caribbean are highly dependent on its coastal and marine ecosystems, which support jobs, provide income, and protect coastal populations and property from floods and storm damage. In simple words, the coastal and marine resources are the source of life for the region. Marine ecosystems represent some of the most heavily exploited ecosystems throughout the world. For example, coastal zones make up just four percent of the earth's total land area and 11% of the world's oceans, yet they contain more than a third of the world's population and account for 90% of the catch from marine fisheries. However, human activities are now threatening many of the world's remaining marine ecosystems and the benefits they provide. Due to coastal development, population growth, pollution and other human activities, 50% of salt marshes, 35% of mangroves, 30% of coral reefs, and 29% of seagrasses have already been lost or degraded worldwide over several decades.

## One of the most biologically diverse and productive systems in the world

Coral reefs, mangroves and seagrass beds are three distinct and characteristic habitat types of the nearshore seascape of the wider Caribbean. The coral reef-mangrove-seagrass complex has been described as one of the most biologically diverse and productive systems in the world (Heileman 2011). Although each habitat has characteristics that make it different from the others and can exist independently, the three frequently occur together and have strong linkages.

## Successful connectivity supports better results for people and nature

Coral reefs, mangroves and seagrass beds provide goods and services both individually and through functional linkages, with their ecological processes working better together than in any single system alone. This is true of their coastal protection services as well as of their role in providing habitat, feeding, and nursery grounds for several commercially important fish and invertebrate species. For example, the role coral reefs and seagrass beds play in reducing the risk of shoreline erosion and promoting shoreline stability offshore improves the functioning of the mangrove ecosystem (Guannel *et al.* 2016). Mangroves, in turn, enhance fisheries abundance on coral reefs (Serafy *et al*. 2015). Densities of at least 11 commercially important fish species in the Caribbean are thought to be linked to the presence of nearby bays containing mangroves and seagrass beds, which serve as nurseries for juveniles. Human impacts on mangroves and seagrass beds that lead to the loss of nursery habitat in mangroves and seagrass beds could have significant negative impacts on reef fish stocks and yields in the Caribbean (Nagelkerken *et al*. 2002).

## Connectivity strengthens capacity to mitigate climate impacts

The transfer of materials, nutrients and energy that occurs among the three ecosystems is important in sustaining the high productivity and biodiversity of the coastal zone (Granek *et al*. 2009 cited in Rodríguez-Ramírez *et al*. 2010). Connectivity even seems to play a role in the habitats' capacity to mitigate climate impacts. There is evidence that coral reefs located within or immediately downstream of seagrass beds may be more resistant to ocean acidification (Camp *et al*. 2016; Manzello *et al*. 2012). The general understanding of 'blue' carbon storage by mangroves, seagrass and tidal marshes at the seascape scale, and over appropriately long timescales, is at an early stage. But evidence suggests that these habitats act together to sustain and enhance their collective capacity to trap and store carbon: seagrasses support mangrove function by protecting them from waves and mangroves protect seagrass beds from excess nutrients and sediment (Huxham *et al*. 2018).

## Ignoring connectivity is a short-sighted approach

Impaired functioning of any of the habitats will directly or indirectly affect the others; this makes it strategic to conserve coastal habitats simultaneously to ensure better provision of ecosystem goods and ecosystem services. Ignoring habitat connectivity and the broader seascape when considering the coral reef-mangrove-seagrass complex is a short-sighted approach.

# 1.2 Overview of the wider Caribbean region

This report uses the term 'wider Caribbean' to refer to the programme area of the Cartagena Convention SPAW Protocol Sub-programme of UNEP-CEP (Gulf of Mexico and Caribbean Sea) and the area covered by the Caribbean Large Marine Ecosystem and the North Brazil Shelf Large Marine Ecosystem (CLME+) Project.[5] The area comprises three adjacent large marine ecosystems (LMEs): Gulf of Mexico LME (GoM-LME), Caribbean Sea LME (CLME) and North Brazil Shelf LME (NBSLME) (Figure 1.1). The combined area is approximately 5.9 million km2, of which some 1.9 million km2 is shelf area.[6] Coral reefs, mangroves and seagrass beds are ecologically and economically important to the wider Caribbean, in particular for marine-based sectors such as fisheries, tourism, shipping and petroleum. All three habitats occur throughout the region.


Figure 1.1 The Cartagena Convention area and the 4 LMEs it largely intersects: The Wider Caribbean

5 The term "wider Caribbean region", as used in this report, covers an area slightly larger than that which is defined as the Wider Caribbean Region in the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78), and as used in the Cartagena Convention. Under MARPOL Annex V Regulation 5(1)(h), the Wider Caribbean Region is defined as: "The Gulf of Mexico and Caribbean Sea proper including the bays and seas therein and that portion of the Atlantic Ocean within the boundary constituted by the 30° N parallel from Florida eastward to 77°30' W meridian, thence a rhumb line to the intersection of 20° N parallel and 59° W meridian, thence a rhumb line to the intersection of 7°20' N parallel and 50° W meridian, thence a rhumb line drawn southwesterly to the eastern boundary of French Guiana.

6 http://www.lmehub.net/

## A geopolitically diverse region

The wider Caribbean includes 26 countries and 19 dependent territories of four nations (Table 1.1). The region comprises small island states and continental countries, with territorial areas, populations and economies that range vastly in size. With areas of 9.8 million $km^2$ and 8.5 million $km^2$ respectively, the United States of America (USA) and Brazil are among the largest countries in the region, while at the other end of the spectrum, there are 18 countries and territories with an area smaller than 500 $km^2$. The region also includes the countries with the highest and lowest per capita gross domestic product (GDP) in the Western Hemisphere: the USA and Haiti, respectively. With 24 countries and territories in the region classified as small island developing states (SIDS), the Caribbean has the largest number of SIDS within an LME in the world (United Nations Human Settlements Programme [UN Habitats] 2012).

**Table 1.1:** Wider Caribbean States, Territories, Associated States, Departments, Outermost Regions and Islands with a Special Status

| **Independent continental states** | **Independent island states** | **Overseas dependent territories, associated states, outermost regions, departments and island with a special status**[7] |
|---|---|---|
| Belize[8] | Antigua & Barbuda | Anguilla *(United Kingdom)* |
| Brazil | The Bahamas | Aruba, Curaçao, St. Maarten[9] |
| Colombia | Barbados | British Virgin Islands *(United Kingdom)* |
| Costa Rica | Cuba | Cayman Islands *(United Kingdom)* |
| Guatemala | Dominica | French Guiana *(France)* |
| Guyana | Dominican Republic | Guadeloupe *(France)* |
| Honduras | Grenada | Montserrat *(United Kingdom)* |
| Panamá | Haiti | Martinique *(France)* |
| México | Jamaica | Puerto Rico *(United States of America)* |
| Nicaragua | St. Kitts & Nevis | Bonaire, St. Eustatius, Saba[10] |
| Suriname | Saint Lucia | St. Barthélemy *(France)* |
| Bolivarian Republic of Venezuela | St. Vincent & the Grenadines | St. Martin *(France)* |
| | | Turks and Caicos Islands *(United Kingdom)* |
| United States of America | Trinidad & Tobago | United States Virgin Islands (USVI) *(United States of America)* |

7 As of October 10, 2010, Holland, Aruba, Curaçao and St. Maarten are partners in the Kingdom of the Netherlands. The islands of Bonaire, Saba, and St. Eustatius have become "special municipalities" of Holland.

8 Low-lying coastal and Small Island Developing States (SIDS) as listed by the United Nations Department of Economic and Social Affairs; see http://sustainabledevelopment.un.org/index.php?menu=1522

9 Kingdom of the Netherlands

10 Special Municipalities of Holland

## A biologically significant area

The wider Caribbean is biologically significant – a fact reflected in the designation of three large marine ecosystems (see below) within its area. The Western Caribbean ecoregion has been identified as one of 10 marine biodiversity hotspots, a centre of endemism in the top two-thirds of the range of risk from human impacts (Roberts *et al*. 2002). There are 15 Ecologically or Biologically Significant Areas (EBSAs) in the wider Caribbean (see section 5.3).

The Caribbean Sea has the highest marine species richness in the Atlantic Ocean. The Gulf of Mexico supports high biodiversity with more than more than 15,000 plant and animal species found in its waters. The shallow marine environment around the islands has more than 12,000 marine species reported. However, data for marine species are still incomplete, so this is a clear underestimate for this diverse tropical region.

The majority of corals and coral reef-associated species in the Caribbean Sea are endemic, making the region biogeographically distinct (Australian Institute of Marine Science [AIMS] 2002; Spalding, Green and Ravilious 2001). It is considered the "high-diversity heart" of the Tropical West Atlantic, itself one of four global centres of tropical marine biodiversity (Robertson and Cramer 2014). The Mesoamerican Reef touches the coasts of Mexico, Belize, Guatemala and Honduras. It is the largest barrier reef in the Western Hemisphere and the second largest in the world.

All the reef-forming coral species in the Caribbean were assessed for the International Union for Conservation of Nature (IUCN) Red List in 2008, and the ecosystem was classified as Endangered at the regional level in 2013 (Keith *et al*. 2013). Of the 63 coral reef species assessed, 11 are listed as Globally Threatened and a further eight species as Data Deficient. The proportion of Threatened species ranges from 17 to 30%, with a best estimate of 20% (13 species). Given the huge loss in coral cover, the proportion of species threatened with extinction is lower than expected and possibly reflects a lag in the impacts of the loss on individual species, given that most occur across the whole region, or that declines were under-estimated in 2008 (Jackson *et al*. 2014). The two *Acropora* species are both listed as Critically Endangered.

Although there is still a major gap in biodiversity knowledge about bony fishes in the Caribbean, there are 1,538 species of bony fish assessed on the IUCN Red List that occur within the marine waters of the Caribbean islands. A recent paper (Linardich *et al*. 2017) presented results of an assessment of nearly 1,000 shore fishes that range in the Greater Caribbean and Gulf of Mexico populations of 940 shore fishes using Red List guidelines. About five percent of these shore fishes are globally or regionally threatened, including six percent of Greater Caribbean endemics and 26% of Gulf endemics. Species-richness analyses show that the highest numbers of Threatened species endemic to the Greater Caribbean are found in Belize, Panama, and the Cayman Islands. Many of the Threatened fish species occurring in the eligible countries are not endemic to the Caribbean and have large distributions and some sort of commercial value (for example, tuna, seahorses and groupers). However, some species have Globally Threatened status, for example the American Eel (*Anguilla rostrata*) and the Nassau Grouper (*Epinephelus striatus*). About nine percent of the species are Data Deficient.

Limiting these to just species found at depths above 200 metres reduces the list to 1,354 species. These have been treated here as the 'nearshore' species, although a number are more likely to be pelagic species that only rarely occur close to the shore. Of these, 37 species (three percent) have been assessed as Globally Threatened, although there are a further 93 species assessed as Data Deficient; if all of these were found to be threatened, the proportion of threatened species would rise to 10%.

Of the 83 species of shark and ray occurring in the Caribbean Islands Biodiversity Hotspot, 17 are globally threatened (20%). These species include smalltooth sawfish (*Pristis pectinata*), which has some important populations in the region, especially around The Bahamas. They also include three Endangered species of shark, whale shark (*Rhincodon typus*) and scalloped and great hammerheads

(*Sphyrna lewini* and *S. mokarran*), as well as Vulnerable species of shark and ray, including great white shark (*Carcharodon carcharias*) and giant oceanic manta ray (*Manta birostris*).

At least 33 species of marine mammals (one quarter of the world's marine mammal species) have been documented from the region – six species of baleen whales (Mysticeti), 24 species of toothed whales (Odontoceti), one sirenian (the West Indian manatee), and three pinnipeds (the hooded seal, the Caribbean monk seal now thought to be extinct, and the accidentally introduced California sea lion). Four species are classified as Endangered and most of the others as Data Deficient (Fanning *et al*. 2011).

## Strong economy - ecosystem interface

More than 134 million people who live on or near the coast benefit from the ocean for their livelihoods, recreation, health, well-being, culture and spirituality. The area of the Caribbean Sea makes up just one percent of the global ocean but with its 2012 estimated value of US$407 billion it accounts for between 14 and 27% of the global ocean economy (Patil *et al*. 2016). For SIDS in the wider Caribbean, the ocean's role as an important generator of livelihoods and income is magnified.

The 'blue economy' concept that has recently emerged focuses on the importance of current and emerging industries dependent on oceans (see Figure 1.2) and is discussed in Section 5.10.

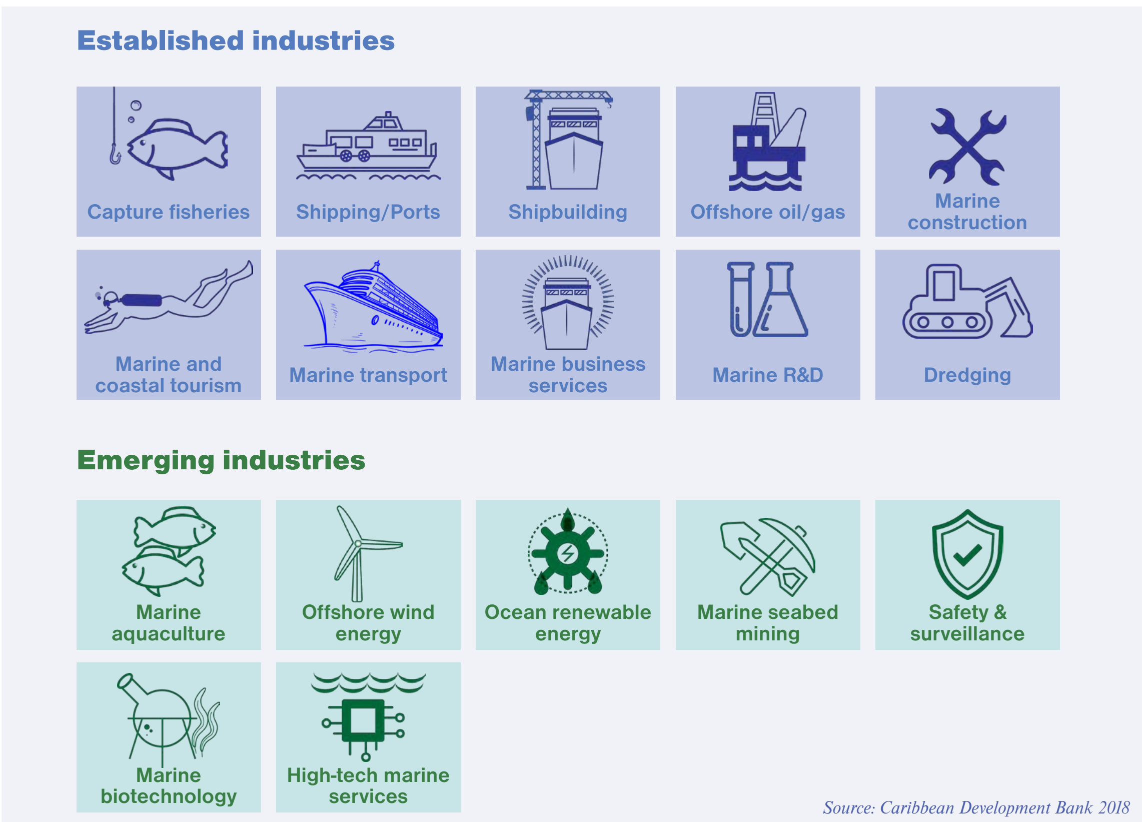



Figure 1.2 Established and emerging blue economy industries in the Caribbean

Despite the broad recognition of the importance of the ocean to economic development, the ability of countries to calculate the economic contribution of marine resources to their national economies is currently hindered by weak statistical systems. The Caribbean Development Bank recently piloted the development of a blue economy satellite account for Jamaica (Ram *et al*. 2019). The study looked at four main industries where blue activities are taking place and measured in the reporting of GDP: (a) manufacturing; (b) transport and storage; (c) agriculture, forestry and fishing; and (d) arts, entertainment, and recreation. Activities in these industries directly related to the country's marine resources were found to have had a measurable and direct impact of 6.9% of gross domestic product (GDP) in 2017 and an average contribution of 6.7% for the period 2012 to 2017. Development of such national blue economy satellite accounts would help to guide policymakers in management of coastal and marine ecosystems in the wider Caribbean.

Furthermore, the indirect contributions of marine resources are typically not captured in national accounting. In 2012, a World Bank study (Patil *et al*. 2016) found that the Caribbean Sea generated 18% of the GDP of the island states and territories from tourism, oil and gas, and maritime shipping, but the estimates largely excluded the non-market values of ecosystem services.

Non-use intrinsic values and intangible benefits of this biodiversity are also significant for the wider Caribbean's socio-cultural heritage, including for indigenous peoples.

## The large marine ecosystems of the wider Caribbean

LMEs are near coastal areas extending from river basins and estuaries to the seaward boundaries of continental shelves and the outer margins of the major ocean current systems. They are areas of high biodiversity that provide essential ecosystem services and tangible and intangible benefits to adjacent coastal communities and countries. The three adjacent LMEs of the wider Caribbean – Gulf of Mexico, Caribbean Sea and North Brazil Shelf – share marine species and provide complementary ecosystem services (Grober-Dunsmore and Keller 2008; Robertson and Cramer 2014; UNIDO 2011; Carrillo *et al*. 2017). While each has its unique features and characteristics, they all support significant coastal populations (Figure 1.3), and natural-resource-based economic activity.

The three focal habitats of this report occur in all three LMEs. The Caribbean Sea LME has the largest extent of coral reefs among the three wider Caribbean LMEs, and with 10,429 km2 of mangroves, the North Brazil Shelf has the highest mangrove coverage of any LME globally (One Shared Ocean 2018).


**The Gulf of Mexico Large Marine Ecosystem (GoM-LME)**

**Total area:** 1.6 million km² | **Coastal area:** 140,753 km² |
**Population:** 40.5 million (2010)
**Population density:** 81 persons per km² |
**Coastal poor:** 12.4 million or 31% of coastal dwellers

The Gulf of Mexico Large Marine Ecosystem is a semi-enclosed oceanic basin that is shared by Mexico, the U.S. and Cuba. The coastal area includes the southern coast of the United States of America and the eastern shoreline of Mexico. The GoM-LME is the ninth largest body of water in the world and the largest semi-enclosed coastal sea in the Western Atlantic. It has a narrow connection to the Atlantic Ocean, and numerous bays and small inlets fringe its shoreline. Many rivers drain into the GoM, most notably the Mississippi and Rio Grande rivers in the northern GoM, and the Grijalva and Usumacinta rivers in the southern Gulf. The land that forms the GoM's coast, including many barrier islands, is almost uniformly low-lying. It is characterised by marshes, swamps and straits of sandy beach.

The GoM supports high biodiversity and biomass of fish, marine mammals and seabirds. It is home to 29 species of marine mammals, including bottlenose dolphins, humpback whales, and sperm whales, all five species of endangered sea turtles, 49 shark species and millions of migrating sea birds, and countless numbers of fishes and invertebrates. The LME has substantial commercial and recreational fisheries, with important fisheries including red snapper, swordfish, grouper, shrimp, crab and oyster. The LME exhibits medium numbers of collapsed and overexploited fish stocks and very high proportions of catch from bottom impacting gear.

*Source*: UNIDO Project Coordination Unit 2011; One Shared Ocean 2018; http://www.lmehub.net/

Figure 1.3 The LMEs of the Wider Caribbean


## The Caribbean Sea Large Marine Ecosystem (CLME)

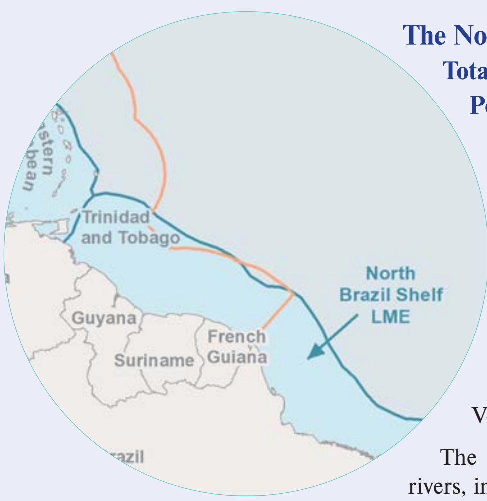
**Total area:** 3.3 million km² | **Coastal area:** 794,777 km² | **Population:** 84.2 million (2010) | **Population density:** 106 persons per km² | **Coastal poor:** 26.6 million or 32%

The semi-enclosed Caribbean Sea Large Marine Ecosystem is a distinct ecological region, bounded to the north by The Bahamas and the Florida Keys, to the east by the Windward Islands, to the south by the South American continent, and to the west by the Central American isthmus. The littoral area includes the eastern coast of the Yucatan Peninsula, the Atlantic coast of Central America, Colombia and Venezuela, and 24 Caribbean island states. The CLME largely corresponds to the boundaries of the Caribbean Sea, the second largest sea in the world.

The Caribbean Sea supports a broad array of commercial and subsistence fisheries and constitutes a sub-area of a distinct and globally important bio-geographic region of coral reef development. The majority of corals and coral reef-associated are endemic, making the region biogeographically distinct with high levels of endemism. The CLME has the greatest concentration of marine species in the Atlantic Ocean and is a global-scale hotspot of marine biodiversity. There is a high degree of connectivity resulting from the influence of currents and species migration. At least 12,046 marine species have been reported in the Caribbean Sea, and approximately 1,400 fish species have been recorded there.

The CLME supports commercial, subsistence and recreational fishing; but is also important for the shipping industry, and recreational and tourism activities. It performs ecological roles such as the provision of essential fish habitats; nursery and recruitment grounds, while also supporting commercial shipping and recreational boating/ yachting activities.

*Source*: Spalding, Green and Ravilious 2001; AIMS 2002; Miloslavich *et al.* 2010; UNDP/GEF CLME+ Project 2013; Muñoz Sevilla and Le Bail 2017; One Shared Ocean 2018; http://www.lmehub.net/




## The North-Brazil Shelf Large Marine Ecosystem (NBSLME)

**Total area:** 1 million km² | **Coastal area:** 508,610 km² | **Population:** 9.6 million (2010) | **Population density:** 19 persons per km² | **Coastal poor:** 2.1 million or 22% of coastal dwellers

The North-Brazil Shelf Large Marine Ecosystem extends along north-eastern South America from the boundary with the Caribbean Sea in the north-west to its southern limit near the Parnaiba River estuary in Brazil. It includes Guyana, Suriname, French Guiana, Venezuela and Northern Brazil (Amapá, Pará, Maranhão States). The littoral area extends from eastern part of Venezuela in the west to the Brazilian State of Maranhão in the east.

The NBSLME is enriched and dominated by the discharge of large rivers, including the Amazon and Orinoco, and by the intense disturbance of sediment transport, tides and currents. High volumes of water and nutrients are transported by the North Brazil Current through this LME into the Caribbean Sea. The highly productive North Brazil Shelf supports important fisheries and has moderate levels of biodiversity characterised by an important degree of endemism. The sea bed is formed mainly by mud in the shallows, and by sand, mud, and gravel at greater depths. The estuaries, coastal lagoons and mangroves of this LME provide habitat for marine turtles and mammals (notably the marine manatee) as well as birds, and various fish species. Several threatened bird species, such as the scarlet ibis, occur and reproduce in the area.

The NBSLME has important groundfish shrimp fisheries, with its shrimp resources supporting one of the most important export-oriented shrimp fisheries in the world. It has high numbers of collapsed and overexploited fish stocks and high proportions of catch from bottom impacting gear.

*Source*: Phillips *et al.* 2011; Isaac and Ferrari 2016; UNDP/GEF CLME+ Project 2013; One Shared Ocean 2018; http://www.lmehub.net/

# 1.3 Distribution of coral reefs, mangroves and seagrass beds in the wider Caribbean

## 1.3.1 Coral reefs

Coral reefs are found along insular and continental coastlines throughout the wider Caribbean (Figure 1.4). Caribbean coral reefs are varied in structure and species composition, and include numerous benthic habitat types such as coral, hard bottom, rubble, algae (macro, turf, coralline crustose), gorgonians, sponges, other sessile invertebrates, seagrass, sand, and unconsolidated areas. Coral reef structures can be dominated by reef-building hard corals, gorgonians (soft corals), invertebrates such as sponges or by algae. Coral reefs throughout the region have different formations and include barrier, linear, fringing, wall, atoll (although not formed through volcanic subsidence as seen in the Pacific), patch, and spur and groove formations. Many coral reefs in the region are fringing reefs that parallel coastlines or encircle islands. Coral reefs are found at multiple depths, from very shallow nearshore areas, such as those surrounding the islands of The Bahamas and the Lesser Antilles, to mesophotic coral ecosystems, which are deeper than 30 metres.

Reef types and coral reef cover within reef habitat vary across the three LMEs. At the country level, there are some specific and current benthic maps including coral cover for numerous sites, but comprehensive and up-to-date basic mapping of coral reef cover at the regional level is not available.

Within the CLME, the Mesoamerican Reef system, which stretches more than 600 miles along the coasts of Mexico, Belize, Guatemala, and Honduras and includes the Belize Barrier Reef Reserve, is the largest transboundary barrier reef and second largest barrier reef in the world. A second, smaller barrier reef lies north of Providencia Island, Colombia, in the southwest Caribbean. Many of the CLME's islands are surrounded by fringing and patch reef habitat. The CLME also hosts mesophotic reef systems such as those found near The Bahamas, Cuba, United States Virgin Islands (USVI) and Puerto Rico.


Figure 1.4 Distribution of Coral Reefs in the Wider Caribbean

*Source: coral reef (WCMC - 2018), Cartagena Convention area (UNEP-CEP - 2017), land (GADM - 2018).*

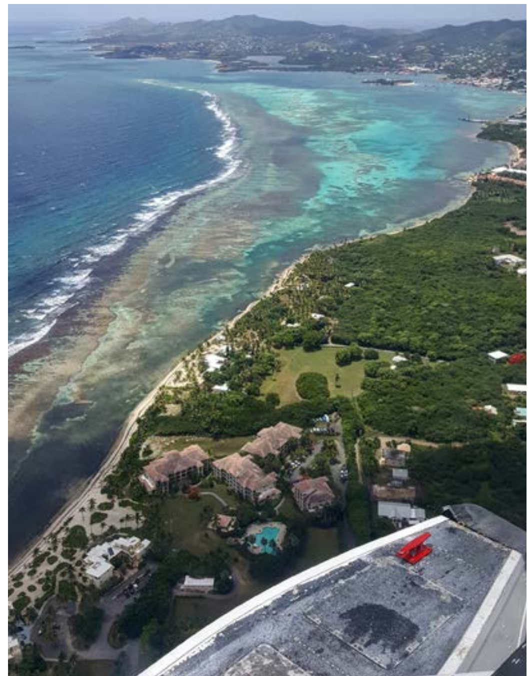



Figure 1.5 Caribbean reefs occur in many forms including linear and fringing reefs found along shorelines and around cays

*Photos by Leslie Henderson 2017 and 2018*

Major reef systems in the GoM-LME include the Flower Garden Banks Reef off the coast of Texas, USA, the Lobos-Tuxpan Reef System and the Campeche Bank Reefs off the coasts of Veracruz and the Yucatan, Mexico. The GoM-LME also contains mesophotic reef areas. During the summer of 2019, six new coral reef areas were reported in the southwest Gulf of Mexico offshore of Veracruz, Mexico, that together comprise a 310-mile-long coral reef corridor (Ortiz-Lozano *et al*. 2019). The newly discovered reef areas include structures at multiple depths, cover a surface area of approximately 1,100 hectares and include a reef structure that is the longest and northernmost reef in Mexico. The identification of these previously undocumented reef areas highlights the need for continued coral reef mapping and characterisation efforts, incorporating local and traditional knowledge sources and the use of emerging technologies throughout the region.

Within the NBSLME, a number of small reefs occur off the coast of Brazil. Just 0.01% of this LME is covered by coral (Global Distribution of Coral Reefs 2010 cited in One Shared Ocean 2018).

There are approximately 62-69 (Veron COTS website and IUCN list, respectively) recognised species of hard corals in the wider Caribbean; many of these are widely distributed but also endemic to the region due to the long isolation of the West Atlantic from the Pacific Ocean. Among the more widespread genera are *Acropora, Monastrea, Porites, Agaricia, Diploria, Colpophylia, Meandrina, Mycetophyllia, Dendrogyra* and *Millepora*. Twenty-two of these species are common to all eight sub-regions identified in Veron *et al*. (2016) (Figure 1.7). Coral species distribution varies across the region, with coral species homogeneity across the Caribbean, except for Guatemala and Trinidad and Tobago where there is less coral diversity (Miloslavich *et al*. 2010). According to Veron *et al*. (2016), the number of hard coral species estimated to be present in each of the following eight greater Caribbean sub-regions is as follows:

- Flower Garden Banks - 27
- Bay of Campeche, Yucatan – 49
- The Bahamas and the Florida Keys – 62 (one species, *Oculina robusta*, is limited to this sub-region)

- Belize and west Caribbean – 60
- Hispaniola, Puerto Rico and the Lesser Antilles – 59
- Jamaica – 59
- Cuba and Cayman Islands - 59
- Netherlands Antilles and south Caribbean – 52

Figure 1.6 Hard, scleractinian, corals such as *Acropora palmata*, *A. cervicornis* and *Diploria strigosa* are responsible for building the structure of the reef, which supports significant biodiversity and provides ecosystem services

*Photos by Leslie Henderson 2019*


Figure 1.7 "Corals of the World Ecoregions" in the Wider Caribbean

*Source: Veron et al. 2016*

## 1.3.2 Mangroves

Mangroves are widespread along the coasts of 34 countries and areas in the wider Caribbean (Figure 1.8), with mangrove cover across the three LMEs ranging from 0.98% of the NBSLME to 0.36% in the GoM-LME to 0.35% of the CLME. The NBSLME has the highest mangrove coverage of any LME, at 10,429 km2 (US Geological Survey 2011 cited in One Shared Ocean 2018). Mangroves occur in a range of coastal habitats and therefore form a range of community types, including: in cays that are entirely inundated during high tide; in fringing communities along semi-protected coastlines; in brackish and salt ponds; in estuaries; and even in inland areas with no apparent above-surface connection with the sea. The structure of mangrove forests varies based on location and physical conditions, with the most highly developed communities (extensive areas with large trees) in estuaries.


Figure 1.8 Distribution of Mangroves in the Wider Caribbean

*Source: mangrove (TNC/CLME+ - 2016), Cartagena Convention area (UNEP-CEP - 2017), land (GADM - 2018)*

Mangrove communities within the CLME typically contain five to six species of mangroves, with black mangrove (*Avicennia germinans*), buttonwood (*Conocarpus erectus*), white mangrove (*Laguncularia racemosa*), and red mangrove (*Rhizophora mangle*) being the most common species (Food and Agriculture Organization [FAO] 2007a and 2007b). Of the 10 species of mangroves native to the North and Central America region, four species – *Avicennia bicolor*[11], *Pelliciera rhizophorae*, *Rhizophora harrisonii*, and *Rhizophora racemosa* – are considered to be Rare, occurring in only a few countries (FAO 2007a). The endemic Central American *Pelliciera rhizophorae* is the only mangrove species occurring in the wider Caribbean that is listed as Vulnerable on the IUCN Red List of Threatened Species (Ellison *et al*. 2010).

Caribbean mangrove forests supposedly host the world's richest mangrove-associated invertebrate fauna such as shrimp and oysters (Cavender-Bares *et al*. 2018), 12 species of mangrove-dependent fish (Serafy *et al*. 2015), and provide foraging and nesting areas for hawksbill turtle (*Eretmochelys imbricate*), green turtle (*Chelonia mydas*), and loggerhead turtle (*Caretta caretta*) (Sealey *et al*. 2018). Jameson

11 This species has been assessed as Vulnerable on the IUCN Red List of Threatened species but is found only on the Pacific coast of Central America (Duke 2010). Avicennia bicolor. The IUCN Red List of Threatened Species 2010: e.T178847A7625682. http://dx.doi.org/10.2305/IUCN.UK.2010-2.RLTS.T178847A7625682.en.

Figure 1.9 Mangroves can be found throughout the Caribbean, often found along coastlines and salt ponds

*Photo by Paige Rothenberger, 2008*

*et al*. (2018) report that at least three fish species of conservation significance found on the Nicaragua Caribbean coast rely on red mangrove habitat at different life stages. The three species are *Pristis perotteti*, smalltooth sawfish (*Pristis pectinata*), and goliath grouper (*Epinephelus itajara*). Serafy *et al*. (2018) note that mangrove forest area was the primary abundance-limiting factor for eight species of reef fish studied, suggesting that the structure, location, and quantity of mangrove areas will have an impact on reef fish abundance.

Mangrove communities also function as nesting and foraging areas for local and migratory species of birds, and a review of the profiles of 24 Ramsar sites in the Caribbean found that 22 of the sites contained mangroves.

## 1.3.3 Seagrasses

Seagrasses are located throughout the wider Caribbean, growing in lagoons between beaches and coral reef or forming extensive meadow in protected bays and estuaries.

The seagrass habitat is acknowledged to be one of the most valuable and vulnerable ecosystems. With extensive distribution along both insular and continental coastlines (Figure 1.11), seagrass is considered one of the characteristic coastal features of the CLME, with coverage estimated to be approximately 66,000 km2 in 2010 (Miloslavich *et al*. 2010).

There are eight species of seagrass in the Caribbean; seven are native to the region and one is an invasive species. Native species include turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), shoal grass (*Halodule wrightii*), widgeon grass (*Ruppia maritima*), star grass (also known as Engelmann's seagrass) (*Halophila engelmannii*), clover grass (*Halophila baillonii*), and paddle grass (*Halophila decipiens*). The invasive species, discovered in the Caribbean in 2002, is *Halophila stipulacea*. Six distinct species of seagrasses have been identified in the bays, lagoons, and shallow coastal waters of the northern GoM-LME. In addition to turtle grass, manatee grass, paddle grass, shoal grass, and star grass they include a freshwater species, widgeon grass (*Ruppia maritima*), which is also saline tolerant. The most common species are turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), and shoal grass (*Halodule wrightii*). Although the three species are often found in mixed beds, by far the most common is *Thalassia testudinum*, which also occurs by itself in large beds.

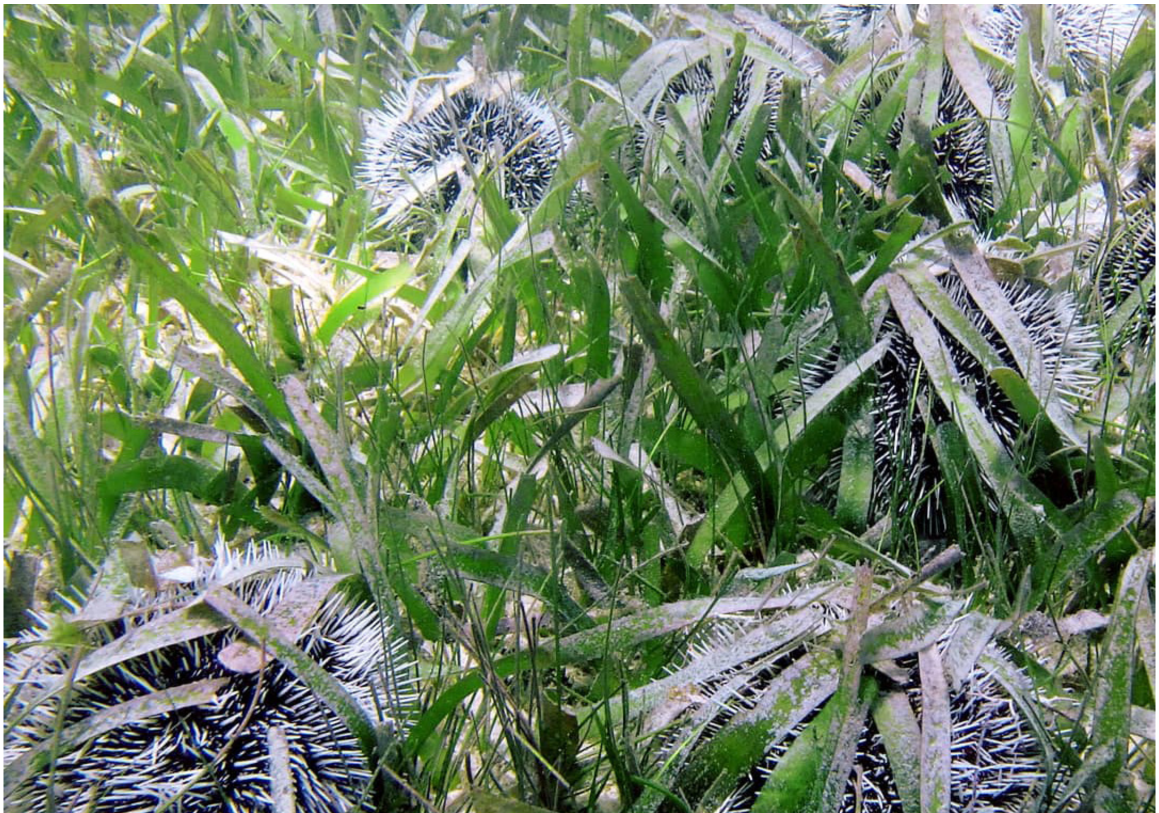


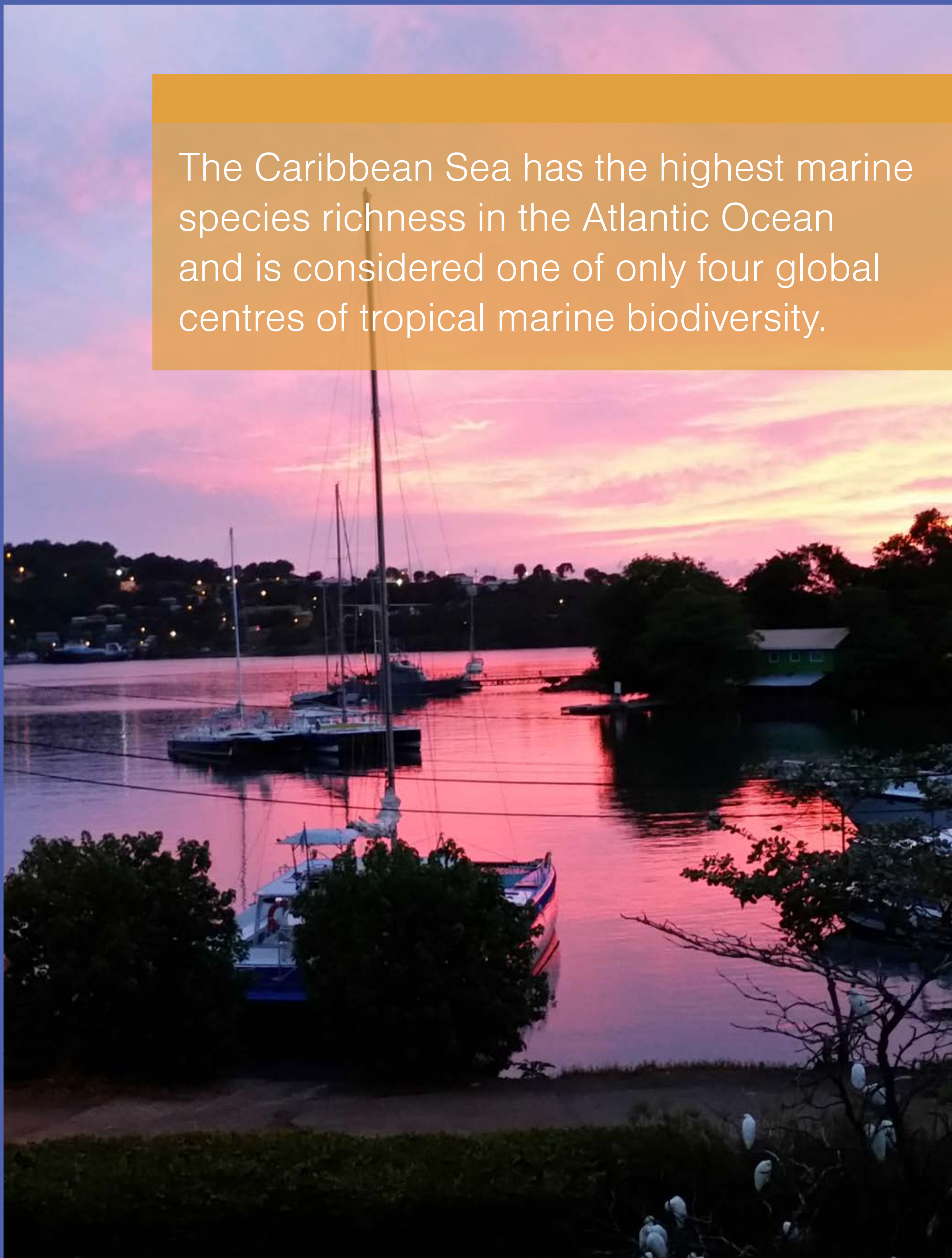
Figure 1.10 Seagrass areas are often dominated by turtle grass (*Thalassia testudinum*) and manatee grass (*Syringodium filiforme*) and provide habitat for numerous species including sea urchins, like these West Indian Sea Eggs (*Tripneustes ventricosus*) as seen in this picture

*Photo by Leslie Henderson, 2019*


Figure 1.11 Distribution of Seagrass Meadows in the Wider Caribbean

*Source: seagrass (TNC/CLME+ - 2017), Cartagena Convention area (UNEP-CEP - 2017), land (GADM - 2018)*

Seagrasses grow primarily at shallow depths along coastlines, typically in salt and brackish water and in sand or silt soils. They are found most commonly in the subtidal zone (one to three metres), but are also frequent in the intertidal zone, particularly in protected coastlines (such as estuaries and coves). Globally, the deepest growing seagrass, paddle grass (*Halophila decipiens*), has been found at depths of 58 metres. In the Caribbean, Halophila decipiens has been identified in the British Virgin Islands at depths greater than 20 metres (Gore *et al*. 2018) and in the USVI (Brewers Bay, St. Thomas) at a depth of more than seven metres (Project Seagrass 2018). Widgeon grass (*Ruppia maritima*), which is viewed as either a salt-tolerant freshwater grass or a true seagrass, is the least common in the Caribbean even though it can withstand a range of salinities. It has been identified in the British Virgin Islands, mainly in salt ponds (Gore *et al*. 2018).



The Caribbean Sea has the highest marine species richness in the Atlantic Ocean and is considered one of only four global centres of tropical marine biodiversity.

*Photo by P. Rothenberger*

# 2 Social and economic importance of nearshore marine habitats in the Caribbean

## Key messages

- The marine environment is central to the long-term sustainability of the economies of the wider Caribbean and linked to the health of the habitats and ecosystems of the three LMEs.
- The Caribbean Sea accounts for 14 to 17% of the global ocean economy and provided approximately US$407 billion (in 2012) to the more than 134 million people who live in close proximity to the sea.
- The estimated US$407 billion provided by the Caribbean Sea is only a fraction of the total economic value of the goods and services provided by the coastal ecosystems in the region. This undervaluation results mainly from the inability of current valuation methods to account for all the services provided by ecosystems, particularly the indirect uses and services with non-use values.
- The Caribbean Sea has the highest marine species richness in the Atlantic Ocean and is considered one of only four global centres of tropical marine biodiversity.
- Studies have estimated that the economic value of intact ecosystems, such as mangroves, is three to four times the economic value of development activities that replace such intact ecosystems. Healthy ecosystems, therefore, provide higher economic returns than degraded ecosystems.
- A significant proportion of the population in the wider Caribbean lives in the coastal zone and is highly dependent on marine resources for recreation, livelihoods, health, well-being, culture and spirituality.
- Activities that degrade, physically alter, or destroy coastal habitats and ecosystems reduce the economic potential of those natural systems, constrain economic development, and adversely affect the well-being of people of the wider Caribbean.

## 2.1 Economic sectors

More than 134 million people who live on or near the coast are supported by the Caribbean Sea's ocean economy. The area of the Caribbean Sea makes up just one percent of the global ocean, but it accounts for between 14 and 27% of the global ocean economy. A 2016 study by the World Bank (Patil *et al*. 2016) put the economic value of the Caribbean Sea alone to the region – including all its services and support to fishing, transport, trade, tourism, mining, waste disposal, energy, carbon sequestration and drug development – at US$407 billion per year in total, of which US$54.55 billion can be directly linked to coastal and marine ecosystems (see Table 2.1). This estimated value, which is based on 2012 data, is projected to nearly double by 2050. But significantly, this figure is likely an underestimation because the region's ocean economy is still not well measured or understood (Patil *et al*. 2016).

**Table 2.1:** Snapshot of the marine habitats-related economic sectors/ industries of the Caribbean Sea[12]

| Type of activity | Ocean service | Economic sector/ industry | Indicative annual gross revenues (US$, billions in 2012 U.S. Dollars) | | | Notes/ methods |
|---|---|---|---|---|---|---|
| | | | Island states and territories | Mainland countries | Total | |
| **Harvesting of living resources** | Seafood | Fisheries | 0.37 | 4.62 | 4.99 | Based on catch data from FAO and value per metric ton from cited studies |
| | | Aquaculture | 0.04 | 1.86 | 1.90 | Based on FAO data |
| | Marine biotechnology | Pharmaceutical chemicals, and so on | n.a | n.a | n.a | Data not available, though noted that a number of drugs have been developed form Caribbean coral reefs |
| **Commerce, tourism and trade** | Tourism and recreation | Tourism | 47.1 | n.a | 47.10 | Tourism in the Island States and Territories projected to increase to over US$70 billion per year by 2024 |
| **Indirect contribution to economic activities and environments** | Carbon sequestration | Blue carbon (that is, coastal vegetated habitats) | 0.02 | 0.07 | 0.09 | Assumptions used on total mangrove coverage, constant rate of mangrove loss, carbon storage and social cost of carbon |
| | Coastal protection | Habitat protection, restoration | n.a | n.a | 1.47 | Protection value of Caribbean coral reefs, estimated by World Resources Institute in 2004 |
| | Waste disposal for land-based industry | Assimilation of nutrients, solid waste | n.a | n.a | n.a | Data not available |
| | Existence of biodiversity | Protection of species, habitats | n.a | n.a | n.a | Data not available for any payments to protect Caribbean Sea biodiversity, nor global willingness-to-pay |
| **TOTAL** | | | | | **54.55** | |

*Source: extracted from Patil et al. 2016*

12 Does not include extraction of non-living resources (minerals, oil and gas) and generation of new resources (freshwater), nor the transport and trade sectors (shipping and ports). When these are included the total value was estimated at US$406.99 billion.

In 2016, the Gulf of Mexico ocean economy made a US$111.4 billion contribution to the combined GDP of the five USA states bordering the GoM-LME – Alabama, Florida, Louisiana, Mississippi and Texas (National Ocean Economics Program 2018). Paradoxically, many of the economic activities that are based on the use of the sea and its resources have contributed to the degradation of the very ecosystems that sustain them. For example, owing to increased sea temperatures due to climate change (see section 3.2) the reduction in coral cover and its associated fisheries production is expected to lead to a potential net revenue loss of between US$95-140 million (current net revenue is US$310 million) per year in the Caribbean basin by 2015 (Trotman *et al*. 2009).

The long-term sustainability of the economies of the wider Caribbean is linked to the health of the ecosystems of the three LMEs.

## Tourism

Tourism is one of the most important economic sectors in the wider Caribbean, particularly in SIDS, where the sector often generates the largest share of foreign exchange earnings.

On average, Gulf-based tourism income contributes nine percent to the national GDPs of the GoM-LME coastal states (Table 2.2). Between 2004 and 2013, the GoM-LME grossed an average of US$252 billion in tourism revenues (One Shared Ocean 2018). Mexico's ocean economy derives US$9.2 billion annually from tourism from the Gulf of Mexico region (UNIDO Project Coordination Unit 2011). In 2016, tourism and recreation generated just over $19 billion in GDP for the counties of the USA States bordering the Gulf of Mexico and just over 0.6 million jobs (National Ocean Economics Program 2018).

Tourism income contributes approximately 18% to the national GDPs of CLME states. For the period 2004-2013, the CLME generated annual revenues of US$90.5 billion. The economies of several Caribbean island states rely heavily on tourism. For example, nearly one-third, or 30.3%, of the economy of the British Virgin Islands is derived from tourism and related activities, and in 2014, tourism generated some US$290 million in revenue there. Tourism contributes 28.6% to Aruba's economy and 21% to Anguilla's. In The Bahamas, tourism accounts for over half of all jobs and makes up 19.4% of the overall economy (Pariona 2017).

Figure 2.1 Beautiful sandy beaches and turquoise waters are an integral part of the tourism wider Caribbean's tourism product

*Photo by Leslie Henderson, 2019*

The NBSLME generated tourism revenue of approximately US$6.541 billion for the period 2004-2013. Tourism activities in the countries surrounding the LME contribute nine percent to GDP (One Shared Ocean 2018).

**Table 2.2:** Economic Contribution of Coastal/Marine-Dependent Sectors in the Wider Caribbean

| Sector/Industry | Gulf of Mexico LME | Caribbean Sea LME | North Brazil Shelf LME |
|---|---|---|---|
| Annual Tourism Revenues* 2004 - 2013 | $252 billion | $90.5 billion | $6.541 billion |
| Tourism contribution to GDP* | 9% | 18% | 9.5% |
| Fisheries Annual Landed Value* 2001 - 2010 | $1.7 billion^ | $ 0.81 billion^ | $0.561 billion^ |
| Shipping | $0.38 billion | Not available | Not available |
| Annual Oil & Gas Revenues | $77.6 billion+ (2011 data) | 0.1478 billion† (Trinidad & Tobago only, 2017) | Not available |

^ Ex-vessel income *One Shared Ocean, 2018 † Khan, 2018 + UNIDO Project Coordination Unit, 2011

## Fisheries

The fisheries sector is a source of nutrition, employment, recreation and foreign exchange in the wider Caribbean. While the fisheries in the Caribbean are primarily small-scale and subsistence, those of the Gulf of Mexico and North Brazil Shelf include large-scale commercial efforts.

The countries of the GoM-LME generated a yearly average ex-vessel income from fisheries of US$1.7 billion for the years 2001-2010. The region's coastal communities get an average of eight percent of its total animal protein from fish (One Shared Ocean 2018). The GoM-LME also supports a profitable commercial fishing industry, with 758,000 tonnes of fish landed in 2010, worth US$979 million, with Mexico landing 29% of the catch and the USA the rest. Mexico's ocean economy derives US$0.38 billion from fisheries annually from the GoM-LME (UNIDO Project Coordination Unit 2011).

The CLME generated a yearly average ex-vessel earning of US$810 million for the period 2001-2010. The artisanal and subsistence fisheries of the Caribbean Sea provide about nine percent of the total animal protein for the coastal populations of the LME (One Shared Ocean 2018). The region's fisheries are based mainly on medium pelagic species, lobster, shrimp and molluscs (Muñoz Sevilla and Le Bail 2017). They also provide livelihoods for many people in the harvest and post-harvest sectors (Critical Ecosystem Partnership Fund 2019). Artisanal fisheries are the backbone of the local economy in many rural coastal communities and can be an important aspect of cultural identity. The CLME region has become more dependent on pelagic fisheries due to the diminishing reef and nearshore fisheries caused by habitat destruction, alien invasive species like the lionfish, and overfishing. In the CLME+ region, countries of the Lesser Antilles are now the main pelagic fishing countries, and except for Venezuela and the USA, Guadeloupe and Martinique provide substantial markets for pelagic species, open to the European market (United Nations Development Programme [UNDP] 2015).

The NBSLME's estimated total ex-vessel income from fisheries was US$561 million for the years 2001-2010. The region's coastal communities get nine percent of their animal protein from fish (One Shared Ocean 2018). In 2010, the region recorded a total catch of 415,000 tonnes per year, with Brazil accounting for the largest proportion (57%). The fisheries in the NBSLME, unlike the CLME, include industrial fleets, along with artisanal fisheries. The small-scale fisheries utilise gill-net and long lines, and corrals for fish, as well as manual collection for some species such as crabs and bivalves. Industrial shrimp fleets use lines, traps and trawlers (Muñoz Sevilla and Le Bail 2017). The region's demersal fisheries and shrimp, specifically, red snapper and Atlantic seabob shrimp (Xiphopenaeus kroyeri) fisheries hold high economic value. The fishing sector accounts for four percent of GDP in Suriname (WTO 2007 cited in Smith and Burkhardt 2017) and in 2017, contributed two percent to Guyana's GDP (Private Sector Commission 2019) (see Table 2.3).

**Table 2.3:** Comparison of the value of fisheries in the three LMEs in the wider Caribbean

| | GoM-LME | CLME | NBSLME |
|---|---|---|---|
| **Ex-vessel income 2001-2010** | US$1.7 billion | US$810 million | US$561 million |
| **Percentage of animal protein from fish for coastal communities** | 8% | 9% | 9% |
| **Total catch in 2010** | 758,000 tonnes | 148,509 tonnes | 415,000 tonnes |
| **Value of 2010 catch** | US$979 million | US$583 million | n.a |

*Source: UNIDO Project Coordination Unit 2011; Muñoz Sevilla and Le Bail 2017; One Shared Ocean 2018; Masters 2012*

## Recreational fishing and wildlife observation activities

Sportfishing generates considerable income in some countries, such as The Bahamas where it contributes an estimated US$500 million annually to the national economy through related expenditures by tourists and employs some 18,000 Bahamians (FAO/Department of Marine Resources 2016). Marine sport-fishing is also important in providing jobs in the GoM-LME. In 2010, an estimated 22 million fishing

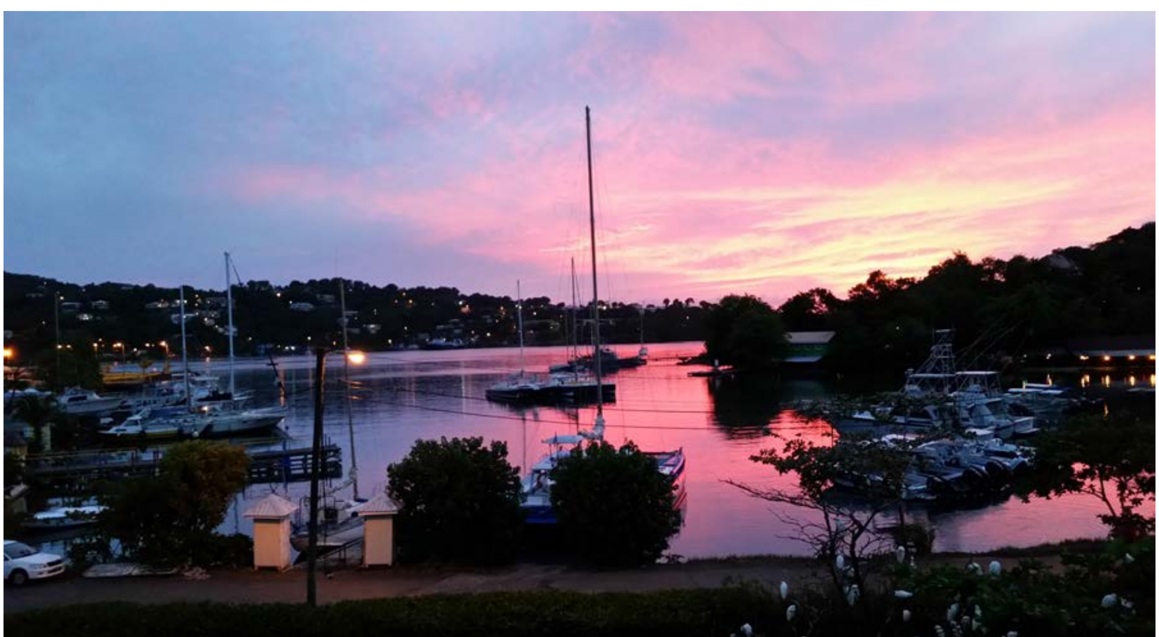


Figure 2.2 Marina full of sportfishing and sail charter boats in Castries, Saint Lucia

*Photo by Paige Rothenberger*

trips were taken which landed 147 million fish in the GoM-LME (UNIDO Project Coordination Unit 2011). In 2016, in the USA alone, associated sport fishing expenditures (on both fishing trips and durable equipment purchases) across the GoM-LME totalled US$11 billion (National Marine Fisheries Service 2018). Wildlife observation and interaction activities are growing in popularity in some CLME countries, with whale watching tours contributing approximately US$23 million to the regional economy in 2008. Whale and shark-related activities in Belize are worth upwards of US$1.23 million, while diving with sharks in The Bahamas generated US$78 million in revenue in 2007 (UNDP 2015).

## Shipping

The expansion of the Panama Canal in 2016 has increased maritime transport activity across the entire wider Caribbean. Shipping generates an estimated US$0.38 billion annually in the GoM-LME, while Mexico's ocean economy derives $0.05 billion from transportation/shipping (UNIDO Project Coordination Unit 2011). Ten of the most active USA ports are located in the Gulf, and two ports in Mexico receive an estimated 80% of total imports for the region (Mendoza-Alfaro and Alvarez-Torres 2012). While the volume of global transhipment activities in the CLME has increased, the CLME is yet to capitalise on the full economic potential of the New Panamax Era. Transhipment is expected to increase between 2020 and 2025 when larger ships, which cannot be efficiently handled by USA east coast ports, will be deployed (Rodrigue and Ashar 2015).

## Oil and gas

The wider Caribbean has substantial capacity in oil and gas production, particularly the USA, Guyana, Venezuela and Trinidad and Tobago. The NBSLME is one of the most productive regions for oil and gas. In the GoM-LME, the oil and gas sector is a significant economic driver, providing employment and stimulating infrastructural growth with annual revenues from oil and gas totalling US$77.6 billion (UNIDO Project Coordination Unit 2011).

Trinidad and Tobago is the most established and largest oil and gas producer in the CLME, with the energy sector contributing approximately 34.9% of the country's GDP. Countries like Belize have a moratorium, or in the case of Costa Rica have banned oil exploration, while others like Aruba, The Bahamas and Jamaica are at various stages of exploration.

In Brazil, exploration has extended to northern Brazil, in both shallow and deep-water wells just 60 km off the coast. The recent discovery and exploration of oil in Guyana will also have a tremendous impact on the NBSLME and, by extension, the entire wider Caribbean. With oil reserves estimated to be worth over US$200 billion, Guyana is poised to become one of the principal oil-producing countries in the Southern Hemisphere (Krauss 2017). Oil production began in 2020, projected to average 102,000 barrels/day rising to an average of 424,000 barrels/day in 2025 (International Monetary Fund 2019).

## Subsistence activities

The livelihood strategies of many coastal communities throughout the wider Caribbean include the use of coral reefs and mangroves at an artisanal or subsistence level. Activities include aquaculture and fishing, beekeeping, charcoal production and extraction of wood for the construction of fish pots, planting sticks, racks used in the culture of oysters, use of mangrove bark for tannin in the leather industry and use of coral products as construction materials (See Table 2.4). While these activities are often done at a subsistence level, they are generally an important component of the local economy.

# 2.2 Ecosystem services and human well-being

Coral reefs, mangroves and seagrass beds provide a wide range of ecosystem goods and services as single sub-systems or as linked systems and these are critical to the economies and human well-being of the countries of the wider Caribbean (Table 2.4). While the direct use values (such as tourism, fisheries) of nearshore marine resources are captured in national accounting, the non-direct use values (such as marine species nursery, wave attenuation, erosion control, climate influence) are typically not. These values, however, can be quite significant. In Belize, for example, coastal habitats currently prevent the erosion of over an estimated 300 km2 of Belizean mainland, atolls, and cays, resulting in avoided damages of more than US$2 billion on average per year (Arkema *et al*. 2015).

## Coral reefs

Coral reefs protect approximately 21% of the Caribbean coastline (Burke and Maidens 2004). The estimated value of this service is between US$700 million and US$2.2 billion. Without reefs to provide these services, the expected annual damages from flooding events would possibly double, and costs associated with frequent storms would triple (Beck *et al*. 2018). The annual value of this coastal protection service to coastal capital in 14 locations throughout the region is shown in Figure 2.5.

Coral reefs are nursery habitat for numerous ecologically and commercially important marine species and are a source of compounds for modern medicines (see Table 2.4).

Reefs support fishing and tourism, two key drivers of the region's economies. Coral reefs contribute to the sandy beaches the region is known for. Through the actions of sea urchins and parrotfish, huge volumes of sand are produced (Ogden 1977; Morgan and Kench 2016). The structure of reefs mitigates

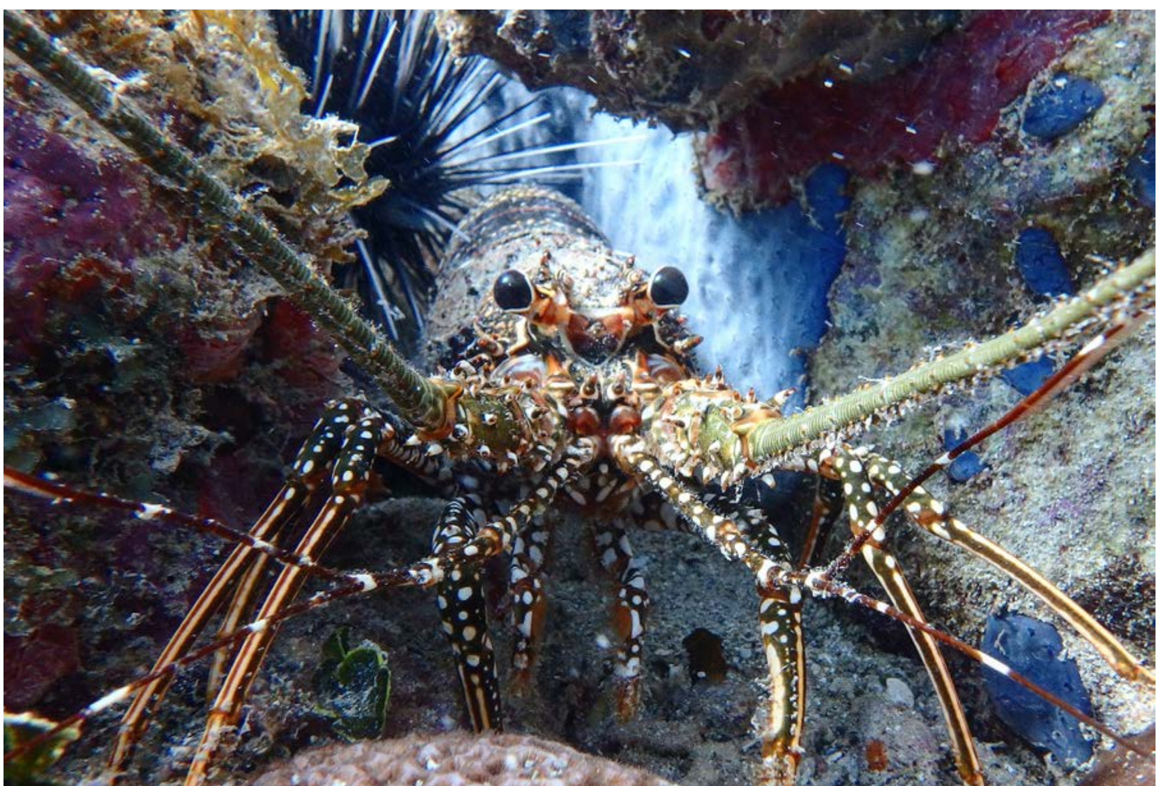


Figure 2.3 Coral reefs support significant biodiversity, including economically important species such as spiny lobster

*Photo by Leslie Henderson, 2017*

Figure 2.4 Coral reefs and calcareous algae are sources of the fine, white sandy beaches that support the tourism sector. Coral reefs also act as barriers protecting shorelines and help to keep sand from washing away during storm events

*Photo by Leslie Henderson, 2019*

against beach erosion. Combined, these processes enable the region's beaches to exist and grow, which directly benefit the tourism economy and human well-being. Data from the Mapping Ocean Wealth tool show that coral reefs in portions of the Caribbean generate approximately US$8.347 billion per year for the tourism industry, with a visitation value of approximately 10.2 million visitors per square kilometre (km2). This visitation value includes combined values of on-reef visitation such as recreational diving and snorkelling as well as off-reef adjacent value such as calm waters, coral sand beaches, views and seafood (K. Longley-Wood, The Nature Conservancy, pers. comm. November 6, 2018).

| **Coastal Protection Value of Caribbean Coral Reefs in Numbers^** |
|---|
| **168 km²**<br>Annual expected area protected from flooding |
| **33,991**<br>Annual expected number of people protected from flooding |
| **$1,487,371,257**<br>Annual expected built capital protected from flooding |
| **$1,107,894,701**<br>Annual expected built capital protected from damage (Replacement cost) |

^Calculations based on data available for Antigua and Barbuda, The Bahamas, Dominica, South Florida and the FL Keys, Grenada, Martinique, Puerto Rico, Saint Lucia, the USVI, the Dominican Republic, Jamaica, and Mexico

Figure 2.5 Coastal Protection Value of Caribbean Coral Reefs

*Source: Mapping Ocean Wealth/ www.oceanwealth.org*

Reefs support fishing and tourism, two key drivers of the region's economies. Coral reefs contribute to the sandy beaches the region is known for. Through the actions of sea urchins and parrotfish, huge volumes of sand are produced (Ogden 1977; Morgan and Kench 2016). The structure of reefs mitigates against beach erosion. Combined, these processes enable the region's beaches to exist and grow, which directly benefit the tourism economy and human well-being. Data from the Mapping Ocean Wealth tool show that coral reefs in portions of the Caribbean generate approximately US$8.347 billion per year for the tourism industry, with a visitation value of approximately 10.2 million visitors per square kilometre (km2). This visitation value includes combined values of on-reef visitation such as recreational diving and snorkelling as well as off-reef adjacent

value such as calm waters, coral sand beaches, views and seafood (K. Longley-Wood, The Nature Conservancy, pers. comm. November 6, 2018).

Coral reefs also provide difficult to quantify benefits such as global carbon storage and sequestration and intrinsic or existence value. The estimated annual net benefits from regional coral reefs are approximately US$391 million from fisheries, US$720 million from coastal protection, US$663 million from tourism and recreation and US$79 million from biodiversity value (Schumann 2011).

Reefs also support cultural and indigenous identities within Caribbean nations where fishing and bathing are important cultural activities passed down through generations and where reef products are integral to local cuisines or were historically used in construction. The diversity of coral reef types and their distribution throughout the region contribute to their value and ability to provide these ecosystem services but also result in differential vulnerabilities to the suite of threats facing them.

## Mangroves

Mangrove forests are important habitat, feeding, and nursery grounds for fish, molluscs, crustaceans and mammals (see Table 2.4). They protect coastal populations and infrastructure from storms and hurricanes, prevent beach erosion and control floods. They also filter and purify water and maintain nutrient cycling and sedimentation processes. They are carbon sinks, storing organic carbon, which is transformed and stored in biomass logs, roots, branches, leaves, flowers, fruits and sediment. These values are recognised by some countries across the region. For example, the Dominican Republic has developed Nationally Appropriate Mitigation Actions to sequester and store blue carbon through mangrove conservation and restoration. Haiti enacted legislation in 2013 banning any type of mangrove exploitation, destruction, building within mangrove areas, or fishing within mangrove sites. For many coastal communities, mangroves are a source of fuel wood, charcoal and raw materials for fishing gear and construction.

A recent study conducted on Australian mangroves shows that mangrove roots can excrete biochemical compounds that reduce water acidity (i.e. make the pH raise). Therefore, healthy mangroves could

Figure 2.6 Mangrove habitats provide several ecosystem services including protecting shorelines by absorbing wave energy, filtering land-based runoff and providing critical habitat for many organisms

*Photo by Leslie Henderson, 2018*

mitigate ocean acidification, at least in the nearby waters (Sippo *et al.* 2016). It means adjacent seagrasses and coral reefs would suffer less from this growing stressor if they are adjacent to a healthy mangrove ecosystem. Studies are needed to determine whether this is also the case in the wider Caribbean.

The value accorded to mangroves varies widely, depending on the location and the type of services valued, with direct use values (e.g. forestry and recreational tourism) valued significantly higher than non-use values (e.g. coastal protection and nutrient retention). A meta-analysis of valuation studies (Salem and Mercer 2012) found a mean of US$28,662/hectares (ha)/year and a median of US$3,847/ha/year, with the highest service value being forestry (US$38,115) and the lowest service being nutrient retention (US$44). The range of values reflects many variables, such as the GDP of the country, region, and the

**Table 2.4:** Summary of Ecosystem Services Provided by Coral Reefs, Mangroves and Seagrass Beds

| Ecosystem Service | Coral Reefs | Mangroves | Seagrass Beds |
|---|---|---|---|
| **PROVISIONING** | | | |
| • Food (fish and shellfish) | ✓ | ✓ | ✓ |
| • Ornamental resources | ✓ | ✓ | ✓ |
| • Material for use in handicraft | ✓ | | ✓ |
| • Construction material | ✓ | ✓ | |
| • Firewood | | ✓ | |
| • Charcoal | | ✓ | |
| • Non-timber forest products | | ✓ | |
| • Dyes (tannins) | | ✓ | |
| • Natural medicines and pharmaceutical products | ✓ | ✓ | ✓ |
| • Genetic resources | ✓ | | |
| **REGULATING** | | | |
| • Coastal protection/Wave attenuation | ✓ | ✓ | ✓ |
| • Sediment trapping and stabilisation | | ✓ | ✓ |
| • Nutrient cycling | ✓ | ✓ | ✓ |
| • Carbon sequestration and storage/ Climate regulation | | ✓ | ✓ |
| • Shoreline stabilisation | | ✓ | ✓ |
| • Water regulation | | ✓ | ✓ |
| • Nutrient regulation | | ✓ | ✓ |
| • Pollutant assimilation | | ✓ | ✓ |
| • Pollination | | ✓ | ✓ |
| **CULTURAL** | | | |
| • Recreational and tourism value | ✓ | ✓ | ✓ |
| • Knowledge systems and educational val-ue | ✓ | ✓ | ✓ |
| • Spiritual and inspirational value | ✓ | ✓ | |
| • Aesthetic | ✓ | ✓ | |
| • Sense of place | ✓ | ✓ | |
| • Heritage/Beqest value | ✓ | ✓ | ✓ |
| **SUPPORTING** | | | |
| • Habitat for fish and shellfish and other aquatic species | ✓ | ✓ | ✓ |
| • Nursery grounds, feeding areas | ✓ | ✓ | ✓ |
| • Material for the formation and mainte-nance of sandy beaches | ✓ | | ✓ |
| • Detritus to the reef system | | | ✓ |
| • Food (detritus) to offshore habitats | | | ✓ |
| • Soil formation | | ✓ | |
| • Primary production | | ✓ | ✓ |

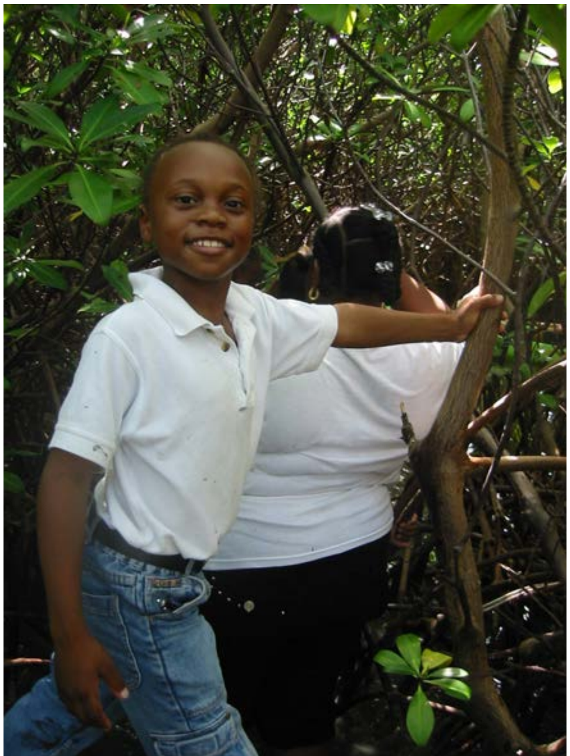


Figure 2.7 Mangrove areas also support cultural and recreational uses and are learning laboratories

*Photo by Paige Rothenberger*


Figure 2.8 Seagrass beds support numerous species including the culturally and commercially important queen conch. Seagrass beds also stabilize sand and provide other important socioeconomic services

*Photo by Henry Tonnemacher*

availability of data on non-use services (such as coastal protection) and ecosystem functioning. Despite the variability in valuing ecosystem services provided by mangroves, studies have suggested that the total economic value of intact mangroves was several times higher than if the mangrove area were converted to another use (Conservation International 2008).

## Seagrass beds

Seagrass beds provide flood reduction and reduce erosion from wave action, thereby increasing shore protection, particularly along beaches and shallow areas. The deposition and stabilisation of sediment benefits adjacent coral reefs. Seagrasses are nutrient sinks, buffering or filtering nutrient and chemical inputs to the marine environment. Seagrass beds provide food and shelter for many marine species at different stages of their life cycles and thus function as nursery areas for commercially important fish species. Seagrass beds are important carbon sinks, though the carbon storage value of seagrass may be underrepresented (Mtwana Nordlund *et al*. 2017). Though there is a significant gap in the information available to determine the variability and value of services provided by seagrasses, globally 28 distinct ecosystem services of seagrasses have been identified (Mtwana Norlund *et al*. 2016). At least 22 of these are provided by the seagrass species found in the wider Caribbean (Table 2.4).

Although seagrasses are a crucial component of coastal communities, the economic value of the services they provide is usually understated and underestimated. In addition to the fact that seagrass beds are common (public property) areas that support a relatively large number of uses and users, the services provided by seagrass beds are mainly indirect use or non-use values. Economic valuation models do not incorporate all the ecological functions of seagrasses, making it difficult to estimate their total economic value. As with mangroves, values accorded seagrasses are highest for direct use values (with commercial values of over of US$80,000/ha/year) and lowest for non-use values (generally under US$20,000/ha/year) (Dewsbury *et al*. 2016).

More intense rainfall from climate change will increase erosion and sediment transport to coastal areas.

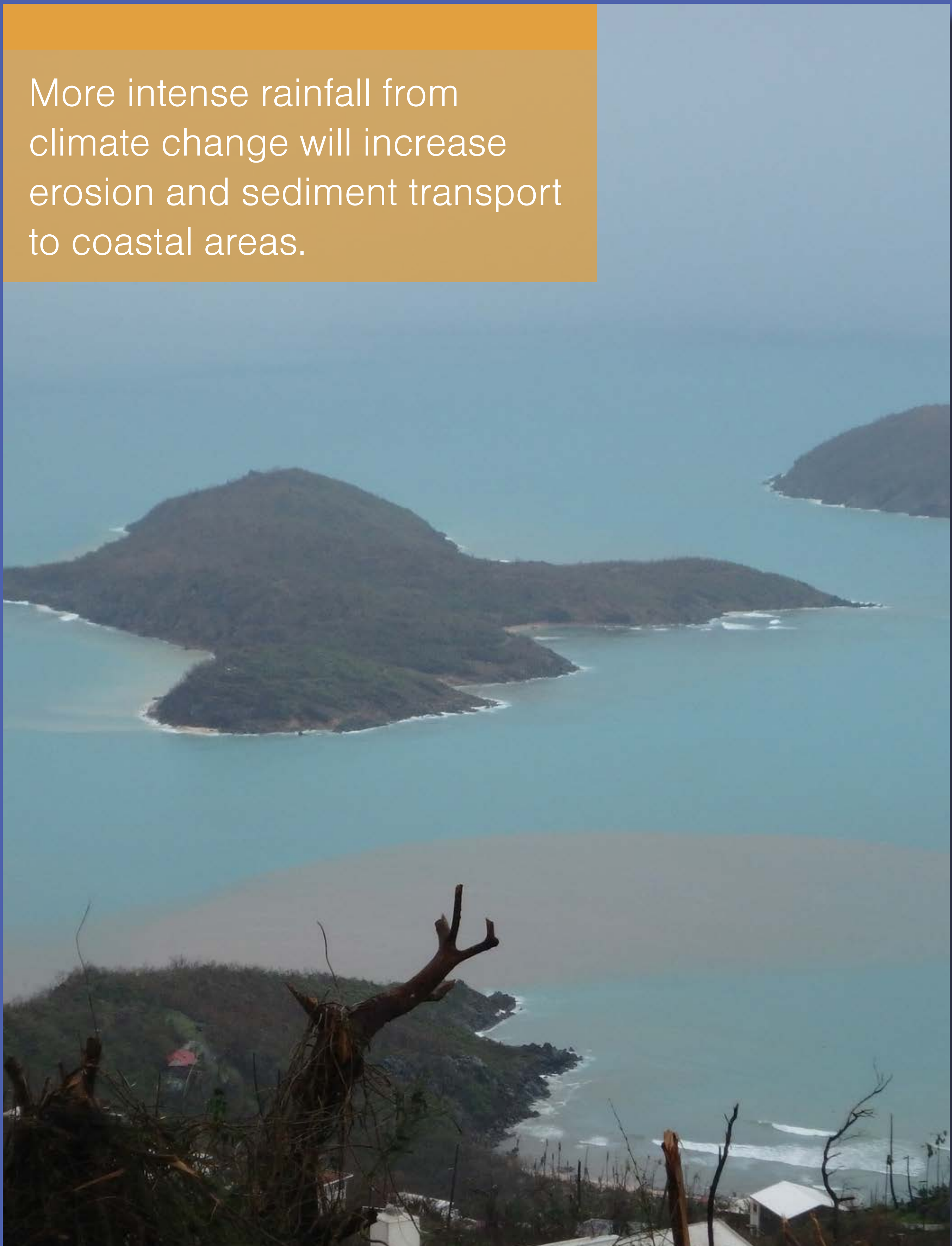


*Photo by L. Henderson*

# 3 Drivers, Pressures and Threats

## Key messages

- For many countries in the wider Caribbean, particularly the islands, the majority of the population, infrastructure, and economic activities are located in the coastal zone. That places great pressure on coastal ecosystems, which provide goods and services for economic development while simultaneously absorbing the wastes and other impacts from development activities.
- The direct human pressures on coastal ecosystems have continued unabated for many decades and in some cases have increased.
- The damage from human activities has compromised the abilities of natural systems to withstand stresses from other sources such as diseases, alien invasive species, intense weather events, and climate change.
- Human stresses on natural systems must be removed or reduced in order to maintain the flow of goods and services from coastal ecosystems. The increasing damage from intense weather events and heightened threats from other sources demand that actions to reduce human stresses must be immediate if wider Caribbean countries are to maintain economic and social stability.

# 3.1 Drivers of change

Drivers are natural or human-induced forces that directly or indirectly cause a change in the environment (Millennium Ecosystem Assessment 2005). The significant and mutually reinforcing anthropogenic drivers of change that are affecting the wider Caribbean's nearshore marine resources include population growth and urbanisation, coastal development, and over-exploitation of natural resources, including overfishing (CLME Project 2011). These trends are occurring against the backdrop of climate change, which both adds pressures and exacerbates existing vulnerabilities.

## Population growth and urbanisation

The wider Caribbean has had historically high growth rates, but as is happening in the rest of Latin America and the Caribbean, the region is undergoing a demographic transition reflecting declining fertility rates and a changing population age structure. According to the latest (2019) population projections from the United Nations, the region's population will begin to decrease in approximately 40 years. The slowing in the region's population growth rate that began in 1990 is expected to shift to a population decline by 2058 (CEPAL-CELADE 2019).

As the region's population continues to grow, albeit at a slower pace than before, there are concurrent trends of structural transformation and urbanisation. The wider Caribbean is the most urbanised region in the developing world, with over 134 million[13] people living on or near the coast. The urbanisation of coastal communities has been the major factor underlying the direct pressures on the Caribbean Sea ecosystem (CARSEA 2007). Urbanisation is particularly high in several CLME SIDS; all of the populations of Anguilla, the Cayman Islands, and Sint Maarten live in urban areas, as do more than 90% of the people of Curacao, Guadeloupe, Puerto Rico, the Turks and Caicos and the USVI (CEPF 2019). The provision of sanitation services has not kept pace with the growing urban populations and most countries are still plagued by insufficient and poorly functioning wastewater treatment infrastructure. Only 37% of domestic municipal wastewater that was generated in the wider Caribbean in 2015 reached treatment plants and 63% was presumably discharged in untreated form (United Nations Environment Programme 2019), threatening people and nearshore habitats.

Fluctuating seasonal populations and intra-regional migration is another dimension of population as a driver of environmental change in the wider Caribbean. The population on many of the smaller islands, such as Aruba, The Bahamas, Barbados, the Cayman Islands, St. Maarten and the USVI, changes during the year due to the seasonal influx of tourists. For example, stop-over tourist arrivals in the USVI between January and May 2015 totalled 373,495, but the resident population only numbers 106,405 people (Caribbean Tourism Organization 2015).

## Coastal development

Urban, residential, tourism, industrial, and port development and infrastructure expansion in the coastal zone have led to the conversion of ecosystems, the depletion of habitats such as seagrass beds and mangroves, damage to coral reefs, and the destabilisation of beaches. The construction along the coast in response to demands from tourism, shipping, and urban infrastructure produces significant adverse impacts on coastal ecosystems, and corresponding impacts on dependent coastal communities. The density of coastal infrastructure also increases the financial risks from climate change and associated impacts like global sea level rise, and weather systems such as hurricanes. Due to the increased intensity of storms and hurricanes, the socioeconomic impacts on coastal development and communities in the wider Caribbean can be disastrous, especially for SIDS.

High tourism dependency has led to a massive amount of capital investment in coastal infrastructure, which has, in turn, damaged the capacity of the ecosystem to provide services to the region. Indeed,

13 This includes the coastal population in the Caribbean Sea LME at 84,263,359; North Brazil Shelf LME at 9,550,602; and Gulf of Mexico LME at 40,522,728 (http://www.lmehub.net/).

the tourism sector has been and continues to be a major contributor to the physical alteration and destruction of habitats in the construction and operation of facilities, and recreational activities (UNEP 1997). In the SIDS of the CLME, most of the coastal infrastructure (hotels, restaurants, marinas, airports) is built to support the tourism industry and shipping, and their economies are therefore extremely vulnerable to climate change (UNEP 2014). While the immediate social and economic impacts of such activities are easy to measure, the indirect longer-term impacts are less obvious and more difficult to quantify. The indirect long-term impacts are usually linked to the adverse ecological impacts of the physical alteration of the habitats, and include habitat loss or degradation, reduced integrity of sand dunes and other coastal barrier systems, reduced species populations, reduced and changed species diversity, decline in productivity and chronic pollution inputs (Gardner 2003).

Countries such as Antigua and Barbuda, Dominica, Jamaica, St. Kitts and Nevis, Saint Lucia, and the USVI have, within the past five years, announced resort, marina, and port development projects that were/are to be located in, or adjacent to, sensitive ecosystems containing corals, mangroves, and seagrasses. Some coastal development initiatives are being framed within blue economy approaches that promote protection of coastal ecosystems (see section 5.10), for example Grenada's Blue Growth Coastal Master Plan. Including the value of this natural capital (which provides climate adaptation and other ecosystem goods and services described in section 2.2) in economic decision-making and environmental impact assessments is critical. Economic costs of not investing in protecting natural capital can be significant. For example, annual loss in net revenue from tourism between 2000 and 2015 attributable to degradation of the region's coral reefs was estimated at US$100-$300 million/year (Burke *et al.* 2011).

Seagrass beds are especially vulnerable to boating-related disturbances like shading by platforms and docks, propeller damage, and human trampling, all of which compromise ecosystem health. Such small-scale disturbances weaken the stability of seagrass beds and lead to increased fragmentation and decline in ecological function (Fonseca and Bell, 1998; Macreadie *et al*. 2009 cited in Trevathan-Tackett *et al*. 2017). Small-scale shading, such as that from docks, has been found to induce seagrass die-offs and compromise the ecosystem's carbon sink function by reducing carbon sequestration capacity and triggering losses of blue carbon stocks (Trevathan-Tackett *et al*. 2017).

## Over-exploitation of natural resources

Throughout the wider Caribbean, marine fishery resources are over-exploited. Overfishing has led to the depletion of key reef species and destructive fishing practices, including the use of inappropriate fishing gear, damages coral reefs and seagrass beds. Fishery resources are used for subsistence, commercial and recreational fisheries, collection and hobby trades as well as illegal, unreported and unregulated (IUU) fishing. Many countries have poorly regulated fisheries, poorly enforced fishery regulations and a lack of political will, which result in unsustainable fishery practices. Additionally, the use of inappropriate and damaging gear types leads to negative impacts on non-target species resulting in bycatch as well as habitat degradation. According to the United Nations Food and Agriculture Organization (FAO), the total fisheries catch by CLME countries within the western central Atlantic has declined from approximately 1.79 million tonnes in the 1990s to approximately 1.25 million tonnes in 2010 (UNDP 2015). Nearly 60% of commercially exploited fishery stocks in the CLME and GoM-LME, and half the stocks in the NBSLME, are either overexploited or have collapsed (One Shared Ocean 2018).

While numerous commercially and ecologically important reef fish species are over-exploited in the wider Caribbean, of particular concern to coral reef ecosystem health and function are herbivores. In many areas of the wider Caribbean, herbivorous parrotfish populations have been over-exploited, to the point where coral reef integrity and resilience are declining. In recognition of this issue, some countries have been putting in place measures to increase their parrotfish populations. For example, parrotfish fishing was first banned in Belize in 2009 (with positive impacts now being seen), and subsequently by countries such as the Dominican Republic in 2017 and in St. Vincent and the Grenadines in 2019.

Exploitation of mangrove resources include conversion for agriculture or aquaculture, extraction of wood for a variety of subsistence and commercial purposes, harvesting of wildlife for food and commerce, and modification for salt production.

## Other processes

Marine transportation: International shipping rules under the United Nations Convention on the Law of the Sea (UNCLOS) grant foreign vessels the right of “innocent passage” through Caribbean waters, exposing the ecosystem to extra pressures of pollution, overfishing, and even the risk of radioactive contamination from shipments of nuclear material.

Governance: Lack of coordinated governance in the region has led to a competitive rather than cooperative approach to issues such as fish stocks and tourism management, to the detriment of the natural environment.

# 3.2 Pressures and threats

The pressures and threats facing marine ecosystems are many and varied (Table 3.1) and may interact with each other in ways not yet fully understood. Some threats are recently emerging and their impacts on habitats and species are not yet fully understood.

**Table 3.1:** Trend of threats to marine ecosystems

| Pressure | Status of threat | CLME | Major findings or other comments |
|---|---|---|---|
| Pollution | ● High | ↗ Increasing | Pollution is from multiple sources. The combined im-pacts of multiple stressors from these pollutants on marine ecosystems is still largely unknown and re-quires further investigation. |
| Invasive species – Pacific lionfish | ● High | ↘↗ Mixed | Eradication of the lionfish is unlikely and impractical, though local efforts to control the population such as targeted harvesting has been shown to be effective. According to the Global Coral Reef Monitoring Network (GCRMN), there are indications that lionfish popula-tions are stabilising or even decreasing at shallower depths due to local harvesting, grouper predation on juvenile lionfish and an ulcerative skin disease. |
| Invasive species - *Halophila stipulacea* | ? Unknown | ? Unknown | Found in Mexico in 2013 and Trinidad in 2018. Re-search is under-way. Its impact is thought to be mixed. It grows and invades fast, it competes for space with Caribbean seagrass species, it is less nu-tritive (for turtles and manatee for instance) and it is not as good at stabilising sand compared to Caribbean species. However, a positive outcome is that it colo-nises areas that were not covered by Caribbean seagrasses therefore helping with stabilising sediments in new areas and creating new ecological niches. |
| Climate Change and Extreme Weather Events | ● High | ↗ Increasing | Climate change has a direct impact on coastal ecosys-tems (e.g. caus-ing coral bleaching), and also amplifies the impact of other drivers of environmental change (e.g. extreme weather events). |
| Disease | ● High | ↗ Increasing | The Caribbean is disproportionately affected by dis-ease and has been considered a hotspot for coral eco-system diseases because of the rapid emergence and spread of diseases, their diversity, high prevalence, wide distribution, numbers of host species and viru-lence. Comprehensive information on the incidence and distribution of dis-eases affecting coral reef eco-systems is lacking. For many diseases the causative agent is still unknown, and mechanisms of infection and transmission poorly understood. A coral disease, Stony Coral Tissue Loss Disease, is currently signifi-cantly affecting many coral reef areas throughout the region (see Box 3.3). |
| *Sargassum* | ● High | ↘↗ Mixed | More research is needed in order to determine the causes of blooms and the ecological and socio-economic impacts. But it is definitely a major issue in the region. |

## Pollution

MCoastal pollution, excess nutrients and declining water quality also negatively impact coastal ecosystems, particularly coral reefs (D'Angelo and Wiedenmann 2014; Wear and Thurber 2015; United Nations Environment Programme 2019).

Land-based sources of pollution include:

- **Untreated domestic wastewater/sewage:** These are major sources of bacterial loads, nutrients, pathogens, heavy metals, and toxins. Partially functioning and inadequate publicly owned treatment works and failing septic systems are responsible.
- **Agricultural runoff:** This contains pesticides with nitrogen and phosphorous that cause eutrophication of coastal waters.
- **Stormwater flows which release sediment, solid wastes and other pollutants:** Large flows are a result of inadequate stormwater management, large rain events, unpaved roads, poor upland and coastal construction practices, land clearing, and coastal and upland habitat loss.
- **Pharmaceuticals and other endocrine disruptors:** An emerging issue of concern is the high level of the use of personal care products, neurotoxicants, chemical herbicides, novel insecticides and pharmaceuticals which impact on species and ecosystems.

Marine sources of pollution include:

- **Improper discharge of vessel waste:** This includes commercial, recreational and cruise vessels which discharge solid waste, sewage, grey water, oily bilge water, and ballast water (which may be a route for transporting invasive species).
- **Dredging of harbours:** Creation and maintenance of harbours for shipping and cruise tourism often results in the release of sediments and pollutants.

The combined impacts of multiple stressors from these pollutants on marine ecosystems is still largely unknown and requires further investigation (United Nations Environment Programme 2019). Assessments of the levels of dissolved inorganic nitrogen in five sub-regions in the area covered by the Cartagena Convention (United Nations Environment Programme 2019) identified areas that are nutrient hotspots (see Figure 3.2).

Observed impacts include eutrophication-causing algal (including *Sargassum*) blooms and low-oxygen (hypoxic) waters, smothering of coastal ecosystems, and increased disease and coral bleaching. These cause degradation of marine ecosystems which has serous impacts on human health, economies and livelihoods (United Nations Environment Programme 2019).

The GoM-LME and NBSLME are already at high risk from eutrophication; the CLME is currently at medium risk but is expected to rise to high risk by 2030. Eutrophication (excess nutrients) results in the

Figure 3.1 Example of land-based sources of pollution that can occur during rain events when unstabilised soils, pollutants and chemicals are washed into the marine environment in storm water runoff

*Photos by Leslie Henderson*

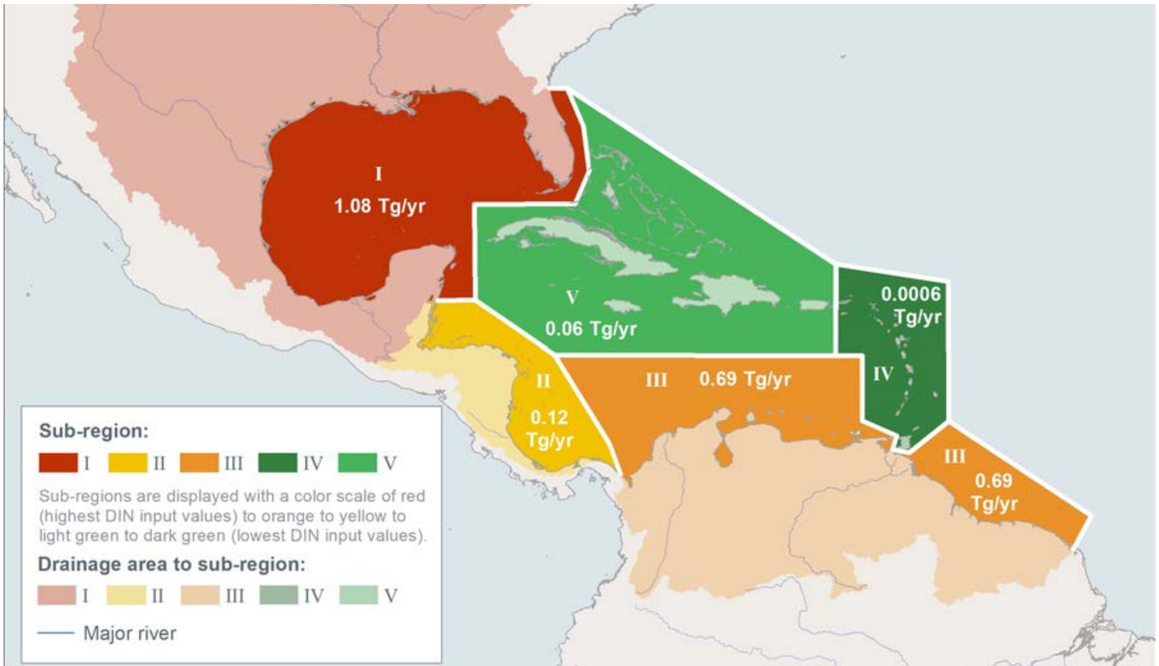



Figure 3.2 Dissolved inorganic nitrogen input from watersheds to coastal areas in five sub-regions (in 2000)

*Source: Sub-regions and DIN values (UNEP-CEP - 2000), drainage area (HydroBASINS - 2018), rivers (Natural Earth - 2019), land (GSHHG - 2013)*

proliferation of marine algae (algal blooms) and low-oxygen (hypoxic) waters. This causes mass mortality of marine fauna such as fish and sea turtles, and also impacts on shellfish. In 2018, harmful algal blooms (HABs) or red tide outbreaks in Florida led the authorities to declare a state of emergency in some counties and to remove thousands of tons of dead fish. When dead algal masses sink and decompose (using up oxygen in the bottom water), low-oxygen 'dead zones' (devoid of macrofauna) near the sea floor are created. 'Dead zones' have been documented in the wider Caribbean, with the most persistent being the extensive zone in the northern Gulf of Mexico (United Nations Environment Programme 2019).

Increased nutrient levels have also been linked to *Sargassum* blooms. From 2011 to 2018, large formations of Sargassum mats, coined the Great Atlantic *Sargassum* Belt by Wang *et al*. (2019), have been present in the central Atlantic Ocean and Caribbean Sea. These *Sargassum* blooms have been increasing in abundance but at an unpredictable frequency, deviating from their normal seasonal fluctuations. It appears that these recent *Sargassum* blooms originated in an area not previously associated with Sargassum growth, north of the mouth of the Amazon River (Gower *et al*. 2013). There is still much speculation around the cause of these blooms, including speculation on the effect of climate change. Recent studies have posited that this new area of *Sargassum* growth may be due to nutrient loading in discharge from the Amazon River caused by increased deforestation and use of fertilizers (Wang *et al*. 2019).

Smothering of coral reefs and seagrass beds by sediments and pollutants has also been observed. The relatively high light requirement of seagrasses makes them vulnerable to reduced light penetration in turbid coastal waters (Duarte *et al*. 2008).

Increased severity of coral disease due to sewage-derived pollutants has been documented (Redding *et al*. 2013) and sewage may introduce disease-causing pathogens as in the case of *Serratia marcescens*, the causative agent of white pox in threatened *Acropora palmata* (elkhorn) corals (Patterson *et al*. 2002).

Coral bleaching is a major concern in the region. Data from the Territorial Coral Reef Monitoring Program in the USVI showed that sediment loads of three $mg/cm^2/day$ of silt-clay sized fraction and six $mg/cm^2/day$ of terrigenous fraction were associated with sites that had a greater prevalence of coral bleaching, old partial colony mortality and combined impairment indicators (Smith *et al*. 2012).

Marine litter and plastics are a significant threat to marine ecosystems. It has been estimated that a total of 79 million tons of solid waste (including 1.3 million tons of plastics) were introduced to coastal waters of the wider Caribbean region in 2015. The highest volume of municipal waste is produced in the Gulf of Mexico and the northern Caribbean islands, with the latter also producing the highest volume of mismanaged plastic waste. The Wider Caribbean also has one of the highest floating microplastic and microplastic concentrations in the world. Microplastic adsorbs organic pollutants from the surrounding seawater and when ingested, can deliver harmful chemicals to marine fauna and humans. Microplastic particles were found in 41 of the 42 digestive tracts of seven species of commercially exploited marine fish analysed in a recent study in Grenada (United Nations Environment Programme 2019).

Mercury is considered by the World Health Organization (WHO) as one of the top 10 chemicals or groups of chemicals of major public health concern owing to its high toxicity. Sources affecting the region may be from air emissions from industries (e.g. coal power plants) and small-scale gold mining. A recent study in several Caribbean SIDS found high concentrations of mercury in human hair samples and attributed this to the consumption of predatory fish, which may bio-accumulate mercury in their tissues. However, further investigations are needed (United Nations Environment Programme 2019).

The impact of oil spills on marine ecosystems is another concern. Currently the major producers are Colombia, Mexico, Trinidad and Tobago, USA and Venezuela, but Guyana is set to become a major producer from 2020 and other countries are engaged in active exploration (e.g. The Bahamas, Barbados, Jamaica and Suriname). Oil terminals are spread across the wider Caribbean region (United Nations Environment Programme 2019). The Deepwater Horizon oil spill contaminated vast areas of the Gulf of Mexico with 800 million litres of crude oil, including deep-ocean communities and over 1,600 km of shoreline. Multiple species of pelagic, tidal, and estuarine organisms, sea turtles, marine mammals and birds were affected, and over 20 million hectares of the Gulf of Mexico were closed to fishing (Barron 2012). Researchers are still trying to understand the immunotoxicology and long-term impacts on coastal and marine ecosystems.

## Invasive species

Invasive species can be problematic in an isolated area such as the Caribbean basin. Invasive aquatic species are a major threat to coastal and marine ecosystems, and shipping is a major pathway for movement of invasive species. That acknowledgement of this threat resulted in development of the

### Box 3.1 Peyssonnelid algal crusts – an emerging threat to regional reefs

Species of peyssonnelid algae that exhibit a crusting growth form appear to be becoming more abundant on several reefs throughout the Caribbean. Three species have been described from the region (Pueschel and Saunders 2009; Eckrich and Engel 2013; Ballantine *et al*. 2016). These species form peyssonnelid algal crusts (PACs), which have been noted to overgrow corals (including important reef framework builders such as *Orbicella* and *Acropora* species), sponges and hard substrates (Pueschel and Saunders 2009; Ballantine and Ruiz 2011; Eckrich *et al*. 2011). What is unclear at this point is whether these PACs are invasive or nuisance species. There is evidence that these PACs appear to be able to aggressively outcompete hard coral species and reduce coral recruitment (Eckrich and Engel 2013; HJR Reefscaping 2015; Bramanti *et al*. 2017; Edmunds *et al*. 2019; T.B. Smith pers. comm.). There is also evidence that PACs differentially affect hard corals, overgrowing them faster than octocorals which in the future may facilitate a phase shift to octocoral dominated reef habitats (Edmunds *et al*. 2019). Given the noted increase in PACs on reefs throughout the region and their potential impact to reduce not only hard coral cover but the resiliency of these systems, it is critical that the Caribbean coral reef community monitor the presence and abundance of these PACs, work to identify and address the factors that have contributed to their rapid expansion and research, and implement and amplify management strategies to mitigate PAC overgrowth.

International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Management Convention) and its entry into force in 2017. As of October 22, 2018, only 10 of the 27 states in the wider Caribbean, as well as France (with overseas departments of Guadeloupe, Martinique and French Guiana, and overseas collectives of Saint Barthélemy and Saint Martin) and the Netherlands (including Aruba, Curaçao, Bonaire, Sint Eustatius, Sint Maarten and Saba), had ratified the convention (see Figure 3.3).

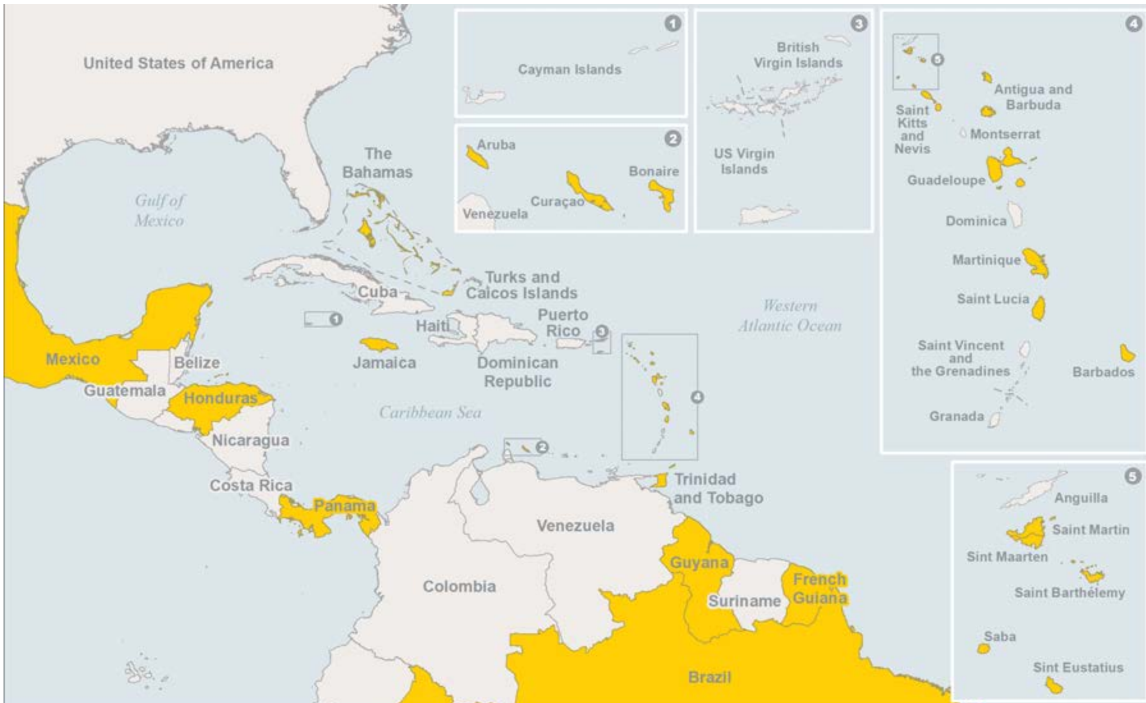



Figure 3.3 States which have ratified the Ballast Water Management Convention

*Source: BWM Convention (IMO - 2020), land (GADM - 2018)*

- **Pacific lionfish:** The invasive Pacific lionfish (*Pterois volitans*) was noted in The Bahamas in 2005, and within five years had spread throughout the wider Caribbean, Gulf of Mexico, and the northern coast of South America. Lionfish have a wide temperature and depth range and have been observed throughout the region at multiple depths, including deep mesophotic coral ecosystems. There are few known natural predators for the lionfish within the wider Caribbean, and since they are voracious predators, they pose a threat to native fish populations and therefore to coral reef ecosystems. Eradication of the lionfish is unlikely and impractical, though local efforts to control the population such as targeted harvesting have shown to be effective (de Leon *et al*. 2013) and are being implemented at many sites throughout the region (e.g. Mexico, Jamaica, Barbados, Cayman Islands, The Bahamas, Turks and

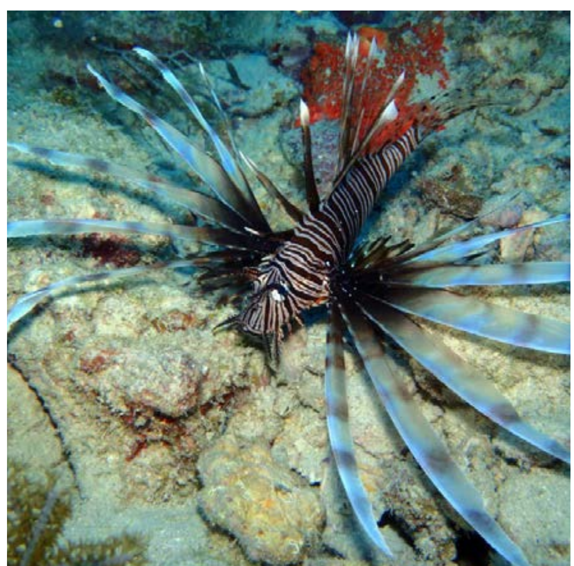


Figure 3.4 The invasive Pacific lionfish has steadily spread throughout the greater Caribbean over the last 10+ years

*Photo by Leslie Henderson*

Caicos, USVI, Puerto Rico, Martinique, Guadeloupe and Bonaire). Additionally, according to the Global Coral Reef Monitoring Network (GCRMN) there are indications that lionfish populations are stabilising or even decreasing at shallower depths due to local harvesting, grouper predation on juvenile lionfish and an ulcerative skin disease.

- **Regal Demoiselle:** The Regal Demoiselle (*Neopomacentrus cyanomos*), usually found in the Indo-West Pacific Region, was found in southwest Mexico in 2013, with existing established populations in the north and west of the Gulf of Mexico. This planktivorous reef fish was also discovered in 2018 in the north-western peninsula of Trinidad, with populations thriving in shipwrecks and rocky shore areas. Research is currently being carried out by the University of Trinidad and Tobago and the Smithsonian Tropical Research Institute (Kingon and Robertson 2018). Researchers have hypothesised that the species was introduced from the Indo-West Pacific through the transportation of oil and gas rigs and support vessels to Trinidad and the Gulf of Mexico, the only areas known to have populations of the Regal Demoiselle in the Western Atlantic. It is expected that the species will soon spread throughout the southern Caribbean given its ability to thrive in coral reefs in the Gulf of Mexico and the rocky shore, estuarine environment of Trinidad. The impacts of the species on native ecosystems are still largely unknown and require further research.
- ***Halophila stipulacea*:** An invasive species of seagrass that is native to the Indian Ocean, *Halophila stipulacea*, has been spreading throughout the Caribbean (Figure 3.5). The species is thought to have entered the Caribbean in the ballast water of ships and is being spread by commercial and recreational shipping. The invasive has been spreading fairly rapidly since being recorded in 2002 (Ruiz and Ballantine 2004). In 2014 it was recorded in 19 Caribbean islands (Willette *et al*. 2014) and has been found both mixed with other seagrasses and in mono-specific patches. While there is some uncertainty regarding the full ecological impact of the species (Rogers *et al*. 2014; Gore *et al*. 2018), preliminary observations of the response to grazing by large herbivores (Christianen *et al*. 2018) and the apparent ability of the species to respond to

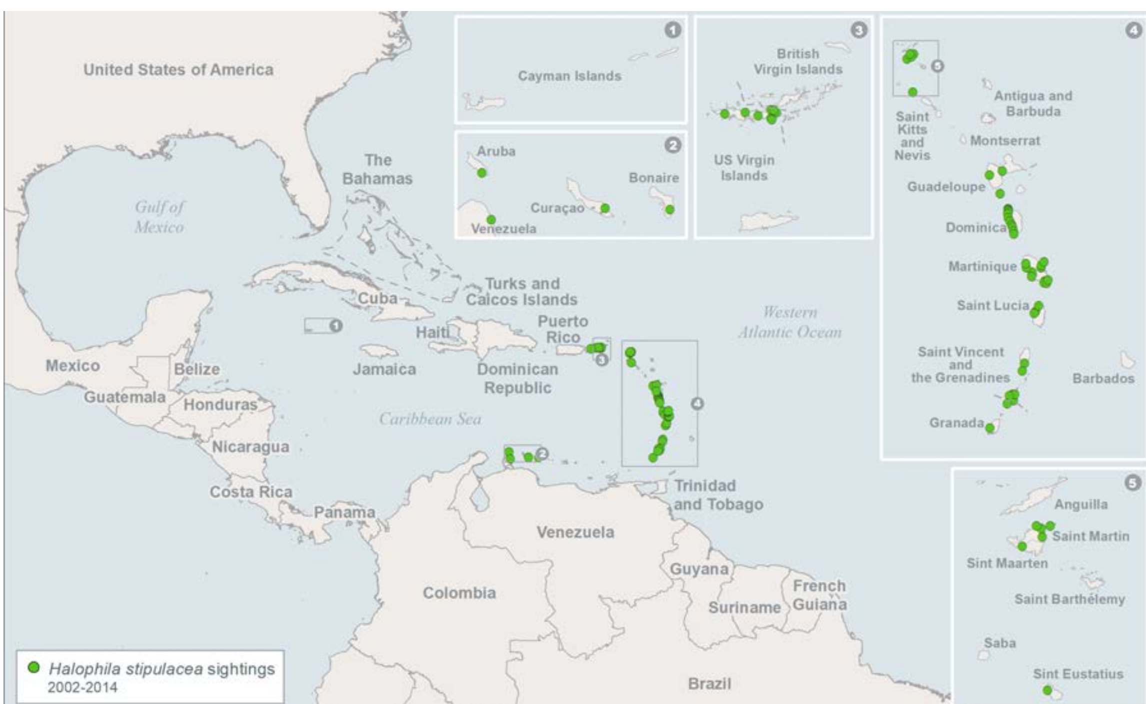



Figure 3.5 Recorded sightings of *Halophila stipulacea* in the Caribbean

*Source: Sightings (invasiveseagrass.org - 2002-2014), land (GADM - 2018)* different environmental conditions and occupy a range of microhabitats (Willette and Ambrose 2009), suggests that the rapid spreading of Halophila stipulacea will result in "a community-level shift in the shallow subtidal zone, with attendant changes in habitat structure, species composition, and trophic interactions" (Scheibling *et al*. 2018).

## Climate change and extreme weather events

Climate change has a direct impact on coastal ecosystems and amplifies the impact of other drivers of environmental change.

Climate change attributes that negatively impact coral reef ecosystems include increasing sea surface temperatures (SST), ocean acidification (OA), more frequent intense storm events (Categories 4 and 5), increased rainfall rates and coastal inundation associated with hurricanes and sea level rise (Bender *et al*. 2010; Knutson *et al*. 2019a; Knutson *et al*. 2019b). Elevated SSTs, when sustained over time, stress the coral and cause it to expel its symbiotic algae or bleach. The longer a coral is bleached, the more likely it is to experience partial or complete mortality and the more likely it is to succumb to additional stressors such as disease-causing pathogens. Local stressors can decrease coral resilience to the negative impacts associated with climate change such as bleaching (Carilli *et al*. 2009). The wider Caribbean has been subject to a series of major coral bleaching events in 1998, 2005, 2010 and then at distributed sites from 2014 through 2017. Reports of heat stress associated with elevated SSTs and incidents of bleaching from the most recent events are summarised in Table 3.2 using data from the U.S. National Oceanic and Atmospheric Administration's (NOAA) Coral Reef Watch.

**Table 3.2:** Heat Stress Associated with Elevated SSTs and Incidents of Bleaching

| Location | Dates | Severity |
|---|---|---|
| South-east Florida and Florida Keys | August & September 2014 | Substantial |
| Florida Reef Tract (including the National Marine Sanctuary) | Sept & Oct 2015 | Moderate to severe bleaching, disease noted; low to moderate mortality |
| Multiple Caribbean sites: Cuba, Turks and Caicos, The Baha-mas, Haiti, Dominican Republic and Mexico | 2015 | |
| South-east Florida and Florida Keys | July – August 2016 | Bleaching Warning – Alert Level 1; low-level bleaching |
| Flower Garden Banks | July – September 2016 | High heat stress |
| Yucatan Peninsula | July – October 2016 | High heat stress |

*Source: NOAA Coral Reef Watch (https://coralreefwatch.noaa.gov/)*

In May 2020, NOAA's Coral Reef Watch programme had the wider Caribbean under a bleaching alert, ranging from bleach watches for the majority of the region to alert level 1 warnings in the southern portions of the region (Figure 3.6). Further, the Coral Reef Watch programme's most four-month coral bleaching heat stress outlook showed continued bleach watch to Alert Level 1 conditions for the southern portions of the wider Caribbean from June 2020 through September 2020 (Figure 3.7).

Frequent and severe thermal stress is believed to result in negative impacts to reef rugosity (Bozec *et al*. 2014), which is of critical importance to the maintenance of biological diversity and continued provision of ecosystem services of these systems. Additionally, sustained elevated SSTs have been documented to result in reduced resilience to coral diseases. For example, during the major Caribbean bleaching event in 2005, reefs throughout the region experienced elevated SSTs that were above normal for more than seven months, with sustained thermal stress over 12-week periods, and was more intense than any of the previous 20 years (Eakin *et al*. 2010). However, at a sub-regional level during the event, the northern and central Lesser Antilles experienced extreme and extended elevated SSTs (> 10 ˚C-weeks) which resulted in extensive and widespread coral bleaching, mortality, subsequent disease outbreaks and the highest losses of coral cover, for example, ranging from 10% to 90% across monitored sites in the USVI (Whelan

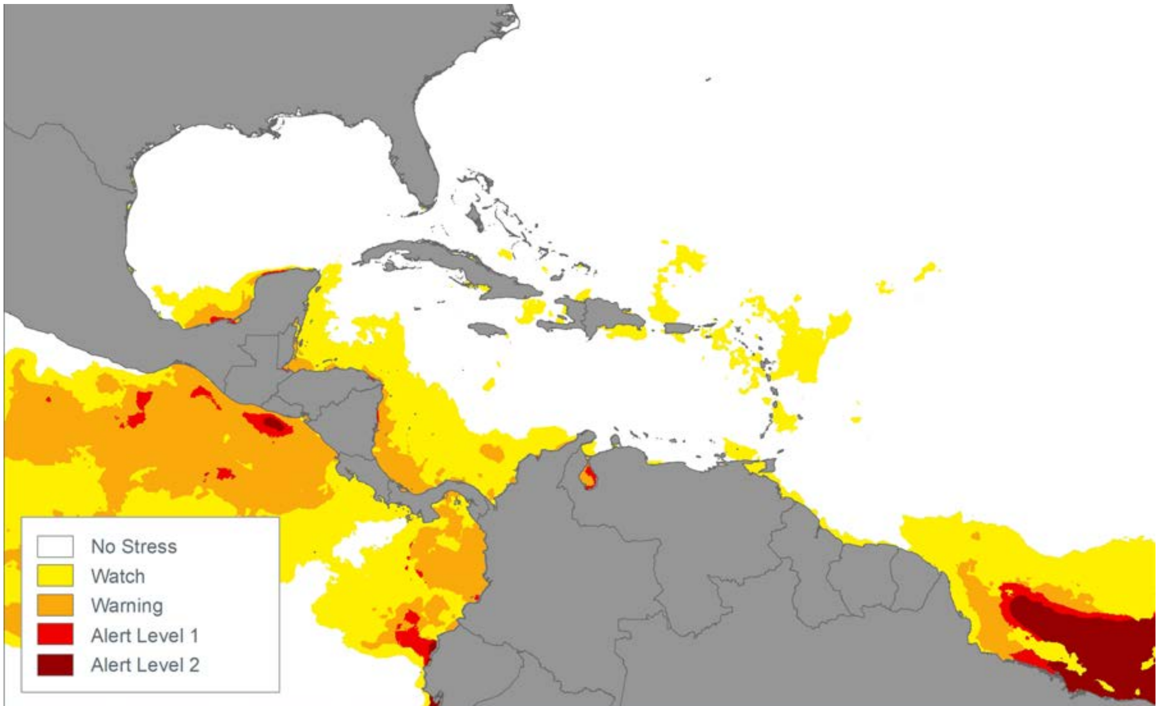



Figure 3.6 NOAA Coral Reef Watch daily 5 km bleaching alert area 7 day max (27 May 2020)

*Source:*

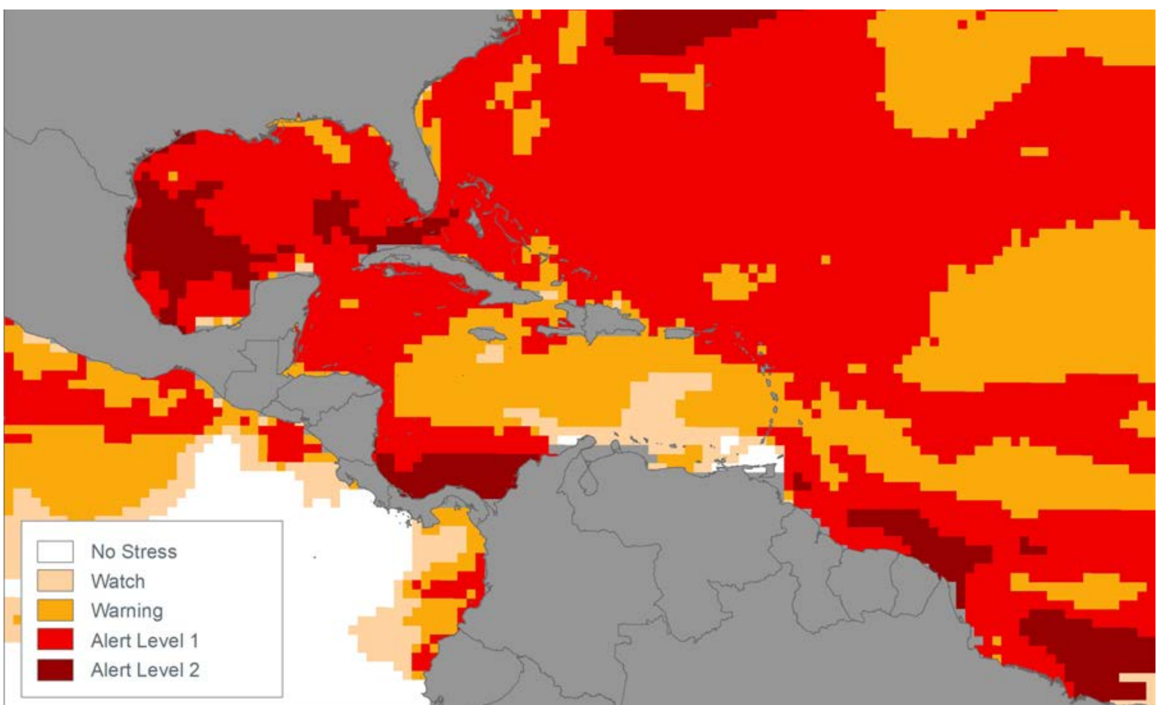



Figure 3.7 NOAA Coral Reef Watch 60% probability coral bleaching heat stress for June – September 2020

*Source:*

*et al*. 2007; Muller *et al*. 2008; Oxenford *et al*. 2008; Rothenberger *et al*. 2008; Wilkinson and Souter 2008; Brandt and McManus 2009; Miller *et al*. 2009; Oxenford *et al*. 2010).

Global climate change is also changing ocean chemistry; as atmospheric CO2 increases, the pH of seawater declines, making it more acidic. OA is thought to make it more difficult for corals to accrete their calcium carbonate skeletons, which give the coral habitat its rugose three-dimensional structure, which is vital to supporting species diversity and for supporting critical ecosystem services such as attenuating wave energy. OA conditions may also lead to dissolution. Both of these scenarios could compromise coral reef ecosystem health and the important ecosystem services, particularly shoreline protection through absorption of wave energy, that these systems provide.

Another climate change impact that can affect coral systems is the increased frequency and intensity of storm events. While storms can increase local circulation around reefs that can help to minimise thermal stress, storms can also cause mechanical damage to reefs in the form of breakage and scouring. Storms within the Caribbean region are often accompanied by significant rain events, which can lead to negative impacts on coral reefs from increased land-based sources of pollution when combined with the steep terrains of some Caribbean jurisdictions, the numerous dirt roads and inadequate stormwater management systems.

Sea level rise, while a concern for Caribbean coastal communities, is also an issue for regional coral reefs. Rising sea levels will likely increase the amount of sedimentation reefs are subject to, negatively affecting feeding, photosynthesis, recruitment and other critical processes. Some coral species have growth rates that may allow them to migrate to stay within optimum depth ranges. However, some coral species with slower growth rates may not be able to keep pace, resulting in reefs with a different species composition and possibly different function than today's reefs. Additionally, existing threats to reefs such as disease, overfishing, poor water quality, increasing sea surface temperatures and ocean acidification will affect corals' ability to adapt to rising sea levels by hampering growth rates, reef accretion and reproduction. It is unclear how coral communities will adapt to the changing conditions associated with rising sea levels and what these changes will mean for ecosystem integrity and services.

Climate change and extreme weather events (such as storms, prolonged droughts, or intense rainfall events that cause flooding and erosion or land slippage) are natural drivers of change in mangrove ecosystems in the wider Caribbean (see Table 3.3) (Island Resources Foundation 1993; FAO 2007; Branoff *et al*. 2018).

### **Table 3.3:** Predicted Impacts of Climate Change on Mangroves

| Changes | Impacts |
|---|---|
| **Temperature:** Global temperatures increased by 0.74°C (±0.18°C) between 1906 and 2005 and most models predict rises of 2–4°C within the next 100 years (IPCC 2007). | Expanded latitudinal limits for some species, alteration of community composition and increases in photosynthesis, respiration, litter, microbial decomposition, floral and faunal diversity, growth, and reproduction, but declining rates of sediment accretion (Alongi 2008). At local and regional scales, changes in weather patterns may induce changes in the salinity regime and community composition, and a change in primary production if the ratio of precipitation to evaporation is altered (IPCC 2007). |
| **Atmospheric carbon dioxide ($CO_2$):** $CO_2$ levels increased from 280 parts per million (ppm) in 1750 to nearly 380 ppm in 2005 (IPCC 2007) and are presently almost 400 ppm[14]. Despite large variations, all models predict a further increase in $CO_2$ levels by the end of the century, with some predicting a doubling or even trebling of today's level. | Responses will be difficult to predict, but rates of photosynthesis, salinity, nutrient availability and water-use efficiency will change (Ball 1988). There may be little or no change in canopy production, but species patterns within estuaries are likely to change based on species-specific responses to the interactive effects of rising $CO_2$, sea-level, temperature, and changes in local weather patterns (Alongi 2008). Elevated $CO_2$ concentration could alter competitive abilities, thus altering community composition along salinity-humidity gradients. |

14 http://www.esrl.noaa.gov/gmd/ccgg/trends/weekly.html

## **Table 3.3** *(continued)*: Predicted Impacts of Climate Change on Mangroves

| Changes | Impacts |
|---|---|
| **Sea-level rise:** Mean global sea-level rose 17 centimetres in the 20th century (IPCC 2007).<br><br>In 2007, the IPCC predicted that mean global sea-level may rise a further 18-79 centimetres by 2100 (IPCC 2007), however, some of the latest research suggests a rise up to 1 metre or more. | This is likely the greatest of challenges facing mangroves as a result of climate change (Gilman, Ellison and Coleman 2007). In the past, mangroves responded to sea-level rise by growing upwards in place or migrating landwards (Alongi 2008). Mangroves are able to increase their elevation by using peat from decaying litter and root growth, and also by trapping sediments. As sea-level rises and wave energy causes their seaward margin to erode, mangroves can also move landward if space is available and conditions are suitable for new seedlings to establish and grow on the landward edge (Gilman *et al*. 2007).<br><br>Mangroves have been observed to shift inland 1.5 km over 70 years, and this ability is determined by local conditions, including presence of infrastructure (e.g. seawalls, dikes, urban developments) and topography of the area (McLeod and Salm 2006). For example, coastal developments such as sea defences 'fix' the intertidal zone and prevent intertidal habitats from expanding landward – a process referred to as 'coastal squeeze.' Therefore, even where mangroves may be able to migrate landward at an adequate pace, they could be hindered by the unavailability of suitable substrates due to human encroachment and land development at coastal boundaries (Spalding *et al*. 2010).<br><br>Mangroves are not adapting at an adequate pace in most sites studied (Cahoon *et al*. 2006). Adaptation to local factors, for example, changes in tidal range and sediment supply, will likely be species dependent (Alongi 2008). When sea-level rise is too rapid for landward migration or soil accretion by mangroves, the edges of the remaining wetlands are exposed, leading to erosion, and release of carbon deposits in the soil. |
| **Intensity and frequency of storms:** Both the number and intensity of very strong cyclones (typhoons and hurricanes) will increase (IPCC 2007; Bender *et al*. 2010) | Impact level will be proportional to the strength, frequency, size, and duration of storms. Impacts include defoliation, tree uprooting, and increased stress from altered mangrove sediment elevation due to soil erosion, deposition, and compression. Recovery from storm damage can be very slow or not occur at all. Large storms have caused mass mortality in some mangrove forests (Cahoon *et al*. 2003) (see Box 3.2). However, a survey of mangroves in Eastern Samar, Philippines showed recovery by means of tree sprouts and surviving seedlings and saplings in natural stands, compared to high to total mortality in (Rhizophora) plantations at 2.5 months and 4.5 months post-Typhoon Haiyan (Primavera *et al*. 2016). |
| **Precipitation patterns:** In the 20th century significantly increased precipitation has occurred in eastern parts of North and South America, North Europe, and North and Central Asia, while drying has been observed in the Mediterranean, southern Africa, the Sahel and parts of southern Asia. It is very likely that the amount of precipitation will increase at high latitudes and decrease in most subtropical land regions, and that heavy precipitation events will become more extreme (IPCC 2007). | Regional and local patterns of growth and distribution may be affected (Field 1995; Ellison 2000). Increased intensity of rainfall events is likely to influence erosion and other physical processes in catchments and tidal wetlands. Increased rainfall may increase diversity and enhance growth and coverage via colonisation of previously unvegetated areas. Reduced rainfall may lead to reduced diversity and productivity of mangroves and increases in salt marsh and salt flat areas (Smith and Duke 1987). |

*Source: Primavera et al. 2018*

The effects of solar radiation and shallow water heating on seagrasses are poorly understood, but at least one study has noticed extensive evidence of seagrass burning in shallow water sites in the Turks and Caicos Islands (Baker *et al*. 2015). The direct effect on seagrass communities of increased temperature related to climate change is uncertain, though the impact from thermal discharges at power plants suggest adverse impacts for both the seagrasses and associated flora and fauna. The need for shallow grass beds to support settling and post-larval development stages of the spiny lobster (Goldstein *et al*. 2008) and some species of crabs suggest that temperature changes in shallow seagrass beds could affect egg development, larval development and survival, and species abundance (Sachlikidis *et al*. 2010; Rebolledo and Collin 2018).

Climate change exacerbates existing stresses and is therefore likely to accelerate the decline in seagrass ecosystems through increased pressures caused by increased sedimentation in runoff associated with more intense rainfall events, increased temperature in coastal waters, and more intense storms (CARSEA 2007; Saunders *et al*. 2017; Bustamante, M. *et al*. 2018).

**Box 3.2 Changes in Mangrove Forests at Five Wetlands in Puerto Rico Following Hurricanes Irma and Maria in September 2017**

Changes determined using spatial imagery datasets from 2010 and 2018 and ground surveys.

- Primary damage to all sites was in the form of defoliation, uprooting of trees, and / or breaking of tree branches and trunks. Damage to vegetation varied greatly across the sites and depending upon habitat type. Overall mortality across all sites and habitats was 27% and overall mangrove mortality was 53%.
- The mangroves at Isabela suffered the most damage, with 95% of the post-hurricane forest classified as dead.
- The mangroves at Punta Tuna also suffered widespread mortality, with 68-98% of mangrove habitat classified as dead.
- There are shifts in vegetation types in the Ciénaga Las Cucharillas due to a change in the hydrologic regime of the area.

*Source: Branoff et al. 2018*

## Disease

There are more than 30 recognised diseases in the wider Caribbean known to affect coral reef organisms, and approximately 80% of all western Atlantic corals are affected by one or more diseases (Sutherland *et al*. 2004; Bruckner 2009), including nine of the 10 threatened coral species on the IUCN Red List (2018). The Caribbean is disproportionately affected by disease and has been considered a hotspot for coral ecosystem diseases because of the rapid emergence and spread of diseases, their diversity, high prevalence, wide distribution, numbers of host species and virulence (Rosenberg and Loya, 2004; Weil *et al*. 2006; Bruckner 2009). Comprehensive information on the incidence and distribution of diseases affecting coral reef ecosystems is lacking.

Diseases affecting coral reef biota have proven to be significant drivers of Caribbean coral reef ecosystem decline, as noted in the widespread mortality of Acroporids in the 1970s and 1980s and *Diadema* in the 1980s (Gladfelter *et al*. 1977; Gladfelter 1982; Lessios *et al*. 1984; Lessios *et al*. 1988); Carpenter 1990). These disease events are thought to have precipitated a region-wide phase shift toward algal-dominated reefs, a situation that is compounded by overfishing of herbivorous parrotfish as described in Section 3.1 (Harvell *et al*. 2004; Jackson *et al*. 2014).

Diseases of coral reef organisms can be caused by external factors or internal dysfunction. Diseases can be biotic or abiotic in origin, and often disease conditions can be triggered or exacerbated by external

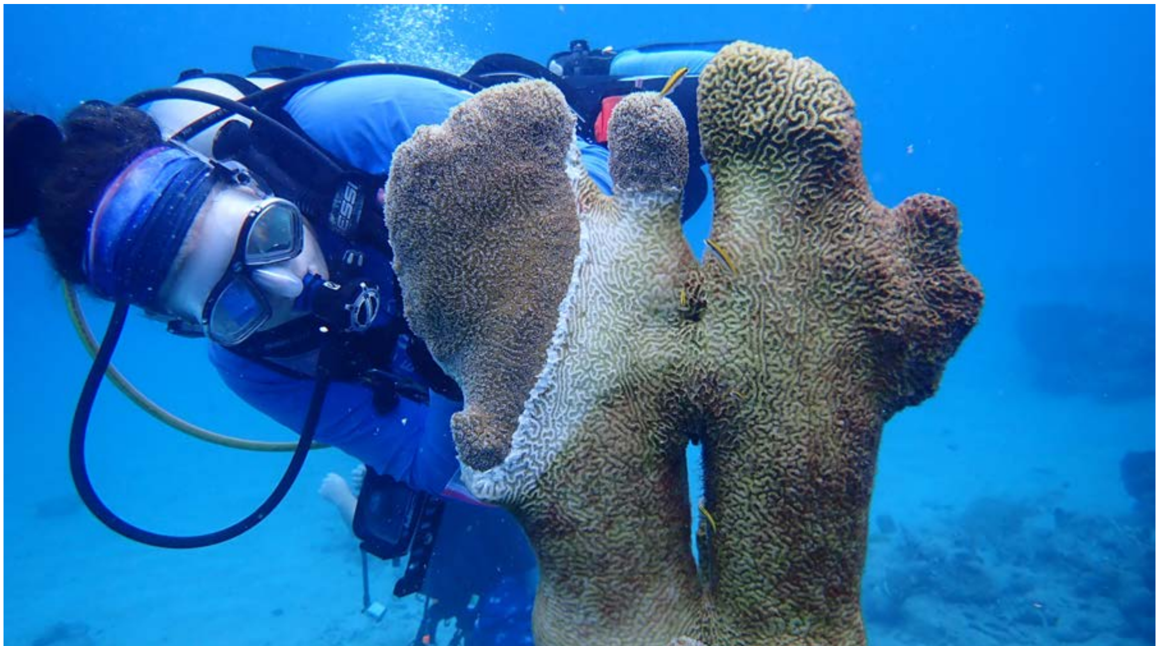


Figure 3.8 Causation for many coral diseases is unknown, however it is more important than ever to develop strategies to treat and stop disease progression. Researchers are actively investigating the use of different treatments to minimise or stop the transmission of various coral diseases

*Photo by Leslie Henderson*

anthropogenically-driven factors such as pollution from land-based sources (e.g. sewage) and other water quality changes, other environmental stressors such as increased water temperatures associated with climate change (Section 3.7) or the presence of macroalgae. The causative agents of some diseases are known, such as *Aspergillus sydowii*, a soil fungus that causes aspergillosis of sea fans (Nagelkerken *et al*. 1997) and *Serratia marcescens*, which is a common faecal enterobacterium introduced via sewage that causes white pox in endangered elkhorn corals (Patterson *et al*. 2002). However, for many diseases the causative agent is still unknown, and mechanisms of infection and transmission poorly understood. Potential pathogens can be spread by direct contact or through vector organisms, but it is also believed that they may be spread through vessel transit and ballast or wastewater. Some pathogens are ubiquitous in the environment and difficult to manage directly, while others such as those introduced through sewage inputs could be more effectively managed through improved wastewater and shipping/maritime policy and management.

Diseases of coral reef organisms present a significant challenge for coastal managers. As the number and variety of stressors impacting coral reefs increase (compounding factors, increased sources of pathogens, cascading health effects, etc.), it is expected that the diversity, incidence, prevalence and severity of diseases will continue to be a threat to these habitats. An emerging threat in the form of Stony Coral Tissue Loss (SCTL), a particularly widespread and lethal coral disease event first documented on Florida coral reefs in 2014 is described below (see Box 3.3 and Figure 3.9)[15]. This example highlights the challenges facing managers and underscores the need to include coral disease detection and response within strategic planning efforts to prepare for such events, as well as the critical need to implement actions to address stressors that are amenable to local and regional management and policy so as to increase the resilience of reefs to less-manageable global threats.

15 For more information please visit: https://floridakeys.noaa.gov/coral-disease/ and https://floridadep.gov/fco/coral/content/florida-reef-tract-coral-disease-outbreak

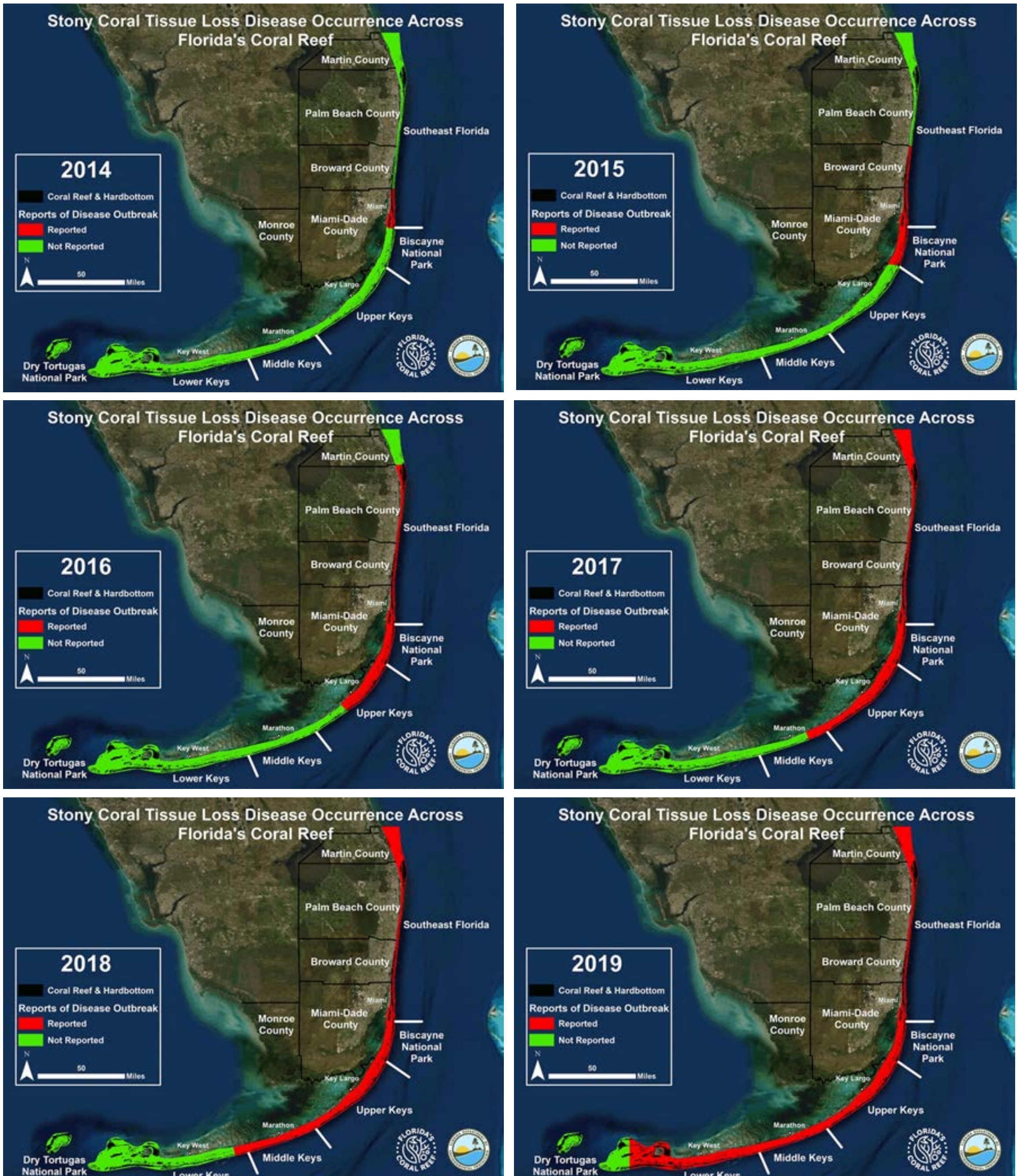



Figure 3.9 Time Series of Stony Coral Tissue Loss (SCTL) Disease Outbreak Progression Along the Florida Reef Tract

*Source: Florida Department of Environmental Protection 2019*

## Sargassum inflow

An increase in the amount of pelagic *Sargassum* entering the Caribbean Basin was noted in 2011, with landings since then increasing in volume and affecting many locations around the wider Caribbean. Many reasons have been advanced for the significant increase in the inflow of pelagic *Sargassum*, but no single driver has been confirmed (Caribbean Environment Programme 2018). Research is currently underway to better understand the causes and impacts of the increased inflow of *Sargassum* entering the Caribbean Sea Basin.

Box 3.3 Stony Coral Tissue Loss (SCTL) disease

In 2014, signs of a particularly virulent coral disease were observed on the Florida reef tract. The disease, termed Stony Coral Tissue Loss (SCTL) is described as tissue loss that spreads from the edge of a colony, or from within a colony on intact tissue, and is characterised by newly exposed white intact skeleton. Tissue loss lesions have been observed to increase in size and fuse together. Recently denuded skeleton is noted to be covered by algae within three to seven days. Some coral species may have bleached tissues adjacent to the tissue-loss lesion, for *S. siderea* one or more areas of darker discoloration may be present along with active tissue loss. According to the Florida Department of Environmental Protection (2019), the SCTL disease outbreak is unique because:

- Large geographic range - Over half of the Florida Reef Tract is affected, more than 96,000 acres.
- Extended duration of the outbreak – SCTL disease has been spreading continuously since 2014 (see Figure 3.9), shows high rates of transmission and mortality and no seasonal patterns of slowing.
- A large number of coral species are affected – More than 20 of Florida's 45 reef-building coral species.
- Disease prevalence is high – Within certain species, disease is observed in 66 out of every 100 colonies surveyed.
- High mortality rates - Affected corals have been documented to die within weeks to months (see Figure 3.10).

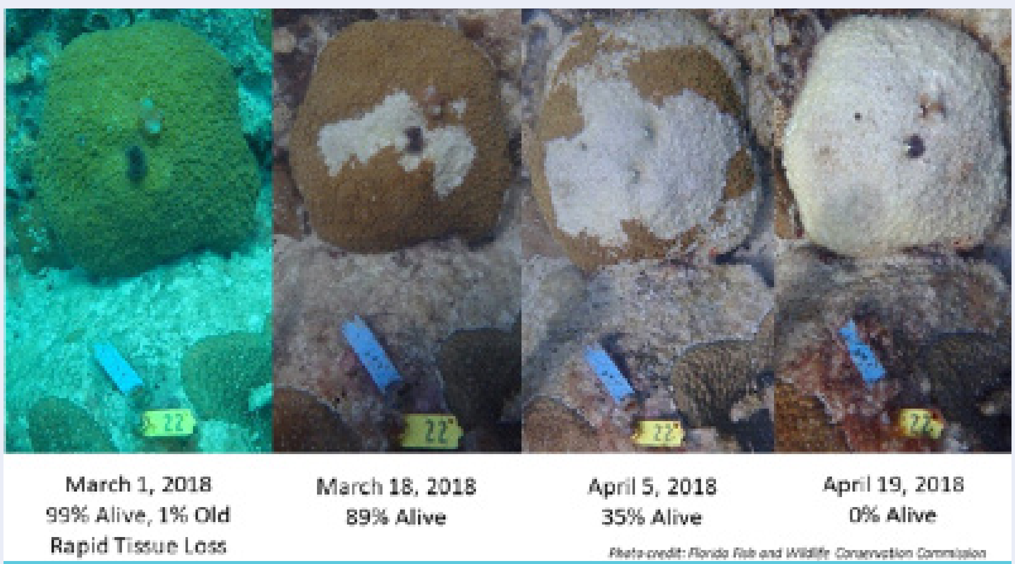
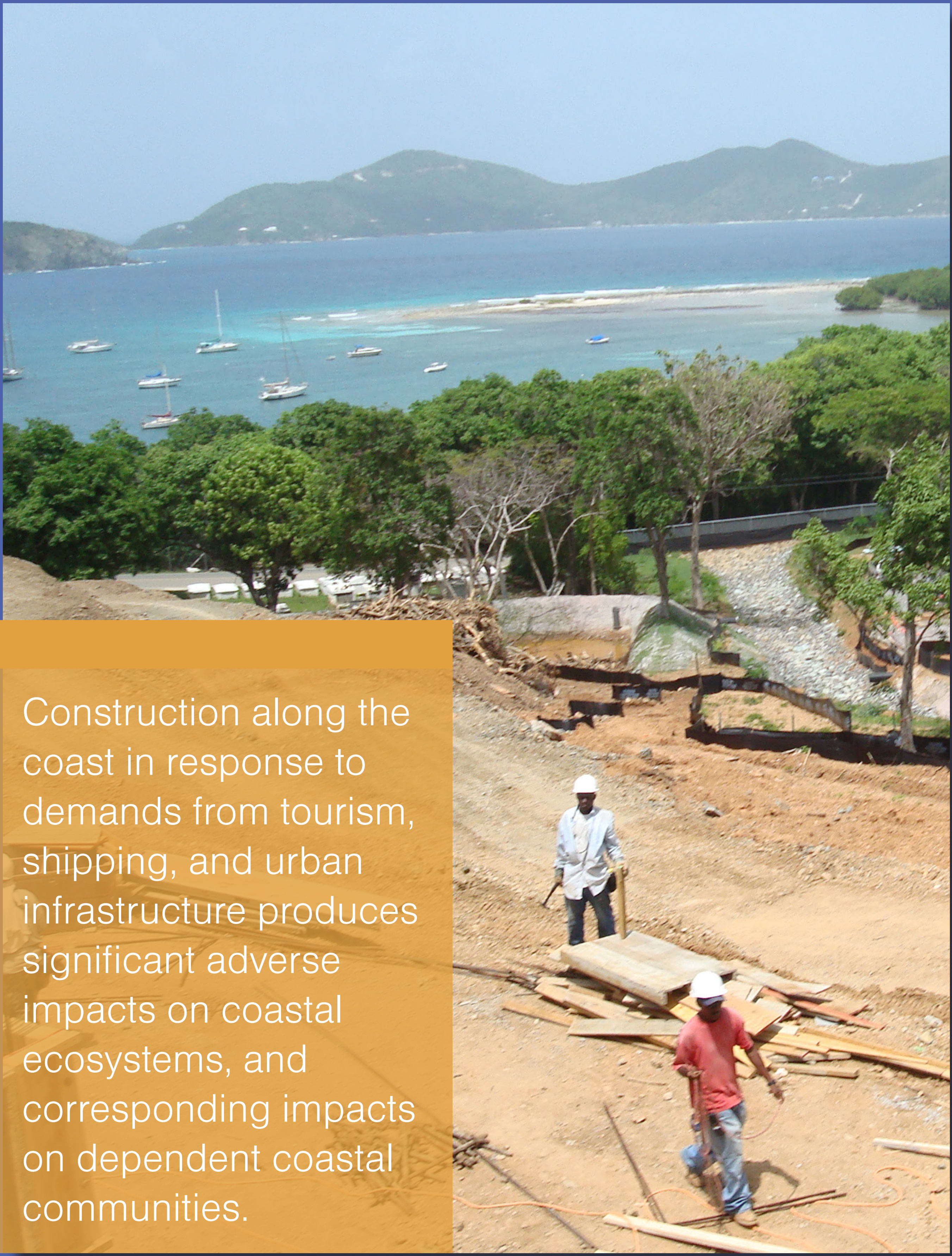



Figure 3.10 Rapid Tissue Loss and Colony Death as a Result of SCTL disease

Although the *Sargassum* rafts provide nursery and habitat functions for many invertebrate and fish species, the increased inflow creates a range of social, health, and economic problems (Caribbean Environment Programme 2018). There are also concerns regarding ecological impacts. When mats of Sargassum die and sink offshore they can smother seagrass beds and coral reefs. The mats can also prevent the surfacing of marine organisms, like dolphins and turtles, which suffocate if entangled. The accumulation of Sargassum along the coast can prevent sea turtles from coming to shore and laying their eggs (Yong 2019). Additionally, shading of corals and seagrass beds and abrasion of corals are considered potential problems. There is general agreement that more research is needed in order to determine the nature and scope of the ecological changes across the different coastal and marine habitats.



Construction along the coast in response to demands from tourism, shipping, and urban infrastructure produces significant adverse impacts on coastal ecosystems, and corresponding impacts on dependent coastal communities.

*Photo by A. Nibbs*

# 4 Status and trends of the nearshore marine habitats

## Key messages

- The wider Caribbean contains globally significant percentages of coral reefs, mangroves, and seagrasses, which, when occurring together is considered one of the most biologically diverse and productive complexes in the world. This ecological complexity makes the Caribbean Sea one of the global centres of biodiversity and accounts for its significant contribution to the global ocean economy.
- There has been a decades-long trend towards loss of acreage, increasing degradation, and decline in the health of the three habitats resulting from anthropogenic and natural stresses.
- Increase in habitat integrity and cover increases the abundance of associated biodiversity, including commercially important species.
- Recovery of areas is generally linked to low levels of stress, often the result of consistent and effective management interventions.

## 4.1 Summary overview

Decades of anthropogenic and natural stresses on the three habitats has resulted in overall poor status based on key indicators, and worsening trends in almost all areas (see Table 4.1).

**Table 4.1:** Overview of status and trends for the three habitats

| Indicator | Status | Trend | Data quality | Major findings or other comments | Related SPAW Protocol focus | Related Multi-Lateral Environmental Agreement (MEA) Target/Reporting Area |
|---|---|---|---|---|---|---|
| Relative cover of reef building organisms and dominant competitors (live coral, algae, invertebrates) | ● Poor | ↘ Declining | ■ ■ ■ Mixed | In general, across the wider Caribbean coral reefs are experiencing negative shifts in community composition with live hard coral cover declining and macroalgae increasing. | Conservation and sustainable use of marine and coastal ecosystems<br>Development of guidelines for the management of protected areas and species | Convention on Biological Diversity (CBD) Aichi Target 10<br>CBD Aichi Target 11<br>SDG 14.2 |
| Coral reef cover | ● Poor | ↘ Declining | ■ ■ ■ Mixed | In general, across the wider Caribbean live cover of reef-building hard coral is declining. | Conservation and sustainable use of marine and coastal ecosystems<br>Development of guidelines for the management of protected areas and species | CBD Aichi Target 10<br>CBD Aichi Target 11<br>SDG 14.2 |
| Macroalgal cover | ● Poor | ↗ Increasing | ■ ■ ■ Mixed | In general, across the wider Caribbean macroalgal cover is increasing, resulting in a net negative shift in community composition on reefs. | Conservation and sustainable use of marine and coastal ecosystems<br>Development of guidelines for the management of protected areas and species | CBD Aichi Target 10<br>CBD Aichi Target 11<br>SDG 14.2 |
| Abundance and biomass of key reef fish taxa | ● Poor | ↘↗ Mixed | ■ ■ ■ Mixed | In general, across the wider Caribbean important reef herbivore populations have been overfished, contributing to the decline of the region's reefs. | Development of guidelines for the management of protected areas and species | CBD Aichi Target 10<br>CBD Aichi Target 11<br>SDG 14.2 |
| Coral reef health | ● Poor | ↘ Declining | ■ ■ ■ Mixed | In general, across the wider Caribbean coral health is declining. The emergent SCTL disease is of particular concern. | Development of guidelines for the management of protected areas and species | CBD Aichi Target 10<br>CBD Aichi Target 11<br>SDG 14.2 |

**Table 4.1** *(continued)*: Overview of status and trends for the three habitats

| Indicator | Status | Trend | Data quality | Major findings or other comments | Related SPAW Protocol focus | Related Multi-Lateral Environmental Agreement (MEA) Target/Reporting Area |
|---|---|---|---|---|---|---|
| Coral reef recruitment | ● Poor | ↘↗ Declining /mixed | ■ ■ ■ Mixed | In general, across the wider Caribbean coral recruitment is declining due to losses in coral cover (stock), loss of settlement habitat and competition from macroalgae. | Development of guidelines for the management of protected areas and species | CBD Aichi Target 10<br>CBD Aichi Target 11<br>SDG 14.2 |
| Abundance of key macro-invertebrate species | ● Mixed/ fair | ↘↗ Mixed | ■ ■ ■ Mixed | Diadema abundance is variable across the wider region, however, continues to be low compared to historical levels. Trends in abundance of other species such as lobster or conch were not investigated as part of this effort. More research is needed. | Development of guidelines for the management of protected areas and species | CBD Aichi Target 10<br>CBD Aichi Target 11<br>SDG 14.2 |
| Water quality | ● Poor | ↘ Declining | ■ ■ ■ Mixed | In general, across the wider Caribbean pollution from several sources is having multiple impacts on coral reef ecosystems but the cumulative effects need further investigation. | Development of guidelines for the management of protected areas and species | CBD Aichi Target 10<br>CBD Aichi Target 11<br>SDG 14.2 |
| Threatened species | ? Unknown | ? Unknown | ■ ■ ■ Mixed | The number of species listed as threatened or endangered in the wider Caribbean is increasing. However, the data necessary to make statements on the status and trends of listed species are not readily accessible. | Conservation of threatened and endangered species (Articles 10, 11 and 21 of the SPAW Protocol call for the implementation of programmes to protect the species listed under Annexes I, II and III.) | CBD Aichi Target 12 |
| Mangrove coverage | ● Poor | ↘ Declining | ■ ■ ■ Poor | In general, across the wider Caribbean mangrove coverage is declining. | Conservation and sustainable use of marine and coastal ecosystems | CBD Aichi Target 5 |

**Table 4.1** *(continued)*: Overview of status and trends for the three habitats

| Indicator | Status | Trend | Data quality | Major findings or other comments | Related SPAW Protocol focus | Related Multi-Lateral Environmental Agreement (MEA) Target/Reporting Area |
|---|---|---|---|---|---|---|
| Mangrove health | ? Unknown | ? Unknown | ■ ■ ■ Poor | There are insufficient data to report on the health of mangrove habitats. | Conservation and sustainable use of marine and coastal ecosystems | CBD Aichi Target 10<br>CBD Aichi Target 11 |
| Seagrass beds coverage | ● Poor | ↘ Declining | ■ ■ ■ Poor | In general, across the wider Caribbean seagrass meadows are declining. | Conservation and sustainable use of marine and coastal ecosystems | CBD Aichi Target 10<br>CBD Aichi Target 11 |
| Seagrass beds health | ? Unknown | ? Unknown | ? Unknown | There are insufficient data to report on the health of seagrass habitats. | Conservation and sustainable use of marine and coastal ecosystems | CBD Aichi Target 10<br>CBD Aichi Target 11 |

# 4.2 Coral reefs

The coral reef ecosystem across the wider Caribbean is changing. Since the 1970s, the region as a whole has experienced a decline in live coral cover and a negative shift in the composition of these systems (Gardner *et al*. 2003; Wilkinson 2004; Bongaerts *et al*. 2010; Jackson *et al*. 2014). The most recent comprehensive analysis of Caribbean coral data estimates that average coral cover has declined from an estimated 34.8% in the 1970s to just 16.3%, with declines occurring at three quarters of monitored locations throughout the region (Jackson *et al*. 2014). During the same time frame, macroalgal cover increased from seven percent to 23.6% (Jackson *et al*. 2014). This phase shift from coral dominated to macroalgal dominated Caribbean coral reefs (see Figure 4.1) is being driven by many causes (see Section 4.2.1). Often these stressors are additive, and further negatively impact coral reef ecosystem resilience.

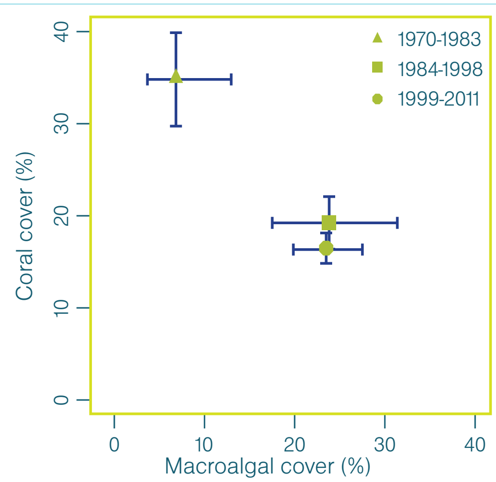



Figure 4.1 Large-scale shifts from coral to macroalgal community dominance since the early 1970s

*Source: Jackson et al. 2014*

However, all is not yet lost. It is also clear from the most recent Caribbean Coral Reefs Status Report (Jackson *et al*. 2014) that there are less impacted and / or more resilient coral reef areas, for example, the Bonaire, Curacao, Venezuelan parks, Flower Garden Banks and the Jardines de la Reina in Cuba and the Mesoamerican Region (see Section 4.2.4), which can serve as models for the policy and management actions needed to address these declines. Effective strategies to protect the region's reefs and to support their resilience, such as the implementation of strong and consistently-enforced environmental regulations (land-use, vessel-use, marine protected areas, fisheries, etc.) for locally manageable coral reef stressors, on a holistic watershed-based level and that incorporate supportive habitats and key species, must be prioritised if the region's coral reefs and the multitude of ecosystem services they provide are to be maintained. Although there are standardised marine ecosystem monitoring methods for biophysical, socio-ecological, and management effectiveness indicators, their use and application are often highly variable, leading to gaps in data and understanding. Despite the challenges posed by incomplete, inconsistent and incompatible coral reef ecosystem data across the region, studies point to a negative shift in the composition of coral systems and decline in live coral cover (Gardner *et al*. 2003; Wilkinson 2004; Bongaerts *et al*. 2010; Jackson *et al*. 2014).

## 4.2.1 Status and trends

Coral reef ecosystems exist in a delicate balance, with different organisms fulfilling defined functional roles to keep the ecosystem as a whole healthy. Corals, algae, invertebrates such as the herbivorous long-spined sea urchin (*Diadema antillarum*), as well as reef fish populations all contribute to a functioning system. Herbivorous fish and urchin are essential biodiversity because of their ecological functions. Healthy biomass of essential species is key to maintain because of their ecological functions (International Coral Reef Initiative [ICRI] 2019). Due to the relative ecological isolation of the wider Caribbean and the proximity of many regional coral reefs to densely populated, economically challenged coastal areas, declines or losses in any critical functional groups are cause for concern.

The structure of the Caribbean basin, which was isolated when the Central American Seaway was closed off, has resulted in low taxonomic diversity and ecological redundancy, putting Caribbean reefs at increased risk to threats (Jackson *et al*. 2014). The IUCN has listed two geographic coral reef areas within the CLME on the IUCN Red List of Ecosystems[16]. The IUCN considers the Meso-American Reef and Caribbean Coral Reefs Critically Endangered and Endangered ecosystems, respectively (Keith and Spalding 2013; Bland *et al*. 2017).

Wider Caribbean coral reefs are vulnerable to numerous global, regional and local threats (see section 3.2) including:

- Declining water quality from land-based and marine sources of pollution
- Global climate change (e.g. ocean warming and acidification, increased number and strength of storms)
- Unsustainable resource use (e.g. overfishing, inappropriate land use, overpopulation)
- Invasive species (e.g. lionfish, macroalgae)
- Diseases (of both coral species and reef biota such as *Diadema antillarum*, *Scarus Guacamaia* (Choat, *et. al.* 2012), and other herbivorous fish[17] (ICRI 2019)
- Direct physical impacts (e.g. vessel groundings)

Wider Caribbean coral reefs have been declining for decades. This decline is primarily attributable to marine diseases of the framework *Acropora* coral species and the important herbivore *Diadema* in the 1970s and 1980s, the effects of heavy tourism visitation, and overfishing of important herbivorous fish species (Jackson *et al*. 2014). Adverse impacts to coral reefs associated with climate change, such as mortality due to bleaching from sustained elevated sea surface temperatures, have been important drivers of loss of coral cover in some, but not all, areas within the wider Caribbean, for example, within the northern and central Lesser Antilles during the 2005 regional thermal event (Jackson *et al*. 2014).

16 https://www.iucn.org/theme/ecosystem-management/our-work/red-list-ecosystems

17 Herbivorous fish help maintain healthy reefs, control the abundance of macro-algae, transfer energy to intermediate carnivorous fish, as well as aid coral recruitment. Moreover, they are natural eroders, producing sediments like the white sand we see on beaches and with this process to help recycle nutrients. They also help to avoid phase change, a process that refers to the replacement of live coral on reefs by algae. Because of the fundamental ecological role of the species, scientists recommend maintaining large biomass of herbivorous fish (parrotfish, surgeonfish, butterflyfish and angelfish) in order to promote good health in reef ecosystems since they increase their capacity of recovery.

Figure 4.2 There are many threats facing Caribbean coral ecosystems including direct physical damage resulting from vessel impacts such as groundings, inappropriate anchoring and pollution

*Photo by Paige Rothenberger*

The percentage of live reef-building coral is also declining. It must be noted that there has been and continues to be great variability in coral cover across the different LMEs. On a broad sub-regional scale, coral cover within the CLME is estimated at 0.64%, the GoM-LME is estimated at 0.09%, and just 0.01% of the NBSLME is covered by coral (Global Distribution of Coral Reefs 2010 cited in One Shared Ocean 2018).

In order to better understand trends in coral cover and what is driving them, a 2014 regional study by Jackson *et al*. (2014) evaluated quantitative coral reef survey datasets from across 34 countries and 90 sites (within the three LMEs) with comparable parameters. From this study, mean live coral cover for the tropical western Atlantic was determined to be 16.8%, with a median of 14.5% and a range of 2.8% for southeast Florida to 53.1% for the Flower Garden Banks (Jackson *et al*. 2014). It is important to note that within the regional data there is considerable variability in coral reef condition (live coral cover, percentage change in coral and macroalgae cover) at the individual jurisdiction level (see Appendix 2 for country-specific data).

Further investigation of the data by Jackson *et al*. (2014) revealed that at a subset of 21 locations with the most complete time series data on long-term coral cover trends, there are three distinct patterns of coral cover change (Figures 4.2 and 4.3). These 21 sites were grouped based on the total amount of change over three time intervals which correspond to major regional ecological events and the tempo of coral cover change. The three time intervals the investigators used in their analysis were:

- 1969-1983 – includes the oldest data through the mass mortality of Diadema antillarum in 1983, and the initial reports and mortality to *Acropora spp.* from white band disease
- 1984-1998 – includes the time period following *Diadema* mortality and the 1998 regional extreme heating/bleaching event
- 1999-2011 – the modern era of degraded coral reefs

From this data, Jackson *et al*. (2014) have determined that reefs within the wider Caribbean with the highest levels of coral cover share certain similarities, namely: lesser impacts from land-based sources of pollution; existence of fisheries regulations and effective enforcement; lower frequency of hurricanes, bleaching and disease; as well as being located in areas of moderate economic prosperity. However, these apparent similarities, as well as the causes of variability in regional coral reef response, require further investigation to identify mechanisms of recovery and plan for appropriate supportive actions.


Figure 4.3 The 21 locations with the most complete time series data analysed by Jackson *et al*. (2014) symbolised by three strikingly contrasting patterns of change in coral cover as demonstrated by their trajectories in Figure 4.4

*Source: Jackson et al. 2014*

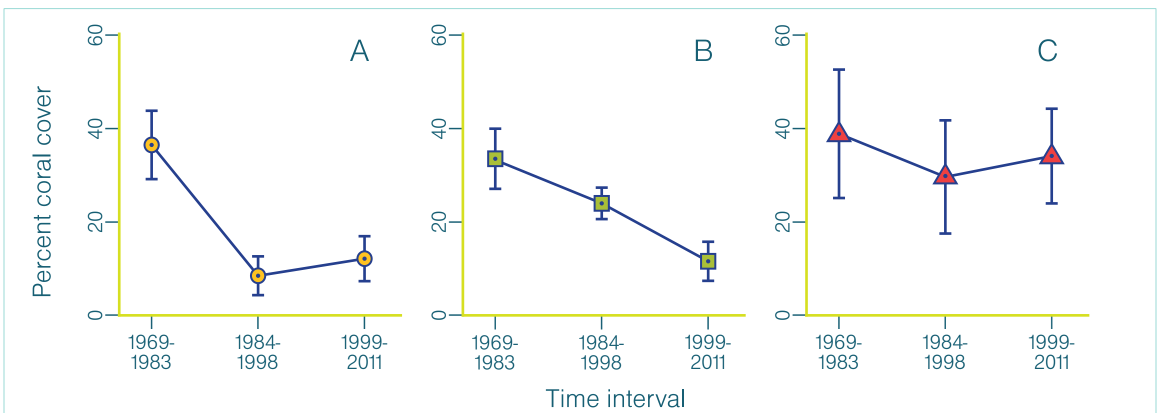



Figure 4.4 Trajectories of coral cover at a subset of 21 reef locations within the Wider Caribbean (A) Hockey stick pattern with a steep decline between the first two intervals followed by little or no change (B) Approximately continuous decline over all three intervals (C) Comparative stability with smaller net changes in cover

*Source: Jackson et al. 2014*

## Macroalgae cover

At a basin-wide scale, the shift from coral-dominated systems to reefs where macroalgae are more abundant than living coral is also evident. Jackson *et al*. (2014) documented mean changes in percentage of live coral and macroalgal cover for all study sites, as well as the subset of 21 sites (see Figure 4.4) across the three time periods previously described (see Table 4.2).

While coral cover has generally been on the decline throughout the wider Caribbean, algal communities have been increasing, particularly the percentage of benthic cover of macroalgae. Macroalgae were historically in low abundance on Caribbean reefs because they were kept in check by herbivores such as the long-spined sea urchin (*Diadema antillarum*) and parrotfish. Due to increases in anthropogenically-sourced nutrients coupled with losses of major herbivores due to disease and overfishing, macroalgae cover on reefs is much higher on reefs today compared to the past and are out-competing corals (Gardner *et al*. 2003; Wilkinson 2004; Bongaerts *et al*. 2010; Jackson *et al*. 2014). In the last 10 years, macroalgae cover has almost doubled (12% to 23%) on monitored Mesoamerican reefs (McField *et al*. 2018).

**Table 4.2:** Mean per cent cover of corals and macroalgae by reef depth across three time periods for all study sites and for the subset of 21 locations in Figure 3.2. Values indicated are means with 95% confidence intervals in parentheses calculated with mixed-effect beta regression that takes into account variability due to location and datasets.

| **Depth** (m) | **All Locations** | | | **21 Locations** | | |
|---|---|---|---|---|---|---|
| | 1970-1983 | 1984-1998 | 1999-2011 | 1970-1983 | 1984 - 1998 | 1999-2011 |
| **Coral cover** (%) | | | | | | |
| 0-20 | 33.0 (28.7, 37.6) | 18.6 (16.2, 21.2) | 16.4 (14.8, 18.1) | 31.5 (27.7, 35.6) | 18 (15.1, 21.3) | 15.8 (13.0, 19.0) |
| 0-5 | 33.2 (22.7, 45.6) | 14.1 (11.2, 17.6) | 15.4 (13.2, 17.9) | 26.6 (20.2, 34.1) | 13.4 (9.5, 18.5) | 12.2 (8.6, 17.0) |
| 5.1-20 | 32.6 (28.1, 37.3) | 19.4 (16.3, 22.9) | 16.5 (14.8, 18.4) | 34.6 (30.3, 39.1) | 19.6 (16.6, 23.0) | 18.6 (12.9, 21.3) |
| **Microalgal cover** (%) | | | | | | |
| 0-20 | 7.0 (3.6, 13.0) | 23.6 (17.3, 31.4) | 23.5 (19.8, 27.6) | 5.6 (2.7, 11.0) | 21.6 (14.0, 31.8) | 23.9 (18.4, 30.5) |
| 0-5 | 12.1 (5.3, 25.2) | 40.1 (24.4, 58.2) | 24.0 (17.9, 31.4) | 10.2 (3.9, 24.2) | 42.4 (29.0, 56.9) | 21.1 (16.0, 27.4) |
| 5.1-20 | 4.0 (1.8, 9.0) | 21.5 (15.1, 29.5) | 23.2 (19.2, 27.8) | 4.0 (1.8, 9.0) | 19.3 (11.3, 31.0) | 25.8 (18.8, 34.2) |

*Source: Excerpted from Jackson et al. 2014*

## Abundance and biomass of key reef fish taxa

Artisanal and subsistence fisheries are common in Caribbean communities and often provide livelihoods and an important source of economical protein. As human populations in the region have increased and fishing gear has become more efficient, the pressure on coral reef fisheries has increased. Regulation of these fisheries across the wider Caribbean is variable. Some countries actively regulate artisanal or small-scale fisheries as well as the take of specific species while others only regulate commercial or offshore fisheries (FAO 2014). Some countries have developed important regulations to protect and manage of herbivorous fish species such as parrotfish. Eleven countries (Mexico, Bermuda, Guatemala, Cuba, USA, Costa Rica, Panama, Colombia, France, Belize, and the Dominican Republic) use legal and management tools to regulate the monitoring of fish and reef species, dynamics and size of populations, measuring ecological functions, biomass, richness, sources of disturbance, analysis of fisheries catch data, closed seasons, regulation of capture, possession, transport or trade of species. However, regulations are not in place for all countries in the wider Caribbean region. Overfishing throughout the wider Caribbean has resulted in reductions in the size and abundance of herbivorous fish species (e.g. surgeonfish, parrotfish) and has been a major driver of the phase shift from coral dominated systems to those dominated by macroalgae (Gardner *et al*. 2003; Wilkinson 2004; Bongaerts *et al*. 2010; Jackson et. al. 2014; ICRI 2019).

Jackson *et al*. (2014) noted a correlation between the level of fishing pressure at a reef site and coral cover. Median coral cover is significantly divergent between less fished and overfished reefs after the mass mortality of Diadema in 1983. Similar results are found for coral cover at reef sites since 2005. The authors also note a significant difference in the proportional loss of coral cover across the three time periods (1970-1983, 1984-1988, 1999-2011) between less-fished sites (with a median of 35% loss in coral cover and range of +35% to -80%) and overfished locations (with a median of a 65% loss in coral cover and range -22% to -90%). When the authors considered the relationship between macroalgal cover and fishing pressure, a trend of two to three times higher macroalgal cover at locations considered overfished was observed (Jackson *et al*. 2014).

## Coral health/condition

As discussed in Section 3.2, corals throughout the wider Caribbean are affected by numerous diseases. Coral diseases continue to contribute to coral reef decline. The recent emergence, high prevalence, high mortality and continued spread of SCTL disease to multiple locations within the Caribbean is particularly troubling. As of September 1, 2019, disease signs consistent with those of SCTL disease have been documented in locations beyond Florida, including Belize, the Dominican Republic, Jamaica, Mexico, St. Maarten, Turks and Caicos and the USVI. The Caribbean node of the Global Coral Reef Monitoring Network (GCRMN-Caribbean) has recommended that assessments be made of coral health in order to estimate disease prevalence at monitored sites, to document incidence, trends and to inform management efforts (UNEP-CEP 2016).

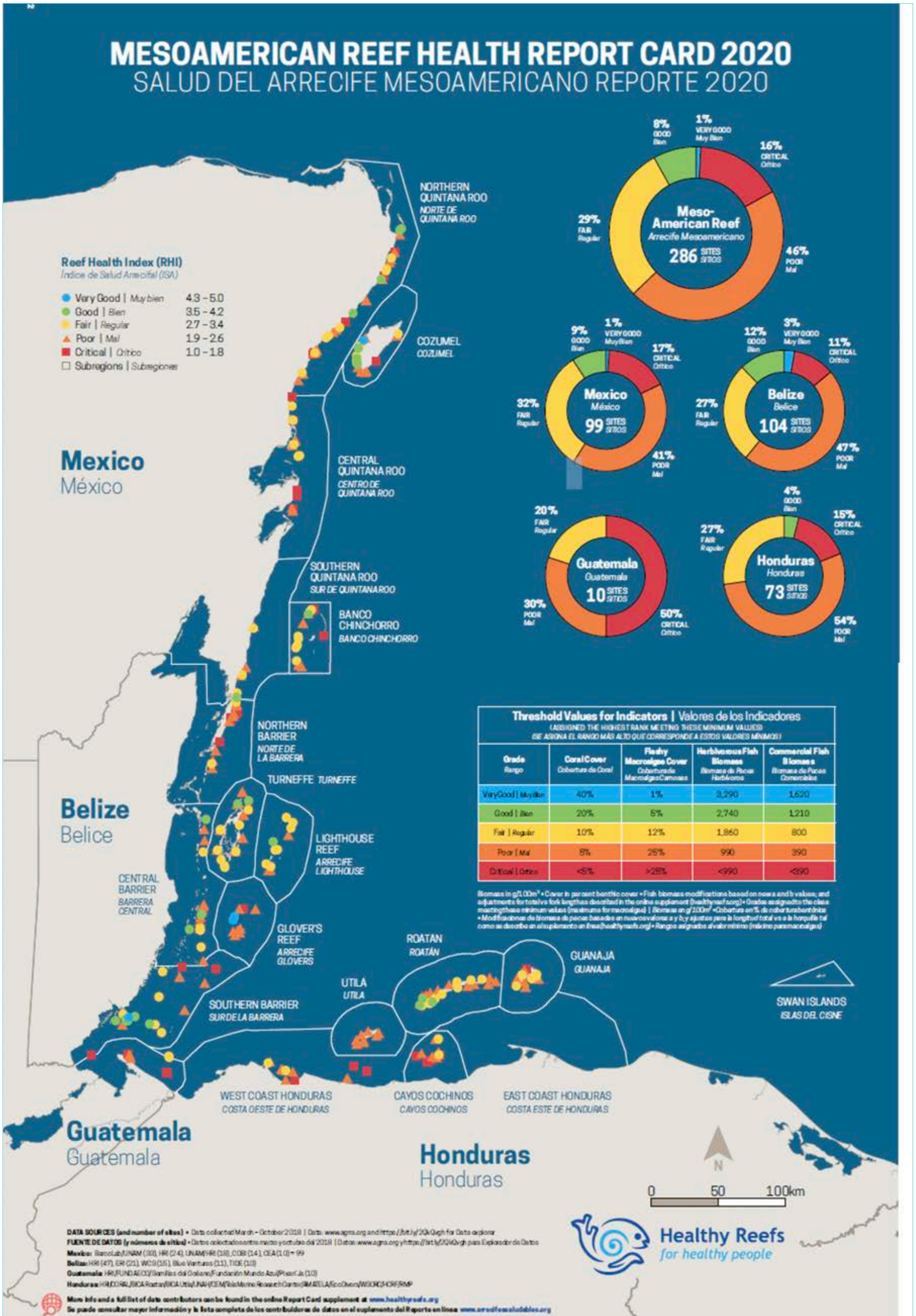
Several countries have been using coral reef monitoring data collected over time to create coral reef report cards, referred to as a Reef Health Index (RHI), which provide a snapshot of ecosystem condition by combining multiple biophysical indicators into qualitative indices. Where there is temporal data at a site, efforts have been made to characterise trends in ecosystem condition. Data for these programmes through 2011 were included in the Jackson *et al*. (2014) regional assessment, but these sub-regional, country and site-specific report cards are examples of products that can be used to inform policy and management strategies as well as provide some insight into the variability of reef condition within the region.

The 2016 regional report cards for six Eastern Caribbean countries[18] scored the sub-region 2.5 or "Poor" on the RHI. The 2020 regional report card for the four Mesoamerican Reef countries of Mexico, Belize,

**Table 4.3:** Country RHI Scores from Reef Report Cards

| Country | Score | Rating | Year RHI reported | Year data collected |
|---|---|---|---|---|
| **Eastern Caribbean** | | | | |
| Antigua and Barbuda | 2.3 | Poor | 2015 | 2005, 2011, 2013 |
| Dominica | 2.75 | Fair | 2015 | 2005 |
| Grenada | 2.5 | Poor | 2015 | 2005, 2014, 2015 |
| Saint Lucia | 2.75 | Fair | 2015 | 2011, 2014 |
| St. Kitts and Nevis | 2.25 | Poor | 2015 | 2011 |
| St. Vincent and the Grenadines | 2.75 | Fair | 2015 | 2005, 2008, 2011, 2014 |
| **Greater Antilles** | | | | |
| Dominican Republic | 2.5 | Poor | 2017 | 2015 |
| Haiti | 2.25 | Poor | 2017 | 2015 |
| Jamaica | 2.25 | Poor | 2017 | 2012, 2013, 2015 |
| **Mesoamerica** | | | | |
| Belize | 3.0 | Fair | 2016, 2018, 2020 | 2016, 2018 |
| Guatemala | 2.0 | Poor | 2016, 2018, 2020 | 2016, 2018 |
| Honduras | 2.5 | Poor | 2016, 2018, 2020 | 2016, 2018 |
| Mexico | 2.8 | Fair | 2016, 2018, 2020 | 2016, 2018 |

*Source: CaribNode http://caribnode.org/ accessed on 16 January 2020 and Healthy Reefs for Healthy People http://healthyreefs.org accessed on 24 June 2020*




Threshold Values for Indicators | Valores de los Indicadores
(ASSIGNED THE HIGHEST RANK MEETING THESE MINIMUM VALUES)
(SE ASIGNA EL RANGO MÁS ALTO QUE CORRESPONDE A ESTOS VALORES MÍNIMOS)

| Grade *Rango* | Coral Cover *Cobertura de Coral* | Fleshy Macroalgae Cover *Cobertura de Macroalgas Carnosas* | Herbivorous Fish Biomass *Biomasa de Peces Herbívoros* | Commercial Fish Biomass *Biomasa de Peces Comerciales* |
|---|---|---|---|---|
| Very Good \| Muy Bien | 40% | 1% | 3,290 | 1,620 |
| Good \| Bien | 20% | 5% | 2,740 | 1,210 |
| Fair \| Regular | 10% | 12% | 1,860 | 800 |
| Poor \| Mal | 5% | 25% | 990 | 390 |
| Critical \| Crítico | <5% | >25% | <990 | <390 |

*Source: Excerpted from www.healthyreefs.org*

Figure 4.5 2020 Mesoamerican Reef Health Report Card

Guatemala and Honduras (Western Caribbean ecoregion) (see Figure 4.5) also scored the region 2.5 or "Poor" on the RHI (McField *et al*. 2020), which is a decline from 2.8 or "Fair" in 2018 . The 2018 report cards for three countries in the Greater Antilles[19] scored the sub-region 2.5 on the RHI (see Table 4.3).

The Nature Conservancy (TNC) prepared report cards[20] for individual sites in the Dominican Republic (Bahía de Samaná), Haiti (Aire Protegee Des Trois Baies), and Jamaica (Bluefields Bay Fish Sanctuary and South West Cay Fish Sanctuary). With the site-based report cards, at three of the sites, the additional parameter of reef structure or rugosity has been characterised which is an important indicator of a reef's ability to support diversity and provide ecosystem services. While these scorecards do not include an overall RHI score, reef health indicators such as coral cover, coral competitors, reef structure, key herbivores and key carnivores are characterised as good, fair, impaired or poor (see Table 4.4).

**Table 4.4:** Greater Antilles Reef Report Cards

| Bahía de Samaná, Do-minican Republic | Aire Protegee Des Trois Baies, Haiti | Bluefields Bay Fish Sanctuary, Jamaica | South West Cay Fish Sanctuary, Jamaica |
|---|---|---|---|
| Coral cover | Coral cover | Coral cover | Coral cover |
| Coral competitors | Coral competitors | Coral competitors | Coral competitors |
| Reef structure | Reef structure | Reef structure | N/A |
| Key herbivores | Key herbivores | Key herbivores | Key herbivores |
| Key carnivores | Key carnivores | Key carnivores | Key carnivores |
| Blue = good, green = fair, yellow = impaired, orange = poor | | | |

*Source: CaribNode http://caribnode.org/ accessed on 22 October 2018*

## Coral recruitment

Coral recruitment is an indicator of the reproductive success of stony reef-building coral species, and by extension an indication of ecosystem health, function and persistence into the future. Regional coral monitoring data evaluated by Jackson *et al*. (2014) points to a continued decline in recruitment of reef-building corals. Caribbean coral recruitment is declining due to losses in coral cover (stock), impaired health of adult coral stock on reefs, loss of settlement habitat and competition from macroalgae.

## Abundance of key macro-invertebrate species

Key coral reef macro-invertebrates include species that are both ecologically and economically important. Key macro-invertebrate species include the herbivorous long-spined sea urchin (*Diadema antillarum*), other sea urchins, sea cucumbers, lobsters and conch. By feeding on algae, they limit competition between algae and coral species and maintain suitable settlement areas for coral recruits. *Diadema* abundance is variable across the wider Caribbean with some localised areas observing increasing numbers of the herbivorous urchins. However, in general, *Diadema* abundance continues to be low compared to historical levels. Availability and accessibility of quantitative data on the abundance of other macro-invertebrate species at regional and sub-regional levels are limited.

## Water quality

As discussed in Section 3.2, water quality is an important driver of the negative changes observed on regional coral reefs (United Nations Environment Programme 2019). There is limited standardised and comparative data on water quality at the region's reefs. However, according to the limited regional data analysed by Jackson *et al*. (2014) water quality has declined, and continues to do so, to the detriment of Caribbean coral reefs.

18 Assessments were conducted for Antigua and Barbuda, Dominica, Grenada, Saint Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines http://www.caribnode.org/tools/reef-assess/region/1/

19 Assessments were conducted for Dominican Republic, Haiti and Jamaica http://www.caribnode.org/tools/reef-assess/region/1283/

20 http://caribnode.org/documents/

## Threatened species

Numerous coral species are considered threatened and protected under the SPAW Protocol (see Appendix 3). In 1991, corals in classes Anthozoa and Hydrozoa, including all species within the orders Milleporina, Antipatharia, Alcyonacea, and Scleractinia, were listed for protection in Annex III of the SPAW Protocol (this listing would also include the hybrid coral *Acropora prolifera*, which likely supports the genetic diversity, resistance and resilience of the critically endangered parent species *A. cervicornis* and *A. palmata*). In 2014, four stony coral species were further listed in Annex II of the SPAW Protocol: *A. cervicornis*, *A. palmata*, *Orbicella annularis* and *O. faveolata* (both species of *Orbicella* were formerly classified in genus *Montastraea*). All species within the orders Milleporina, Antipatharia and Scleractinia are also listed in CITES Appendix II. The IUCN (2019) lists 10 Threatened Species of coral and one of fire coral in the wider Caribbean. The IUCN Red List of Threatened Species[21] provides information on the status of species listed (see Table 4.5). According to the version 2019-2 of the IUCN Red List of Threatened Species, two hard coral species are listed as Critically Endangered, two species as Endangered, and six that are classified as Vulnerable; the species of hydrocoral is classified as Endangered. There are an additional two species of hard coral classified as Near Threatened. Many of these threatened stony coral species are considered reef-building corals which create the reef framework and provide the three-dimensional structure that allows these systems to support large numbers of species and provide significant ecosystem services.

**Table 4.5:** List of coral species with IUCN Red List Status*

| Depth | Depth |
|---|---|
| *Acropora cervicornis* | Critically Endangered |
| *Acropora palmata* | Critically Endangered |
| *Orbicella annularis* | Endangered |
| *Orbicella faveolata* | Endangered |
| *Millepora striata* | Endangered |
| *Agaricia lamarcki* | Vulnerable |
| *Dendrogyra cylin-drus* | Vulnerable |
| *Dichocoenia stokesii* | Vulnerable |
| *Mycetophyllia ferox* | Vulnerable |
| *Oculina varicosa* | Vulnerable |
| *Orbicella franksi* | Vulnerable |
| *Agaricia tenuifolia* | Near Threatened |
| *Porites branneri* | Near Threatened |

* All of these are also listed on the SPAW Protocol.

In 2006, the U.S. Government listed two Caribbean framework reef-building coral species as threatened under the Endangered Species Act (*Acropora palmata* and *A. cervicornisII*). In 2014, an additional three species of reef-building coral (*Orbicella* species complex – *O. annularis*, *O. faveolata* and *O. franksii*) were listed. These additional listings reflect the continued decline of Caribbean coral reefs due to the negative impacts of multiple local and global stressors and repeated impacts and losses from bleaching, elevated SSTs and diseases.

There are also threatened species of mangrove and seagrass within the wider Caribbean. The endemic Central American *Pelliciera rhizophorae* is the only mangrove species occurring in the wider Caribbean that is listed as Vulnerable on the IUCN Red List of Threatened Species (Ellison *et al*. 2010). Of the seven species of seagrass that are native to the Caribbean, two (*Halophila engelmannii* and *Halophila baillonii*) are considered near threatened and vulnerable (Cavender-Bares *et al*. 2018).

## Coral reef monitoring data challenges

In order to most effectively inform policy decisions and management action to protect Caribbean coral reefs, useful and accessible data on their status and trends must exist. Although standardised marine ecosystem monitoring methods for biophysical, socioecological, and management effectiveness indicators exist (e.g. the Atlantic and Gulf Reef Rapid Assessment www.agrra.org, Reef Check www.reefcheck.org, CARICOMP 2001 and SOCMON 2000), their use and application has often been highly variable across the region, leading to gaps in data and understanding. Some countries have monitoring

21 http://www.iucnredlist.org

Figure 4.6 Hard, scleractinian, corals such as *Acropora palmata*, *A. cervicornis* and *Diploria strigosa* are responsible for building the structure of the reef, which supports significant biodiversity and provides ecosystem services.

*Photo by L. Henderson*

programs at the national or system level, while others conduct monitoring activities at an individual site level. In some instances, these activities are limited to protected areas or other identified reef areas of importance. Other countries have representative national, or territorial-wide coral monitoring programs which provide data on condition and trends beyond an area that may be subject to specific management strategies (e.g. an MPA). Some areas are not consistently monitored. Despite the challenges posed by incomplete, inconsistent and incompatible coral reef ecosystem data across the region, studies have been able to discern a negative shift in the composition of coral systems and decline in live coral cover (Gardner *et al*. 2003; Wilkinson 2004; Bongaerts *et al*. 2010; Jackson *et al*. 2014).

Following the "Status and Trends of Caribbean Coral Reefs: 1970-2010" report (Jackson *et al*. 2014) that noted declines in coral reefs, UNEP-CEP and GCRMN-Caribbean developed regional guidelines for the monitoring of biophysical (UNEP 2016) and integrated social science (UNEP 2017) coral reef parameters to address monitoring and assessment gaps identified. The suggested integrated approach to monitoring both biophysical and social science indicators in tandem is intended to enhance the ability to connect observed changes in coral reef ecosystem quality with human and social parameters. These guidelines present a tiered monitoring approach including minimum indicators that should be monitored at every coral reef site to ensure that data collected throughout the region is consistent, comparable and useful for policy and management decisions. These tiered/scalable guidelines are intended to support both existing and developing coral reef monitoring programmes throughout the region, and to ensure that the programmes are contributing data that support an understanding of Caribbean reefs at multiple scales – regional, national, system and site.

Figure 4.7 Moray eel hiding among Orbicella coral colonies

*Photo by Paige Rothenberger*

There continues to be a need for basic coral reef mapping and benthic characterisation within the region (see section 5.6 for key mapping and monitoring responses and initiatives). The use of emerging technologies and incorporation of traditional and local knowledge would strengthen these efforts and likely result in improved outputs. Current maps delineating and characterising coral reef habitats are critical to support policy and management efforts to protect them. GCRMN-Caribbean efforts to standardise, increase and integrate the collection of biophysical coral reef data across the region will serve to fill gaps and to provide data on coral reef condition to support policy decisions and management action.

## 4.2.2 Mesophotic Coral Ecosystems

Mesophotic Coral Ecosystems (MCEs) within the wider Caribbean include Pulley Ridge in the Gulf of Mexico, the USVI, and La Parguera in Puerto Rico. Due to difficulty in assessing MCEs because of depth constraints, these areas have typically been underrepresented in coral reef surveys and resulting marine planning efforts. Recent studies suggest that MCE coverage in the Caribbean may equal or be greater than shallower reef habitat (Locker *et al*. 2010). These systems have many of the same species as nearshore reefs, but also have some that are specific and restricted to the mesophotic depths. These reefs are subject to many of the same stressors as shallower reef systems but since they have not been included in the planning processes, may be under-protected. Several hypotheses about the services that MCEs can provide to mitigate the natural and anthropogenic impacts that are decimating shallower Caribbean reefs such as serving as climate refugia or providing sources of larval exchange are being investigated. Unfortunately, studies are increasingly showing that MCEs are also threatened by the same suite of stressors facing shallower reefs, and likely do not function as refugia from thermal events associated with climate change (Smith *et al*. 2015; Smith *et al*. in press). Further, some work suggests that MCEs are ecologically distinct from shallower reefs, thus potentially limiting their ability to replenish depleted near-shore reefs (Rocha *et al*. 2018) and highlighting the need to protect these systems. MCEs highlight the importance of mapping and monitoring efforts, the use of emerging technology to better access deeper reefs and tapping into local knowledge.

## 4.2.3Resilient areas

Despite the significant degradation of regional reefs over the past decades, there is evidence from the Jackson *et al*. (2014) assessment that some reef areas are less impacted by threats. Reefs in Bonaire, Curacao, Venezuelan parks, Flower Garden Banks and the Jardines de la Reina in Cuba appear to have not just higher coral cover but higher comparative resilience to climate change-driven heating events and hurricanes as well (Jackson *et al*. 2014). These areas provide much-needed validation of the effectiveness of strong, consistently enforced environmental regulations. Governments in these areas, and more recently Belize, have taken effective action to implement strong fisheries regulations to protect, and over time, rebuild reef fish populations which are vital to supporting resilient coral reefs and sustaining ecosystem function (Bozec *et al*. 2014; Jackson *et al*. 2014; McClanahan 2015; Steneck *et al*. 2018).

From the sub-regional example of the Mesoamerican Reef, there are encouraging trends of improvement in some reef health indicators within the countries and among sites when considering the 10 years of RHI data across the sub-region (McField *et al*. 2018):

- The sub-regional RHI for the Mesoamerican Reef improved from 2.3 (poor) to 2.8 (fair) over the 10 years.
- Honduras has the highest RHI (3.0), followed by Belize (2.8), Mexico (2.8) and Guatemala (2.0).
- Three of the four indicators of reef health improved over the decade – coral cover, herbivorous fish and commercial fish.
- 21% of monitored corals bleached in 2015/16, but no mortality was noted.
- Fully protected replenishment zones appear to be working, with commercial fish species two times more abundant over the 10 years.
- New fishery management actions to protect parrotfish in Guatemala, Belize and the Bay Islands of Honduras appear to be working.

Unfortunately, coverage of macroalgae continues to increase on monitored reefs, with biomass nearly doubling across the region. Management actions to address land-based sources of nutrient and pollutant runoff need to be implemented, along with steps to increase herbivory on reefs (McField *et al*. 2018).

# 4.3Mangroves

## 4.3.1 Status and trends

In general, mangrove ecosystems are also declining throughout the wider Caribbean region.

### Mangrove extent

One of the findings of the 2005 global assessment of mangroves was that the North and Central America region contained the third largest area of mangroves (FAO 2007a), which, at approximately 22,402 $km^2$, accounted for 14.7% of the global extent. Mexico holds 3.66% of the world's mangroves, Venezuela 2.95%, and Colombia 2.05% (Hamilton and Casey 2016).

The 2005 global assessment of mangroves (FAO 2007a) noted that, although the net loss and rate of loss of mangroves decreased during the period 1980-2005, the North and Central America region still lost approximately 700,000 ha (7,000 $km^2$), or approximately 23% of the coverage at the start of the period. Regional mangrove losses continued at a rate of 0.12% per year between 2000 and 2012 (Hamilton and Casey 2016).

During the 1980s and 1990s, the highest rates of deforestation were in Barbados, Dominica, Dominican Republic, Jamaica, Haiti, Honduras, and El Salvador (CARSEA 2007). Antigua and Barbuda and Barbados were also among the countries that experienced "high negative change rates" in the period 2000-2005 (FAO 2007a). A compilation of mangrove forest estimates for the period 1993-2012 indicated that the pattern of decline in mangrove cover continued beyond 2005, with the greatest reduction in coverage said to be in Barbados (87%), USVI (60%), and the Dominican Republic (42%) (Serafy *et al*. 2015).

In the Caribbean, the main reasons for the loss of mangroves were the conversion of mangrove areas to other uses, mainly infrastructure, aquaculture, rice production, salt production, and tourism development (CARSEA 2007; FAO 2007a).

Countries reported to have maintained a relatively constant acreage of mangroves during the period 1980-2005 were Anguilla, Aruba, Montserrat, Saint Lucia, and the Turks and Caicos Islands (CARSEA 2007; FAO 2007a). Meanwhile, Cuba and Puerto Rico experienced net gains in acreage at one percent and 12% respectively (FAO 2007a; Serafy *et al*. 2015). The gains in Cuba and Puerto Rico were attributed to increased legal protection, natural colonisation of new areas, re-colonisation of abandoned agricultural lands, and restoration initiatives.

The decreased rate of loss towards the end of the 2005 global assessment period most likely resulted from increased awareness of the value of mangrove ecosystems and that increased awareness was generating new legislation and protection regimes, as well as restoration efforts (FAO 2007a). However, Giri *et al*. (2011) have suggested that the 2005 estimate of mangrove forests globally may have been higher than the actual coverage due to the resolution of the images used for the study and that a subsequent review estimated that the actual coverage might have been 12.3% less than reported in the FAO study. The new research suggested that, due to the smaller coverage, the consequences of continued loss of mangrove forests will be more serious than previously stated. The difficulties associated with obtaining accurate data on mangrove forest coverage using remotely captured images is highlighted by the differences in coverage estimated in different studies for the same period (CARSEA 2007; FAO 2007b), and more so for different periods (Juman and Ramsewak 2013; Wiener 2014).

## Mangrove health/condition

Although there are studies that assess the coverage of mangroves, most use satellite imagery and it is difficult and expensive to determine the health of the ecosystem. Therefore, there is no clear picture of the condition of mangrove ecosystems at the regional scale in the CLME, except for the continued loss of mangrove forests cover (Cavender-Bares *et al*. 2018). Country studies indicate that the structure and functional characteristics of mangrove communities are dependent on location, and thus display a significant degree of variation. Additionally, gains and losses are site-specific and influenced by both human development impacts and natural changes (Juman and Ramsewak 2013; Wiener 2014; Institute of Marine Affairs 2016; Gore *et al*. 2018; Sealey and Logan 2018; Sealey *et al*. 2018; Jameson *et al*. 2018).

The mangrove ecosystems in the NBSLME display a different dynamic from the mangroves within the CLME. In the North Brazil Shelf area, the coverage and state of the mangrove ecosystems are dependent to a large degree on the coastal hydrodynamics and the volume of mud discharged by the Amazon River (Toorman *et al*. 2018). The mud is transported westward along the coastline in large mud banks, and the consolidation of the calmer areas between the mudbanks and the coastline facilitate the colonisation by red mangrove (Rhizophora mangle). The cycle of mud consolidation, migration, and erosion takes approximately 30 years, during and after which the level of erosion of the mangrove areas and coastline is dependent on the level of human disturbance.

The future status of mangrove ecosystems in the CLME and NBSLME is expected to reflect both older and more recent trends, responsive to both anthropogenic and natural stresses. Mangroves will continue to be lost in response to the traditional pressures associated with population expansion, agricultural activities, infrastructure development, extractive practices, and pollution (IPBES 2018; Primavera *et*

Figure 4.8 Mangroves can be found throughout the Caribbean along coastlines and salt ponds.

*Photo by P. Rothenberger*

*al*. 2018; Ramsar Convention on Wetlands 2018; Sheppard 2018; Toorman *et al*. 2018). The response to climate change will be both positive and negative, depending on the location of the forest and the existence of other forms of stress. An example of a positive impact is the potential landward expansion of mangrove forests due to sea level rise, though that expansion may result in loss of other types of wetlands (Juman and Ramsewak 2013). Of the various responses of mangroves to climate change, the extent of the impact from sedimentation is still uncertain. More intense rainfall events will undoubtedly increase erosion and sediment transport to coastal wetlands, but whether or not that impact will be offset by longer drought periods is unknown.

## 4.3.2 Status of associated species

While it is well known that mangroves provide a range of habitat and nursery functions for associated species (see section 1.3.2), the status of the floral and faunal species associated with mangrove forests in the wider Caribbean is unclear. Apart from the structural damage from intense storms, it is also unclear how the natural and anthropogenic stresses will affect the capacity of mangrove ecosystems to maintain their habitat and associated functions.

Mangroves are often closely associated with other types of coastal wetlands, thereby increasing the ecological, social, and economic value of these coastal wetland associations.

# 4.4 Seagrass meadows

## 4.4.1 Status and trends

About 30% of surveyed seagrass beds worldwide have disappeared within the last century, with rates of loss approximately 110 km2/year since 1980 (Waycott *et al*. 2009 cited in Trevathan-Tackett *et al*. 2017). In general, seagrass habitats are also declining throughout the wider Caribbean.

Although the value of seagrass ecosystems is known, particularly in juxtaposition to coral reef and mangrove ecosystems, they receive comparatively little attention in marine resources monitoring and research programmes at both the national and regional level. Thus, seagrass monitoring initiatives tend to often be short-term and sporadic. The only long-term regional monitoring programme that included seagrass, the Caribbean Coastal Marine Productivity (CARICOMP) programme, was established in 1992 and terminated in 2012. Of the 22 sites (with 52 monitoring stations) in the programme, many concluded monitoring activities by 2007 (van Tussenbroek *et al*. 2014). However, data generated by long-term monitoring programmes are supplemented by periodic assessments. Consequently, any statement regarding the current status of seagrass ecosystems in the Caribbean presents, at best, general trends.

### Seagrass extent

Though the extent of seagrass ecosystems in the CLME is estimated to be approximately 66,000 $km^2$ (Miloslavich *et al*. 2010), there are few estimates of coverage at the national level, though it is more frequent to find estimates of site-specific changes in acreage over time (Institute of Marine Affairs 2016; Gore *et al*. 2018). Information available on national estimates of seagrass coverage includes 34 $km^2$ in Anguilla and 40 $km^2$ in the British Virgin Islands (Gore *et al*. 2018).

The global trend in degradation and loss of seagrass beds is also observed in the wider Caribbean. In the Caribbean, areas of seagrass have shown degradation and recovery over time, but the general trend is towards significant degradation and even loss of some beds (van Tussenbroek *et al*. 2014; Sheppard 2018). This pattern of location-specific loss and gain is also repeated at the national level, as shown by the 2002-2015 seagrass monitoring program in Trinidad and Tobago (Institute of Marine Affairs 2016). In the United Kingdom Overseas Territories, the seagrass beds are more extensive in the British Virgin Islands and Anguilla than in Montserrat, but the trend in the three territories is towards degradation and loss of native seagrass species (Gore *et al*. 2018).

The state of seagrass ecosystems in the wider Caribbean reflects the high variability in bed density, structure, location, biophysical setting, and anthropogenic stressors. Thus, the status of seagrass beds at a particular location may change in response to seasonal influences, the impact of intense natural events such as storms, or the existence of particular pressures such as pollution sources (Guannel *et al*. 2016; Chollett *et al*. 2017 and see Section 3.2). That variability implies that assessment of ecosystem status, determination of the level of contribution and value of ecosystem services, and the design of interventions should be site-specific (Guannel *et al*. 2016).

### Seagrass health/condition

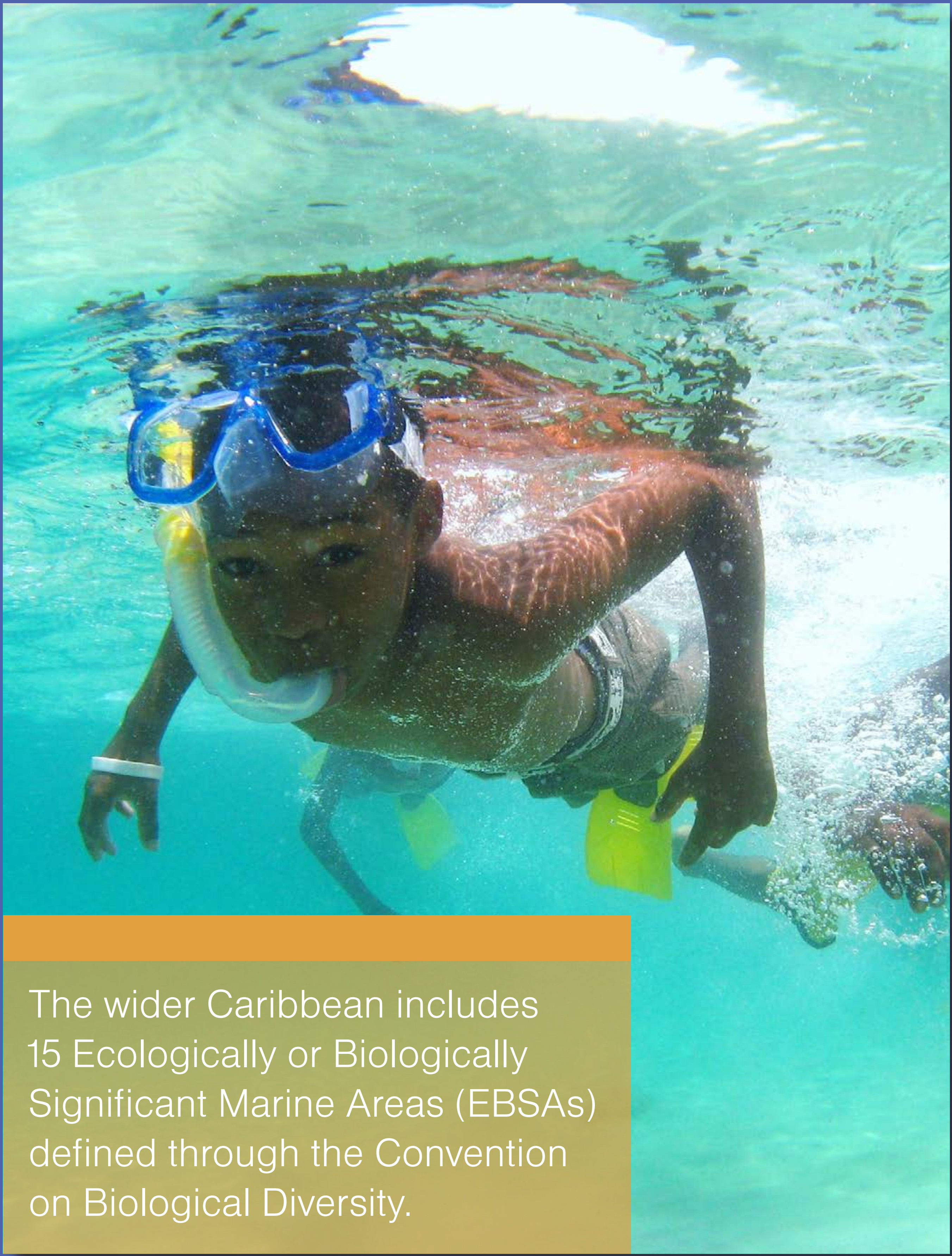
Given the paucity of research and monitoring studies, there is very little information on the health of seagrass beds at a regional level. Standardised, regular and long-term monitoring is needed.

## 4.4.2 Status of associated species

One of the major functions of seagrass ecosystems is its habitat function, providing shelter or a grazing area for many species of marine fauna. That function increases in impact and value when seagrass ecosystems are connected to adjacent mangrove or coral reef ecosystems since seagrass beds function as nurseries for the juveniles of species that spend their adult phases in the adjacent ecosystems. Seagrass communities provide food for marine fauna such as fish, conch, sea urchins, Caribbean manatee and sea turtles (CARSEA 2007). The Jamaica national policy for seagrass conservation (Technical Support Services, Inc. 1996) lists 22 species of fish for which seagrass communities serve as a permanent dwelling, nursery area, or as a food source.

Seagrass also produce detritus, some of which serve as food for bottom-dwelling fish and other fauna within the seagrass communities, while much is exported to adjacent and offshore ecosystems. The rate of production of organic matter in seagrass ecosystems is estimated at one kilogram of carbon per square metre per year (1 kg C/m2/year) (CARSEA 2007).

All the pressures that affect the state of seagrass ecosystems will affect the associated species either directly or indirectly through the habitat functions of the ecosystem, though the productivity and contribution of the ecosystem are influenced by the level of human impact (Coll *et al*. 2011). Changes in seagrass communities that will affect the related faunal species include changes in community structure, seagrass species composition, whether beds are monospecific or mixed, and spatial isolation or connectivity. Habitat preference by some species is related to life stage. This means alteration of seagrass communities could affect abundance and distribution of some fish species (Olinger *et al*. 2017), particularly important commercial species such as the Caribbean spiny lobster (Goldstein *et al*. 2008). Seagrass bed structure also impacts predation on some species, such as sea urchins. It has been suggested that the preference by green turtles for native seagrasses could facilitate expansion by the invasive species of seagrass, with adverse outcomes for the turtle (Christianen *et al*. 2018).



The wider Caribbean includes 15 Ecologically or Biologically Significant Marine Areas (EBSAs) defined through the Convention on Biological Diversity.

*Photo by H. Tonnemacher*

# 5 Key Responses and Initiatives

## Key messages

- There are many programmes for environmental and natural resources management at both national and regional levels, and those programmes are generally sensitive to the development constraints of SIDS.
- The increase in the number of Multi-Lateral Environmental Agreements (MEAs) has been accompanied by an increase in the level and sources of financing for national and regional programmes. These have not reversed the trend in degradation of coastal ecosystems, as the historical threats and driving forces have been maintained by national development decision processes.
- The gap between economic development objectives and community well-being is increasingly being addressed by civil society organisations, which requires redesign of the national governance architecture to enable effective participatory decision-making and programme design and delivery.
- The architecture for regional ocean governance needs to be rationalised in order to ensure appropriate and effective programming to maintain the health of wider Caribbean coastal ecosystems and the flow of ecosystem goods and services.

# 5.1 Overview

In the wider Caribbean, the historical threats and driving forces persist to the current day (CARSEA 2007; Cooper and Renard 2011; Chollett *et al*. 2017; IPBES 2018) and their impacts are amplified by more recent stressors, such as climate change. The interventions to protect the integrity of coastal ecosystems are driven by both national obligations and participation in regional and international programmes and initiatives (see Appendix 4 for selected examples).

Environmental governance philosophy and frameworks in the late 1980s and early 1990s articulated and supported movement towards greater environmental planning, assessments, and reporting. In the wider Caribbean, as elsewhere, there was significant focus on environmental assessments, preparation of national environmental profiles, preparation of national conservation strategies, and development of a range of guidelines for incorporating environmental considerations into physical planning (Caribbean Conservation Association 1991; McShine 1995). That evolved into national state of the environment reporting to track progress in environmental management interventions and outcomes. While environmental assessments are still used in the permitting process in most countries, national conservation planning and reporting have become less widespread.

There has been significant growth in the number of international environmental programmes and MEAs. This growth has been accompanied by establishment of more global financing mechanisms and increase in the number and scale of stakeholder institutions, projects and initiatives. However, management and conservation work in the region has been disjointed, carried out on a project-by-project basis, with limited consolidation of efforts and projects (Muñoz Sevilla and Le Bail 2017). Recognising the importance of coordination, sharing of knowledge and collaboration among initiatives, the CLME+ Hub (https://clmeplus.org/the-clme-hub/) is being developed as an online platform designed to serve as a global gateway of knowledge, resources and tools to support the achievement of the CLME+ Vision and SAP. This includes featured projects, programmes and initiatives and supports efforts to develop an integrated governance mechanism for the region.

# 5.2 Governance architecture and processes

## 5.2.1 International and regional mechanisms

The challenges and strategies for developing effective regional integrating and coordinating mechanisms for governance of the marine ecosystems of the wider Caribbean have been documented (e.g. Mahon *et al*. 2013; Mahon and Fanning 2019a and 2019b). The institutional framework that governs decision-making for the wider Caribbean reflects a complex arrangement of overlapping mandates involving:

- national governments and their agencies;
- regional inter-governmental bodies and their technical agencies – for example, Caribbean Community (CARICOM), Central American Integration System (SICA), Organisation of Eastern Caribbean States (OECS); Association of Caribbean States (ACS), Organization of American States (OAS);
- United Nations programmes, commissions, regional offices, and sub-regional offices; and
- civil society, academia, resource users and other stakeholders, which are playing increasing roles.

Collaborative decision-making by inter-governmental institutions utilises a range of mechanisms such as treaties, ministerial bodies, regional and sub-regional secretariats, and memoranda of understanding. Policy making and decision-making can therefore take place at national, sub-regional, and regional levels, and can be thematically focused. Decision-making at these three levels is also responsive to global compacts established by MEAs (see Appendix 5 for parties to relevant global agreements), regional and extra-regional trade associations and extra-regional governments.

**Table 5.1:** Members of the CLME+ SAP Interim Coordination Mechanism

| CLME+ Interim Coordination Mechanism members |
|---|
| The United Nations Environment Programme (UNEP) represented by its Caribbean Regional Coordinating Unit (UNEP CAR/RCU) |
| The Food and Agriculture Organization of the United Nations (FAO) on behalf of the Western Central Atlantic Fishery Commission (WECAFC) |
| The Intergovernmental Oceanographic Commission of the United Nations Educational, Scientific, and Cultural Organization (UNESCO-IOC) |
| The Organisation of Eastern Caribbean States (OECS), represented by the OECS Commission |
| The Caribbean Regional Fisheries Mechanism (CRFM) |
| The Central American Fisheries and Aquaculture Organisation (OSPESCA) |
| The Central American Commission for Environment and Development (CCAD) |
| The Caribbean Community (CARICOM), represented by the CARCOM Secretariat |

*Source: Fanning et al. 2019*

Additionally, the work of the inter-governmental institutions is increasingly being supported by regional and national civil society organisations, either through advocacy or programme implementation. Many regional inter-governmental institutions and programmes maintain consultation processes with stakeholder groups without integrating the groups into the decision-making processes to any substantive degree (CARSEA 2007), though a small number of institutions have established formal mechanisms for participation by the civil society sector.

Recognising that weak governance – including legal and institutional frameworks, inadequate environmental quality standards and legislation – was identified as a root cause of the problems facing the three habitats, strengthening and expanding the regional, sub-regional and national-level collaborative governance and living marine resources management efforts is a key focus of the CLME+ Project in the implementation of the CLME+ SAP. The thematic scope of enhanced and new regional governance arrangements is the sustainable, climate-resilient management and use of shared living marine resources of the CLME+ region, with the inherent aim of progressively expanding this scope in order to more fully embrace, in the medium- to long-term, the wider-ranging concept of integrated ocean governance and socially just, sustainable oceans-based growth. A CLME+ SAP Interim Coordination Mechanism[22] has already been established and is currently functioning as a grouping of key inter-governmental organisations with a formal mandate directly related to the management and sustainable use of the marine environment of the CLME+ region (see Table 5.1).

Proposals for the establishment of a permanent Coordination Mechanism for the CLME+ SAP and for broader partnership arrangements have been developed (Fanning *et al*. 2019). Membership in the Coordination Mechanism will be open to the countries that have formally endorsed the CLME+ SAP as well as to key organisations with a formal mandate on the marine environment of the CLME+ region. A Memorandum of Understanding is currently being formulated as the constituting instrument of the Coordination Mechanism. Voluntary partnership arrangements are also being considered, possibly involving community and statutory agencies, private sector bodies, financing institutions and influential individuals committed and contributing to the implementation of the SAP. It is envisaged that these arrangements will bring together stakeholders to work as complements of each other, act collaboratively and in a coordinated manner, and bring into full play the formal mandate or role, and comparative advantages of each stakeholder, and in alignment with the concept of interactive and participatory governance.

22 https://clmeplus.org/interim-coordination-mechanism-icm/

Figure 5.1 Mangrove replanting by civil society and local communities in Haiti.

*Source: Fondation Pour La Protection de La Biodiversité Marine (FoProBiM)*

## 5.2.2 Civil society engagement

A variety of non-state actors use the coastal and marine environments, thus the identification and implementation of solutions to maintain and enhance the viability of marine resources should involve the multiplicity of actors in the space (Scarano *et al*. 2018).

However, the current engagement mechanisms for environmental management are designed primarily for awareness building and consultations. The participation of the civil society sector has been inconsistent at both national and regional levels, and even significant experiments with shared governance, such as the delegation of management responsibility by state agencies to non-governmental organisations (e.g. management of protected areas in Jamaica), have been limited.

One area of expanding interest and participation by stakeholders is in resource monitoring/research as citizen scientists. While there are concerns regarding the suitability and constraints of citizen science initiatives in monitoring and research, the practice is extensively used in many of the more developed countries. Citizen science is also being suggested as a useful tool to support policy development and meet the requirements of international environmental agreements (Crabbe 2012; Danielsen *et al*. 2013). Project Seagrass, Reef Check, and Sandwatch are examples of citizen science initiatives with activities in the Caribbean.

Regional and global development compacts have articulated the need for full civic engagement in decision-making processes, and the Caribbean civil society sector has stated its willingness to become full partners in all stages of the development process (Civil Society Consultative Working Group 2013). Civil society organisations may attend meetings of the SPAW STAC and Conference of the Parties as observers.

A key framework that has been developed is the CLME+ People Managing Oceans: Civil Society Action Programme for Sustainable Management of the Shared Living Marine Resources of the Caribbean and North Brazil Shelf Large Marine Ecosystem (CLME+ CSAP), which is aligned with the CLME+ SAP (CANARI 2018). People Managing Oceans provides a framework to guide civil society's role as partners in implementing the CLME+ SAP. It outlines specific actions identified by civil society on how it can best contribute to addressing priorities under each of the strategies in the CLME+ SAP. It further identifies capacity building requirements needed by civil society to play an effective role, in partnership with governments and other stakeholders. This Programme includes specific strategies and actions for civil society to implement for management and conservation of the three habitats.

## 5.3 Designation of Ecologically Sensitive or Important Areas

Sites and sub-regions have been declared ecologically sensitive or biologically important under a number of different frameworks (see Appendix 5 for signatories), including the following:

Ecologically or Biologically Significant Marine Areas (EBSAs) defined through the Convention on Biological Diversity (CBD). EBSAs were identified in the wider Caribbean in 2012 as part of a contribution towards achieving Aichi Target 11 "10 percent of the world's oceans conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures by 2020" (Secretariat of the Convention on Biological Diversity 2014). EBSAs are areas that have been shown to hold the greatest richness of species and productivity of living organisms, possess rare or endemic or threatened species, are home to unique communities of fauna and flora, or are at risk. The wider Caribbean includes 15 EBSAs (Figure 5.2).

**Particularly Sensitive Sea Areas (PSSAs)** are designated under the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78). A PSSA is an area that needs special protection through action by the International Maritime Organization (IMO) because of its significance for recognised ecological or socio-economic or scientific reasons and which may be vulnerable to damage by international maritime activities (International Maritime Organization 2006). The Saba Bank (Netherlands Antilles) was designated a PSSA in 2012, making it the second such designation in the Caribbean, following the designation of the Sabana-Camagüey Archipelago in Cuba in 1997.

**Wetlands listed under the Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat.** Criteria for Ramsar sites include the presence of vulnerable, endangered, or critically endangered species or threatened ecological communities and the presence of populations of plant and/or animal species that are important for maintaining the biological diversity of a particular biogeographic region. Nearly 100 sites in the wider Caribbean have been listed under the Convention, many of which contain coral reefs, mangroves, and seagrasses (see Appendix 6).

**Protected Areas listed under the SPAW Protocol of the Cartagena Convention.** Thirty-five protected areas have been listed under the SPAW Protocol on the basis that they were established to "conserve, maintain and restore" a wide range of values important to the welfare of residents and maintenance of essential ecosystem processes (see Appendix 7).

**World Heritage Natural Sites** listed under the Convention concerning the Protection of the World Cultural and Natural Heritage, 1972. World Heritage Sites are areas of outstanding universal value that meet one of 10 criteria. There are six World Heritage Natural Sites in the wider Caribbean that include coral reef, mangrove or seagrass ecosystems (see Table 5.2). In mid-2018, the Belize Barrier Reef Reserve System was removed from the List of World Heritage in Danger because of safeguarding measures taken by the country, including the introduction of a moratorium on oil exploration in the entire maritime zone of Belize and strengthening of forestry regulations that support better protection of mangroves.


Figure 5.2 Ecologically or Biologically Significant Marine Areas (EBSAs) in the Wider Caribbean. 1. Mesoamerican Barrier Reef, 2. Miskito Cays, 3. Corn Island, 4. Tortuguero - Barra del Colorado, 5. Cahuita-Gandoca, 6. Pedro Bank, Southern Channel and Morant, 8. Caracol/Fort Liberté/Monti Cristi (Northern Hispaniola Binational Area), 9. Marine Mammal Sanctuary Banco de la Plata y Banco de la Navidad, 10. Seaflower, 11. Saba Bank, 12. Eastern Caribbean, 13. Sargasso Sea, 14. La Región Talud Continental Superior del Sinú, 15. La Region Talud Continental Superior de Magdalena, 16. Amazonian-Orinoco Influence Zone, 17. Parcel do Manuel Luiz and Banco do Álvaro, 18. Banks Chain of Northern Brazil and Fernando de Noronha, and 19. Northeastern Brazil Shelf-Edge Zone. EBSA 7 (Navassa Island) was removed during the review process before the CBD COP finalized the EBSAs. EBSA 10 (Seaflower) no longer has an official boundary and is not shown on the map. Gaps in the geographic scope to describe EBSAs (represented by the marine space falling outside the blue polygon) include the United States of America (where a separate national processes was underway at the time the other EBSAs were being mapped) and Cuba and Venezuela (as these countries did not have representatives present at the time the other EBSAs were being mapped)

*Source: Secretariat of the Convention on Biological Diversity, 2014*

**Particularly Sensitive Sea Areas (PSSAs)** are designated under the International Convention for the Prevention of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78). A PSSA is an area that needs special protection through action by the International Maritime Organization (IMO) because of its significance for recognised ecological or socio-economic or scientific reasons and which may be vulnerable to damage by international maritime activities (International Maritime Organization 2006). The Saba Bank (Netherlands Antilles) was designated a PSSA in 2012, making it the second such designation in the Caribbean, following the designation of the Sabana-Camagüey Archipelago in Cuba in 1997.

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**Table 5.2:** Coastal/Marine World Heritage Natural Sites in the Wider Caribbean

| | |
|---|---|
| Belize | Belize Barrier Reef Reserve System |
| Cuba | Alejandro de Humboldt National Park (AHNP) |
| Honduras | Río Plátano Biosphere Reserve |
| Mexico | Sian Ka'an |
| Saint Lu-cia | Pitons Management Area |
| USA | Everglades National Park |

*Source: https://whc.unesco.org/en/list/?type=natural*

**Key Biodiversity Areas (KBAs)** are sites that contribute significantly to the global persistence of biodiversity, in terrestrial, freshwater and marine ecosystems. The most recent KBA identification process in the wider Caribbean took place in the Caribbean Islands Biodiversity Hotspot (see Figure 5.3) as part of the recent update of the Critical Ecosystem Partnership Fund's (CEPF's) ecosystem profile for the

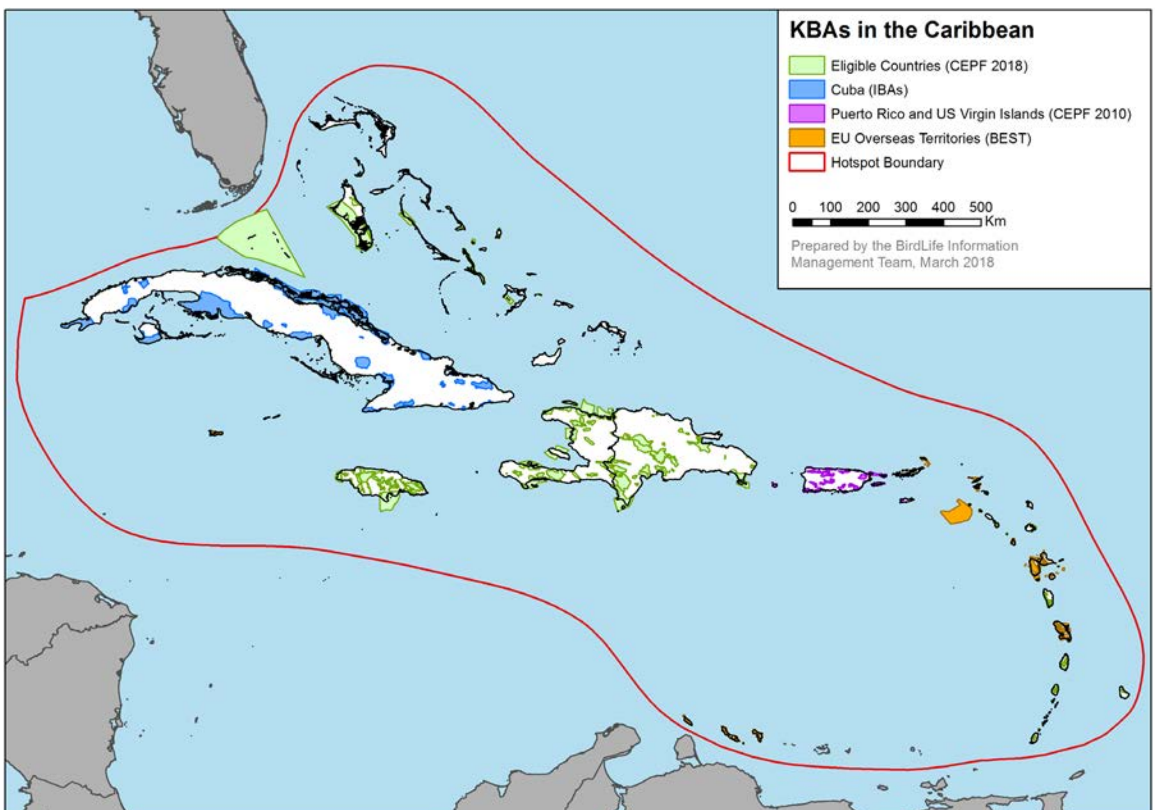



Figure 5.3 KBAs in the Caribbean Islands Biodiversity Hotspot

*Source: Critical Ecosystem Partnership Fund 2019*

23 http://www.keybiodiversityareas.org/

Caribbean Islands. This process followed the Global Standard for the Identification of Key Biodiversity Areas (IUCN 2016) to analyse more than 400 sites, but did not result in the definition of any KBAs triggered by corals, despite the importance of corals in the region and the presence of 11 Threatened Species of corals and fire corals. This was due to a lack of adequate coral data that were available to the KBA assessment team. While data on the presence of the species at sites were available, there was no information about the number of colonies, their status (e.g. if they were affected by bleaching), and the extension/size of the corals (David Diaz, BirdLife, pers comm, 6 September 2018). This process identified 324 KBAs in the Caribbean Islands Biodiversity Hotspot (see Figure 5.3), most of which are or include coastal and marine elements (Critical Ecosystem Partnership Fund 2019). KBAs in other countries of the wider Caribbean similarly have a large number of sites with coastal and/or marine elements identified in the World Database of Key Biodiversity Areas[23], with a rapid review estimating approximately 330 KBAs in the wider Caribbean with coastal/marine extensions which may feature mangrove, coral reef or seagrass habitats. This would need to be verified using the updated IUCN criteria for KBAs, however, this estimate illustrates that a significant number of sites have already been identified for conservation. However, many of these sites are small and coverage is fragmented.

**Important Bird and Biodiversity Areas (IBAs).** Although defined for the conservation of globally threatened, range restricted and/or congregatory birds, IBAs support conservation strategies because many endemic plants and animals are also found in IBAs, and their protection helps promote the conservation of biodiversity on a global level. Many of the coastal IBAs in the wider Caribbean include mangroves. Assessments in 2019 identified two KBAs in danger (Jaragua National Park and Los Haitises National Park in the Dominican Republic) and in 2014 identified one KBA in danger (Northern Everglades in the USA), but it is likely that many more are at risk.

## 5.4 Designation of protected areas and community conserved areas

The number of protected areas designated under national laws and international programmes, including Ramsar, has increased in the past decade (Cavender-Bares *et al*. 2018) and there is increased focus on the need for enhanced management planning and effectiveness. Across the LMEs of the region, the number of MPAs established, and the area of marine and coastal habitat protected has increased nearly 29-fold (see Table 5.3). However, within protected areas, the area that is covered by different habitat types (including mangroves, coral reefs and seagrass beds) is not usually recorded.

**Table 5.3:** Change in marine and coastal protected areas 1983 – 2014

| LME | MPA Coverage pre-1983 | MPA Coverage 2014 | % change in area under MPA status |
|---|---|---|---|
| Caribbean | 6,463 km2 | 143,096 km2 | 2,114% |
| Gulf of Mexico | 6,671 km2 | 290,795 km2 | 4,259% |
| North Brazil Shelf | 3,312 km2 | 40,957 km2 | 1,137% |
| Total | 16,446 km2 | 474,848 km2 | 2,887% |

*Source: www.onesharedocean.org, 03 November 2018*

The inclusion of the criterion “other effective area-based conservation measures” in the 2020 assessment of Aichi Biodiversity Targets has resulted in the establishment of community conserved areas in many countries of the Insular Caribbean.

**The Caribbean Challenge Initiative (CCI)**[24], with its 20-by-20 goal, has been a catalyst for the increased declaration of marine and coastal protected sites in the insular Caribbean. As part of the CCI, 11 participating countries have agreed to conserve and effectively manage at least 20% of their marine and coastal environments by 2020 and to provide long-term sustainable financing to support these efforts. Part of the commitment includes the establishment of national action plans which incorporate effectively managed coastal and marine protected areas, as well as restoration activities, responsible fishery and tourism practices, efforts to reduce marine pollution and climate change adaptation. During the first phase of the CCI, more than 50 new MPAs were established, and the total marine area protected across participating countries increased from seven percent to approximately 10%.

### Box 5.1 Recent Marine Protected Area Declarations in the Wider Caribbean

**2015**

- The Bahamas declared 23 new marine protected areas, totalling just under 4.5 million hectares.
- One of two new MPAs declared by Panama was Banco Volcán on its Caribbean coast.
- Belize expanded the Hol Chan Marine Reserve. This expansion, along with the Corozal Bay Wildlife Sanctuary and Bacalar Chico Marine Reserve, now protects all the northern waters of Belize.

**2016**

- St. Kitts and Nevis declared its first marine management area, using the provisions of the Fisheries Aquaculture and Marine Resources Act. The area encompasses a two-mile radius around its entire coastline, covering approximately 51% of the coastal and nearshore area of the twin-island state.
- Mexico created the Mexican Caribbean Biosphere Reserve (Reserva de la Biosfera Caribe Mexicano). Although the biosphere reserve covers an area of intense tourism development, this designation prevents the exploration and exploitation of petroleum and supports protection of the Mexican portion of the Mesoamerican Barrier Reef System.

**2017**

- Grenada established the Grand Anse Marine Protected Area, which includes almost 2,023 hectares of nearshore marine area, protecting important tourist attractions and sources of sustainable tourism income for local communities.
- Haiti declared two new MPAs – Jeremie-Abricot and Baraderes-Cayemites – in the Grand Sud region, bringing the total number of MPAs officially declared by the Government of Haiti to 11. Haiti's first MPAs were declared in 2013.

**2018**

- Honduras created its newest MPA with the declaration of the Tela Wildlife Marine Refuge (El Refugio de Vida Silvestre Marino de Tela).

## 5.5 Improving management capacity

Outside of formal tertiary education programmes, capacity for effective management of significant areas, particularly protected areas, is provided through national training events and regional initiatives. Regional initiatives include the following:

**Caribbean Marine Protected Area Management Network and Forum (CaMPAM) Training of Trainers Programme in Marine Protected Areas Management:** The training programme, developed and coordinated by the UNEP-CEP SPAW Sub-programme has, since 1999, trained

24 www.caribbeanchallengeinitiative.org

approximately 200 persons directly, with more than 2,000 indirectly from the follow-on training events (Bustamante, G. 2018).

**MPAConnect Initiative:** MPAConnect is a capacity-building programme and learning network among Caribbean marine natural resource managers spearheaded by NOAA's Coral Reef Conservation Program (CRCP) and the Gulf and Caribbean Fisheries Institute (GCFI)[25]. In 2010, an initial assessment of Caribbean MPA management capacity was completed through a partnership between the GCFI, NOAA CRCP and CaMPAM. In 2011, a total of 27 MPAs in 10 countries and territories in the wider Caribbean were evaluated (Gombos *et al*. 2011). These assessments led to the identification of prioritised MPA management capacity needs, which were then the focus of a series of training sessions and workshops (with CaMPAM and partner agencies). The MPA capacity assessment was repeated in 2017 at a total of 32 coral reef MPAs across the same 10 Caribbean countries and territories (Doyle *et al*. 2017). MPA management capacity needs prioritised through the 2017 assessment are the focus of the current cycle of training and technical support being provided through the MPAConnect initiative.

## 5.6 Mapping, monitoring and assessment

Beyond programmes within national and state institutions, there are several interdisciplinary and multi-sectoral initiatives and partnerships that are facilitating the collection, generation and analysis of data on marine habitats. The intent of these initiatives is to provide data and decision support tools for managers, scientists and stakeholders, and to better inform planning and management efforts.

**GCRMN-Caribbean coral reef monitoring guidelines:** The lack of basic, comparable data on coral reef habitat extent, and basic characterisation and condition across the region makes it challenging to discern ecosystem trends and to attribute changes in coral reef health and environmental quality to particular causes (anthropogenic or otherwise). In an effort to address such gaps in monitoring and assessment of coral reef condition to more effectively inform policy and management action and ultimately better protect regional reefs, GCRMN-Caribbean has developed monitoring guidelines (see Section 4.2.1). In addition to improving Caribbean coral reef monitoring protocols, GCRMN-Caribbean is working to enhance data management and reporting. Through training workshops and the provision of technical assistance, GCRMN-Caribbean and partners are revitalising the regional network of practitioners implementing the Caribbean coral reef monitoring guidelines. New, revised or enhanced coral reef monitoring efforts utilising the GCRMN-Caribbean guidelines have been implemented in St. Eustatius, St. Maarten, Cuba, Jamaica and the Mesoamerican reef countries.

**TNC-Caribbean, Carnegie Institution for Science and Planet Mapping Initiative:** Many locations in the wider Caribbean lack current and accurate data for the benthic habitats of their coastal areas, including coral reefs, which would provide critical information on habitat extent. TNC is working to address this gap by collecting coastal ecosystem data at multiple scales through a partnership with the Carnegie Institute for Science utilising state of the art remote sensing tools and technology from satellites (Planet.com) and the Carnegie Airborne Observatory, a plane that can collect three-dimensional hyperspectral imagery and which has the ability to provide data at the species-level for corals.

Hyperspectral data has been collected for the Dominican Republic and St. Croix and is being processed. Maps created for the Dominican Republic will be used to support the country's MPA planning efforts. Once completed, these products will be shared with governments, partners and stakeholders to support coral reef resource management and the establishment and improved management of MPAs, to better understand the economic value of these systems and inform post-hurricane restoration efforts including supporting coral nursery work. The mapping effort in the Caribbean is serving as a pilot project for the technology, which would then be rolled out to support coral reef management institutions worldwide.

25 https://www.gcfi.org/initiatives/mpa-capacity-program/

The map data has a depth limit of about 25 meters (S. Schill, pers. comm. 17 October 2018), so while these products can inform work in shallower reef areas, there is still a need for improved data concerning deeper scleractinian (mesophotic) reef areas.

**Caribbean Science Atlas:** The Caribbean Science Atlas[26] is a web-based tool that compiles scientific resources including geospatial data from TNC in the Caribbean region. The site includes datasets, links to decision support tools and story maps. To date, spatial data has been compiled for 1,284 protected areas, 167 coral reef areas and 99 mangrove areas.

**Mapping Ocean Wealth:** The data collected as part of the mapping effort described above will be incorporated into the Mapping Ocean Wealth Initiative (oceanwealth.org), which uses this type of data along with predictive models to explore and demonstrate how and where ecosystem benefits from coastal areas including coral reefs, seagrass and mangroves are generated. This information can be used to inform policy and investment decisions as well as direct management actions to protect areas that provide critical ecosystem services such as storm and flood protection or underpin critical economic sectors such as fisheries and tourism. Figure 5.4 is an example map product from the Mapping Ocean Wealth tool displaying the recreation and tourism value of Grenada's coral reefs.

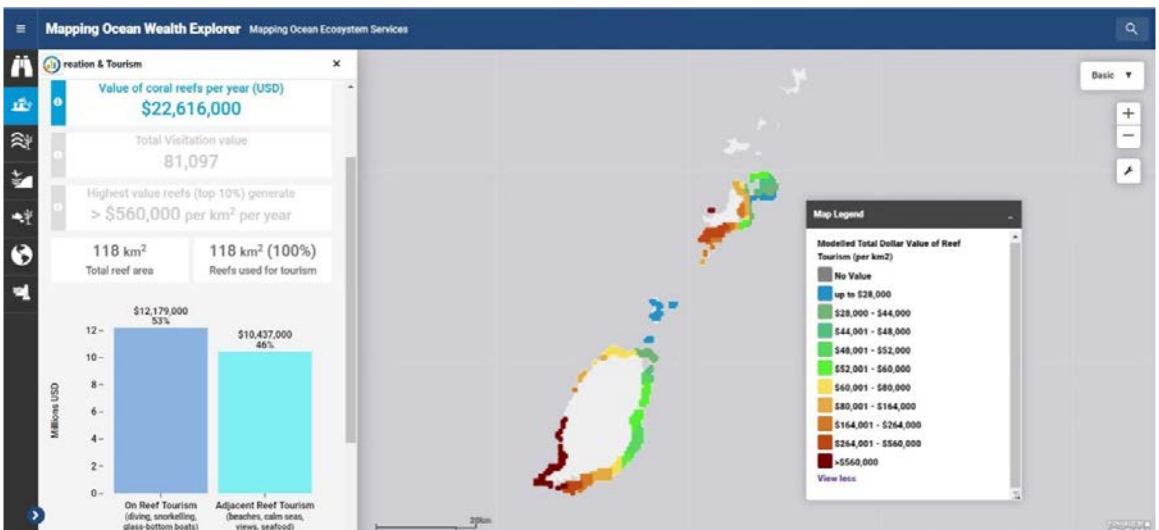



Figure 5.4 Recreation and tourism value of Grenada's coral reefs displayed using the Mapping Ocean Wealth Tool

*Source: maps.oceanwealth.org*

**TNC Coastal Resilience Tool:** The Coastal Resilience Tool (coastalresilience.org) is a collaborative project, led by TNC. Coastal Resilience is a management approach and online decision-support tool for addressing the effects of climate change. Within the Caribbean, Coastal Resilience projects include the Resilient Islands programme and work in the Dominican Republic, Grenada, St. Vincent and the Grenadines, Jamaica and the USVI. The Coastal Resilience tool incorporates demographic, socioeconomic and ecological data together to calculate the vulnerability of coastal communities to climate impacts, reduce risk and increase understanding of the value of nature-based solutions. Tools available to inform management and policy actions include vulnerability assessments, community planning guides and tools and ecosystem-based adaptation projects.

**Allen Coral Atlas/Global Coral Mapping Partnership:** Launched in 2018, the Allen Coral Atlas uses high-resolution satellite imagery and advanced analytics to map and monitor the world's coral reefs in detail. Maps currently available show the composition and structure of five important reefs located throughout the world, including Lighthouse Reef, Belize. The Global Coral Mapping Partnership (Paul

26 https://caribbeanscienceatlas.tnc.org

Allen Philanthropies, Planet, Carnegie Science, Hawai´i Institute of Marine Biology) intend to map the world's reefs by 2020.[27]

**The NBS Mangrove Project (Setting the Foundations for Zero Net Loss of the Mangroves that Underpins Human Well-being in the North Brazil Shelf Large Marine Ecosystem):** This aimed to help establish a shared and multi-national process for an Integrated Coastal Management in the North Brazil Shelf, with the initial focus being on Guyana and Suriname. The project collected baseline knowledge and conducted technical assessments to better understand and manage mangrove habitats and coastal ecosystems. This included assessing blue carbon potential, local community benefits, ecosystem-based solutions, and policy, regulations and financing for conservation.[28] Standard operating procedures for mangrove cover analysis and an Open Standards planning framework were developed. Research gaps were identified.

## 5.7 Habitat restoration

National efforts for management of mangrove ecosystems are increasingly focusing on restoration as a component of climate change adaptation (see Box 5.2). The traditional practice of mangrove replanting by environmental groups as part of awareness programmes needs to be brought into more structured programmes, where ecosystem-based adaptation initiatives can benefit from the application of standard methods and evaluation mechanisms while supporting national development goals (Mercer *et al*. 2012).

**Box 5.2: Selected mangrove replanting initiatives**

- **Bonaire** – Restoration project to stop die off.
- **Suriname** – "Building with Nature" project to protect mudflats along dynamic coastlines.
- **Suriname** – Developing local managed mangrove ecotourism to enhance their protection.
- **Panama** – Project for the Protection of Reserves and Carbon Sinks in Mangroves and Protected Areas is implemented with assistance from UNDP. Objective is continued provision of ecosystem services to support climate change adaptation.
- **Trinidad and Tobago** – Wetlands restoration for carbon sequestration includes, but does not specifically target, mangroves.

*Source: Regional Stakeholder Workshop on the "State of Marine Ecosystems and shared Living Marine Resource in the Wider Caribbean (CLME+ and Gulf of Mexico)" and "Regional Strategy and Action Plan for the Valuation, Protection and/or Restoration of Key Marine Habitats in the CLME+" held at Crowne Plaza Panama | Panama City, Panama 3 - 4 December 2018*

**National level coral restoration:** Active coral restoration is occurring in numerous locations throughout the wider Caribbean (see Box 5.3), under the auspices of a number of different organisations often in partnership with local and site-based government agencies. The goal of these efforts is to repair reef habitats after acute or chronic disturbances and to increase the amount of live coral cover on reefs to increase their resiliency to further stress and boost ecosystem function.

**Global Coral Reef Restoration Project:** Partnering with Mote Marine Lab, SECORE International, the Coral Reef Alliance and academia, TNC is creating an International Coordination Node to build the scientific capacity for coral restoration in the region, and to support the investment in scientific advances to expand current restoration efforts. TNC is working in 17 countries throughout the wider Caribbean to support coral restoration efforts and is developing three restoration hubs in The Bahamas,

27 http://allencoralatlas.org/

28 https://nbslmegef.wordpress.com/

Box 5.3: Examples of countries and territories that are implementing coral restoration projects

| | | |
|---|---|---|
| Barbados | Dominican Republic | Netherlands Antilles |
| Belize | Florida | Saint Lucia |
| Bonaire | Grenada | Trinidad and Tobago |
| Colombia | Honduras | Turks and Caicos |
| Cuba | Jamaica | USVI |
| Curacao | Mexico | |

Dominican Republic and USVI. Two restoration techniques are being implemented through this initiative – microfragmentation and facilitated sexual reproduction.

**Coral Restoration Consortium:** The Coral Restoration Consortium (CRC) (crc.reefresilience.org) is a community of practice created in 2017 to foster collaboration and technology transfer among coral reef restoration practitioners. The CRC has several working groups focused on different aspects of coral restoration (e.g. different propagation types, genetics, management and monitoring), and held a conference for restoration practitioners, Reef Futures 2018: A Coral Restoration and Intervention-Science Symposium. The CRC maintains several web-based resources including restoration best practices, an interactive map of restoration initiatives and story maps.

**Reef Restoration and Adaptation Program:** The Reef Restoration and Adaptation Program is a collaboration of coral reef and restoration experts targeting the development of measures to conserve and restore the Great Barrier Reef in Australia. An output of the programme, which is useful for coral restoration practitioners around the world, is a report that presents the current state of practice (Bostrom-Einarsson *et al*. 2019).

Figure 5.5 Many countries have active coral restoration programmes which produce corals in nurseries, such as this in-situ nursery in the USVI, that can be outplanted onto damaged reef areas

*Photos by Leslie Henderson*

## 5.8 Sustainable financing

Much of the funding for conservation and management of marine ecosystems comes from multi-lateral sources (such as the Global Environment Facility [GEF] or the European Union [EU]), bilateral funding from developed countries and national budget support. However, the region is facing many challenges including increasing national debts, economic burdens due to natural disasters, and reduced foreign aid and access to concessional financing (Caribbean Development Bank 2018) which reduce these sources.

Some private foundations focus on supporting coastal and marine conservation and sustainable use in the region, for example the Sandals Foundation[29], the Guy Harvey Ocean Foundation[30] and Virgin Unite[31].

Several national and regional funds have been or are being established which channel funds to address conservation of ocean resources.

**Coastal Zone Management Trust, Quintana Roo, Mexico:** The Coastal Zone Management Trust is a trust fund (*Fideicomiso* in Spanish) that receives taxes collected by the government from local hotel owners and the tourism industry. The fund has two roles. It aims to continuously maintain the coral reef and local beaches but also buys an insurance policy. The reef insurance pays out when a certain windspeed crosses the area covered by the insurance to fund the repair and rebuilding of the coral reef, restoring its protective power and hence its financial benefit to the local economy. Collectively, through the trust fund-purchased insurance, the local community maintains and restores an important asset from storm damage and protects its interests through risk transfer. The trust fund also supports activities to continuously manage and conserve the coastal area – both before and after a storm event – meaning the reef is better able to withstand storm damage when a hurricane hits.[32]

**The Green Fund, Trinidad and Tobago:** The Green Fund was established in 2001 and is funded through 0.03% tax on Gross Sales or receipts on every dollar spent in Trinidad and Tobago (initially 0.1% but this was increased in 2015 to 0.3%). As at September 2017, less than 10% of the total available fund had been awarded to fewer than 20 projects and a balance of approximately US$770 million remained.[33] The fund targets support to civil society and community organisations, but can also be accessed by statutory authorities. It cannot be accessed by for-profit companies or the public sector. The fund's focus is broadly on environmental conservation, restoration or remediation and can include funding for marine ecosystems.

**Environmental Foundation of Jamaica (EFJ), Jamaica:** Born out of a creative 'debt-for-nature swap' between the Governments of the United States and Jamaica, over its 24 years (1993-2017), through a strong track record of financial and grant accountability systems, and impressive returns on investments, the EFJ has taken a corpus of US$21.39 million and has made grant awards of approximately US$42 million to just over 1,250 projects. The EFJ consolidated operations with the Jamaica Protected Areas Trust/Forest Conservation Fund, which was formed in 2004 also through a debt-for-nature swap between the Governments of the United States and Jamaica. Combined, the EFJ (which is the name the consolidated entity maintained) has 38 years' experience in grant-making and has awarded approximately US$50 million in grants to 1,321 projects. Coastal zone and marine management are one of the thematic areas of focus.[34]

29 https://sandalsfoundation.org/

30 https://guyharvey.com/pages/ocean-foundation

31 https://www.virgin.com/unite/

32 https://www.nature.org/content/dam/tnc/nature/en/documents/The Nature Conservancy_Mexico_CoastalManagementTrust_Factsheet.pdf

33 Information presented at the Validation Workshop held May 2, 2019 as part of the Mapping and Capacity Assessment of CSOs conducted under the project Capacity Development for Improved Management of Multilateral Environmental Agreements (MEAs) for Global Environmental Benefits.

34 http://www.efj.org.jm/

**Mesoamerican Reef Fund (MAR Fund) and associated national funds:** The general objective of the MAR Fund is to contribute to the conservation of the ecological functions of the Mesoamerican Reef System in Mexico, Belize, Guatemala and Honduras. It aims to: (1) support the protection and conservation of coastal and marine ecosystems in prioritised areas; (2) promote the participation of civil society in best management practices and sustainable use of coastal and marine resources; and (3) strengthen communication and exchanges for effective adoption of new practices. The MAR Fund is resourced by contributions from multiple sources, which have included private foundations, bilateral development agencies, international non-profit organisations, universities, inter-governmental agencies, and individuals. Annual calls for proposals are issued and governmental agencies, academia and civil society organisations are eligible. MAR Fund is a privately run fund comprised of international collaborators, experts, the Central American Commission on Environment and Development, and the in-country funds from each of the Mesoamerican Reef countries (see Table 5.4) – Protected Areas Conservation Trust and Belize Marine Fund (Belize), Fundación para la Conservación de los Recursos Naturales y Ambiente en Guatemala (Guatemala), Fundación Biósfera (Honduras), Fondo Mexicano para la Conservación de la Naturaleza (Mexico).

**Table 5.4:** National Funds under the MAR Fund

| Country | Fund | Description |
|---|---|---|
| Belize | Belize Marine Fund (BMF) | This fund was launched in October 2016 with a US$10M endowment challenge grant from the Oak Foundation. The Fund needs to raise US$15M in matching funding. The vision of the BMF is to provide long-term financial sustainability for addressing high-priority marine resources management and conservation issues in Belize for greater impact throughout the Mesoamerican Reef Eco-region. The recently developed (2019-2021) Strategic Plan will guide its investments over the next three years. It is envisioned that through its investments the BMF will achieve improved status of marine resources in Belize, contributing towards increased health and resilience of the Mesoamerican Reef, strengthening ecosystem services for the benefit of all stakeholders. The Strategic Plan identifies three key strategic areas for intervention: (1) Improved management effectiveness of marine protected areas across the national seascape; (2) Reduced pressures on the marine resources; and (3) Effective marketing of Belize's reef at national and international levels. |
| Belize | Protected Areas Conservation Trust (PACT) | Belize's National Trust, PACT, provides funds for conservation and promoting environmentally sound management of Belize's natural and cultural resources. PACT's revenues are primarily derived from a Conservation Fee of US$3.75 paid by overnight visitors, a 15% commission from the cruise ship passenger head tax, fiduciary services, and interest earned on its Term Deposits. Addi-tional sources of revenues for the Trust include 20% on concession arrangements within the protected areas, 20% of all recreation-related license fees and permit fees collected in conjunction with protected areas and donations. PACT redistributes the revenue throughout the National Protected Areas System. To date, PACT has invested more than US$1.6 million in conservation in Belize.[35] |
| Guatemala | Fundación para la Conservación de los Recursos Naturales y Ambiente en Guatemala | The Fundación para la Conservación de los Recursos Naturales y Ambiente en Guatemala was created in 2000 as a private non-governmental, non-profit independent organisation to support biodiversity conservation and environmental management. It has managed funds of about US$4 million to support initiatives on biodiversity and natural resources, environmental education, natural and cultural heritage, coastal marine resources, research and environmental law. It also administers US$24 million under the Tropical Forest Conservation Fund, a product of a debt-for-nature swap with the United States.[36] |

35 https://www.pactbelize.org/

36 http://fcg.org.gt/

## Table 5.4 *(continued)*: National Funds under the MAR Fund

| | | |
|---|---|---|
| Honduras | Fundación Biósfera | Fundación Biósfera was established in 2002 and has administered five local projects funded by MAR Fund and one financed by WWF in the Caribbean coast of Honduras. It also supports implementation work in Roatan and Utila Islands as part of the Conservation of Marine Resources in Central America KfW-funded project by MAR Fund. |
| Mexico | Fondo Mexicano para la Conservación de la Naturaleza | Fondo Mexicano para la Conservación de la Naturaleza is an independent, non-profit organisation founded in 1994. It has supported over 1,000 projects with a total of more than US$60 million focused on the conservation and sustainable use of biodiversity in Mexico.[37] |

*Source: https://www.marfund.org/*

**Caribbean Biodiversity Fund (CBF) and associated National Conservation Trust Funds:** The CBF is a regional endowment fund that was established in 2012 to provide a sustainable flow of resources for the conservation, protection and maintenance of biodiversity within national protected area systems and any other areas of biological importance in the Caribbean. The CBF is part of the sustainable financing architecture that has been set up to support the CCI and its "20-by-20" goal to effectively conserve and manage at least 20% of the marine and coastal environment by 2020 in participating countries (see Section 5.4). Currently, the CBF manages approximately US$102 million through a conservation-focused endowment (US$75 million) and a sinking fund to support ecosystem-based adaptation (US$50 million)[38]. The CBF mobilises resources and channels support to partner national conservation trust funds and directly to selected national and regional projects. Where trust funds previously did not exist in CCI participating countries, or where new mechanisms were needed, national biodiversity trust funds have been created (see Table 5.5). Except for the Dominican Republic's National Fund for the Environment and Natural Resources (Fondo MARENA), which is a government fund, the trust funds have been set up as private legal entities, independent from government. The trust funds associated with the CBF all have vertical agreements with the regional endowment. CBF funding available for disbursement to the participating national conservation trust funds will be approximately 4.5% of the monthly value of the portion of the CBF endowment earmarked for each trust fund (Caribbean Biodiversity Fund 2014).

## Table 5.5: National Conservation Trust Funds under the Caribbean Biodiversity Fund

| Country | Fund |
|---|---|
| Antigua and Barbu-da | Marine Ecosystems Protected Areas Trust Fund |
| The Bahamas | Bahamas Protected Areas Fund |
| Dominican Republic | National Fund for the Environment and Natural Resources of the Dominican Republic (Fondo MARENA) |
| Grenada | Grenada Sustainable Development Trust Fund |
| Jamaica | Environmental Foundation of Jamaica |
| | National Conservation Trust Fund of Jamaica |
| St. Kitts and Nevis | St. Christopher and Nevis Conservation Fund |
| Saint Lucia | Saint Lucia National Conservation Fund |
| St. Vincent and the Grenadines | St. Vincent and the Grenadines Conservation Fund |

*Source: https://www.caribbeanbiodiversityfund.org/*

37 https://marfund.org/en/founding-members/

38 Accessed on April 13, 2020 at https://www.caribbeanbiodiversityfund.org/

**Critical Ecosystem Partnership Fund (CEPF):** The CEPF is a global multi-donor initiative (involving l'Agence Française de Développement, Conservation International, the EU, the GEF, the Government of Japan and the World Bank) supporting conservation actions in the Caribbean Islands and Mesoamerica biodiversity hotspots. The initial US$6.9 million investment (2010-2015) in the Caribbean Islands hotspot focused primarily on terrestrial biodiversity but did include some funding for conservation actions in MPAs.[39] The Ecosystem Profile that will guide investment priorities for the next phase of funding has been developed (Critical Ecosystem Partnership Fund 2019). CEPF also invested US$14.5M in the Mesoamerica Biodiversity Hotspot (2002-2011) but similarly the focus was on terrestrial hotspots.[40]

**Caribbean Sea Regional Innovation Fund (CarSIF):** This is a small grants facility established by CANARI to support innovation and best practices by civil society organisations and community micro-enterprises to address priorities needs and actions in the Caribbean on marine and coastal governance and management. Funding priorities are aligned with the CLME+ People Managing Oceans: Civil Society Action Programme (2020-2030)[41]. Current funding windows are under the EU-funded Powering Innovations in Civil Society and Enterprises for Sustainability in the Caribbean (PISCES[42]) project being implemented by CANARI and the GEF-funded StewardFish[43] project being led by FAO, with CANARI as an executing partner.

**BIOPAMA:** Under the EU-funded Africa-Caribbean-Pacific Biodiversity and Protected Areas Management (BIOPAMA) Programme implemented by IUCN and the Joint Research Centre of the European Commission (JRC), the BIOPAMA Action Component is a €20 million facility which provides medium and small grants to address management of protected and conserved areas, sustainable use of biodiversity and natural resource priorities for actions on the ground.[44]

**Blue Lab:** As part of its global Accelerator Labs network, UNDP has established the Blue Lab to support Caribbean countries towards the sustainable development of their ocean-based economic sectors. Support can be provided to civil society, entrepreneurs, start-ups, individuals and governments for initiatives directly related to the blue economy in fisheries, renewable energy, waste management, sustainable tourism and innovative finance. The Blue Lab's current primary geographical scope is Barbados, the British Virgin Islands and Dominica but the ambition is to expand this. The Federal Republic of Germany, the State of Qatar, represented by the Qatar Fund for Development, and UNDP's core partners are the founding investors of the Accelerator Labs Network.[45]

Development of a mechanism to enhance coordination and synergies among the many small grant funds and programmes in the region is an ongoing initiative under the CLME+ Project. The overall aim is to enhance the overall scope, outcomes and sustainability of support for civil society action on marine resources governance and management in the CLME+ region, through improving coordination among the different small grant programmes, projects and initiatives and alignment with the strategies and priority actions in the CLME+ People Managing Oceans: Civil Society Action Programme.

There are several innovative tools for sustainable financing which could be tested in the region using blended finance approaches and public-private partnerships, including blue bonds, debt-for-nature swaps, Social Impact Bonds and Development Impact Bonds, crowdsourcing diaspora funding, contingently recoverable grant resources, blue levies and insurance investments (Caribbean Development Bank 2018).

39 https://www.cepf.net/our-work/biodiversity-hotspots/caribbean-islands

40 https://www.cepf.net/our-work/biodiversity-hotspots/mesoamerica

41 This Civil Society Action Programme was developed by civil society for civil society and outlines the role that CSOs can play in contributing to the implementation of the politically endorsed 10-year Strategic Action Programme for the Sustainable Management of the Shared Living Marine Resources of the Caribbean and North Brazil Shelf Large Marine Ecosystems (CLME+ SAP).

42 https://canari.org/pisces/

43 https://www.thegef.org/project/developing-organizational-capacity-ecosystem-stewardship-and-livelihoods-caribbean-small

44 https://action.biopama.org/

45 https://undpbb.exposure.co/the-blue-lab

## 5.9 UNEP-CEP initiatives

Under the Cartagena Convention, three protocols are relevant to management of coastal and marine ecosystems:

- The SPAW Protocol contains detailed provisions addressing the establishment of protected areas and buffer zones for *in situ* conservation of wildlife, national and regional cooperative measures for the protection of wild flora and fauna, the introduction of non-native or genetically altered species, environmental impact assessment, research, education, and other topics.
- The Land-based Sources of Marine Pollution (LBS) Protocol has as Objective 1 to reduce priority pollutants and establishes effluent and emissions limitations and/or best management practices for priority pollutants.
- The Oil Spills Protocol has as Objective 2 to facilitate co-operation and mutual assistance in cases of emergency to prevent and control major oil spill incidents.

Each of these Protocols is implemented through sub-programmes (see www.unenvironment.org/cep/ for information on work programmes, projects and initiatives).

## 5.10 Blue economy/blue growth initiatives

Several definitions of blue economy have emerged, and there is still need for a universally accepted definition for the wider Caribbean.

Andrew (2018) posits that the concept is intertwined with green economy approaches that:

- embrace a 'triple bottom line' approach, which is characterised by economic viability/wellbeing, social inclusion/equity and environmental sustainability;
- pursue climate resilient, low carbon development; and
- are managed within a framework of good economic and political governance.

The Caribbean Development Bank (2018) identified four main blue economy themes based on common definitions:

1. Sustainable and inclusive growth and development
2. Reducing the risk of over-exploitation and risky methods of extraction/usage of the ocean's resources
3. Enhancing the welfare of coastline communities in terms of economic opportunities and social protection
4. Ensuring resilience of countries to natural disasters and the impact of climate change

At the heart of the blue economy concept, therefore, is the sustainable use of ocean resources (natural capital from living and non-living marine resources and ecosystems and their services) for economic growth and sustainable livelihoods while maintaining the ocean, its ecosystems, and their processes. If properly managed by reducing over-exploitation, managing risks to ecosystems and operating within environmental limits, many of these natural capital assets are renewable and capable of yielding a sustained flow of benefits (Caribbean Development Bank 2018).

Multilateral institutions like the Caribbean Development Bank, the Inter-American Development Bank and the World Bank have identified the blue economy as a strategic development opportunity for the Caribbean. Some countries in the region, like Barbados and Grenada, have taken steps to enhance their blue growth policy framework. The OECS is developing a sub-regional Green-Blue Economy Strategy and Action Plan and is also developing regional and national ocean policies and marine spatial planning frameworks to operationalise blue economy approaches[46].

There are several ongoing initiatives aimed at developing the blue economy in wider Caribbean (e.g. see Table 5.6). Most of the initiatives identified thus far focus on ecosystem conservation or creating an enabling policy environment for blue growth, targeted at directly stimulating private sector engagement and investment. However, supporting community micro and small 'blue enterprises' to deliver inclusive approaches to benefit coastal communities also needs to be emphasised (Leotaud *et al*. 2020 in press) (e.g. see Box 5.4).

**Box 5.4 Inclusive local blue economy in action**

In the tiny fishing village of Laborie on the south-west coast of Saint Lucia, the Laborie Development Foundation works with the community to promote social, and economic development that will contribute to a "culturally vibrant community where there is continuous improvement in the quality of life and where people are able to enjoy all the basic necessities and to participate fully in the process of development." Work has involved development of tourism, agriculture and fishing, youth and sports, education and the human resources, and health care and social services.

*Source: www.ilovelaborie.com*

Although the blue economy concept is gaining traction in the CLME+ region, its potential has not been maximised, primarily because the blue economy has not been formally recognised as an important economic driver (Caribbean Development Bank 2018). What is more, the CLME+ region's opportunities for sustainable blue growth are jeopardised by habitat degradation, unsustainable fisheries practices and pollution. New measures for economic performance and the use of economic tools such as ecosystem valuation and natural capital accounting are important in ensuring sustainability in the use of ocean resources in blue economy approaches (Andrew 2018).

**Table 5.6:** Examples of blue economy initiatives in the wider Caribbean

| **Project/Initiative** (Timeline) | **Implementing Agencies** | **Target Countries** | **Description** |
|---|---|---|---|
| Blue Tech Challenge (2018-2019) | Inter-American Development Bank and Compete Caribbean Partnership Facility | The Bahamas, Barbados, Belize, Guyana, Haiti, Jamaica, Suriname, Trinidad and Tobago, Antigua and Barbuda, Dominica, Grenada, Saint Lucia, St. Kitts and Nevis, and St. Vincent and the Grenadines | Grant and loan facility to support business models that apply new technologies or solutions to foster the long-term sustainability of the ocean economy. |
| Ministry of Maritime Affairs and the Blue Economy (Established June 2018; ongoing) | Government of Barbados | Barbados | Ministry with responsibility for preserving Barbados' coastlines, marine environment and ensuring the health of reefs and marine habitats aims to ensure sustainable use and development of fisheries, marine assets, resources, minerals and species for sustainable recreation and decent livelihoods. Mandate includes the creation of new MPAs and the introduction of new and emerging maritime/sea-based industries. |

46 Taking place under the Caribbean Region Oceanscape Project (CROP) in the OECS https://oecs.org/en/crop

**Table 5.6** *(continued)*: Examples of blue economy initiatives in the wider Caribbean

| **Project/Initiative** (Timeline) | **Implementing Agencies** | **Target Countries** | **Description** |
|---|---|---|---|
| First and Second Fiscal Resilience and Blue Growth Development Policy Credits – Grenada (Issued 2018 and 2019; ongoing) | World Bank and Government of Grenada | Grenada | Development policy credit provided to support: (1) fiscal measures and compli-ance with the Fiscal Responsibility Law; and (2) Grenada's transition to a Blue Economy by strengthening marine and coastal management, marine ecosystem health, and climate resilience. Supports implementation of the Grenada - Blue Growth Coastal Master Plan (see below). |
| Grenada Blue Growth Coastal Master Plan 2016 | Government of Grenada | Grenada | Blue growth vision and coastal master plan for the islands of Grenada, Carriacou and Petite Martinique that outlines an ap-proach for development to improve sus-tainable productivity on land and at sea. Promotes maritime clusters of industries, suppliers, and educational and research institutions that reinforce each other and encourages investment into strategic pro-jects via public-private partnerships, and or private development (see Patil and Diez 2016). |
| Caribbean Regional Oceanscape Project (CROP) (2017-2021) | OECS Secretariat and the World Bank | Grenada, Saint Lucia, St. Vincent and the Grenadines, Dominica, St. Kitts and Nevis, regional OECS | CROP is designed in alignment with the Eastern Caribbean Regional Ocean Policy (ECROP) and has an overall objective to develop and implement integrated ocean governance policies to leverage sustaina-ble public and private investment in the waters of OECS members. Activities in-clude development of coastal and marine spatial plans and national coastal blue growth master plans. |
| OECS Green-Blue Economy Strategy and Action Plan (2019-2020) | OECS Com-mission with technical assistance from CANARI | Anguilla, Antigua and Barbuda, the British Virgin Islands, the Commonwealth of Dominica, Grenada, Guadeloupe, Martinique, Montserrat, St. Kitts and Nevis, Saint Lucia, and St. Vincent and the Grenadines | Sub-regional strategy and plan which will define key principles, objectives, policy needs, pathways and capacity needs for environmentally sustainable, inclusive and resilient economic transformation in OECS members. |
| Resilience of the Blue Economy and the Coastal Ecosystem in Northern Honduras (2016-2020) | Nordic Development Fund, IDB | Honduras | Will contain and reduce the loss of man-grove ecosystems in Honduras. |
| New investment announced at Our Ocean 2019 conference | Global Environment Facility, UNDP and national governments | Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Panama | Will assess opportunities, challenges and analyse and develop action plans for transboundary collaborative management of coastal and marine ecosystems related to the blue economy along the Pacific coasts of these seven countries. |

## Table 5.6 *(continued)*: Examples of blue economy initiatives in the wider Caribbean

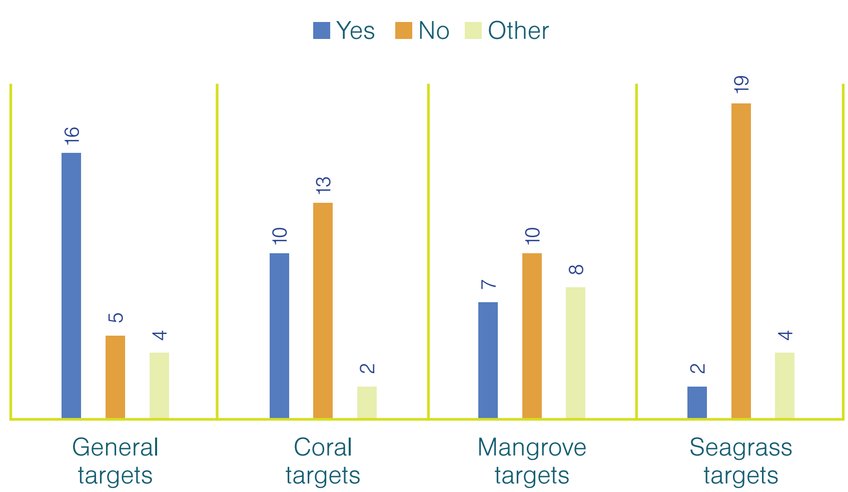
| **Project/Initiative** (Timeline) | **Implementing Agencies** | **Target Countries** | **Description** |
|---|---|---|---|
| International Blue Carbon Initiative | IUCN, UNESCO IOC, Conservation International | Throughout Central and South America | Blue Carbon A-Z: From Small Projects to Policy Implementation[47] initiative imple-mented by the Centro Agronómico Tropi-cal de Investigación y Enseñanza (CATIE) provides blue carbon scientific and political advising services on carbon stock invento-ries, livelihoods and vulnerability, assess-ment of land-use dynamics and associat-ed emissions, and policy development. Current work in Panama, Costa Rica, Honduras and El Salvador. |

# 5.11 National Biodiversity Strategies and Plans

A plethora of national, sectoral and local policies, strategies and plans exist that are relevant to management, conservation and sustainable use of coastal ecosystems (e.g. national development plans, national policies on wetlands, integrated coastal zone management plans, individual MPA management plans).

Nevertheless, National Biodiversity Strategies and Action Plans (NBSAPs), are the main vehicles for national implementation of the Convention on Biological Diversity. A review of the NBSAP targets for 25 wider Caribbean countries (see Appendix 8) to ascertain how marine conservation, and specifically coral reef, mangrove, and seagrass habitats, were reflected revealed the following:

- Targets are most frequently articulated for marine ecosystems/habitats in general.
- Where targets were articulated for specific habitats, of the three featured in this report, coral reef targets were the most common, while those for seagrasses were the least common. In fact, most countries did not include seagrass beds in national targets, even at the action level. Mangroves, in many instances, were included in targets for forest and/or wetlands (see Figure 5.6).




Note: "Other" refers to instances where ecosystems were mentioned in an objective, strategy or action

Figure 5.6 NBSAP Targets for marine biodiversity

47 https://www.thebluecarboninitiative.org/blue-carbon-activities/2019/2/1/blue-carbon-a-z-from-small-projects-to-policy-development-latin-america

Environmental monitoring and information management are critical components of countries' conservation capacity. Based on the NBSAPs reviewed, it appears at least nine of the countries have established and operationalised environmental monitoring systems. In some cases, however, the systems are for specific species or climate change, and not necessarily for biodiversity overall. In many cases it was unclear, as monitoring was mentioned but no monitoring system was identified.

While monitoring and evaluation are mentioned in most plans, few NBSAPs explicitly identify monitoring and evaluations systems. In most cases, it appears monitoring is carried out sporadically through projects or programmes, and with reference to specific species and is not done in a comprehensive or systematic manner.

While there was no specific section addressing challenges in the NBSAPs, a number of them highlighted challenges and concerns throughout the document. These included:

- **Data for monitoring:** Many challenges with data availability and use were identified (see Figure 5.7). The lack of Geographic Information System (GIS) data and mapping of natural resources was mentioned in many of the NBSAPs; the importance and need for this data and representative maps for effective resource management were highlighted.
- **Monitoring and evaluation:** Most, if not all countries, identified the issue of monitoring and evaluation as a shortcoming in biodiversity conservation. There were references to monitoring being done in some countries, with the need for improvement and development of a framework, while others were less explicit leaving some uncertainty with respect to how monitoring is carried out.
- **Valuation of natural resources:** The valuation of natural resources/ecosystems, or lack thereof, is also a recurring theme in the NBSAPs.
- **Legislative framework:** Supporting legislation and incorporation of biodiversity data into decision-making processes was also highlighted as a shortcoming for the management of these ecosystems. Legislation is either outdated or absent, which is vital to the implementation of systematised biodiversity management. State parties have to describe in their annual national reports their advances, challenges and lessons learned in relation to essential biodiversity species for vulnerable ecosystems, as well as how these have been implemented.
- **Competing development and biodiversity conservation interest:** Competing interests and the dependence of country economies on these ecosystems have also posed an issue for managing marine biodiversity. Loss of habitat and habitat fragmentation due to development and agriculture were highlighted in some NBSAPs. Issues such as pollution and invasive alien species were also common themes in the plans.
- **Enforcement:** Apart from monitoring, enforcement is also a challenge in biodiversity management as in many cases enforcement is lacking or there are no mechanisms in place.
- **Knowledge, information and awareness:** The lack of use of traditional knowledge and a repository for such was another common challenge cited in the NBSAPs. Lack of knowledge on biodiversity and public education and awareness was also mentioned.
- **Resources:** Lack of financial and human resources were also highlighted as challenges to biodiversity conservation.

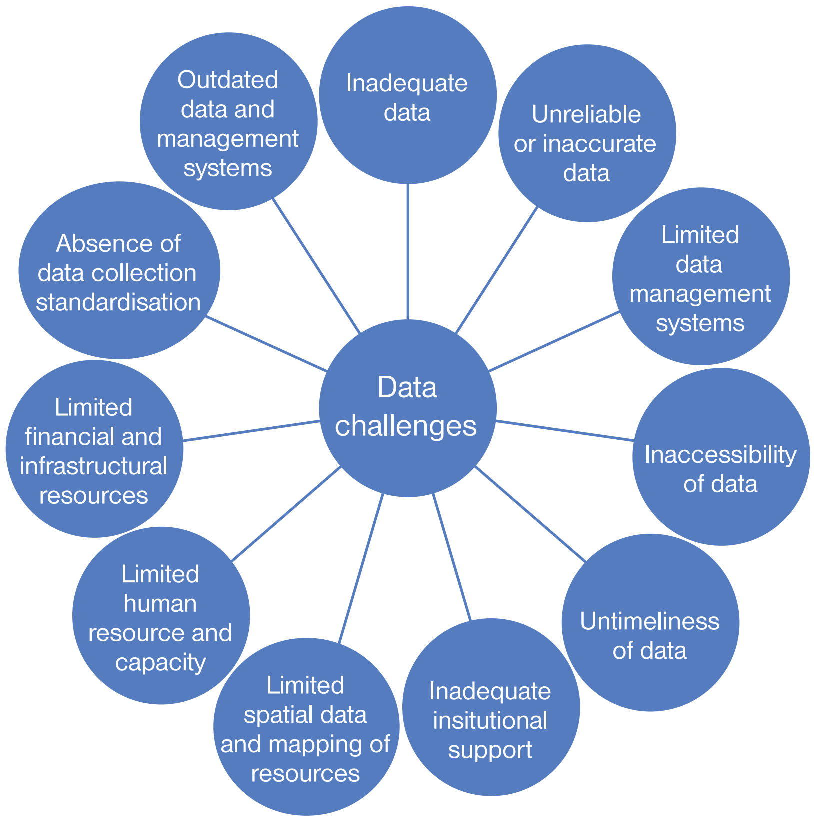
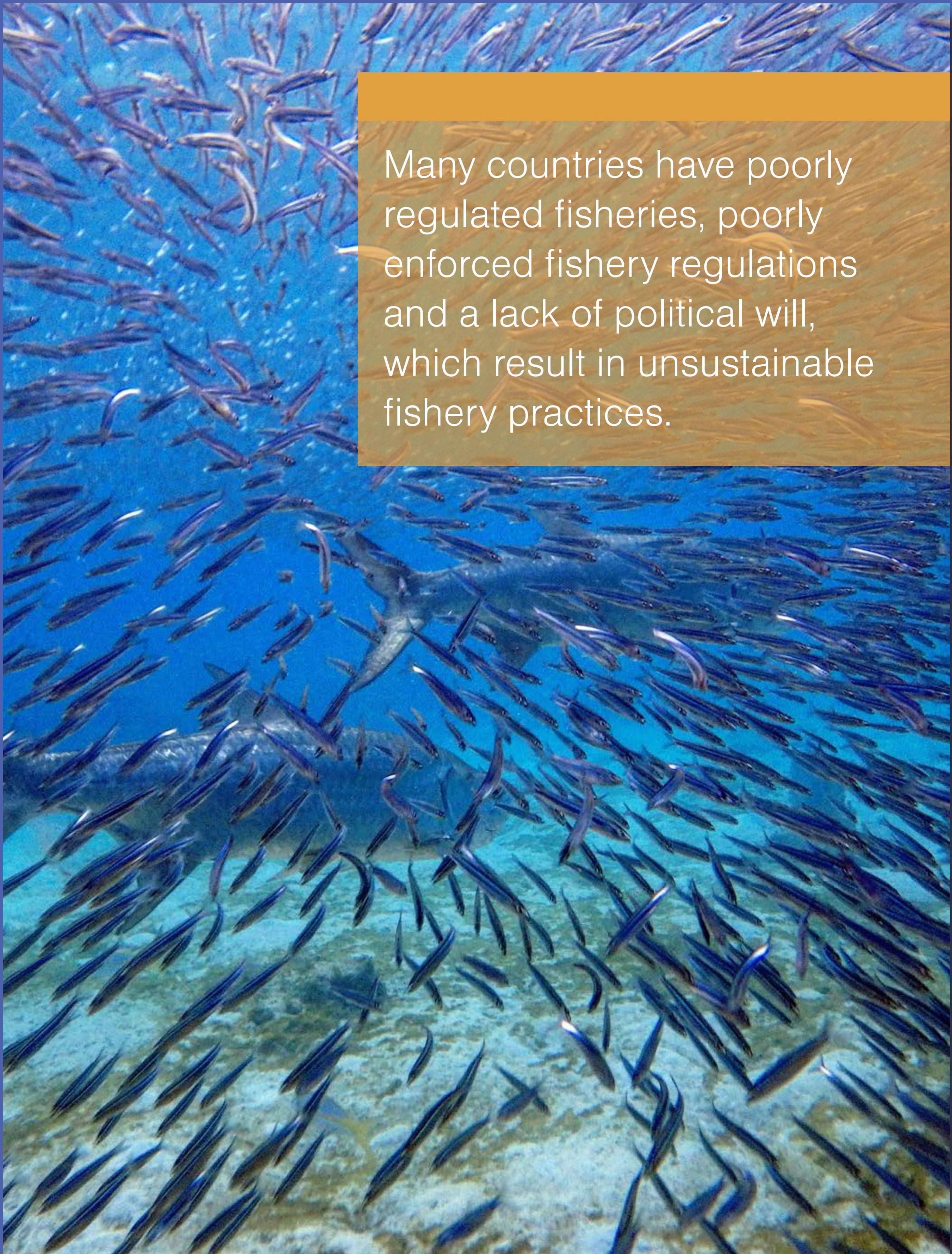



Figure 5.7 Common data challenges highlighted in NBSAPs



Many countries have poorly regulated fisheries, poorly enforced fishery regulations and a lack of political will, which result in unsustainable fishery practices.

*Photo by L. Henderson*

# 6 Challenges, opportunities and recommendations for action

## Key messages

- National institutional frameworks and arrangements need to be strengthened to guide strategic, information-based, long-term and comprehensive management approaches.
- There are significant data and knowledge gaps that constrain effective management. Much of the data that is available is incomplete, inconsistent and incompatible, which makes it difficult to undertake regional analyses on status and trends.
- Although progress is being made to address threats and conserve critical coastal and marine ecosystems, the progress has not been enough to reverse the trend in continued degradation and loss of critical coastal ecosystems.
- Effectiveness of management actions can be enhanced through building capacity and knowledge, ensuring coordination and coherence, focusing on management effectiveness and outcomes, strengthening public engagement and collaborative governance, improving communication and using stewardship approaches that recognise the value of natural ecosystems to development.

# 6.1 Introduction

The development of policies, programmes, and projects at the national and regional levels for management of the marine environment in the Caribbean is opportunistic, driven by the availability of external sources of funds rather than coherent, long-term programmes to meet agreed environment and development goals. In that context, the potentials of the policy, legal, and institutional frameworks are not always optimised. Thus, it is difficult to determine the adequacy of the enabling environment, institutional arrangements, and capacities to produce effective management of the marine environment without mapping and evaluating the management frameworks and processes. Though it is outside the scope of this report to attempt such a full assessment, some general statements can be made based on the objectives stated in national and regional resource management projects, the outcomes of such projects and programmes, and the consistent demand by the civil society sector and communities for information and access to the development decision-making processes.

Turner and Rabalias (2018) make the point that maintaining sustainable environments "depend on a greater convergence of policy tools, appropriate infrastructure, institutional capacity, joint observing programs, and monitoring actions" (p 459), and this convergence of tools and programmes is generally lacking in the Caribbean.

# 6.2 Challenges at the national level

At the national level, the existing enabling legislation for protection of the marine environment is often outdated, assigned to different agencies, and not supported by appropriate regulations and guidance on management approaches and tools. That constraint is highlighted by the constant need to resolve conflicts in the development control process. The existence of perverse incentives resulting from the lack of policy coherence is most evident in the consistent publication of articles in national newspapers noting the conflicts between development projects and stated environmental management objectives.

Participants in the December 2018 workshop on the state of the marine ecosystems report and regional strategy and action plan[48] identified the following challenges to effective management of nearshore marine habitats:

(a) **Knowledge, awareness, and perception of value:** The general public lacks sufficient knowledge and awareness of ecological processes, the status of habitats and species, the impacts of their use of the resources, and their continued ability to use the resources. That awareness deficit results in a perception of value weighted towards consumption of biodiversity resources.

(b) **Coherence of management strategies:** Natural resources management programmes are generally not based on comprehensive national strategies, and tend to lack sufficient linkages between threats, programmes, and specific interventions. There is also a preference for projects and immediate outputs versus long-term programmes.

(c) **Competing development and conservation interests:** National and local economies are heavily dependent on exploitation of ecosystem goods and services, resulting in the trend towards habitat degradation and loss, even with national commitment and actions towards managing marine biodiversity.

48 Regional Stakeholder Workshop on the "State of Marine Ecosystems and shared Living Marine Resource in the Wider Caribbean (CLME+ and Gulf of Mexico)" and "Regional Strategy and Action Plan for the Valuation, Protection and/or Restoration of Key Marine Habitats in the CLME+" held at Crowne Plaza Panama | Panama City, Panama 3 - 4 December 2018

Figure 6.1 Beautiful sandy beaches and turquoise waters are an integral part of the wider Caribbean's tourism product.

*Photos by L. Henderson*

**(d) Institutional capacity:** There are inadequate human and financial resources at the national level, and regional cooperation is inadequate to close the resource and capacity gaps. Management capacity assessments for marine protected areas have identified a range of capacity needs in management institutions in the Caribbean (Gombos *et al*. 2011; Doyle *et al*. 2017; Gill *et al*. 2017).

**(e) Willingness to change:** There is insufficient political will to create the changes necessary to adequately protect biodiversity resources. This reflects both the economic tension and the unwillingness or inability of the public to reduce or change the way they exploit natural resources.

**(f) Science and data:** Standard methods are not routinely used in decision-making processes and monitoring. An example is the inability to determine the cause of the low survival rate in mangrove replanting initiatives. In the case of coral reefs, effective management is constrained by the lack of quantitative scientific data to provide support and understanding of the cumulative impacts of the various threats (Hughes *et al*. 2010; Jackson *et al*. 2014) (see Section 3.2).

**(g) Collaborative management:** Collaborative management still presents a challenge, particularly when working with community groups. Resource and capacity constraints adversely affect the sustainability of some stewardship programmes, particularly succession planning and building financial sustainability.

**Table 6.1:** Gaps in knowledge on coral reefs, mangroves and seagrass beds

| Gaps in knowledge regarding the status of the three ecosystems | Gaps in knowledge regarding the impacts of threats on the three ecosystems | Gaps in knowledge affecting management actions |
|---|---|---|
| • Current and accurate GIS mapping of benthic habitats is lacking.<br>• Local and traditional knowledge on biodiversity is not being collected and there is no repository for this.<br>• Knowledge about the status of key species, for example, bony fishes and key macro-invertebrate species (e.g. lobster and conch) is inadequate.<br>• Data is lacking to properly characterise and assess the condition/health of the three ecosystems across the region. | • The lack of basic, compara-ble data on coral reef habitat extent, basic characterisa-tion and condition across the region makes it challenging to discern ecosystem trends and to attribute changes in coral reef health and envi-ronmental quality to particu-lar causes (anthropogenic or otherwise).<br>• More research is needed to determine the nature and scope of the ecological changes across the different coastal and marine ecosys-tems due to Sargassum blooms.<br>• More research is needed to correlate potential mercury sources with fish contamina-tion levels, and mercury body burden with dietary habits in the region.<br>• The immunotoxicology and long-term impacts on eco-systems due to oil spills is not yet fully understood.<br>• Comprehensive information on the incidence, distribu-tion, trends, causative agents, and mechanisms of transmission of diseases af-fecting coral reef ecosys-tems is lacking. | • The lack of adequate coral data hinders definition of KBAs triggered by corals, despite there being threatened species in areas at high risk.<br>• There is a significant gap in the information available to determine the variability and value of services provided by seagrasses.<br>• Lack of ecosystem valuation studies and the collection of data on the economic uses of coastal and marine ecosystems hinders use of natural capital accounting approaches and development of blue/ ocean satellite accounts that could help to inform economic decision-making that fully appreciates the contribution of these ecosystems to national and regional development.<br>• Apparent similarities among reefs with the highest levels of coral cover share certain similarities (lesser impacts from land-based sources of pollution; existence of fisheries regulations and effective enforcement; lower frequency of hurricanes; bleaching and disease; as well as being located in areas of moderate economic prosperity) and the causes of variability in regional coral reef response require further investigation to identify mechanisms of recovery and plan for appropriate supportive actions. The combined impacts of multiple stressors from these pollutants on marine ecosystems is still largely unknown and requires further investigation. |

# 6.3 Data and knowledge gaps

Although there are standardised marine ecosystem monitoring methods for biophysical, socio-ecological, and management effectiveness indicators, their use and application are often highly variable, leading to gaps in data and understanding.  Much of the data is incomplete, inconsistent and incompatible, which makes it difficult to do regional analyses on status and trends.  At the country and site level some data is being collected, but comprehensive data across the wider Caribbean is not available.

The review of the state of the three habitats and the impact of various threats (Sections 3 and 4) identified several critical gaps in data and knowledge that hamper decision-making and implementation of management actions (see Table 6.1), which can be included in the research agenda being developed under the CLME+ Project.

In addition to gaps in knowledge, storage and knowledge management also need to be addressed. The review identified that decision-makers and managers do not have access to scientific information needed, and also that traditional knowledge is not being used in decision-making.

# 6.4 Conclusions and recommended responses

The 2016 review for Latin America and the Caribbean of progress towards the Aichi Biodiversity Targets (UNEP-WCMC 2016) found progress being made towards achieving most of the targets, though the progress was insufficient to reach a single target by 2020. For Targets 10 and 14, "reducing pressures on vulnerable ecosystems" (specifically coral reefs) and "safeguarding ecosystem and essential services," the situation had gotten worse. For Target 15, "ecosystems restored and resilience enhanced," the data was insufficient for progress to be assessed. The 2018 review for CARICOM countries similarly found progress, but was unable to determine whether the targets would be met by 2020 due to lack of appropriate indicators or insufficient quantitative data (CARICOM 2018).

The two progress reports summarise the difficulty in assessing the outcomes and impacts of responses and actions that are intended to reverse biodiversity loss and improve ecosystem stability and recovery. They highlight gaps in capability (knowledge and attitudes in application of scientific rigor, sense of stewardship, and desire to learn), capacity (for design, programme and process management, data collection and management, and evaluation), robustness of the enabling environment (policies, laws, regulations, procedures), and leadership. Two other recent regional assessments (IPBES 2018; Sheppard 2018) convey a similar message, while bringing the human dimension more into focus.

Key conclusions and recommendations are as follows:

**(i)** **Timely, reliable, and quality data are essential to objective decision-making, particularly in the context where the natural environment, that is the basis of social and economic development in the Caribbean, is limited and fragile. Decision support systems should be established and adequately resourced.** The use of appropriate methodologies in programme and process design, baseline assessments, monitoring and evaluation, data collection and management, public engagement and communication should become standard operating procedure. Development of capacity for planning and data management should also include capacity for translation of data and information for periodic reporting, public awareness and education, and general use and public policy development.

**(ii)** **Policy coherence should be used as one of the primary strategies for enhancing biodiversity protection.** The presence of a coherent enabling environment, including regulatory and procedural guidance, should reduce adverse impacts of sector-driven economic activities on nearshore and marine habitats. It should reduce the potential for the introduction of invasive species, and it should reduce the creation of perverse incentives that result in degradation or loss of coastal and marine ecosystems. A coherent policy approach can be framed as an approach recognising human rights to a healthy environment including sound management of nearshore vulnerable habitats. This incorporates principles of legality, prevention, the precautionary approach, and common but differentiated responsibilities, and information-based management.

**(iii)** **Environmental management programmes should reflect greater understanding of the human dimensions of sustainable development, with greater emphasis on public engagement and shared governance.** Despite consistent efforts by professionals and organisations to inform senior decision makers of the benefits of mangrove ecosystems, and that maintaining the supply of those goods and services depend on the health of the ecosystems, senior officials consistently announce economic initiatives that will result in degradation or loss of mangrove or other coastal ecosystems. This practice is partially motivated by the demands of constituent groups for economic benefits in the short term. In order to encourage individuals and communities to more consistently opt for natural resource benefits over the long term, resource management institutions should shift their participatory processes from outreach and education to public engagement in the decision-making process.

(iv) **Design and evaluation of management interventions should reflect a focus on programme outcomes and impacts, and should include protocols to evaluate management effectiveness, programme impacts, and the performance of site-based interventions.** Decision-making in national development processes in the Caribbean is geared more towards meeting short term objectives rather than long term development goals. This is demonstrated in the packaging of development initiatives as four-year medium term economic strategies, in the focus within programmes and projects on delivering outputs rather than outcomes linked to strategic objectives, in the absence of resource assessment for critical ecosystems that are under targeted management regimes, in inadequate investment to establish monitoring and data management systems, and in the reluctance to conduct performance evaluations of place-based interventions. Project development and national reporting is often based on statement of intent rather than evaluation of outcomes and impacts from previous interventions. Even with substantial financial[49] and human investment, evaluation protocols and data capture and management systems are not given the attention required to support objective evaluation of policy processes or management interventions. The result is uncertainty regarding the utility of actions taken to reduce the loss of biodiversity and maintain the integrity of ecosystems. Specific to seagrass ecosystems, there is a substantial data gap on status and coverage of seagrass ecosystems in national biodiversity strategies and action plans, coastal/marine protected areas, and other site-based management strategies.

(v) **The timeframe for translating research to policy needs to be shortened and the processes of translation and uptake improved.** In addition to the lag time between problem identification and research outputs, scientific literature is often placed behind pay walls, thereby reducing access by public sector managers and decision makers. At the very least, monitoring and research should inform the design and evaluation of interventions. However, in the context of enhancing understanding of the human-nature dynamic, the basic assumptions used to shape design of resource management strategies may need to be reviewed. There are multiple ways that humans relate to nature, and as many reasons for the form that interaction takes. This diversity of interest influences social dynamics both at the community level as well as within and between user groups, and those social dynamics affect public policy processes, particularly under conditions of shared governance. As such, research to support improved management of coastal and marine ecosystems should increasingly include the use of conceptual frameworks that facilitate human dimensions research.

(vi) **Public engagement strategies should focus not only on making the link between conservation outcomes and human well-being, they must also provide opportunities for experiencing the non-material contributions of nature and demonstrate equity in the distribution of the benefits of nature's contribution to people.** A person's attitude towards the use of nature depends on the person's worldview, which itself is shaped by cultural norms and personal circumstances. The dominant worldview in the Caribbean towards natural resources is to perceive value based on extractive or replacement use. That world view can only be changed by experiencing the non-use values through contact with nature, understanding the flow of ecosystem goods and services to multiple parts of a community, and establishment of place connection and place value. Using ecosystems to develop economic sectors (e.g. tourism) should not be at the expense of protecting ecosystem goods and services that are key for livelihoods and well-being of coastal communities, who are often vulnerable and marginalised from economic opportunity.

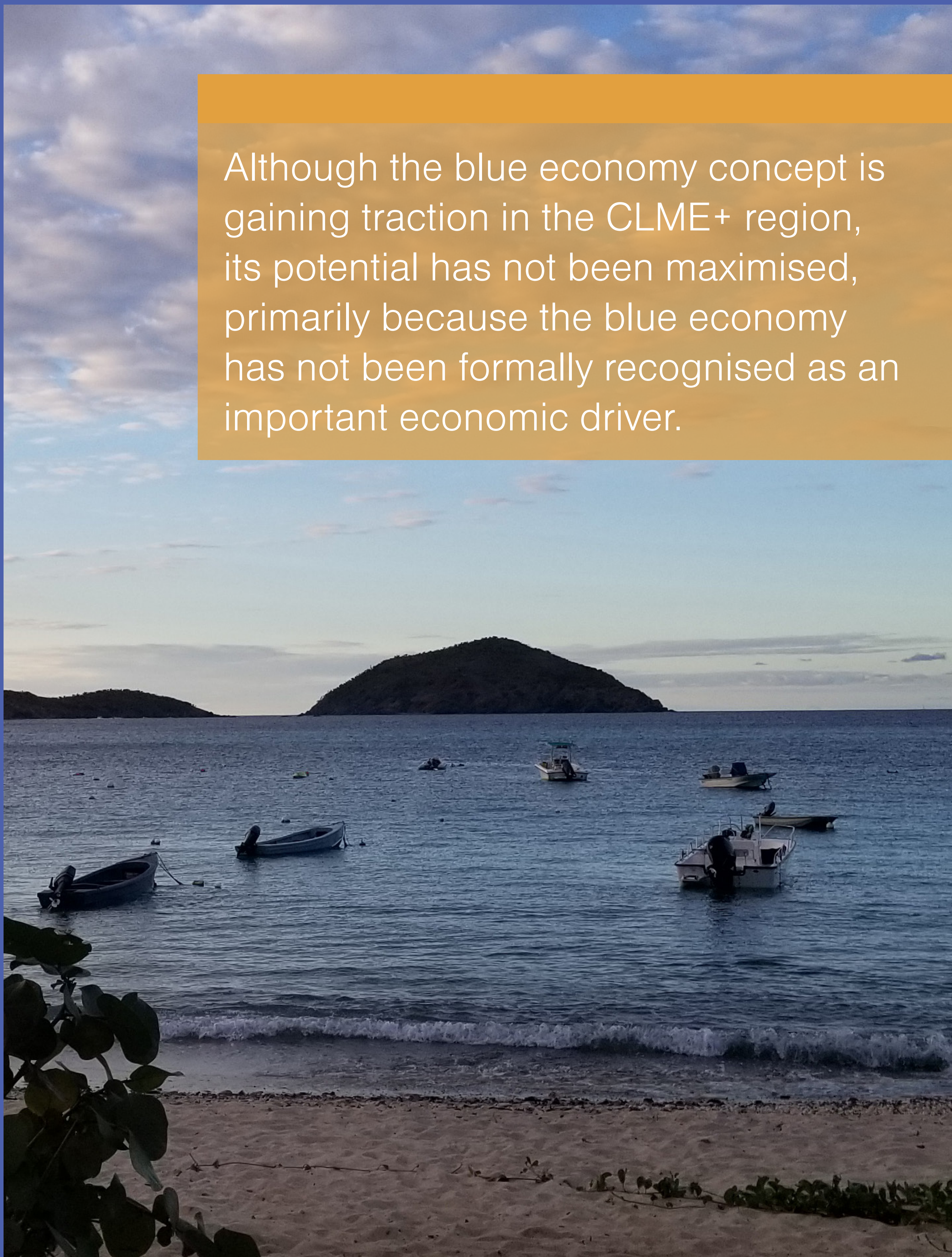
49 Many countries in the wider Caribbean are beneficiaries of repeated four- to five-year projects supported through international funds (such as the GEF) and other public and private support.

Figure 6.2 Regulating coastal development is critical to protect marine habitats

*Photos by A. Nibbs*

**(vii) Enhanced linkages between initiatives of development partners could enhance conservation outcomes, particularly in multi-country projects.** One area for consideration is adoption of harmonised protocols for resource assessment and data capture for site-based interventions, as with protected areas management and reporting under Ramsar, world heritage, biodiversity, and Cartagena conventions.

**(viii) The principles and practices of place value and place stewardship should be incorporated into management systems and decision processes relevant to conservation of coastal ecosystems.** The practice of placing infrastructure and development projects in ecologically sensitive areas, sometimes against the advice of public sector resource management institutions, demonstrates irrational decision-making. The persistence of the factors causing biodiversity losses in coastal ecosystems suggests that one of the major issues in protecting coastal ecosystems is leadership failure. At the very least it implies that leaders consistently undervalue or discount the contributions of nature to economic and social well-being. Blue economy approaches using ecosystem valuation, satellite accounts and natural capital valuation can help to inform economic decision-making that fully appreciates the contribution of these ecosystems to national and regional development.



Although the blue economy concept is gaining traction in the CLME+ region, its potential has not been maximised, primarily because the blue economy has not been formally recognised as an important economic driver.

*Photo by P. Rothenberger*

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# Appendix 1 Selected regional Strategies and Plans to Protect Coastal Ecosystems in the Caribbean

See the CLME+ Hub at https://clmeplus.org/ for updates.

| Strategy or Plan | Description |
|---|---|
| CLME+ Strategic Action Programme (SAP) (2015-2025) | This 10-year Programme for the sustainable management of shared Living Marine Resources in the Caribbean and North Brazil Shelf Large Marine Ecosystems (CLME+ region). As of June 3, 2019 as the last update (see https://www.clmeproject.org/sap-overview/), this has been politically endorsed by a total of 35 Ministers representing 25 countries and 6 overseas territories: Antigua & Barbuda, Bahamas, Barbados, Belize, Brazil, Colombia, Costa Rica, Dominica, Dominican Republic, France (with 6 overseas territories in the CLME+ region), Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Montserrat (UK overseas territory), Nicaragua, Panama, St. Kitts & Nevis, Saint Lucia, St. Vincent & the Grenadines, Suriname, Trinidad and Tobago, the United States of America. https://www.clmeproject.org/sap-overview/ |
| Regional Strategy and Action Plan (RSAP) for the Valuation, Protection and/or Restoration of Key Marine Habitats in the Wider Caribbean (2021 – 2030) (in development) | The RSAP is one of the tools developed by the SPAW Sub-Programme of UNEP-CEP to support conservation and sustainable use of coastal and marine ecosystems in the wider Caribbean. The RSAP contributes to implementation of the CLME+ SAP, specifically Strategy 4 to enhance the governance arrangements for ecosystem-based management of reefs and associated ecosystems. |
| People Managing Oceans: Civil Society Action Programme (2020-2030) | This Civil Society Action Programme for the sustainable management of the shared living marine resources of the Caribbean and North Brazil Shelf Large Marine Ecosystems identifies key strategies and actions that will help to guide the work of civil society organisations, fisherfolk organisations and community enterprises and the government agencies and donors that support them to engage in governance and management of the Caribbean Sea and contribute to implementation of the CLME+ SAP. https://clmeplus.org/people-managing-oceans-civil-society-action-programme/ |
| Research Agenda for the Wider Caribbean Region (in development) | https://clmeplus.org/a-research-agenda-for-the-wider-caribbean-region/ |
| CARICOM Biodiversity Strategy (2018-2022) (in development) | The CARICOM Biodiversity Strategy is the framework for regional level assistance to Members of CARICOM in their implementation of the Convention on Biological Diversity (CBD) Global Strategic Plan for Biodiversity (2011-2020) and the entire biodiversity cluster of multilateral environmental agreements, including the SPAW Protocol. Relevant areas include areas of biodiversity conservation, protected area management, ecosystem restoration/resilience building and economic valuation. |
| The OECS Biodiversity and Ecosystems Framework and Stra-tegic Action Plans (2020-2035) (in development) | https://www.oecs.org/our-work/environmental-sustainability/biodiversity-and-ecosystems-management |
| Regional Strategy for Mangrove Manage-ment, Conservation, Restoration and Monitoring in the Mesoamerican Reef 2020-2025 | This is a guiding platform for shared actions across the four countries that make up the Mesoamerican reef ecoregion, Mexico, Belize, Guatemala and Honduras. The specific objectives of the strategy are: (1) Manage, conserve, restore and monitor the mangrove ecosystem in the MAR ecoregion. (2) Promote sustainable livelihoods that reduce stress on the mangrove ecosystem. (3) Promote the effective application of legal frameworks that protect the mangrove ecosystem through strengthening of institutions and key stakeholders. https://marfund.org/en/wp-content/uploads/2020/06/ERMCRMM-2020-Final-English-Web.pdf |
| Integrated Coastal Management (ICM) Plan for North-Brazil Shelf mangroves (in development) | Initial baseline knowledge and technical assessments done and support provided towards development of transboundary coordination mechanism(s) between Guyana, Suriname, French Guiana and Brazil towards improved ICM of mangrove habitat of the North Brazil Shelf region. https://nbslmegef.wordpress.com/ |

## **Appendix 2** Country-specific Coral Reef Data

List of coral reef locations used in Jackson *et al.* (2014), with extent of sampling, range of years sampled, depth, changes in coral cover for locations sampled more than once, and recent biomass of parrotfish. Locations without percent coral cover were included for data for macroalgae, sea urchins, or fish.

| Label | Country or Territory | Location | # of data sets | # of surveys | Start year | End year | # of years | Year span | Depth range (m) | Oldest coral cover (%) | Most recent cover coral (%) | Change coral cover (%) | Oldest macroalgal cover (%) | Most recent MA cover (%) | Change MA cover (%) | Parrotfish biomass after 1999 (g/m2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Antigua & Barbuda | Antigua & Barbuda | 2 | 227 | 2005 | 2008 | 3 | 4 | 2 - 14 | 16.5 | 3.8 | -12.7 | 24.8 | 13.8 | -11 | 19.4 |
| 2 | Aruba | Aruba | 1 | 13 | 1986 | 1986 | 1 | 1 | 5 - 5 | 24 | 24 | | | | | |
| 3 | Bahamas | Cay Sal Bank | 1 | 685 | 2011 | 2011 | 1 | 1 | 4 - 28 | 7.1 | 7.1 | | 68.7 | 68.7 | 0 | 14.8 |
| 4 | | Exuma Land Sea Park | 1 | 138 | 1993 | 2007 | 14 | 15 | 0 - 20 | 7.3 | 7.8 | 0.5 | 11.2 | 33.7 | 22.5 | 9.8 |
| 5 | | Other | 4 | 2237 | 1994 | 2011 | 14 | 18 | 0 - 27 | 9.7 | 11.7 | 2 | 10.5 | 44.7 | 34.2 | 27.7 |
| 6 | Barbados | Leeward | 7 | 186 | 1974 | 2007 | 24 | 34 | 1 - 22 | 37.4 | 15 | -22.4 | 0 | 14.5 | 14.5 | |
| 7 | | South | 1 | 104 | 1978 | 2007 | 12 | 30 | 3 - 25 | 11.1 | 17.4 | 6.3 | 6.8 | 1.8 | -5 | |
| 8 | | Windward | 1 | 3 | 2002 | 2003 | 2 | 2 | 12 - 13 | | | | | | | |
| 9 | Belize | Atoll Leeward | 4 | 963 | 1970 | 2009 | 9 | 40 | 0 - 18 | 55.5 | 20.7 | -34.8 | 43.9 | 45.6 | 1.7 | 6 |
| 10 | | Atoll Windward | 7 | 710 | 1970 | 2011 | 12 | 42 | 0 - 25 | 93.2 | 20.9 | -72.3 | 6.8 | 51.5 | 44.7 | 6.3 |
| 11 | | Central Barrier | 6 | 751 | 1978 | 2012 | 21 | 35 | 0 - 49 | 32.5 | 15.9 | -16.6 | 4.9 | 55.5 | 50.6 | 7.2 |
| 12 | | Gulf Honduras | 1 | 191 | 2006 | 2006 | 1 | 1 | 5 - 18 | 7.6 | 7.6 | | | | | 4.5 |
| 13 | | Inner Barrier | 2 | 697 | 1994 | 2009 | 14 | 16 | 1 - 15 | 42.4 | 16.2 | -26.2 | 4.1 | 1.6 | -2.5 | 10.7 |
| 14 | | Northern Barrier | 6 | 581 | 1997 | 2012 | 14 | 16 | 1 - 26 | 33.3 | 16.9 | -16.4 | 20.3 | 48.8 | 28.5 | 8.9 |
| 15 | | Southern Barrier | 3 | 414 | 1997 | 2011 | 9 | 15 | 1 - 24 | 23.5 | 13.5 | -10 | 12.8 | 66.8 | 54 | 6.4 |
| 16 | Bermuda | Bermuda | 5 | 365 | 1977 | 2012 | 19 | 36 | 0 - 40 | 19.4 | 38.6 | 19.2 | 8.4 | 12.1 | 3.7 | 21.9 |
| 17 | British Virgin Islands | British Virgin Islands | 2 | 292 | 1992 | 2012 | 21 | 21 | 5 - 13 | 18 | 14.3 | -3.7 | 5 | 10.2 | 5.2 | 13.8 |

| Label | Country or Territory | Location | # of data sets | # of surveys | Start year | End year | # of years | Year span | Depth range (m) | Oldest coral cover (%) | Most recent cover coral (%) | Change coral cover (%) | Oldest macroalgal cover (%) | Most recent MA cover (%) | Change MA cover (%) | Parrotfish biomass after 1999 (g/m2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18 | Cayman Islands | Grand Cayman | 5 | 356 | 1995 | 2009 | 8 | 15 | 2 - 20 | 19 | 30.7 | 11.7 | 13.9 | 31.4 | 17.5 | 12.7 |
| 19 | | Little and Brac | 4 | 700 | 1988 | 2011 | 13 | 24 | 2 - 27 | 36.1 | 24.6 | -11.5 | | | | 15.7 |
| 20 | Colombia | Providencia | 1 | 52 | 1999 | 2006 | 6 | 8 | 1 - 21 | 20.5 | 20.5 | | 41.9 | 41.9 | 0 | |
| 21 | | San Andrés | 4 | 85 | 1992 | 2006 | 9 | 15 | 2 - 20 | 28.2 | 12.6 | -15.6 | 19.8 | 23.8 | 4 | |
| 22 | | Santa Marta Region | 10 | 61 | 1977 | 2005 | 21 | 29 | 3 - 23 | 28 | 31.1 | 3.1 | 0 | 3.3 | 3.3 | |
| 23 | Costa Rica | Cahuita | 2 | 90 | 1977 | 2011 | 17 | 35 | 2 - 10 | 40.4 | 18 | -22.4 | 13.2 | 12.5 | -0.7 | 39.8 |
| 24 | Cuba | Jardines de la Reina | 3 | 898 | 2001 | 2011 | 3 | 11 | 0 - 17 | 15.6 | 30.1 | 14.5 | 32 | 35.7 | 3.7 | 20.4 |
| 25 | | North | 2 | 597 | 1989 | 2001 | 7 | 13 | 0 - 23 | 6.8 | 15.9 | 9.1 | 38.5 | | | 6.9 |
| 26 | | Southwest | 4 | 1168 | 1998 | 2011 | 6 | 14 | 0 - 21 | 9.8 | 25.2 | 15.4 | 43.2 | 19.1 | -24.1 | 8.4 |
| 27 | Curacao | Curacao Northwest | 6 | 202 | 1983 | 2011 | 16 | 29 | 2 - 20 | 18.1 | 13.3 | -4.8 | 6 | 8.3 | 2.3 | 31.6 |
| 28 | | Curacao Southwest | 13 | 335 | 1973 | 2011 | 27 | 39 | 1 - 40 | 40.7 | 31.5 | -9.2 | 0 | 7.8 | 7.8 | 15.2 |
| 29 | | Curacao Windward | 1 | 6 | 2001 | 2001 | 1 | 1 | 20 - 20 | | | | | | | 8.6 |
| 30 | Dominica | Dominica | 1 | 9 | 2007 | 2009 | 2 | 3 | 5 - 14 | 11.4 | 9 | -2.4 | 10.6 | 0.1 | -10.5 | |
| 31 | Dominican Republic | North | 2 | 202 | 2004 | 2006 | 2 | 3 | 0 - 12 | 23.4 | 21.3 | -2.1 | 8.9 | 8.9 | 0 | 3.1 |
| 32 | | Punta Cana | 1 | 235 | 2003 | 2003 | 1 | 1 | 1 - 8 | 8 | 8 | | | | | 3.9 |
| 33 | | South | 2 | 140 | 1994 | 2004 | 6 | 11 | 4 - 33 | 7.8 | 28.1 | 20.3 | 17.7 | 9.9 | -7.8 | 9.2 |
| 34 | French Antilles | Guadeloupe | 1 | 192 | 1988 | 2011 | 20 | 24 | 1 - 15 | 23 | 18.6 | -4.4 | 52.5 | 33.8 | -18.7 | 24.4 |
| 35 | | Martinique | 1 | 38 | 2001 | 2007 | 7 | 7 | 5 - 10 | 35.7 | 17.4 | -18.3 | 33.7 | 33.8 | 0.1 | 20.4 |
| 36 | | St. Barthelemy | 1 | 47 | 2002 | 2011 | 10 | 10 | 10 - 10 | 25.3 | 10.8 | -14.5 | 14.9 | 53 | 38.1 | 17.1 |
| 37 | Grenada | Grenada other | 1 | 12 | 2005 | 2009 | 3 | 5 | 2 - 20 | 41.7 | 27.7 | -14 | | | | |
| 38 | | Leeward | 1 | 11 | 2007 | 2009 | 2 | 3 | 17 - 30 | 10.1 | 12.8 | 2.7 | 37.6 | 65.9 | 28.3 | |
| 39 | Guatemala | Guatemala | 1 | 59 | 2006 | 2006 | 1 | 1 | 7 - 15 | 9.9 | 9.9 | | | | | 3 |

| Label | Country or Territory | Location | # of data sets | # of surveys | Start year | End year | # of years | Year span | Depth range (m) | Oldest coral cover (%) | Most recent cover coral (%) | Change coral cover (%) | Oldest macroalgal cover (%) | Most recent MA cover (%) | Change MA cover (%) | Parrotfish biomass after 1999 (g/m2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | Honduras | Bay Islands | 3 | 981 | 1987 | 2010 | 4 | 24 | 0 - 19 | 20.6 | 21.6 | 1 | 34.5 | 43 | 8.5 | 11.8 |
| 41 | | Near shore | 1 | 328 | 2006 | 2006 | 1 | 1 | 2 - 20 | 12 | 12 | | | | | 22.5 |
| 42 | Jamaica | Montego Bay | 7 | 348 | 1973 | 2007 | 18 | 35 | 0 - 16 | 10.6 | 19.4 | 8.8 | 0 | 53.4 | 53.4 | 4.6 |
| 43 | | North central | 17 | 724 | 1969 | 2011 | 38 | 43 | 1 - 120 | 44.6 | 19.6 | -25 | 1.1 | 24.2 | 23.1 | 6.9 |
| 44 | | Northeast | 3 | 308 | 1977 | 2007 | 9 | 31 | 1 - 17 | 47 | 11.8 | -35.2 | 26.9 | 55.9 | 29 | 5.4 |
| 45 | | Pedro Bank | 1 | 301 | 2005 | 2005 | 1 | 1 | 1 - 21 | 14.7 | 14.7 | | | | | 15.4 |
| 46 | | Port Royal Cays | 3 | 20 | 1977 | 2011 | 11 | 35 | 4 - 13 | 24.9 | 4.7 | -20.2 | 55.7 | 7.7 | -48 | |
| 47 | | West | 4 | 269 | 1977 | 2012 | 12 | 36 | 1 - 18 | 40.3 | 7.8 | -32.5 | 20.7 | 55.7 | 35 | 8.1 |
| 48 | Mexico | Alacran | 2 | 7 | 1985 | 1985 | 1 | 1 | 2 - 35 | 11.2 | 11.2 | | 45.6 | | | |
| 49 | | Chinchorro Bank | 2 | 486 | 2000 | 2008 | 5 | 9 | 0 - 29 | 17 | 7.9 | -9.1 | 7.7 | 7.7 | 0 | 1.4 |
| 50 | | Cozumel Leeward | 4 | 678 | 1984 | 2011 | 11 | 28 | 0 - 28 | 25.5 | 12.1 | -13.4 | 32.9 | 21.6 | -11.3 | 3.5 |
| 51 | | Cozumel Windward | 1 | 77 | 2005 | 2005 | 1 | 1 | 1 - 17 | 9.2 | 9.2 | | | | | 0.7 |
| 52 | | North East Yucatan | 6 | 1105 | 1979 | 2010 | 15 | 18 | 0 - 28 | 20.1 | 7.9 | -12.2 | 30.9 | 10.6 | -20.3 | 6.2 |
| 53 | | South East Yucatan | 2 | 1028 | 1985 | 2009 | 7 | 11 | 0 - 21 | 29.8 | 15.9 | -13.9 | 40.4 | 36.3 | -4.1 | 5.1 |
| 54 | | Veracruz | 3 | 152 | 1965 | 1999 | 4 | 35 | 1 - 21 | 34.1 | 17.2 | -16.9 | | | | |
| 55 | Navassa | Navassa | 1 | 5 | 2002 | 2012 | 5 | 11 | 27 - 28 | 46.4 | 10.7 | -35.7 | 41.7 | 65.7 | 24 | |
| 56 | Netherlands | Bonaire Leeward | 9 | 408 | 1973 | 2011 | 23 | 39 | 3 - 40 | 54.8 | 37.1 | -17.7 | 6.1 | 17.7 | 11.6 | 32.3 |
| 57 | | Bonaire Windward | 4 | 236 | 1988 | 2008 | 4 | 21 | 3 - 31 | 31.9 | 9.7 | -22.2 | 35 | 66.3 | 31.3 | 19.1 |
| 58 | | Saba | 2 | 219 | 1993 | 2003 | 7 | 11 | 3 - 20 | 19.5 | 9.4 | -10.1 | 25.1 | 5.5 | -19.6 | 13.5 |
| 59 | | Saba Bank | 1 | 54 | 1999 | 1999 | 1 | 1 | 14 - 21 | 24.3 | 24.3 | | | | | 14.5 |
| 60 | | St. Eustatius | 1 | 213 | 1999 | 2007 | 4 | 9 | 11 - 19 | 21.8 | 21.8 | | | | | 23 |
| 61 | Nicaragua | Corn Islands | 2 | 269 | 1993 | 2003 | 5 | 11 | 2 - 16 | 28.2 | 24.4 | -3.8 | 37.4 | | | 5.1 |

| Label | Country or Territory | Location | # of data sets | # of surveys | Start year | End year | # of years | Year span | Depth range (m) | Oldest coral cover (%) | Most recent cover coral (%) | Change coral cover (%) | Oldest macroalgal cover (%) | Most recent MA cover (%) | Change MA cover (%) | Parrotfish biomass after 1999 (g/m2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62 | Panama | Bahia Las Minas | 3 | 215 | 1985 | 2011 | 19 | 27 | 2 - 14 | 23.7 | 12.3 | -11.4 | 42 | 3.2 | -38.8 | |
| 63 | | Bocas del Toro | 4 | 473 | 1999 | 2011 | 13 | 13 | 1 - 17 | 29.7 | 13.6 | -16.1 | 12.5 | 10.4 | -2.1 | 12.3 |
| 64 | | Costa Arriba | 3 | 154 | 1985 | 2011 | 19 | 27 | 2 - 17 | 24.7 | 13.9 | -10.8 | 56 | 31.6 | -24.4 | |
| 65 | | San Blas | 3 | 1118 | 1980 | 2005 | 23 | 26 | 0 - 21 | 38.8 | 30.9 | -7.9 | 0.6 | | | 13.3 |
| 66 | Puerto Rico | Guanica | 1 | 6 | 2005 | 2006 | 2 | 2 | 2 - 18 | 27.6 | 17.3 | -10.3 | | | | |
| 67 | | Jobos Bay | 1 | 25 | 2009 | 2009 | 1 | 1 | 0 - 12 | 8.7 | 8.7 | | 15 | 15 | 0 | 2.1 |
| 68 | | La Paguera | 5 | 1265 | 1989 | 2012 | 20 | 24 | 0 - 112 | 16.4 | 19.2 | 2.8 | 5.4 | 10.4 | 5 | 5.6 |
| 69 | | Mona Islands | 1 | 38 | 2008 | 2008 | 1 | 1 | 30 - 103 | 4.5 | 4.5 | | 60.7 | 60.7 | 0 | |
| 70 | | Turrumote | 1 | 11 | 2002 | 2010 | 6 | 9 | 0 - 19 | 23.8 | 23.8 | | | | | 9.5 |
| 71 | | Vieques & Culebra | 5 | 358 | 1978 | 2008 | 7 | 31 | 2 - 48 | 42.6 | 8.1 | -34.5 | 1.9 | 10.6 | 8.7 | 19 |
| 72 | St. Kitts & Nevis | St. Kitts & Nevis | 2 | 446 | 2007 | 2011 | 3 | 5 | 4 - 24 | 10.3 | 11.1 | 0.8 | 48.5 | 36.8 | -11.7 | 13 |
| 73 | Saint Lucia | St. Lucia Leeward | 2 | 12 | 1993 | 2009 | 3 | 17 | 8 - 21 | 48.5 | 10.1 | -38.4 | 41.4 | 8.1 | -33.3 | |
| 74 | St. Martin | St. Martin | 1 | 52 | 1999 | 2007 | 3 | 9 | 8 - 12 | 12.5 | 12.5 | | | | | 12.1 |
| 75 | St. Vincent & the Grenadines | Grenadines | 4 | 304 | 1976 | 2007 | 5 | 32 | 2 - 17 | 30.4 | 19.5 | -10.9 | | | | 16.7 |
| 76 | | St. Vincent | 2 | 108 | 2007 | 2009 | 3 | 3 | 2 - 11 | 29.2 | 24.9 | -4.3 | 2.3 | 0.4 | -1.9 | 6.8 |
| 77 | Trinidad & Tobago | Trinidad & Tobago | 1 | 16 | 1994 | 2012 | 16 | 19 | 10 - 10 | 24.1 | 19.1 | -5 | 0 | 0.9 | 0.9 | |
| 78 | Turks & Caicos | Turks & Caicos Islands | 2 | 565 | 1999 | 1999 | 1 | 1 | 2 - 23 | 17.7 | 17.7 | | 11.7 | 11.7 | 0 | 7.4 |

| Label | Country or Territory | Location | # of data sets | # of surveys | Start year | End year | # of years | Year span | Depth range (m) | Oldest coral cover (%) | Most recent cover coral (%) | Change coral cover (%) | Oldest macroalgal cover (%) | Most recent MA cover (%) | Change MA cover (%) | Parrotfish biomass after 1999 (g/m2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 79 | USA | Dry Tortugas | 9 | 671 | 1975 | 2011 | 19 | 37 | 1 - 28 | 20.8 | 8 | -12.8 | 0.6 | 31.7 | 31.1 | 7.5 |
| 80 | | Flower Garden Banks | 3 | 347 | 1974 | 2011 | 6 | 38 | 18 - 43 | 56.7 | 53.1 | -3.6 | 13.2 | 25.6 | 12.4 | 35.8 |
| 81 | | Lower Florida Keys | 5 | 1094 | 1972 | 2011 | 24 | 40 | 1 - 27 | 31.8 | 10.3 | -21.5 | 15.3 | 15.2 | -0.1 | 24.2 |
| 82 | | Middle Florida Keys | 4 | 390 | 1991 | 2011 | 17 | 21 | 3 - 24 | 8.4 | 8 | -0.4 | 7 | 22.8 | 15.8 | 8.4 |
| 83 | | Southeast Florida | 4 | 256 | 1989 | 2011 | 17 | 23 | 2 - 17 | 12.5 | 2.8 | -9.7 | 3.4 | 4.6 | 1.2 | 3.6 |
| 84 | | Upper Florida Keys | 13 | 1880 | 1965 | 2011 | 31 | 47 | 0 - 27 | 27.9 | 6.1 | -21.8 | 0.8 | 15.3 | 14.5 | 20.3 |
| 85 | United States Virgin Islands | St. Croix | 10 | 505 | 1976 | 2011 | 32 | 36 | 0 - 40 | 23.2 | 4.7 | -18.5 | 3 | 8.9 | 5.9 | 13.1 |
| 86 | | St. Thomas | 5 | 473 | 1978 | 2010 | 19 | 33 | 0 - 33 | 27.4 | 13.6 | -13.8 | 1.5 | 47.7 | 46.2 | 11.4 |
| 87 | | St. Thomas shelf edge | 2 | 620 | 2002 | 2011 | 10 | 10 | 30 - 40 | 26.1 | 33.6 | 7.5 | 42.9 | 26.8 | -16.1 | 9.2 |
| 88 | | St. John | 11 | 2991 | 1978 | 2011 | 31 | 34 | 0 - 27 | 34.1 | 10.1 | -24 | 0.6 | 28.9 | 28.3 | 8.3 |
| 89 | Venezuela | Los Roques | 2 | 209 | 1999 | 2008 | 7 | 10 | 1 - 15 | 69 | 78 | 9 | | | | 60.7 |
| 90 | | Morrocoy | 2 | 165 | 1996 | 2011 | 16 | 16 | 5 - 13 | 55 | 38.5 | -16.5 | | | | |

## **Appendix 3** SPAW Protocol, Cartagena Convention Annex II: List of endangered or threatened species

| Family – Famille Familia | Scientific name - Nom scientifique Nombre científico | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Date of Listing | IUCN Status |
|---|---|---|---|---|---|---|
| **FAUNA – FAUNE – FAUNA** | | | | | | |
| **Class/ Classe/Clase: GASTROPODA** | | | | | | |
| **Order/ Ordre/ Orden: STYLOMMATOPHORA (formerly PULMONATA)** | | | | | | |
| ***Bulimulidae*** | *Orthalicus reses reses* | Stock Island, Florida tree snail | Escargot arboricole | Caracol terrestre Sotck Island | 1991 | NE |
| **Class/ Classe/Clase: OSTEICHTHYES** | | | | | | |
| ***Percidae*** | *Etheostoma okaloosae* | Okaloosa darter | | | 1991 | LC |
| | *Etheostoma rubrum* | Bayou darter | | | 1991 | EN |
| **Class/ Classe/Clase: AMPHIBIA** | | | | | | |
| **Order/ Ordre/ Orden: ANURA** | | | | | | |
| ***Bufonidae*** | *Anaxyrus houstonensis* (formerly *Bufo houstonensis*) | Houston toad | | | 1991 | EN |
| | *Peltophryne lemur* | Puerto Rican Crested Toad Ridge-headed Toad | | Sapo concho | 1991 | CR |
| ***Eleutherodactylidae* (**formerly included in ***Leptodactylidae)*** | *Eleutherodactylus barlagnei* | Barlagne Robber frog | Hylode de Barlagne | | 1991 | EN |
| | *Eleutherodactylus jasperi* | Golden coqui | | Coquí dorado | 1991 | CR |
| | *Eleutherodactylus johnstonei* | Johnstone's Robber Frog | Hylode de Johnstone | coquí antillano | 1991 | LC |
| | *Eleutherodactylus martinicensis* | Martinique Robber frog | Hylode de la Martinique | | 1991 | NT |
| | *Eleutherodactylus pinchoni* | Pinchon's Piping Frog | Hylode de Pinchon | | 1991 | EN |
| | *Eleutherodactylus limbatus* (formerly *Sminthillus limbatus*) | Habana robber frog | | | 1991 | VU |
| ***Hylidae*** | *Phyllodytes auratus* (formerly *Amphodus auratus*) | Golden tree frog El Tucuche golden frog | | | 1991 | CR |
| **Order/ Ordre/ Orden: CAUDATA** | | | | | | |
| ***Plethodontidae*** | *Phaeognathus hubrichti* | Red Hills salamanders | | | 1991 | EN |

| Family – Famille Familia | Scientific name - Nom scientifique Nombre científico | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Date of Listing | IUCN Status |
|---|---|---|---|---|---|---|
| Class/ Classe/Clase: REPTILIA | | | | | | |
| Order/ Ordre/ Orden: CROCODYLIA | | | | | | |
| ***Alligatoridae*** | *Melanosuchus niger* | Black caiman | Caiman noir | Caimán negro | 1991 | NE |
| ***Crocodylidae*** | *Crocodylus acutus* | American crocodile | Crocodile américain | Cocodrilo americano cocodrilo narigudo Cocodrilo de Tumbes | 1991 | VU |
| | *Crocodylus intermedius* | Orinoco crocodile | Crocodile de l'Orénoque | Cocodrilo del Orinoco, Caimán del Orinoco | 1991 | CR |
| | *Crocodylus moreletii* | Morelet's crocodile / central american crocodile | Crocodile de Morelet | Cocodrilo de Morelet cocodrilo mexicano o de pantano | 1991 | LC |
| Order/ Ordre/ Orden: SQUAMATA | | | | | | |
| ***Boidae*** | *Chilabothrus inornatus* (formerly *Epicrates inornatus)* | Puerto rican boa | Boa de Puerto Rico | Boa o culebrón De Puerto Rico | 1991 | LC |
| | *Chilabothrus monensis granti* (formerly *Epicrates monensis granti )* | Virgin Islands tree boa | Boa arboricole des Iles Vierges – Pas de nom commun trouvé | Boa de la cordillera O de las Islas Vírgenes | 1991 | NE |
| | *Chilabothrus monensis monensis* (formerly *Epicrates monensis monensis)* | Mona Island boa | Boa de l'île Mona | Boa o culebrón de Mona | 1991 | EN |
| ***Colubridae*** | *Nerodia clarkii taeniata* (formerly *Nerodia fasciata taeniata)* | Atlantic saltmarsh snake | | | 1991 | NE |
| ***Dactyloidae*** (formerly included in ***Iguanidae***) | *Anolis roosevelti* | Culebra Island Giant Anole | | | 1991 | CR |
| ***Iguanidae*** | *Cyclura carinata* | Turks and Caicos rock iguana, Bahamas Rock Iguana, Turks and Caicos Ground Iguana | Iguane terrestre Des îles Turks et Caïcos | Iguana de Turcas y Caicos | 1991 | CR |
| | *Cyclura collei* | Jamaica Ground Iguana, Jamaican Iguana, Jamaican Rock Iguana | Iguane terrestre De la Jamaique | Iguana jamaiquina | 1991 | CR |
| | *Cyclura cychlura* | Northern Bahamian Rock Iguana | | | 1991 | VU |
| | *Cyclura nubila* | Cuban Ground iguana | Iguane terrestre de Cuba | Iguana cubana | 1991 | VU |

| Family – Famille Familia | Scientific name - Nom scientifique Nombre científico | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Date of Listing | IUCN Status |
|---|---|---|---|---|---|---|
| **Iguanidae** | *Cyclura pinguis* | Anegada Rock iguana | Iguane terrestre De l'Ile Anegada | Iguana de Puerto Rico Iguana de Anegada | 1991 | CR |
| | *Cyclura ricordii* | Ricord's rock iguana | Iguane de Ricord | La Iguana Ricordi | 1991 | |
| | *Cyclura rileyi* | San Salvador iguana, Central Bahamian Rock Iguana | Iguane terrestre Des Bahamas | Iguana de Bahamas | 1991 | EN |
| | *Cyclura stejnegeri* | Mona Rhinoceros Iguana, Mona Ground Iguana, Mona Island Iguana | Iguane de Mona | Iguana de Mona | 1991 | EN |
| **Scincidae** | *Eumeces egregius* | Mole Skink | | | 1991 | LC |
| | *Neoseps reynoldsi* | Florida sand skink | | | 1991 | VU |
| **Sphaerodactylidae** (formerly included in **Gekkonidae**) | *Sphaerodactylus micropithecus* | Monito Gecko Monito Dwarf Gecko | | Salamanquita de Monito | 1991 | EN |
| **Teiidae** | *Ameiva polops* | St. Croix Ground Lizard | | | 1991 | CR |
| **Typhlopidae** | *Typhlops guadeloupensis* | Guadeloupe blind snake | Typhlops de Guadeloupe | | 1991 | NE |
| **Order/ Ordre/ Orden: TESTUDINES** | | | | | | |
| **Cheloniidae** | *Caretta caretta* | Loggerhead sea turtle | Tortue caouanne | Cayuma, Tortuga-marina caguama | 1991 | VU |
| | *Chelonia mydas* | Green sea turtle | Tortue verte | Tortuga verde | 1991 | EN |
| | *Eretmochelys imbricata* | Hawksbill turtle | Tortue imbriquée | Tortuga de carey | 1991 | CR |
| | *Lepidochelys kempii* | Kemp's Ridley turtle | Tortue de Kemp | Tortuga lora | 1991 | CR |
| | *Lepidochelys olivacea* | Olive ridley turtle | Tortue olivâtre | Tortuga Golfina, Olivacea | 1991 | VU |
| **Dermochelyidae** | *Dermochelys coriacea* | Leatherback sea turtle | Tortue luth | Tortuga laúd | 1991 | VU |
| **Emydidae** | *Graptemys oculifera* | Ringed map turtle | Tortue annelée | | 1991 | VU |
| | *Pseudemys alabamensis* | Alabama red-bellied turtle | | Tortuga de vientre rojo De Alabama | 1991 | EN |
| **Testudinidae** | *Gopherus polyphemus* | Gopher tortoise | Gophère polyphème, Tortue De La Floride, Tortue Gaufrée | Tortuga Terrestre De Florida | 1991 | VU |
| **Class/ Classe/Clase: AVES** | | | | | | |
| **Order/ Ordre/ Orden: CAPRIMULGIFORMES** | | | | | | |
| **Caprimulgidae** | *Caprimulgus noctitherus* | Puerto Rican nightjar | Angoulevent de Puerto Rico | Guabairo, Chotacabras portorriqueño | 1991 | EN |

| Family – Famille Familia | Scientific name - Nom scientifique Nombre científico | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Date of Listing | IUCN Status |
|---|---|---|---|---|---|---|
| **Order/ Ordre/ Orden: CHARADRIIFORMES** | | | | | | |
| ***Charadriidae*** | *Charadrius melodus* | Piping Plover | Pluvier siffleur, Gravelot siffleur | Chorlo chiflador Frailecillo silbador | 1991 | NT |
| ***Laridae*** | *Sternula antillarum antillarum* (formerly *Sterna antillarum antillarum)* | Least Tern | Petite sterne | Charrancito americano | 1991 | NE |
| | *Sterna dougallii dougallii* | Roseate Tern | Sterne de Dougall | Charrán rosado | 1991 | NE |
| ***Scolopacidae*** | *Numenius borealis* | Eskimo curlew | Courlis esquimau | Zarapito Boreal | 1991 | CR |
| **Order/ Ordre/ Orden: CICONIIFORMES** | | | | | | |
| ***Ciconiidae*** | *Jabiru mycteria* | Jabiru | Jabiru d'Amérique | Cigüeña jabirú , tuyuyu | 1991 | LC |
| | *Mycteria americana* | Wood stork | Tantale d'Amérique | Tántalo Americano | 1991 | LC |
| **Order/ Ordre/ Orden: COLUMBIFORMES** | | | | | | |
| ***Columbidae*** | *Patagioenas inornata wetmorei* (formerly *Columba inornata wetmorei)* | Puerto Rican plain pigeon | Pigeon simple de Puerto Rico | Torcaza boba de Puerto Rico | 1991 | NE |
| **Order/ Ordre/ Orden: FALCONIFORMES** | | | | | | |
| ***Accipitridae*** | *Chondrohierax uncinatus* | Hook-billed Kite | Milan bec-en-croc | Gavilán pico gancho | 1991 | LC |
| | *Haliaeetus leucocephalus* | Bald Eagle | Pygargue à tête blanche | Águila cabeza blanca | 1991 | LC |
| | *Harpia harpyja* | Harpy Eagle | Harpie féroce | Aguila Arpía | 1991 | NT |
| | *Rostrhamus sociabilis plumbeus* | Everglade Snail kite | Milan des marais | Caracolero común | 1991 | NE |
| ***Falconidae*** | *Falco femoralis septentrionalis* | Northern Aplomado Falcon | Faucon aplomado | Halcón aleto | 1991 | NE |
| | *Falco peregrinus* | Peregrine Falcon | Faucon pèlerin | Halcón peregrino | 1991 | LC |
| | *Caracara plancus* (formerly *Polyborus plancus)* | Southern crested Caracara | Caracara huppé | Carancho Caracara quebrantahuesos | 1991 | LC |
| **Order/ Ordre/ Orden: GALLIFORMES** | | | | | | |
| ***Cracidae*** | *Aburria pipile* (formerly *Pipile pipile)* | Trinidad Piping Guan | Pénélope siffleuse | Pava de Trinidad | 1991 | CR |
| ***Phasianidae*** | *Tympanuchus cupido attwateri* | Attwater's Greater Prairie-Chicken | Tétras cupidon d'Attwater | Gallo de las praderas De Attwater | 1991 | NE |

| Family – Famille Familia | Scientific name - Nom scientifique Nombre científico | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Date of Listing | IUCN Status |
|---|---|---|---|---|---|---|
| **Order/ Ordre/ Orden: GRUIFORMES** | | | | | | |
| ***Gruidae*** | *Grus americana* | Whooping Crane | Grue blanche | Grulla trompetera | 1991 | EN |
| | *Grus canadensis nesiotes* | Sandhill Crane | Grue canadienne | Grulla canadiense | 1991 | NE |
| | *Grus canadensis pulla* | Sandhill crane | Grue canadienne | Grulla canadiense | 1991 | NE |
| **Order/ Ordre/ Orden: PASSERIFORMES** | | | | | | |
| ***Cardinalidae*** | *Passerina ciris* | Painted bunting | Passerin nonpareil | Azulillo pintado | 2017 | NT |
| ***Corvidae*** | *Aphelocoma coerulescens coerulescens (formerly Aphelocoma coerulescens cyanotis)* | Florida scrub jay | Geai à gorge blanche | Chara floridana | 1991 | NE |
| | *Corvus leucognaphalus* | White-necked Crow | Corneille d'Hispaniola | Cuervo de cuello blanco | 1991 | VU |
| ***Emberezidae*** | *Ammodramus maritimus mirabilis* | Cape Sable Seaside sparrow | Bruant maritime du Cap Sable | | 1991 | NE |
| | *Ammodramus savannarum floridanus* | Florida Grasshopper Sparrow | Bruant sauterelle de Floride | Gorrión sabanero Pechileonado de Florida | 1991 | NE |
| ***Fringillidae*** (formerly included in ***Emberezidae***) | *Carduelis cucullata* | Red Siskin | Tarin (chardonneret) rouge du Vénézuela | Cardenalito | 1991 | NE |
| ***Mimidae*** | *Cinclocerthia ruficauda* | Brown Trembler | Trembleur brun | Cocobino Pardo | 1991 | LC |
| | *Ramphocinclus brachyurus* | White-Breasted Thrasher | Moqueur à gorge-blanche | Cuitlacoche Pechiblanco | 1991 | EN |
| ***Parulidae*** (formerly included in ***Emberezidae***) | *Vermivora bachmanii* | Bachman's warbler | Paruline de Bachman | Bijirita de Bachman | 1991 | CR |
| | *Setophaga kirtlandii* (formerly *Dendroica kirtlandii)* | Kirtland's Warbler | Paruline de Kirtland | Reinita de Kirtland | 1991 | NE |
| ***Turdidae*** | *Catharus bicknelli* | Bicknell's Thrush | Grive de Bicknell | Zorzal/ tordo de Bicknell | 2014 | VU |
| **Order/ Ordre/ Orden: PELECANIFORMES** | | | | | | |
| ***Pelecanidae*** | *Pelecanus occidentalis* | Brown Pelican | Pélican brun | Pelícano Pardo | 1991 | LC |
| **Order/ Ordre/ Orden: PICIFORMES** | | | | | | |
| ***Picidae*** | *Picoides borealis* | Red-Cockaded Woodpecker | Pic à face blanche | Pico de Florida | 1991 | NT |
| **Order/ Ordre/ Orden: PROCELLARIIFORMES** | | | | | | |
| ***Hydrobatidae*** | *Hydrobates pelagicus* | European Storm-Petrel | Océanite tempête | Paíño europeo | 1991 | LC |

| Family – Famille Familia | Scientific name - Nom scientifique Nombre científico | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Date of Listing | IUCN Status |
|---|---|---|---|---|---|---|
| ***Procellariidae*** | *Pterodroma hasitata* | Black-capped Petrel | Pétrel diablotin | Petrel de Cornilla negra Petrel Antillano | 2014 | EN |
| | *Puffinus lherminieri* | Audubon's Shearwater | Puffin d'Audubon | Pardela de Audubon | 1991 | LC |
| **Order/ Ordre/ Orden: PSITTACIFORMES** | | | | | | |
| ***Psittacidae*** | *Amazona arausiaca* | Red necked parrot / Amazon | Amazone de Bouquet | Amazona Cabenazul | 1991 | VU |
| | *Amazona barbadensis* | Yellow-shouldered Amazon | Amazone à épaulettes jaune | Amazona de Espalda Amarilla | 1991 | VU |
| | *Amazona guildingii* | St Vincent Amazon | Amazone de Saint-Vincent | Amazona de San Vicente | 1991 | VU |
| | *Amazona imperialis* | Imperial Amazon | Amazone impériale | Amazona imperial | 1991 | EN |
| | *Amazona leucocephala* | Cuban Amazon, Rose-throated parrot | Amazone de Cuba | Amazona cubana | 1991 | NT |
| | *Amazona versicolor* | St Lucia Amazon | Amazone de Sainte-Lucie | Amazona de Santa Lucía | 1991 | VU |
| | *Amazona vittata* | Puerto Rican Amazon | Amazone de Puerto Rico | Amazona de Puerto Rico | 1991 | CR |
| | *Ara macao* | Scarlet Macaw | Ara rouge | Guacamayo macao | 1991 | LC |
| **Class/ Classe/Clase: CHONDRICHTHYES** | | | | | | |
| **Order/ Ordre/ Orden: PRISTIFORMES** | | | | | | |
| ***Pristidae*** | *Pristis pectinata* | Smalltooth sawfish | Poisson-scie trident | Pez sierra peine | 2017 | CR |
| | *Pristis pristis* | Largetooth sawfish | Poisson-scie | Pez sierra | 2019 | CR |
| **Class/ Classe/Clase: MAMMALIA** | | | | | | |
| **Order/ Ordre/ Orden: CARNIVORA** | | | | | | |
| ***Canidae*** | *Speothos venaticus* | Bush dog | Chien des buissons, Chien des bois | Perrito Venadero | 1991 | NT |
| ***Felidae*** | *Leopardus pardalis* (formerly *Felis pardalis*) | Ocelot | Ocelot | Ocelote | 1991 | LC |
| | *Leopardus tigrinus* (formerly *Felis tigrina*) | Oncilla, tiger cat | Oncille | Leopardo tigre (formerly Gato tigre) | 1991 | VU |
| | *Leopardus wiedii* (formerly *Felis wiedii*) | Margay | Margay | Margay | 1991 | NT |
| | *Puma yagouaroundi* (formerly *Felis yagouaroundi* ) | Jaguarundi | Jaguarondi | Yaguarundí | 1991 | LC |
| ***Phocidae*** | *All spp.* | | | | 1991 | EXCTINT |
| ***Mustelidae*** | *Pteronura brasiliensis* | Giant otter | Loutre géante du Brésil | Lobo del rio | 1991 | EN |
| ***Ursidae*** | *Tremarctos ornatus* | Spectacled Bear | Ours à lunettes | Oso de Anteojos | 1991 | NE |

| Family – Famille Familia | Scientific name - Nom scientifique Nombre científico | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Date of Listing | IUCN Status |
|---|---|---|---|---|---|---|
| **Order/ Ordre/ Orden: CETACEA (All spp)** | | | | | | |
| ***Balaenopteridae*** | *Balaenoptera musculus* | Blue whale | Rorqual bleu | Ballena azul | 1991 | EN |
| | *Balaenoptera physalus* | Fin whale | Rorqual commun | Rorcual común, ballena de aleta | 1991 | EN |
| | *Balaenoptera borealis* | Sei whale | Rorqual boréal | Ballena sei | 1991 | EN |
| | *Balaenoptera edeni* | Bryde's whale | Rorqual tropical (de Bryde) | Ballena de Bryde, | 1991 | DD |
| | *Megaptera novaeangliae* | Humpback whale | Baleine a bosse | Ballena jorobada | 1991 | LC |
| | *Balaenoptera acutorostrata* | Common minke whale | Petit Rorqual | Ballena minke | 1991 | LC |
| ***Balaenidae*** | *Eubalaena glacialis* | North Atlantic right whale | Baleine franche des Basques | Ballena franca del norte | 1991 | EN |
| ***Physeteridae*** | *Physeter macrocephalus* | Sperm whale | Cachalot | Cachalote | 1991 | VU |
| | *Kogia breviceps* | Pygmy sperm whale | Cachalot pygmée | Cachalote pigmeo | 1991 | DD |
| | *Kogia Simia* (formerly *Kogia simus)* | Dwarf sperm whale | Cachalot nain | Cachalote enano | 1991 | DD |
| ***Ziphiidae*** | *Ziphius cavirostris* | Cuvier's beaked whale | Baleine à bec de Cuvier | Ballena de Cuvier | 1991 | LC |
| | *Mesoplodon europaeus* | Gervais' beaked whale | Baleine à bec de Gervais | Ballena de pico de Gervais | 1991 | DD |
| | *Mesoplodon densirostris* | Blainville's beaked whale | Baleine à bec de Blainville | Ballena de pico de Blainville | 1991 | DD |
| | *Mesoplodon mirus* | True's beaked whale | Mésoplodon de True | Ballena de pico de True | 1991 | DD |
| | *Mesoplodon bidens* | Sowerby's beaked whale | Mésoplodon de Sowbery | Ballena de pico de Sowerby | 1991 | DD |
| ***Delphinidae*** | *Orcinus orca* | Killer whale | Orque | Orca | 1991 | DD |
| | *Feresa attenuata* | Pygmy killer whale | Orque pygmée | Orca pigmea | 1991 | DD |
| | *Pseudorca crassidens* | False killer whale | Fausse orque | Orca falsa | 1991 | DD |
| | *Globicephala macrorhynchus* | Short-finned pilot whale | Globicéphale tropical | Calderón de aleta corta | 1991 | DD |
| | *Peponocephala electra* | Melon-headed whale | Péponocéphale | Delfín cabeza de melón | 1991 | LC |
| | *Lagenodelphis hosei* | Fraser's dolphin | Dauphin de Fraser | Delfín De Fraser, Borneo | 1991 | LC |
| | *Stenella attenuata* | Pantropical spotted dolphin | Dauphin tacheté pantropical | Delfín manchado pantropical | 1991 | LC |
| | *Stenella frontalis* | Atlantic spotted dolphin | Dauphin tacheté atlantique | Delfín manchado del Atlántico | 1991 | DD |
| | *Stenella longirostris* | Spinner dolphin | Dauphin à long bec | Delfín rotador | 1991 | DD |
| | *Stenella clymene* | Clymene dolphin | Dauphin de clymène | Delfín de clymen | 1991 | DD |
| | *Delphinus delphis* | Short-beaked Common Dolphin | Dauphin commun | Delfin común de pico corto | 1991 | LC |
| | *Tursiops truncatus* | Common bottlenose dolphin | Grand dauphin | Delfín nariz de botella | 1991 | LC |

| Family – Famille Familia | Scientific name - Nom scientifique Nombre científico | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Date of Listing | IUCN Status |
|---|---|---|---|---|---|---|
| ***Delphinidae*** | *Stenella coeruleoalba* | Striped dolphin | Dauphin bleu et blanc | Delfín listado | 1991 | LC |
| | *Grampus griseus* | Risso's dolphin | Dauphin de Risso | Delfín de Risso | 1991 | LC |
| | *Steno bredanensis* | Rough-toothed dolphin | Steno rostré, steno à rostre étroit | Delfín de dientes rugosos | 1991 | LC |
| | *Sotalia fluviatilis* | Tucuxi | Sotalie | Tucuxi | 1991 | DD |
| **Order/ Ordre/ Orden: CHIROPTERA** | | | | | | |
| ***Molossidae*** | *Tadarida brasiliensis* | Brazilian Free-tailed Bat | Molosse du Brésil | Murciélago cola de ratón | 1991 | LC |
| ***Mormoopidae*** | *Pteronotus davyi* | Davy's naked-backed bat | Ptéronote de Davy, Chauve-souris à dos nu | Murciélago de espalda desnuda | 1991 | LC |
| ***Phyllostomidae*** | *Ardops nichollsi* | Tree Bat | Ardops des Petites Antilles | | 1991 | LC |
| | *Brachyphylla cavernarum* | Antillean Fruit-eating Bat | Brachyphylle des antilles | | 1991 | LC |
| | *Chiroderma improvisum* | Guadeloupe Big-eyed Bat | Chiroderme de la Guadeloupe | | 1991 | EN |
| ***Vespertilionidae*** | *Eptesicus guadeloupensis* | Guadeloupe Big brown bat | Sérotine de la Guadeloupe | Gran murciélago Marrón de Guadalupe | 1991 | EN |
| **Order/ Ordre/ Orden: CINGULATA (formerly: EDENTATA)** | | | | | | |
| ***Dasypodidae*** | *Priodontes maximus* (formerly *Priodontes giganteus)* | Giant armadillo | Tatou géant | Armadillo gigante | 1991 | VU |
| **Order/ Ordre/ Orden: LAGOMORPHA** | | | | | | |
| ***Leporidae*** | *Sylvilagus palustris hefneri* | Lower keys marsh rabbit | | | 1991 | CR |
| **Order/ Ordre/ Orden: DIDELPHIMORPHIA (formerly MARSUPIALIA)** | | | | | | |
| ***Didelphidae*** | *Chironectes minimus* | Water Opossum, Yapok | Opossum aquatique, yapock | Cuica de agua, Tlacuache acuático | 1991 | LC |
| **Order/ Ordre/ Orden: PRIMATES** | | | | | | |
| ***Atelidae*** (formerly: ***Cebidae***) | *Alouatta palliata* | Mantled Howler Monkey | Singe hurleur à manteau | Mono congo | 1991 | LC |
| **Order/ Ordre/ Orden: RODENTIA** | | | | | | |
| ***Capromyidae*** | *Mesocapromys angelcabrerai (formerly Capromys angelcabrerai)* | Cabrera's hutia | | | 1991 | EN |
| | *Mesocapromys auritus (formerly Capromys auritus)* | Large-Eared hutia | | Jutía rata | 1991 | EN |
| | Mysateles garridoi (formerly Capromys garridoi ) | Garrido's hutia | | Jutía de Garrido | 1991 | CR |

| Family – Famille Familia | Scientific name - Nom scientifique Nombre científico | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Common name – Nom commun – Nombre comun | Date of Listing | IUCN Status |
|---|---|---|---|---|---|---|
| | *Mesocapromys nanus* (formerly *Capromys nanus)* | Dwarf hutia | Hutia nain | Jutía enana | 1991 | CR |
| | *Mesocapromys sanfelipensis* (formerly *Capromys sanfelipensis)* | San Felipe Hutia | | Jutía de la Tierra | 1991 | CR |
| ***Dasyproctidae*** | *Dasyprocta guamara* | Orinoco agouti | | Guamara | 1991 | NT |
| ***Cricetidae*** (formerly included in ***Muridae***) | *Neotoma floridana smalli* | Key Largo Woodrat | | | 1991 | NE |
| | *Peromyscus gossypinus allapaticola* | Cotton mouse | Souris de coton | | 1991 | NE |
| | *Peromyscus polionotus* (formerly *Peromyscus polionotus allophrys Peromyscus polionotus ammobates Peromyscus polionotus niveiventris Peromyscus polionotus phasma Peromyscus polionotus trissyllepsis)* | Oldfield Deermouse/mouse | | | 1991 | LC |
| **Order/ Ordre/ Orden: SIRENIA (All spp)** | | | | | | |
| ***Trichechidae*** | *Trichechus manatus* | West Indian manatee | Lamantin des Antilles | Manatí antillano | 1991 | VU |
| **Class/ Classe/Clase: ANTHOZOA** | | | | | | |
| **Order/ Ordre/ Orden: SCLERACTINIA** | | | | | | |
| ***Acroporidae*** | *Acropora cervicornis* | Staghorn coral | Corne de cerf | Coral cuerno de ciervo | 2014 | CR |
| | *Acropora palmata* | Elkhorn coral | Corne d'élan | Coral cuerno de alce | 2014 | CR |
| ***Faviidae*** | *Montastraea annularis* | Boulder star coral | Corail étoile massif | | 2014 | EN |
| | *Montastraea faveolata* | Mountainous star coral | Corail étoile massif | | 2014 | EN |

# **Appendix 4** Key Programmes and Initiatives

CODES
Area of activity: T/CB = training/capacity building; SF = financing; SGF = small grant facility; MPA mgmt = marine protected area management; M/M = mapping/monitoring; R = research; ER = ecosystem rehabilitation; Gov/Pol = governance/policy framework; Sust L = sustainable livelihoods/socio economic issues; DB = database

| Initiative/ time frame | Lead & main partners | Description | Target/ participating countries | Target ecosystem | | | | Area of activity | | | | | | | | | | Sector | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Coral Reefs | Mangroves | Seagrass | CMR-general | T/CB | SF | SGF | MPA mgmt | M/M | R | ER | Gov/Pol | Sust L | DB | Govt | Civ Soc | Private |
| Allen Coral Atlas/ Global Coral Mapping Partnership | Paul Allen Philanthropies, Planet, Carnegie Science, Hawai'i Institute of Marine Biology (HIMB) | The Allen Coral Atlas uses high resolution satellite imagery and advanced analytics to map and monitor the world's coral reefs in detail. Maps currently available show the composition and structure of five important reefs located throughout the world. By 2020, the atlas will cover globe. http://allencoralatlas.org/ | Belize (Lighthouse Reef) | x | | | | | | | | x | | | | | | | x | |
| Atlantic and Gulf Rapid Reef Assessment (AGRRA) Program<br><br>Ongoing | Ocean Research and Education Foundation (ORE) | The AGRRA program assesses key attributes of coral reefs in the tropical Western Atlantic to inform reef policies, legislation, management and conservation. The AGGRA protocol is a standardised method for surveying coral health that has been used by several groups to produce coral reef report cards. AGRRA's open-source Data Explorer houses the largest database on Caribbean coral reef health indicators, with data available from more than 2,480 site surveys in 29 countries or territories throughout the Caribbean. www.agrra.org | CLME+ and Florida | x | | | | x | | | | x | x | | | | x | x | x | |
| Caribbean Aqua-Terrestrial Solutions (CATS) Programme<br><br>2013 -2017 | Caribbean Public Health Agency (CARPHA)<br><br>OECS<br>CRFM | Umbrella 'Ridge-to-Reef Approach' programme that brought together two regional programmes: "Adaptation of Rural Economies and Natural Resources to Climate Change", and "Management of Coastal Resources and Conservation of Marine Biodiversity". Supported adaptive measures in agriculture, forestry and water and wastewater management in Jamaica, Belize, Guyana, Dominica, Grenada, St. Kitts & Nevis, Saint Lucia, and St. Vincent & The Grenadines. Focused on Marine Protected Areas (MPAs) in five East Caribbean countries. | MPA countries: Dominica, Grenada, St. Kitts & Nevis, Saint Lucia, and St. Vincent & The Grenadines | | | | x | | | | x | | | | | | | x | x | |

CODES

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| Initiative/ time frame | Lead & main partners | Description | Target/ participating countries | Target ecosystem | | | | Area of activity | | | | | | | | | | Sector | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Coral Reefs | Mangroves | Seagrass | CMR-general | T/CB | SF | SGF | MPA mgmt | M/M | R | ER | Gov/Pol | Sust L | DB | Govt | Civ Soc | Private |
| CCI and CBF<br><br>Ongoing | TNC | The CCI is coalition of Caribbean governments, businesses and partners committed to protecting 20% of marine and coastal resources by 2020 (20 by 20 goal). The CBF was established to support implementation of the CCI. The CBF mobilises resources and channels support to partner national conservation trust funds and directly to selected national and regional projects. It manages a conservation-focused endowment ($43 million) and a sinking fund to support ecosystem-based adaptation (EbA) ($26.5 million). The first call for proposals of the EbA facility was issued in November 2018.<br>www.caribbeanchallengeinitiative.org<br>https://www.caribbeanbiodiversityfund.org/ | The Bahamas, the British Virgin Islands, the Dominican Republic, Grenada, Jamaica, Puerto Rico, St. Lucia, St. Kitts and Nevis and St. Vincent and the Grenadines. | | | | x | | x | x | x | | | | x | x | | x | x | |
| CARIBNODE<br><br>Ongoing | | A regional information system that brings together authoritative data from national and regional entities, making it possible to create tools for resource management across the region.<br>http://www.caribnode.org | Antigua and Barbuda<br>Dominica<br>Dominican Republic<br>Grenada<br>Haiti<br>Jamaica<br>Saint Kitts and Nevis<br>Saint Lucia<br>Saint Vincent and the Grenadines | | | | x | | | | | | | | | | x | | | |
| Caribbean Coral Strategy<br><br>Ongoing | TNC | Several initiatives and tools as part of the strategy. Along with the Caribbean Challenge Initiative: Coastal Resilience Tool, TNC-Caribbean, Carnegie Institution for Science and Planet Mapping Initiative launched a ground-breaking initiative to create the first-ever high-resolution map of the shallow waters of the entire Caribbean Basin. | | | | | | | | | | | | | | | | | | |

CODES

Area of activity: T/CB = training/capacity building; SF = financing; SGF = small grant facility; MPA mgmt = marine protected area management; M/M = mapping/monitoring; R = research; ER = ecosystem rehabilitation; Gov/Pol = governance/policy framework; Sust L = sustainable livelihoods/socio economic issues; DB = database

| Initiative/ time frame | Lead & main partners | Description | Target/ participating countries | Target ecosystem | | | | Area of activity | | | | | | | | | | Sector | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Coral Reefs | Mangroves | Seagrass | CMR-general | T/CB | SF | SGF | MPA mgmt | M/M | R | ER | Gov/Pol | Sust L | DB | Govt | Civ Soc | Private |
| Caribbean Marine Protected Area Management Network and Forum (CaMPAM)<br><br>Ongoing | UNEP-CEP/ SPAW<br><br>Gulf and Caribbean Fisheries Institute; NOAA's Coral Reef Conservation Program | A social network for enhancing the effectiveness of MPAs in the wider Caribbean. CaMPAM's mission is to build the capacity of marine protected area managers, practitioners and fishers in the wider Caribbean to promote the application of best marine management practices for the transboundary coordination of ecologically connected areas. CaMPAM operates the UNEP-CEP/SPAW the small and medium size grants fund. Most recently, it operated the small grant facility under the ECMANN Project.<br><br>Maintains the Marine Protected Areas Database http://campam.gcfi.org/CaribbeanMPA/ CaribbeanMPA.php | Wider Caribbean | | | | x | x | | x | x | | | | | x | x | | | |
| CANARI Coastal and Marine Livelihoods and Governance Programme<br><br>Ongoing | Caribbean Natural Resources Institute (CANARI) | CANARI's Coastal and Marine Livelihoods and Governance programme aims to improve livelihoods and contribute to poverty reduction by promoting and facilitating sustainable use and governance of coastal and marine resources, building effective institutions and facilitating collaboration among key stakeholders, through participatory research, capacity building, and sharing lessons learned.<br><br>CANARI has developed the People Managing Oceans: Civil Society Action Programme of the CLME+ SAP.<br>www.canari.org | Insular Caribbean | | | | x | x | | | x | | | | x | x | | x | x | |

CODES

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| Initiative/ time frame | Lead & main partners | Description | Target/ participating countries | Target ecosystem | | | | Area of activity | | | | | | | | | | Sector | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Coral Reefs | Mangroves | Seagrass | CMR-general | T/CB | SF | SGF | MPA mgmt | M/M | R | ER | Gov/Pol | Sust L | DB | Govt | Civ Soc | Private |
| Caribbean and North Brazil Shelf Large Marine Ecosystem Project (2015-2020) Strategic Action Programme (CLME+ SAP)<br><br>2015-2020 | United Nations Office of Project Services (UNOPS) through co-executing arrangements with CANARI, UWI-CERMES, CRFM, FAO-WECAFC, GCFI, IOC of UNESCO, OECS, OSPESCA and UNEP-CEP | Aimed at improving management of shared living marine resources in the Caribbean Large Marine Ecosystem and the North Brazil Shelf Large Marine Ecosystem. Focus on improving transboundary governance and management of shared living marine resources | CLME+ | x | x | x | x | x | | | | | | | x | | | x | x | |
| Coastal Zone Management Trust | State Government of Quintana Roo, Mexico; TNC | A trust fund (Fideicomiso in Spanish) that receives taxes collected by the government from local hotel owners and the tourism industry.<br><br>The fund has two roles. It aims to continuously maintain the coral reef and local beaches but also buys an insurance policy. The reef insurance pays out when a certain wind speed crosses the area covered by the insurance to fund the repair and rebuilding of the coral reef, restoring its protective power and hence its financial benefit to the local economy.<br><br>A proposed initial project encompasses 60km of beaches and reef along the coast of Cancún and Puerto Morelos, with potential to include Tulum, Solidaridad and Cozumel municipalities. | Mexico | x | | | | | x | | | | | x | | | | x | | x |

CODES
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| Initiative/ time frame | Lead & main partners | Description | Target/ participating countries | Target ecosystem | | | | Area of activity | | | | | | | | | | Sector | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Coral Reefs | Mangroves | Seagrass | CMR-general | T/CB | SF | SGF | MPA mgmt | M/M | R | ER | Gov/Pol | Sust L | DB | Govt | Civ Soc | Private |
| Critical Ecosystem Partnership Fund (CEPF)<br><br>2019 – to be confirmed/ announced | Conservation International<br><br>[Regional Implementation Team for new investment to be identified] | Supports the development of conservation strategies in biodiversity hotspots focusing on KBAs.<br><br>A new investment in the Caribbean Islands Biodiversity Hotspot will begin in 2020. Coastal and marine resources in target KBAs with marine extensions will be eligible for support. | Antigua and Barbuda; The Bahamas; Barbados; Dominica; the Dominican Republic; Grenada; Haiti; Jamaica; Saint Lucia; St. Kitts and Nevis; and St. Vincent and the Grenadines | | | | x | x | x | x | | | | x | x | x | | | x | |
| EU BEST – voluntary scheme for Biodiversity and Ecosystem Services in EU Outermost Regions and Overseas Countries and Territories | European Commission and the Global Island Partnership (GLISPA) | Supports activities such as designation and management of terrestrial and marine protected areas, participative approach and integrated approach of ecosystem management, combating invasive alien species, valuing ecosystem services, creating synergies using ecosystem services for climate change adaptation and mitigation, endangered species protection, as well as networking, education, capacity building and outreach activities. | EU Overseas Territories and Countries | | | | x | | | x | x | x | | | x | x | | | x | |

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R = research; ER = ecosystem rehabilitation; Gov/Pol = governance/policy framework; Sust L = sustainable livelihoods/socio economic issues; DB = database

| Initiative/ time frame | Lead & main partners | Description | Target/ participating countries | Target ecosystem | | | | Area of activity | | | | | | | | | | Sector | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Coral Reefs | Mangroves | Seagrass | CMR-general | T/CB | SF | SGF | MPA mgmt | M/M | R | ER | Gov/Pol | Sust L | DB | Govt | Civ Soc | Private |
| Eastern Caribbean Marine Managed Areas Network (ECMMAN) Project<br><br>2013-2017 | TNC<br>OECS Secretariat, Social and Sustainable Development Division; UNEP SPAW-Regional Activity Centre (RAC) through CaMPAM; CRFM through the Caribbean Network of Fisherfolk Organisations (CNFO) | Project to strengthen MPA management in six OECS countries by: declaring new Marine Managed Areas (MMAs) and strengthening existing ones; building strong constituencies for sustainable livelihoods and ocean use; improving and updating an Eastern Caribbean Decision Support System that provides accessible decision making tools and incorporates current ecological, socio-economic, and climate change data; and instituting sustainability mechanisms to support the MMA network, including regional political commitments and actions, collaboration mechanisms on marine and coastal resources, and sustainable financing. | St. Kitts and Nevis, Antigua and Barbuda, Dominica, Saint Lucia, St. Vincent and the Grenadines and Grenada | x | | | x | x | x | x | x | x | | | | x | | x | x | |
| MPA Connect | GCFI, NOAA Coral Reef Conservation Program (CRCP) | A learning network of MPA managers and professionals in the Caribbean that works to increase the effectiveness of MPA management by addressing specific capacity needs of individual MPAs through a variety of means, including regional peer to peer workshops, site-specific technical support, learning exchanges and direct grant funding. | The Bahamas, Belize, The British Virgin Islands, Grenada, Honduras, México The Netherlands/ Saba The Netherlands/ Sint Eustatius Saint Lucia, Saint Vincent & the Grenadines, The Turks and Caicos Islands | x | x | x | x | x | | x | x | | | | | | | x | x | |

CODES

Area of activity: T/CB = training/capacity building; SF = financing; SGF = small grant facility; MPA mgmt = marine protected area management; M/M = mapping/monitoring; R = research; ER = ecosystem rehabilitation; Gov/Pol = governance/policy framework; Sust L = sustainable livelihoods/socio economic issues; DB = database

| Initiative/ time frame | Lead & main partners | Description | Target/ participating countries | Target ecosystem | | | | Area of activity | | | | | | | | | | Sector | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Coral Reefs | Mangroves | Seagrass | CMR-general | T/CB | SF | SGF | MPA mgmt | M/M | R | ER | Gov/Pol | Sust L | DB | Govt | Civ Soc | Private |
| Global Coral Reef Restoration Project<br><br>Ongoing | California Academy of Sciences, SECORE International, TNC | Coral reef restoration by seeding reefs with sexually reproduced coral offspring. The programme offers training for partners from island nations and territories—including organisations capable of translating their efforts into local management plans that support this large-scale coral restoration initiative. The project started in the Caribbean in 2017 and is planned to expand into the Pacific region after its initial phase. | Curaçao, Mexico, U.S. Virgin Islands. | x | | | | x | | | | | x | x | | | | | x | |
| Healthy Reefs for Healthy People Initiative | World Wildlife Fund (WWF); the Meso-American Barrier Reef System Project (MBRS); the World Bank; the Summit Foundation; Perigee Environmental. | An international, multi-institutional effort that tracks the health of the Meso-American Reef, the human choices that shape it and progress in ensuring its long-term integrity. Includes a focus on ecological issues as well as socio-economic, cultural, and policy factors influencing reef health and, in turn, the impact those factors may have on local communities. | Belize, Honduras, Guatemala, Mexico | x | x | x | | x | | | | | x | | | x | x | x | x | |
| Integrated Transboundary Ridge-to-Reef Management of the Mesoamerican Reef (MAR2R) | Central American Commission on Environment and Development (CCAD)/ SICA | Enhance regional collaboration for the ecological integrity of the Mesoamerican Reef and scale up the ridge to reef approach to its management. | Mexico, Belize, Guatemala and Honduras, | x | | | x | | | | x | | | | | x | | x | x | x |

CODES
Area of activity: T/CB = training/capacity building; SF = financing; SGF = small grant facility; MPA mgmt = marine protected area management; M/M = mapping/monitoring; R = research; ER = ecosystem rehabilitation; Gov/Pol = governance/policy framework; Sust L = sustainable livelihoods/socio economic issues; DB = database

| Initiative/ time frame | Lead & main partners | Description | Target/ participating countries | Target ecosystem | | | | Area of activity | | | | | | | | | | Sector | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Coral Reefs | Mangroves | Seagrass | CMR-general | T/CB | SF | SGF | MPA mgmt | M/M | R | ER | Gov/Pol | Sust L | DB | Govt | Civ Soc | Private |
| NOAA National Coral Reef Monitoring Program | NOAA (USA) | Government agency that protects, conserves, and restore the USA's coral reefs by maintaining healthy ecosystem function. Focus on climate change resilience; reducing land-based sources of pollution; improving fisheries' sustainability; and restoring viable coral populations. https://coralreef.noaa.gov<br><br>Maintains CoRIS: Coral Reef Information System, an information portal that provides access to NOAA coral reef information and data products with emphasis on the U.S. states, territories and remote island areas. https://www.coris.noaa.gov/ | Florida, Puerto Rico, US Virgin Islands | x | | | | x | | | | x | x | x | | | x | x | x | |
| The Ramsar Caribbean Wetlands Regional Initiative (CARIWET) | Regional Initiative Committee. (Coordinated by Jamaica and Cuba) | Facilitates the implementation of the Ramsar Convention in the Caribbean, through the development of a Regional Strategy. A new activity area on ecosystem services was added in 2016, and the work plan was extended to 2024 (Ramsar Convention Secretariat, 2018). | | | x | | | | | | | | | | | | | | | |
| Regional Activity Centre for the Protocol Concerning Specially Protected Areas and Wildlife for the Wider Caribbean Region (SPAW-RAC) | UNEP-CEP, CaMPAM, GCFI, Wider Caribbean Sea Turtle Network (WIDECAST), World Commission on Protected Areas (WCPA) | Implements the SPAW Protocol | Wider Caribbean | x | x | x | x | x | | | x | | | | x | | | x | x | |

CODES
Area of activity: T/CB = training/capacity building; SF = financing; SGF = small grant facility; MPA mgmt = marine protected area management; M/M = mapping/monitoring;
R = research; ER = ecosystem rehabilitation; Gov/Pol = governance/policy framework; Sust L = sustainable livelihoods/socio economic issues; DB = database

| Initiative/ time frame | Lead & main partners | Description | Target/ participating countries | Target ecosystem | | | | Area of activity | | | | | | | | | | Sector | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Coral Reefs | Mangroves | Seagrass | CMR-general | T/CB | SF | SGF | MPA mgmt | M/M | R | ER | Gov/Pol | Sust L | DB | Govt | Civ Soc | Private |
| Socio-economic Monitoring for Coastal Management (SocMon) | IUCN WCPA-Marine, GCRMN, NOAA | | Wider Caribbean | | | | x | | | | x | | | | | | | x | x | |
| **Citizen Science** | | | | | | | | | | | | | | | | | | | | |
| Reef Check | Reef Check Foundation | EcoMonitoring Program: Trains volunteer divers in the use of a globally standardized scientific protocol to collect data on the status of coral reefs to inform management.<br><br>Reef Check also supports MPA management in-country, e.g., La Calata MPA in the Dominican Republic | CLME | x | | | | | | | x | x | | | | | | | x | |
| Sandwatch | Sandwatch Foundation | | | | | | x | | | | | x | | | | | | | x | |
| Seagrass Spotter | | Citizen science | | | | x | | | | | | x | | | | | | | x | |

# Appendix 5 Parties to selected Global Agreements

| STATE | TREATY | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cartagena Convention | | | Basel Convention | Cartagena Protocol to the Convention on Biological Diversity | Convention on Biological Diversity | Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) | Convention on Migratory Species | Ramsar Convention | United Nations Framework Convention on Climate Change | International Convention for the Control and Management of Ships' Ballast Water and Sediments | International Convention for the Prevention of Pollution from Ships (MARPOL) | World Heritage Convention | United Nations Educational, Scientific and Cultural Organization (UNESCO) Man and the Biosphere (MAB) Programme |
| | Cartagena Convention & Oil Spills Protocol | SPAW Protocol | LBS Protocol | | | | | | | | | | | |
| Antigua and Barbuda | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| The Bahamas | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Barbados | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Belize | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Brazil | | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Colombia | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Costa Rica | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ |
| Cuba | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Dominica | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Dominican Republic | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| France | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Grenada | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Guatemala | ✓ | | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Guyana | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | |
| Haiti | | | | | | ✓ | | | | ✓ | | | ✓ | ✓ |
| Honduras | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Jamaica | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Mexico | ✓ | | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Netherlands | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Nicaragua | ✓ | | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Panama | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| St. Kitts and Nevis | ✓ | | | ✓ | ✓ | ✓ | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Saint Lucia | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| STATE | TREATY | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Cartagena Convention | | | Basel Convention | Cartagena Protocol to the Convention on Biological Diversity | Convention on Biological Diversity | Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) | Convention on Migratory Species | Ramsar Convention | United Nations Framework Convention on Climate Change | International Convention for the Control and Management of Ships' Ballast Water and Sediments | International Convention for the Prevention of Pollution from Ships (MARPOL) | World Heritage Convention | United Nations Educational, Scientific and Cultural Organization (UNESCO) Man and the Biosphere (MAB) Programme |
| | Cartagena Convention & Oil Spills Protocol | SPAW Protocol | LBS Protocol | | | | | | | | | | | |
| St. Vincent and the Grenadines | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | | ✓ | | ✓ | ✓ | |
| Suriname | | | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | |
| Trinidad and Tobago | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| United Kingdom | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | ✓ |
| United States of America | ✓ | ✓ | ✓ | | | | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |
| Venezuela | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | ✓ | ✓ |

# Appendix 6 Sites Listed under the Ramsar Convention

| | |
|---|---|
| (yellow) | Countries to confirm these contain coral reefs, mangroves and/or seagrass beds |
| (pink) | No sites noted from Ramsar Site Listing |

| Country Name | Ramsar sites | Date of designation | Region, province, state | Area (ha) |
|---|---|---|---|---|
| Anguilla | Sombrero Island Nature Reserve Marine Park | 22/05/2018 | Anguilla | 1,051 |
| Antigua and Barbuda | Codrington Lagoon | 02/06/2005 | Barbuda | 3,600 |
| Bahamas | Inagua National Park | 07/02/1997 | Great Inagua Island | 32,600 |
| Barbados | Graeme Hall Swamp | 12/12/2005 | Christ Church | 33 |
| Belize | Crooked Tree Wildlife Sanctuary | 22/04/1998 | Belize | 6,637 |
| Belize | Sarstoon Temash National Park | 19/10/2005 | Toledo | 16,955 |
| Brazil | Amazon Estuary and its Mangroves | 19/03/2018 | Amapá, Maranhão, Pará | 3,850,253 |
| Brazil | Atol das Rocas Biological Reserve | 11/12/2015 | Rio Grande do Norte | 35,186 |
| Brazil | Baixada Maranhense Environmental Protection Area | 28/02/2000 | Maranhão | 1,775,036 |
| Brazil | Cabo Orange National Park | 02/02/2013 | Amapá | 657,328 |
| Brazil | Par.Est.Mar. do Parcel Manoel Luís incl. the Baixios do Mestre Álvaro and Tarol | 30/11/1993 | Maranhão | 34,556 |
| Brazil | Reentrancias Maranhenses | 30/11/1993 | Maranhão | 2,680,911 |
| Colombia | Delta del Río Baudó | 05/06/2004 | Chocó | 8,888 |
| Colombia | Sistema Delta Estuarino del Río Magdalena Ciénaga Grande de Santa Marta | 18/06/1998 | Magdalena | 400,000 |
| Costa Rica | Gandoca-Manzanillo | 11/12/1995 | Limón | 9,445 |
| Costa Rica | Humedal Caribe Noreste | 20/03/1996 | Limón,Heredia | 75,310 |
| Cuba | Buenavista | 18/11/2002 | Villa Clara,Sancti Spíritus | 313,500 |
| Cuba | Ciénaga de Lanier y Sur de la Isla de la Juventud | 18/11/2002 | Isla de la Juventud | 126,200 |
| Cuba | Ciénaga de Zapata | 12/04/2001 | Matanzas | 452,000 |
| Cuba | Gran Humedal del Norte de Ciego de Ávila | 18/11/2002 | Ciego de Ávila | 226,875 |
| Cuba | Humedal Delta del Cauto | 18/11/2002 | Granma, Las Tunas | 47,836 |
| Cuba | Humedal Río Máximo-Cagüey | 18/11/2002 | Camagüey | 22,000 |
| Dominica | | | | |
| Dominican Republic | Humedales de Jaragua | 04/07/2014 | Pedernales | 32,979 |
| Dominican Republic | Parque Nacional Manglares del Bajo Yuna | 02/02/2013 | Duarte, Sánchez Ramírez, Samaná, Maria Trinidad Sánchez | 77,519 |
| French Guiana | Basse-Mana | 08/12/1993 | Guyane | 59,000 |
| French Guiana | Estuaire du fleuve Sinnamary | 15/09/2008 | Guyane | 28,400 |
| French Guiana | Marais De Kaw | 08/12/1993 | Guyane | 137,000 |
| Grenada | Levera Wetland | 22/05/2012 | St. Patrick | 518 |
| Guadeloupe | Grand Cul-de-Sac Marin de la Guadeloupe | 08/12/1993 | Guadeloupe | 29,500 |
| Guatemala | Punta de Manabique | 28/01/2000 | Izabal | 151,878 |
| Guatemala | Refugio de Vida Silvestre Bocas del Polochic | 20/03/1996 | Izabal | 20,760 |
| Guatemala | Reserva de Usos Múltiples Río Sarstún | 22/03/2007 | Izabal | 32,202 |
| Guyana | | | | |
| Haiti | | | | |

| Country Name | Ramsar sites | Date of designation | Region, province, state | Area (ha) |
|---|---|---|---|---|
| Honduras | Barras de Cuero y Salado | 23/06/1993 | Atlántida | 13,225 |
| Honduras | Parque Nacional Jeanette Kawas | 28/03/1995 | Atlántida | 78,150 |
| Honduras | Refugio de Vida Silvestre Punta Izopo | 20/03/1996 | Atlántida | 11,200 |
| Honduras | Sistema de Humedales Cuyamel-Omoa | 02/02/2013 | Cortes | 30,029 |
| Honduras | Sistema de Humedales de Santa Elena | 22/03/2018 | Departamento de Islas de la Bahía, Honduras | 1,543 |
| Honduras | Sistema de Humedales Laguna de Zambuco | 22/04/2013 | Atlántida | 649 |
| Jamaica | Black River Lower Morass | 07/10/1997 | Southwestern region | 5,700 |
| Jamaica | Palisadoes - Port Royal | 22/04/2005 | Kingston | 7,523 |
| Jamaica | Portland Bight Wetlands and Cays | 02/02/2006 | St. Catherine, Clarendon | 24,542 |
| Martinique | Etang des Salines | 15/09/2008 | Martinique | 207 |
| Mexico | Anillo de Cenotes | 02/02/2009 | Yucatán | 891 |
| Mexico | Área de Protección de Flora y Fauna Laguna de Términos | 02/02/2004 | Campeche | 705,016 |
| Mexico | Área de Protección de Flora y Fauna Yum Balam | 02/02/2004 | Quintana Roo | 154,052 |
| Mexico | Dzilam | 07/12/2000 | Yucatán | 61,707 |
| Mexico | Humedal de Importancia Especialmente para la Conservación de Aves Acuáticas Reserva Ría Lagartos | 04/07/1986 | Yucatán | 60,348 |
| Mexico | Humedales de la Laguna La Popotera | 05/06/2005 | Veracruz | 1,975 |
| Mexico | Laguna de Tamiahua | 27/11/2005 | Veracruz | 88,000 |
| Mexico | Laguna Madre | 02/02/2004 | Tamaulipas | 307,894 |
| Mexico | La Mancha y El Llano | 02/02/2004 | Veracruz | 1,414 |
| Mexico | Manglares de Nichupté | 02/02/2008 | Quintana Roo | 4,257 |
| Mexico | Manglares y humedales de la Laguna de Sontecomapan | 02/02/2004 | Veracruz | 8,921 |
| Mexico | Manglares y Humedales del Norte de Isla Cozumel | 02/02/2009 | Quintana Roo | 32,786 |
| Mexico | Manglares y Humedales de Tuxpan | 02/02/2006 | Veracruz | 6,870 |
| Mexico | Parque Nacional Arrecife Alacranes | 02/02/2008 | Yucatán | 334,113 |
| Mexico | Parque Nacional Arrecife de Puerto Morelos | 02/02/2004 | Quintana Roo | 9,066 |
| Mexico | Parque Nacional Arrecifes de Cozumel | 02/02/2005 | Quintana Roo | 11,987 |
| Mexico | Parque Nacional Arrecifes de Xcalak | 27/11/2003 | Quintana Roo | 17,949 |
| Mexico | Parque Nacional Isla Contoy | 27/11/2003 | Quintana Roo | 5,126 |
| Mexico | Parque Nacional Sistema Arrecifal Veracruzano | 02/02/2004 | Veracruz | 52,238 |
| Mexico | Playa Tortuguera Chenkán | 02/02/2004 | Campeche | 121 |
| Mexico | Playa Tortuguera Rancho Nuevo | 27/11/2003 | Tamaulipas | 30 |
| Mexico | Playa Tortuguera X'cacel-X'cacelito | 02/02/2004 | Quintana Roo | 362 |
| Mexico | Reserva de la Biosfera Banco Chinchorro | 02/02/2004 | Quintana Roo | 144,360 |
| Mexico | Reserva de la Biosfera Los Petenes | 02/02/2004 | Campeche | 282,857 |
| Mexico | Reserva de la Biosfera Pantanos de Centla | 22/06/1995 | Tabasco | 302,706 |
| Mexico | Reserva de la Biosfera Ría Celestún | 02/02/2004 | Yucatán, Campeche | 81,482 |
| Mexico | Reserva Estatal El Palmar | 27/11/2003 | Yucatán | 50,177 |
| Mexico | Sian Ka'an | 27/11/2003 | Quintana Roo | 652,193 |
| Mexico | Sistema Lagunar Alvarado | 02/02/2004 | Veracruz | 267,010 |

| Country Name | Ramsar sites | Date of designation | Region, province, state | Area (ha) |
|---|---|---|---|---|
| Montserrat | | | | |
| Nicaragua | Cayos Miskitos y Franja Costera Immediata | 08/11/2001 | Atlántico Norte | 85,000 |
| Nicaragua | Sistema de Humedales de la Bahía de Bluefields | 08/11/2001 | Atlántico Sur | 86,501 |
| Nicaragua | Refugio de Vida Silvestre Río San Juan | 08/11/2001 | Río San Juan, Atlántico Sur | 43,000 |
| Panama | Humedal de Importancia Internacional Damani-Guariviara | 09/03/2010 | Ngäbe-Buglé | 24,089 |
| Panama | San San - Pond Sak | 09/06/1993 | Bocas del Toro | 16,414 |
| Puerto Rico | | | | |
| Saint Kitts and Nevis | | | | |
| Saint Lucia | Mankòtè Mangrove | 19/02/2002 | Vieux Fort | 60 |
| Saint Lucia | Savannes Bay | 19/02/2002 | Vieux Fort | 25 |
| Saint Martin | Zones humides et marines de Saint-Martin | 27/10/2011 | Saint Martin | 2,997 |
| Saint Vincent and the Grenadines | | | | |
| Suriname | Coppenamemonding Nature Reserve | 22/07/1985 | Saramacca | 12,000 |
| Trinidad and Tobago | Buccoo Reef / Bon Accord Lagoon Complex | 08/07/2005 | Tobago | 1,287 |
| Trinidad and Tobago | Caroni Swamp | 08/07/2005 | Trinidad | 8,398 |
| Trinidad and Tobago | Nariva Swamp | 21/12/1992 | Trinidad | 6,234 |
| United States | Corkscrew Swamp Sanctuary | 23/03/2009 | Florida | 5,261 |
| United States | Everglades National Park | 04/06/1987 | Florida | 610,497 |
| United States | Okefenokee National Wildlife Refuge | 18/12/1986 | Georgia,Florida | 162,635 |
| United States | Pelican Island National Wildlife Refuge | 14/03/1993 | Florida | 2,203 |
| Venezuela | Laguna de la Restinga | 04/09/1996 | Nueva Esparta | 5,248 |
| Venezuela | Laguna de Tacarigua | 04/09/1996 | Miranda | 9,200 |
| Venezuela | Parque Nacional Archipiélago Los Roques | 04/09/1996 | Distrito Capital | 213,220 |
| Venezuela | Refugio de Fauna Silvestre de Cuare | 23/11/1988 | Falcón | 12,000 |
| Venezuela | Refugio de Fauna Silvestre y Reserva de Pesca Ciénaga de Los Olivitos | 04/09/1996 | Zulia | 26,000 |

## **Appendix 7** Protected Areas Listed under the SPAW Protocol, Cartagena Convention

| Country | Site |
|---|---|
| Belize | Glover's Reef Marine Reserve |
| Belize | Hol Chan Marine Reserve |
| Belize | Port Honduras Marine Reserve |
| Colombia | Sanctuary Cienaga Grande de Santa Marta |
| Colombia | Regional Seaflower Marine Protected Area |
| Colombia | Regional Natural Park of Wetlands |
| Cuba | Parque Nacional Guanahacabibes |
| Cuba | Parque Nacional Cayos de San Felipe |
| Dominican Republic | National Park Jaragua |
| Dominican Republic | La Caleta Submarine Park |
| Dominican Republic | National Park Sierra de Bahoruco |
| Dominican Republic | National Park Haitises |
| French West Indies | Ile du Grand Connétable Guyane |
| French West Indies | Parc National de la Guadeloupe |
| French West Indies | Étangs Lagunaires de Saint-Martin |
| French West Indies | Réserve Naturelle Nationale de Saint-Martin |
| French West Indies | Sanctuaire Agoa |
| French West Indies | Réserve Naturelle de PetiteTerre |
| French West Indies | Étangs des Salines Martinique |
| French West Indies | Versants Nord de la Montagne Pelée |
| French West Indies | Réserve naturelle de l'Amana Guyane |
| French West Indies | Réserve naturelle nationale de Kaw-Roura Guyane |
| Grenada | Molinière-Beauséjour Reserve |
| CaribbeanNetherlands | Saba National Marine Park |
| CaribbeanNetherlands | St Eustatius National Marine Park |
| CaribbeanNetherlands | Man O War Shoal Marine Park Sint Maarten |
| CaribbeanNetherlands | Bonaire National Marine Park |
| CaribbeanNetherlands | The Quill and Boven National Park St. Eustatius |
| CaribbeanNetherlands | Saba Bank National Park |
| CaribbeanNetherlands | Mt. Scenery National Park Saba |
| Saint Vincent and the Grenadines | Tobago Cays Marine Park |
| United States of America | Florida Key National Marine Sanctuary |
| United States of America | Dry Tortugas National Park |
| United States of America | Everglades National Park |
| United States of America | Flower Garden Banks National Marine Sanctuary |

## **Appendix 8** NBSAP Review Summary Table

Summary of information collated from NBSAPs of 25 countries from the CLME+ SPAW Region.

| Country | LME | Ecoregion | NBSAP Submission | NBASP Post COP 10 (2010) | NBSAP Period | General Marine Biodiversity Target (yes or no) | National Coral Reef Target | National Target Mangrove | National Target Sea grass beds | Environmental monitoring system established | Environmental monitoring system operational | Data Challenges |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Antigua and Barbuda** | CLME | Eastern Caribbean | 2015 | Yes | 2014 - 2020 | Yes | Yes | Yes | No | Yes | Yes | Yes |
| **The Bahamas** | CLME | Bahamian | 2002 | No | Unspecified | No | No | No | No | No | No | Yes |
| **Barbados** | CLME | Lesser Antilles | 2002 | No | Unspecified | No, but objectives, strategies and actions are identified | No, but strategies outlined | No | No | Yes | Yes | Yes |
| **Belize** | CLME | Western Caribbean | 2016 | Yes | 2016-2020 | Yes | No | Yes, though targets are not specific to mangroves there are activities for mangroves | No | Yes | Yes | No. No challenges specific to data identified |
| **Brazil** | North Brazil Shelf | Amazonian | 2018 | | 2016-2020 | Yes | Yes | No specific target for mangroves but included in other broader targets | No | Yes | Unsure- listed unplanned actions, unsure if it is now operational | No. No challenges specific to data identified |
| **Colombia** | CLME | Southwestern Caribbean | 2017 | Yes | 2016-2030 | Yes | No | No | No | Yes | Yes | |
| **Costa Rica** | CLME | Southwestern Caribbean | 2017 | Yes | 2016-2025 | Yes | Yes | Yes | | Yes | Yes | Yes |
| **Cuba** | CLME | Greater Antilles | 2016 | Yes | 2016-2020 | Yes | Yes | Yes | Yes | No | No | Yes |
| **Dominica** | CLME | Eastern Caribbean | 2014 | Yes | 2014-2020 | Yes | No | No | No | No | No | Yes |

50 Excludes Overseas Territories and the United States.

| Country | LME | Ecoregion | NBSAP Submission | NBASP Post COP 10 (2010) | NBSAP Period | General Marine Biodiversity Target (yes or no) | National Coral Reef Target | National Target Mangrove | National Target Sea grass beds | Environmental monitoring system established | Environmental monitoring system operational | Data Challenges |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dominican Republic** | CLME | Greater Antilles | 2012 | Yes | 2011-2020 | No specific national target for marine biodiversity stated, but targets include marine and coastal ecosystems | Yes | No | No | Yes | Unsure | Yes |
| **Grenada** | CLME | Eastern Caribbean | 2016 | Yes | 2016-2020 | Yes | Yes | Yes | No | No | No | Yes |
| **Guatemala** | CLME | Western Caribbean | 2014 | Yes | 2012-2022 | Yes | No | No | No | Not clear if established | | |
| **Guyana** | North Brazil Shelf | Guianan | 2015 | Yes | 2012-2020 | No | No | Yes | No | No | No | Yes |
| **Haiti** | CLME | Greater Antilles | 2008 (NBSAP Profile) | No | Unspecified | Yes | Yes | Yes | No | No | No | Yes |
| **Honduras** | CLME | Southwestern Caribbean | 2017 | Yes | 2018-2022 | Yes | No | No | No | | | |
| **Jamaica** | CLME | Greater Antilles | 2016 | Yes | 2016-2021 | Yes | Yes | No, but there are activities addressing mangroves | No, but activities addressing seagrass | Yes, but these are monitoring programmes for Climate Change and pollution not biodiversity | Yes | Yes |
| **Mexico** | Gulf of Mexico and CLME | Southern Gulf of Mexico and Western Caribbean | 2016 | Yes | 2016-2030 | No specific targets set | No | No | No specific target, but activity identified | Yes. | Yes | |
| **Nicarargua** | CLME | Southwestern Caribbean | 2016 | Yes | 2015-2020 | No, but actions are highlighted under strategic goals | No | No specific targets were set, but guidelines and strategic goals include mangroves | No | Yes, but for particular species | Yes | No |

| Country | LME | Ecoregion | NBSAP Submission | NBASP Post COP 10 (2010) | NBSAP Period | General Marine Biodiversity Target (yes or no) | National Coral Reef Target | National Target Mangrove | National Target Sea grass beds | Environmental monitoring system established | Environmental monitoring system operational | Data Challenges |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Panama** | CLME | Southwestern Caribbean | 2000 | No | Unspecified | No | No | No, but it is mentioned under the strategic guidelines | No | Yes | Unsure | Yes |
| **Saint Kitts and Nevis** | CLME | Eastern Caribbean | 2016 | Yes | 2014-2020 | Yes | Yes | Yes | No | Yes, though limited | Yes | Yes |
| **Saint Lucia** | CLME | Eastern Caribbean | 2008 (Draft) | No | 2008-2018 | Yes | No | No | No | No | No | Yes |
| **Saint Vincent and the Grenadines** | CLME | Eastern Caribbean | 2018 | Yes | 2015-2020 | Yes | No, but overall target includes coral reefs activities | No, but there are national targets and activities including coastal and marine ecosystems | No, but overall target includes activities for seagrass beds | No | No | No |
| **Suriname** | North Brazil Shelf | Guianian | 2013 | Yes | 2012-2016 | No specific targets were set, but objectives and sub-objectives outlined | No | Yes, as an objective, but not a target | No | No | No | No |
| **Trinidad and Tobago** | CLME | Southern Caribbean | 2018 | Yes | 2017-2022 | Yes | Yes | No, but overall target includes wetland indicators | No, but overall target includes seagrass indicators | Yes | Yes, but unsure of extent | Yes |
| **Venezuela** | CLME and North Brazil Shelf | Southern Caribbean | 2011 | Yes | 2010 - 2020 | No | No | No | No | No | No | Yes |

## United Nations Environment Programme

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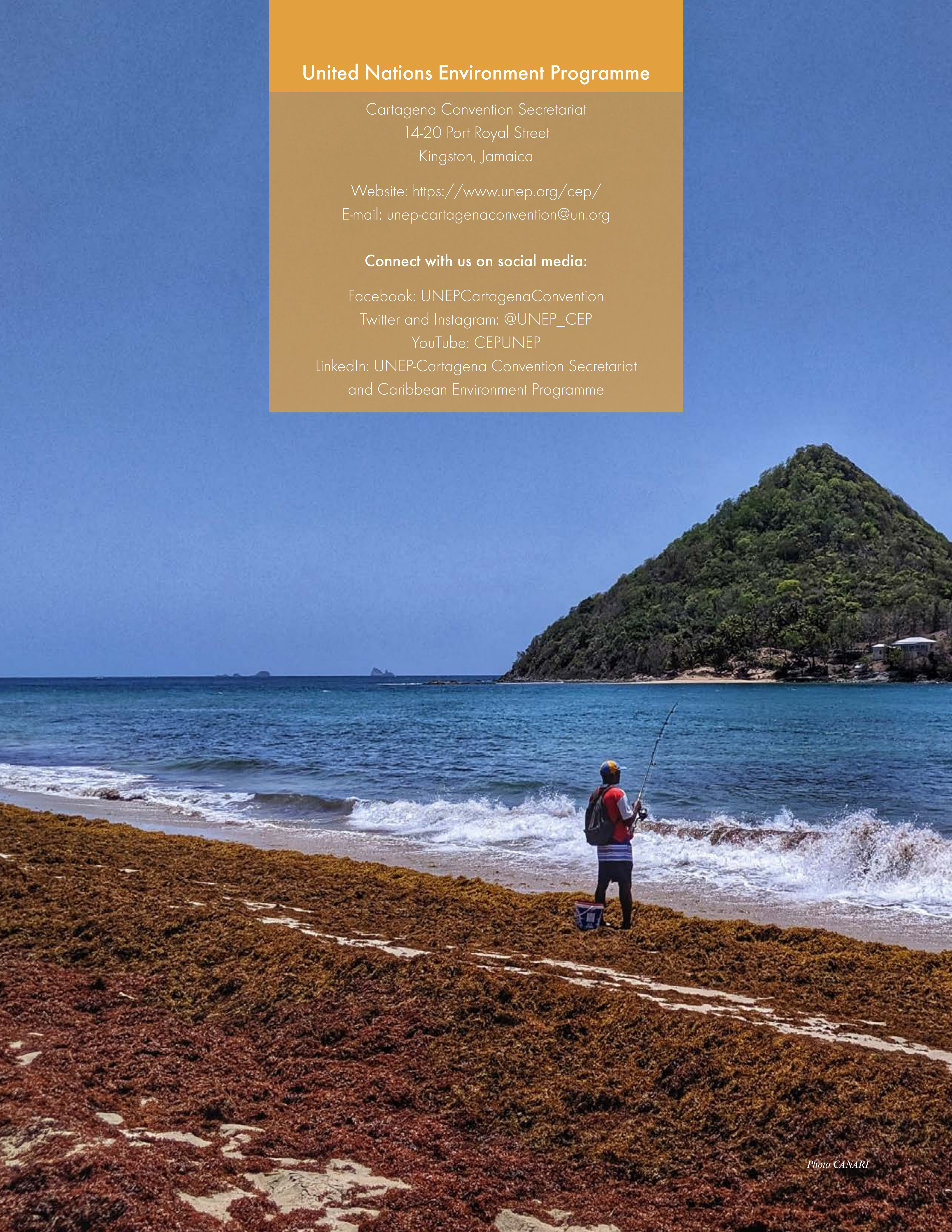

*Photo CANARI*