



Distr. LIMITED

UNEP(DEPI)/CAR WG.42/INF.5
1 February 2021

Original: ENGLISH

Ninth Meeting of the Scientific and Technical Advisory Committee (STAC) to the Protocol Concerning Specially Protected Areas and Wildlife (SPA) in the Wider Caribbean Region

17–19 March 2021

THE STATE OF NEARSHORE MARINE HABITATS IN THE WIDER CARIBBEAN

For reasons of public health and safety associated with COVID-19, this meeting is being convened virtually. Delegates are kindly requested to access all meeting documents electronically for download as necessary.

*This document has been reproduced without formal editing.

**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.
00**



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

ACKNOWLEDGMENTS

Development of this Information Product and its contents, and/or the activities leading thereto, have benefited from the financial support of the **UNDP/GEF Project**:

**“Catalysing Implementation of the Strategic Action Programme (SAP) for the Sustainable Management of shared Living Marine Resources in the Caribbean and North Brazil Shelf Large Marine Ecosystems”
(CLME+ Project, 2015-2020)**

The CLME+ Project is executed by the United Nations Office for Project Services (UNOPS) in close collaboration with a large number of global, regional and national-level partners. All are jointly referred to as the “CLME+ Project co-executing partners”.

www.clmeproject.org

info@clmeproject.org



As a GEF Agency, the United Nations Development Programme (UNDP) implements a global portfolio of GEF co-funded Large Marine Ecosystem projects, among which the CLME+ Project.
www.undp.org



Through the International Waters (IW) focal area, the Global Environment Facility (GEF) helps countries jointly manage their transboundary surface water basins, groundwater basins, and coastal and marine ecosystems.
www.thegef.org



UNOPS mission is to serve people in need by expanding the ability of the United Nations, governments and other partners to manage projects, infrastructure and procurement in a sustainable and efficient manner.
www.unops.org

CLME+ Project Information Products are available on the CLME+ Hub (www.clmeplus.org) and can be downloaded free of cost.

Publication:

United Nations Environment Programme - Caribbean Environment Programme (UNEP-CEP), August 2020
Tel: (876) 922-9267-9 Fax: (876) 922-9292 Website: <https://www.unenvironment.org/cep/> Email: unep-cartagenaconvention@un.org
© UNEP-CEP
Front cover photo © Anna Giro

Citation: United Nations Environment Programme- Caribbean Environment Programme (2020). The State of Nearshore Marine Habitats in the Wider Caribbean. Port-of-Spain: CANARI.

UNEP-CEP and **CANARI** encourage the reproduction, dissemination and use of this Information Product. Except where otherwise indicated, material from this Information Product may be copied, downloaded, reproduced and disseminated for private study, research, educational and [advocacy][/]awareness-raising purposes, or for use in non-commercial products or services, without special permission from the copyright holder(s), provided that the appropriate acknowledgment of the source is made and that endorsement by the Author(s) and/or the GEF, UNDP and the CLME+ Project co-executing partners of the users' views, products or services is not implied in any way.

[No part of this publication may be reproduced, disseminated or used for any commercial purposes or resold without the prior written permission of the Author(s).]

CLME+ Project Information Product Series [– *Technical Reports*]

Disclaimer:

The designations employed and the presentation of information in any format in this Information Product do not imply the expression of any opinion whatsoever on the part of the GEF, UNDP and/or any of the CLME+ Project (co-)executing partners [other than the Author(s)] concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the GEF, UNDP and/or any of the CLME+ Project (co-)executing partners [other than the Author(s)] in preference to others of a similar nature that are not mentioned.

Unless expressly stated otherwise, the content, facts, findings, interpretations, conclusions, views and opinions expressed in this Information Product are those of the Author(s). Publication as a CLME+ Project Information Product does not by itself constitute an endorsement of the GEF, UNDP and/or any of the CLME+ Project (co-)executing partners [other than the Author(s)] of such content, facts, findings, interpretations, conclusions, views or opinions.

The GEF, UNDP and/or any of the CLME+ Project (co-)executing partners [other than the Author(s)] do not warrant that the information contained in this Information Product is complete and correct and shall not be liable whatsoever for any damages incurred as a result of its use.

CLME+ Project (c o-)executing partners:



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



Empowered lives.
Resilient nations.



www.theGEF.org



Credits and Acknowledgments

Coordination: Cartagena Convention Secretariat, United Nations Environment CEP (Ileana C Lopez)

Lead author: CANARI

This report was prepared by the Caribbean Natural Resources Institute (CANARI) for the United Nations Environment Programme - Caribbean Environment Programme (UNEP-CEP). It was developed by Nicole A. Brown, Lloyd Gardner, Nicole Leotaud and Paige Rothenberger for CANARI.

Contributing authors:

Ileana Lopez (UNEP-CEP)

Other contributors:

UNEP-CEP acknowledges the support and feedback from inter-governmental organisations, governments and stakeholders from academia, civil society, the private sector, and regional and global agencies for the commitment in the preparation of this report envisaged to enhance management and conservation in support of sustainable socio-economic development, through actions specifically targeting coral reefs, mangroves and seagrass beds.

SPAW Protocol Scientific and Technical Advisory Committee (STAC 8)

Interamerican Association for Environmental Defense (AIDA) |

Financial Support:

The Secretariat gratefully acknowledges the Catalysing implementation of the Strategic Action Programme for the sustainable management of shared Living Marine Resources in the Caribbean and North Brazil Shelf Large Marine Ecosystems (UNDP/GEF CLME+ Project)

Mapping

John Knowles (UNDP/GEF CLME+ Project)

Reviewers

SPAW Protocol National Focal Points

Experts

PREFACE

Background

Protecting the Caribbean Sea and its resources is vital to safeguarding the future of the countries that border it. More than 134 million¹ 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 biodiversity² richness and biomass, threats to their sustainability, and the actions needed to protect them (United Nation Environment Programme [UNEP] 2019).

Scope of the Report

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.

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 (SOME) 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

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,

³ <http://www.lmehub.net/>

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.

TABLE OF CONTENTS

ACRONYMS	9
EXECUTIVE SUMMARY	12
1. INTRODUCTION TO THE WIDER CARIBBEAN AND ITS NEARSHORE HABITATS	15
1.1 Understanding the coral reef-mangrove-seagrass complex	15
1.2 Overview of the wider Caribbean region	16
1.3 Distribution of coral reefs, mangroves and seagrass beds in the wider Caribbean	24
1.3.1 Coral reefs	24
1.3.2 Mangroves	27
1.3.3 Seagrasses	30
2. SOCIAL AND ECONOMIC IMPORTANCE OF NEARSHORE MARINE HABITATS IN THE CARIBBEAN	33
2.1 Economic sectors	33
2.2 Ecosystem services and human well-being	39
3. DRIVERS, PRESSURES AND THREATS	46
3.1 Drivers of change	46
3.2 Pressures and threats	49
4. STATUS AND TRENDS OF THE NEARSHORE MARINE HABITATS	66
4.1 Summary overview	66
4.2 Coral reefs	68
4.2.1 Status and trends	69
4.2.2 Mesophotic Coral Ecosystems	79
4.2.3 Resilient areas	80
4.3 Mangroves	81
4.3.1 Status and trends	81
4.3.2 Status of associated species	83
4.4 Seagrass meadows	83
4.4.1 Status and trends	83
4.4.2 Status of associated species	84
5. KEY RESPONSES AND INITIATIVES	85
5.1 Overview	85
5.2 Governance architecture and processes	86
5.2.1 International and regional mechanisms	86
5.2.2 Civil society engagement	88
5.3 Designation of Ecologically Sensitive or Important Areas	89

5.4	Designation of protected areas and community conserved areas	92
5.5	Improving management capacity.....	94
5.6	Mapping, monitoring and assessment	95
5.7	Habitat restoration.....	98
5.8	Sustainable financing	100
5.9	UNEP-CEP initiatives.....	105
5.10	Blue economy/blue growth initiatives	105
5.11	National Biodiversity Strategies and Plans.....	108
6.	CHALLENGES, OPPORTUNITIES AND RECOMMENDATIONS FOR ACTION	111
6.1	Introduction	111
6.2	Challenges at the national level	111
6.3	Data and knowledge gaps	113
6.4	Conclusions and recommended responses.....	114
	References	117
Appendix 1	Selected regional Strategies and Plans to Protect Coastal Ecosystems in the Caribbean	137
Appendix 2	Country-specific Coral Reef Data.....	140
Appendix 3	147
	SPAW Protocol, Cartagena Convention Annex II: List of endangered or threatened species	147
Appendix 4	Key Programmes and Initiatives	154
Appendix 5	Parties to selected Global Agreements	163
Appendix 6	165
	Sites Listed under the Ramsar Convention.....	165
Appendix 7	Protected Areas Listed under the SPAW Protocol, Cartagena Convention.....	168
Appendix 8	NBSAP Review Summary Table	169

List of tables

Table 1.1	Wider Caribbean States, Territories, Associated States, Departments, Outermost Regions and Islands with a Special Status.....	18
Table 2.1	Snapshot of the marine habitats-related economic sectors/ industries of the Caribbean Sea.....	34
Table 2.2	Economic Contribution of Coastal/Marine-Dependent Sectors in the Wider Caribbean.....	36
Table 2.3	Comparison of the value of fisheries in the three LMEs in the wider Caribbean.....	37
Table 2.4	Summary of Ecosystem Services Provided by Coral Reefs, Mangroves and Seagrass Beds.....	43
Table 3.1	Trend of threats to marine ecosystems.....	49
Table 3.2	Heat Stress Associated with Elevated SSTs and Incidents of Bleaching.....	56
Table 3.3	Predicted Impacts of Climate Change on Mangroves.....	59
Table 4.1	Overview of status and trends for the three habitats.....	66
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.	73
Table 4.3	Country RHI Scores from Reef Report Cards.....	75
Table 4.4	Greater Antilles Reef Report Cards.....	77
Table 4.5	List of coral species with IUCN Red List Status*.....	78
Table 5.1	Members of the Interim Coordination Mechanism of the proposed CLME+ Partnership.....	87
Table 5.2	Coastal/Marine World Heritage Natural Sites in the Wider Caribbean.....	91
Table 5.3	Change in marine and coastal protected areas 1983 – 2014.....	93
Table 5.4	National Funds under the MAR Fund.....	102
Table 5.5	National Conservation Trust Funds under the Caribbean Biodiversity Fund.....	103
Table 5.6	Examples of blue economy initiatives in the wider Caribbean.....	107
Table 6.1	Gaps in knowledge on coral reefs, mangroves and seagrass beds.....	113

List of figures

Figure 1.1	The Cartagena Convention area and the 4 LMEs it largely intersects: The Wider Caribbean.....	18
Figure 1.2	Established and emerging blue economy industries in the Caribbean.....	21
Figure 1.3	The LMEs of the Wider Caribbean.....	22
Figure 1.4	Distribution of Coral Reefs in the Wider Caribbean.....	24
Figure 1.5	Caribbean reefs occur in many forms including linear and fringing reefs found along shorelines and around cays	25
Figure 1.6	Hard, scleractinian, corals such as <i>Acropora palmata</i> , <i>A. cervicornis</i> and <i>Diploria strigosa</i> are responsible for building the structure of the reef, which supports significant biodiversity and provides ecosystem services	26
Figure 1.7	“Corals of the World Ecoregions” in the Wider Caribbean.....	27
Figure 1.8	Distribution of Mangroves in the Wider Caribbean.....	28
Figure 1.9	Mangroves can be found throughout the Caribbean, often found along coastlines and salt ponds.....	29
Figure 1.10	Seagrass areas are often dominated by turtle grass (<i>Thalassia testudinum</i>) and manatee grass (<i>Syringodium filiforme</i>) and provide habitat for numerous species including sea urchins, like these West Indian Sea Eggs (<i>Tripneustes ventricosus</i>) as seen in this picture.....	31
Figure 1.11	Distribution of Seagrass Meadows in the Wider Caribbean.....	32

Figure 2.1	Beautiful sandy beaches and turquoise waters are an integral part of the tourism wider Caribbean’s tourism product.....	35
Figure 2.2	Marina full of sportfishing and sail charter boats in Castries, St. Lucia	38
Figure 2.3	Coral reefs support significant biodiversity, including economically important species such as spiny lobster	40
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	40
Figure 2.5	Coastal Protection Value of Caribbean Coral Reefs.....	41
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	42
Figure 2.7	Mangrove areas also support cultural and recreational uses and are learning laboratories	44
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	45
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	50
Figure 3.2	Dissolved inorganic nitrogen input from watersheds to coastal areas in five sub-regions (in 2000)....	51
Figure 3.3	States which have ratified the Ballast Water Management Convention.....	53
Figure 3.4	The invasive Pacific lionfish has steadily spread throughout the greater Caribbean over the last 10+ years	54
Figure 3.5	Recorded sightings of <i>Halophila stipulacea</i> in the Caribbean	55
Figure 3.6	NOAA Coral Reef Watch daily 5 km bleaching alert area 7 day max (27 May 2020).....	57
Figure 3.7	NOAA Coral Reef Watch 60% probability coral bleaching heat stress for June – September 2020	57
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.....	62
Figure 3.9	Time Series of Stony Coral Tissue Loss (SCTL) Disease Outbreak Progression Along the Florida Reef Tract	63
Figure 3.10	Rapid Tissue Loss and Colony Death as a Result of SCTL disease.....	64
Figure 4.1	Large-scale shifts from coral to macroalgal community dominance since the early 1970s	69
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	70
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		72
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	72
Figure 4.5	2020 Mesoamerican Reef Health Report Card	76
Figure 4.6	Moray eel hiding among <i>Orbicella</i> coral colonies.....	80
Figure 5.1	Structure of the proposed CLME+ Partnership.....	88
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).....	90
Figure 5.3 KBAs in the Caribbean Islands Biodiversity Hotspot.....	92
Figure 5.4 Recreation and tourism value of Grenada’s coral reefs displayed using the Mapping Ocean Wealth Tool	97
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	100
Figure 5.6 NBSAP Targets for marine biodiversity.....	109
Figure 5.7 Common data challenges highlighted in NBSAPs	110

List of boxes

Box 3.1 Peyssonnelid algal crusts – an emerging threat to regional reefs.....	55
Box 3.2 Changes in Mangrove Forests at Five Wetlands in Puerto Rico Following Hurricanes Irma and Maria in September 2017	60
Box 3.3 Stony Coral Tissue Loss (SCTL) Disease	64
Box 5.1: Recent Marine Protected Areas Declarations in the Wider Caribbean	94
Box 5.2: Selected mangrove replanting initiatives	98
Box 5.3: Examples of countries and territories that are implementing coral restoration projects.....	99
Box 5.4 Inclusive local blue economy in action.....	106

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
SOME	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
WIDECAS	Wider Caribbean Sea Turtle Conservation Network
WWF	World Wildlife Fund

EXECUTIVE SUMMARY

This State of Nearshore Marine Habitats Report is prepared as an output of the Specially Protected Areas and Wildlife (SPA) 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.”

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 has 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 develop the CLME+ Partnership to enhance collaborative governance arrangements that link various efforts and stakeholders from regional agencies, governments, academia, 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 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.

1. INTRODUCTION TO THE WIDER CARIBBEAN AND ITS NEARSHORE HABITATS

Key messages

- More than 134 million⁴ 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.

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

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/>).

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.

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 km² and 8.5 million km² 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 km². 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).

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/>

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



Source: Cartagena Convention area (UNEP-CEP - 2017), LMEs (NOAA - 2009), land (GADM - 2018).

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 status⁷
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)

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



Independent continental states	Independent island states	Overseas dependent territories, associated states, outermost regions, departments and island with a special status ⁷
Guatemala Guyana Honduras Panamá México Nicaragua Suriname Bolivarian Republic of Venezuela United States of America	Dominica Dominican Republic Grenada Haiti Jamaica St. Kitts & Nevis Saint Lucia St. Vincent & the Grenadines Trinidad & Tobago	French Guiana (<i>France</i>) Guadeloupe (<i>France</i>) Montserrat (<i>United Kingdom</i>) Martinique (<i>France</i>) Puerto Rico (United States of America) Bonaire, St. Eustatius, Saba ¹⁰ St. Barthélemy (<i>France</i>) St. Martin (<i>France</i>) Turks and Caicos Islands (<i>United Kingdom</i>) United States Virgin Islands (USVI) (<i>United States of America</i>)

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.



¹⁰ Special Municipalities of Holland

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



Source: Caribbean Development Bank 2018

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.

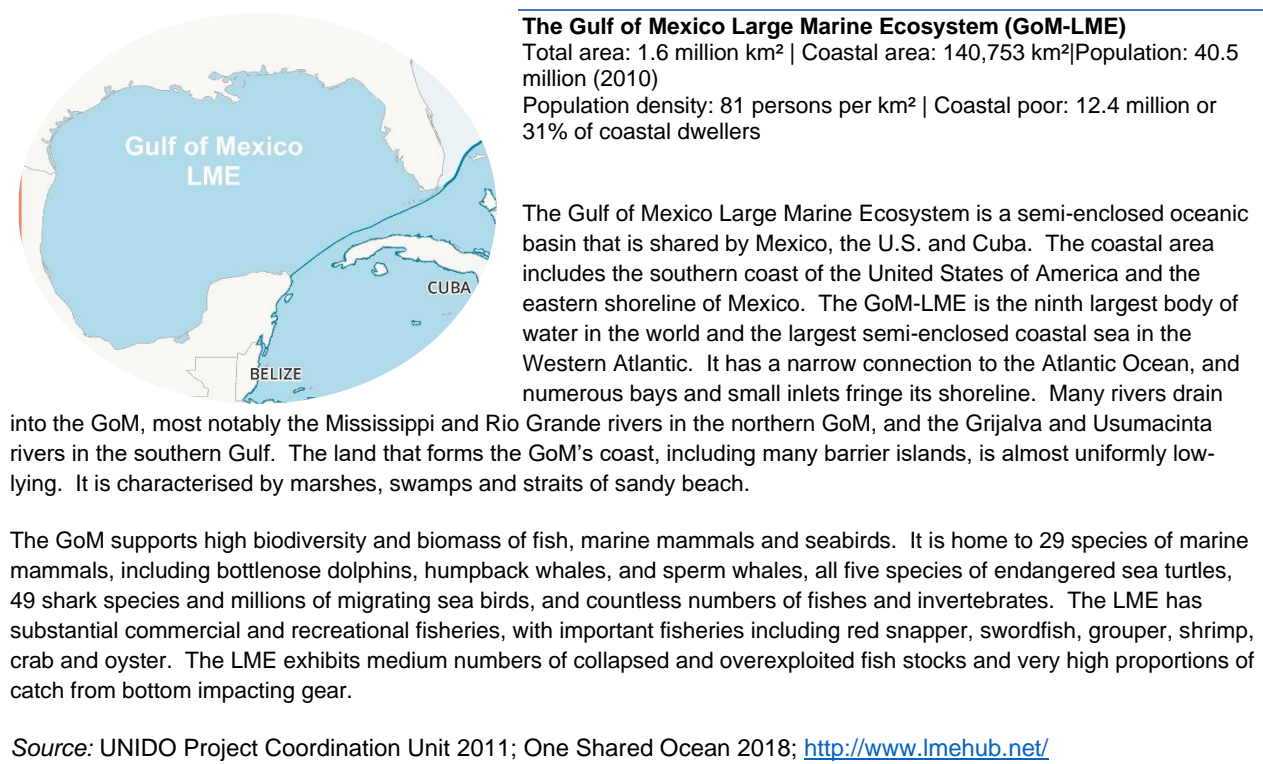
Non-use intrinsic values and intangible benefits of this biodiversity are also significant for the wider Caribbean’s socio-cultural heritage, including for indigenous peoples.

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).

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 Parnaíba 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.

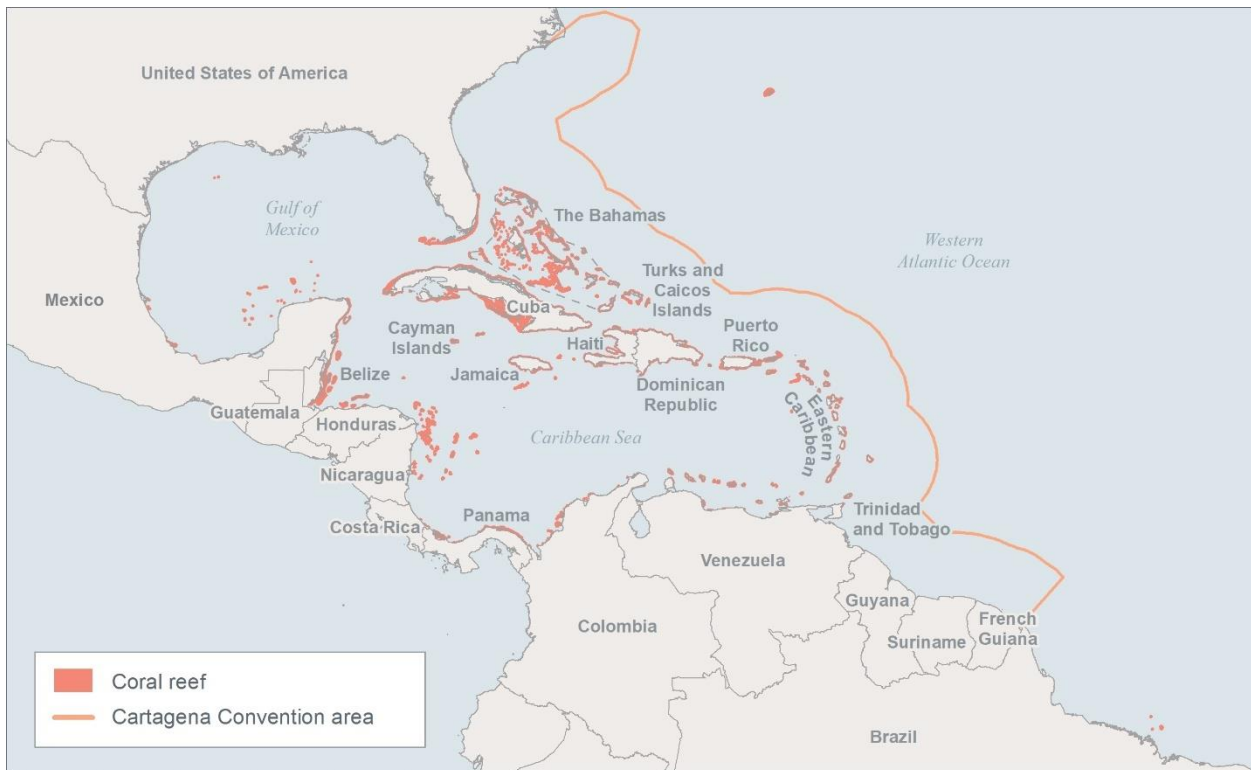
Source: Phillips et al. 2011; Isaac and Ferrari 2016; UNDP/GEF CLME+ Project 2013; One Shared Ocean 2018; <http://www.lmehub.net/>

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.

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).

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 1.5 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*, *Colpophyllia*, *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)

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



Photo by Paige Rothenberger, 2008

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).

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>.

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 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

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).

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)

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 Sea¹²

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 from 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.

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

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).

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 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).

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



Photo by Paige Rothenberger

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 transshipment activities in the CLME has increased, the CLME is yet to capitalise on the full economic potential of the New Panamax Era. Transshipment 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).

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

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).

Figure 2.5 Coastal Protection Value of Caribbean Coral Reefs

Coastal Protection Value of Caribbean Coral Reefs in Numbers[^]	
168 km² Annual expected area protected from flooding	
33,991 Annual expected number of people protected from flooding	
\$1,487,371,257 Annual expected built capital protected from flooding	
\$1,107,894,701 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	
Source: Mapping Ocean Wealth/ www.oceanwealth.org	

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.

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

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 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 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).

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 value	✓	✓	✓
• Spiritual and inspirational value	✓	✓	
• Aesthetic	✓	✓	
• Sense of place	✓	✓	
• Heritage/Bequest value	✓	✓	✓
SUPPORTING			
• Habitat for fish and shellfish and other aquatic species	✓	✓	✓
• Nursery grounds, feeding areas	✓	✓	✓
• Material for the formation and maintenance 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

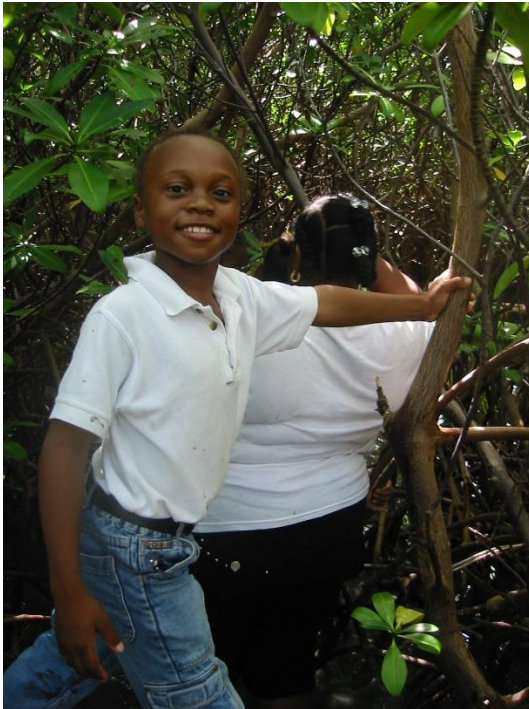


Photo by Paige Rothenberger

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).

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

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).

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 million¹³ 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, 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).

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/>).

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	Trend	Major findings or other comments
Pollution	● High	↗ Increasing	Pollution is from multiple sources. The combined impacts of multiple stressors from these pollutants on marine ecosystems is still largely unknown and requires 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 populations are stabilising or even decreasing at shallower depths due to local harvesting, grouper predation on juvenile lionfish and an ulcerative skin disease.
Invasive species - <i>Halophila stipulacea</i>	? Unknown	? Unknown	Found in Mexico in 2013 and Trinidad in 2018. Research is underway. Its impact is thought to be mixed. It grows and invades fast, it competes for space with Caribbean seagrass species, it is less nutritive (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 colonises 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 ecosystems (e.g. causing 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 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. Comprehensive information on the incidence and distribution of diseases affecting coral reef ecosystems 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 significantly affecting many coral reef areas throughout the region (see Box 3.3).
<i>Sargassum</i>	● 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

Coastal 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).

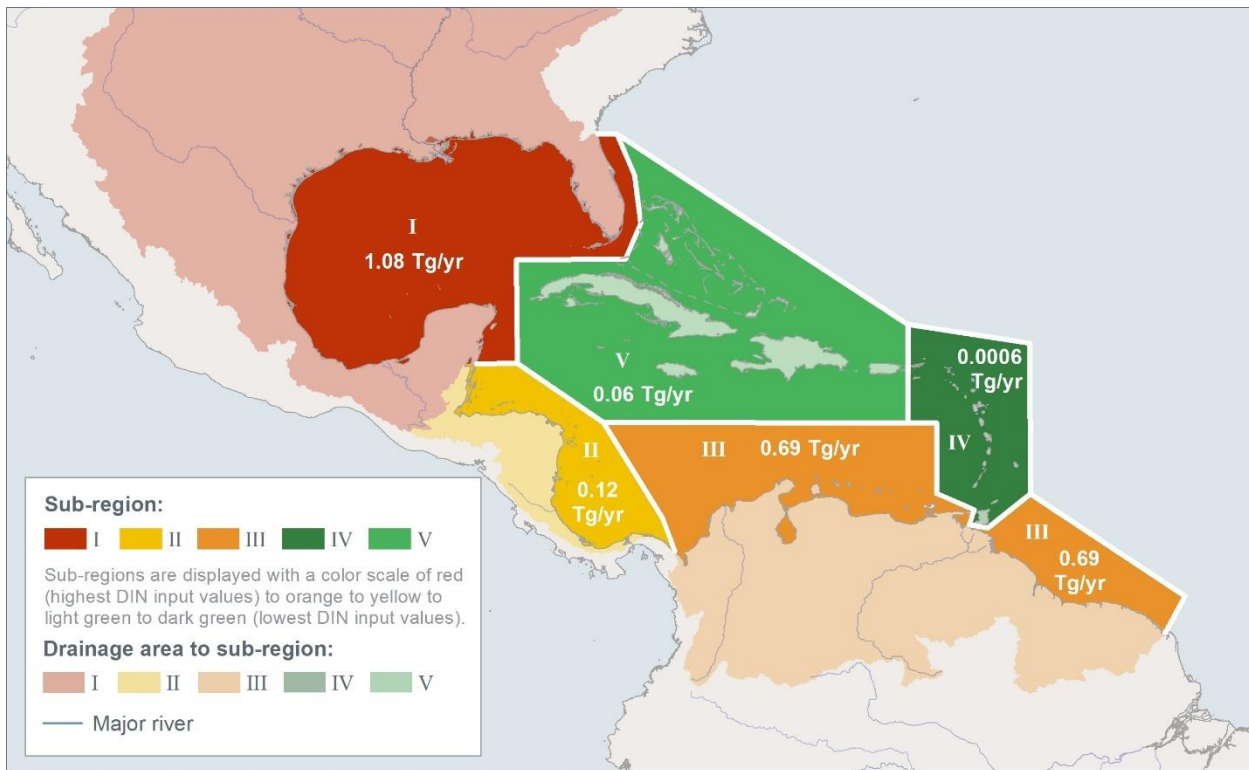
Assessments of the levels of dissolved inorganic nitrogen in five sub-regions in the area covered by the Cartagena Convention (United Nations Environment Programme 2019) identified areas that are nutrient hotspots (see Figure 3.2).

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)

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 serious 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 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/cm²/day of silt-clay sized fraction and six mg/cm²/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).

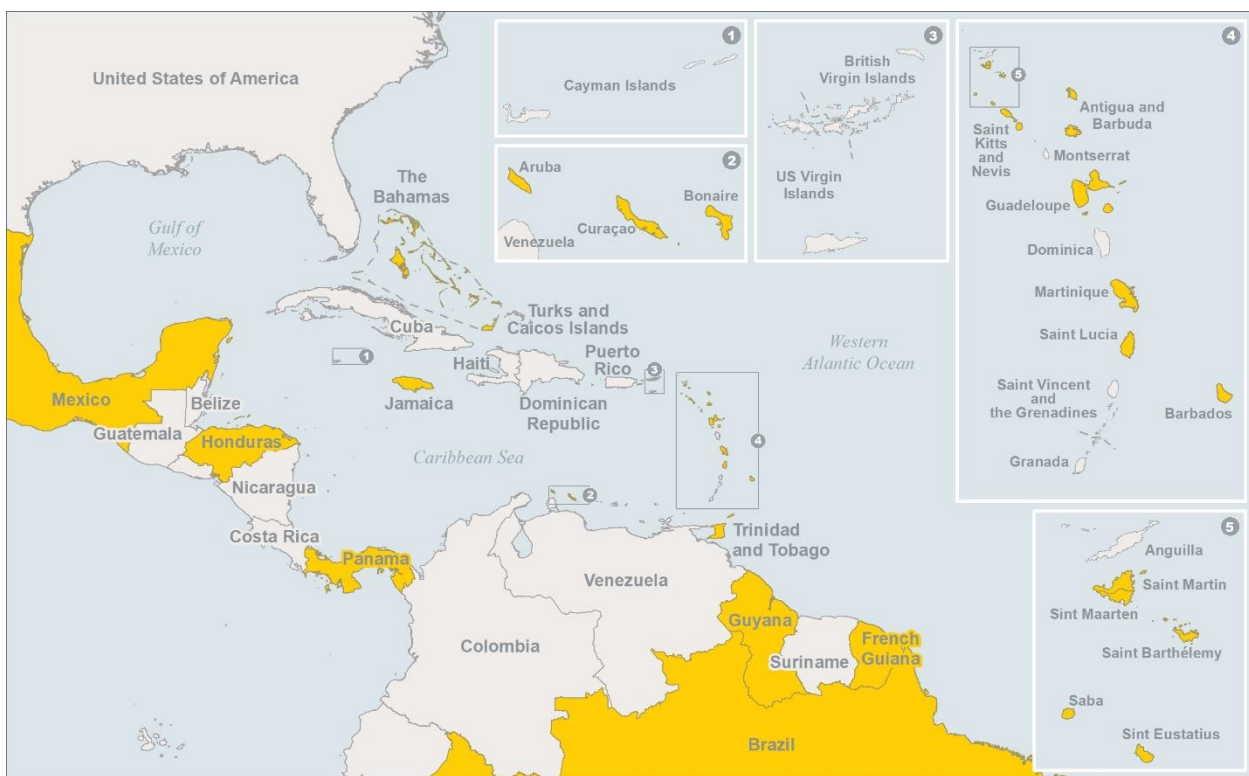
Mercury is considered by the World Health Organization (WHO) as one of the top 10 chemicals or groups of chemicals of major public health concern owing to its high toxicity. Sources affecting the region may be from air emissions from industries (e.g. coal power plants) and small-scale gold mining. A 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 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 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.

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

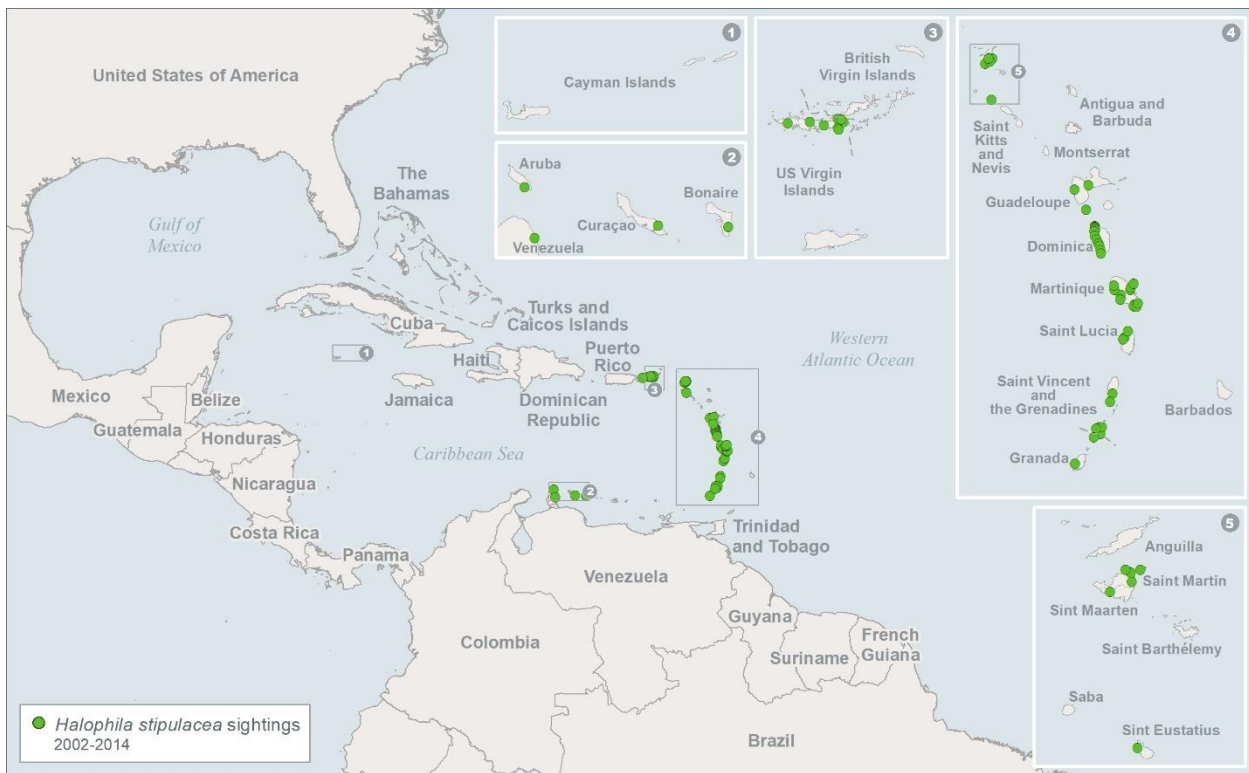


Photo by Leslie Henderson

- **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 (Kington 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 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).

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



Source: Sightings (invasiveseagrass.org - 2002-2014), land (GADM - 2018)

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.

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 Bahamas, 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).

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

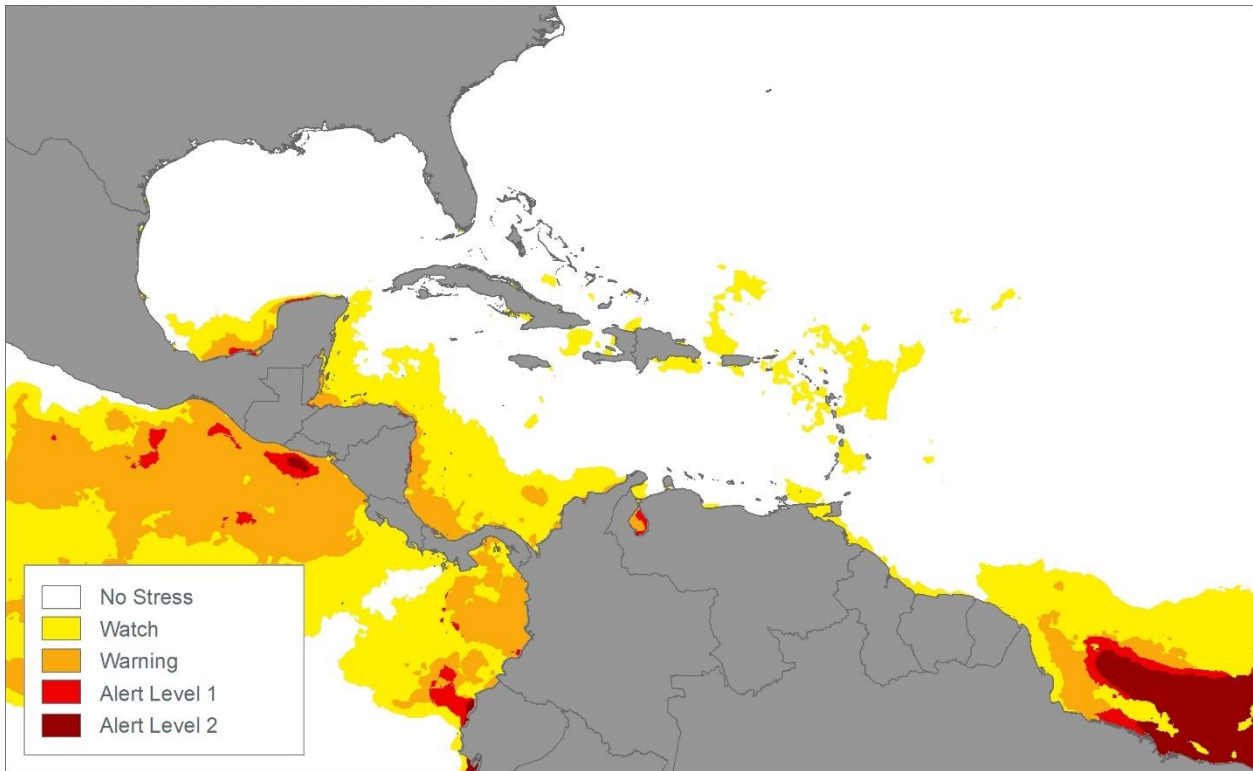
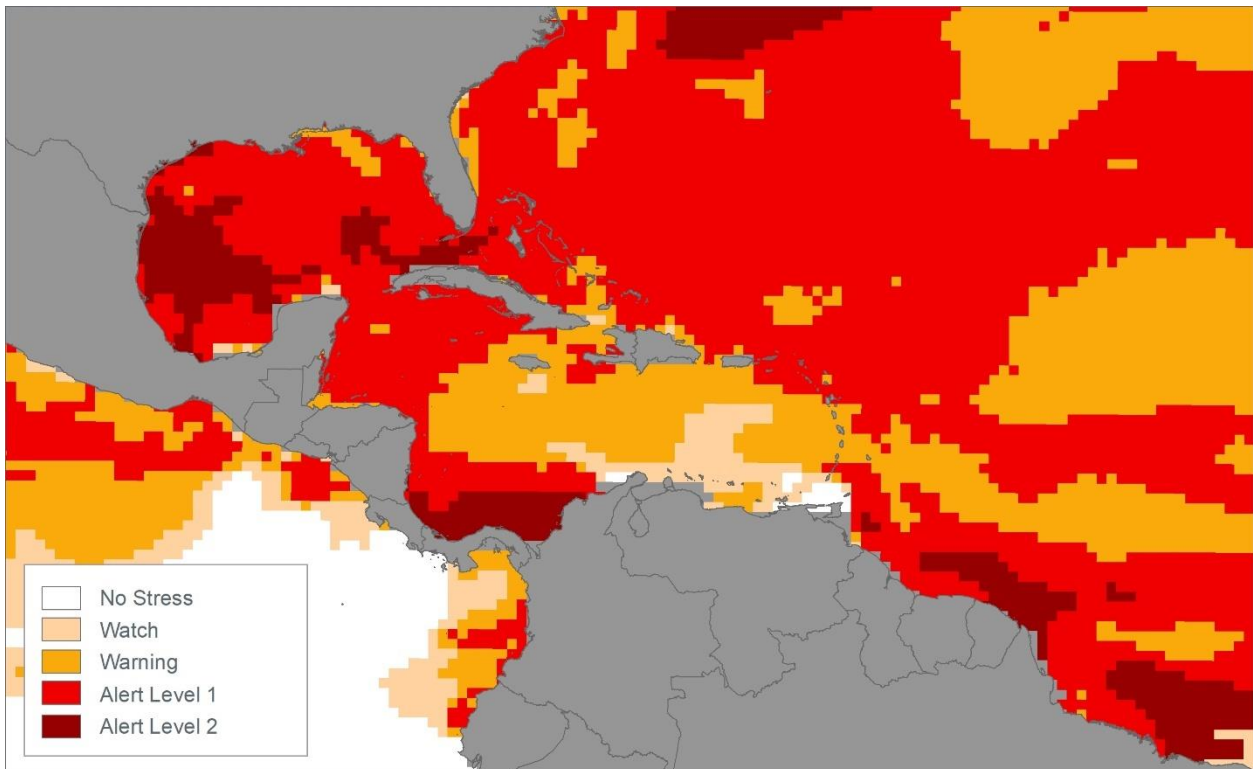


Figure 3.7 NOAA Coral Reef Watch 60% probability coral bleaching heat stress for June – September 2020



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 ($> 10^{\circ}\text{C}$ -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 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 CO_2 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).

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).

Table 3.3 Predicted Impacts of Climate Change on Mangroves

Changes	Impacts
<i>Temperature:</i> 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).
<i>Atmospheric carbon dioxide (CO₂):</i> 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.
<i>Sea-level rise:</i> Mean global sea-level rose 17 centimetres in the 20th century (IPCC 2007). 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). 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

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



Changes	Impacts
	<p>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).</p> <p>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.</p>
<p><i>Intensity and frequency of storms:</i> Both the number and intensity of very strong cyclones (typhoons and hurricanes) will increase (IPCC 2007; Bender et al. 2010)</p>	<p>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 (<i>Rhizophora</i>) plantations at 2.5 months and 4.5 months post-Typhoon Haiyan (Primavera et al. 2016).</p>
<p><i>Precipitation patterns:</i> 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).</p>	<p>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).</p>

Source: Primavera 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 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.

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

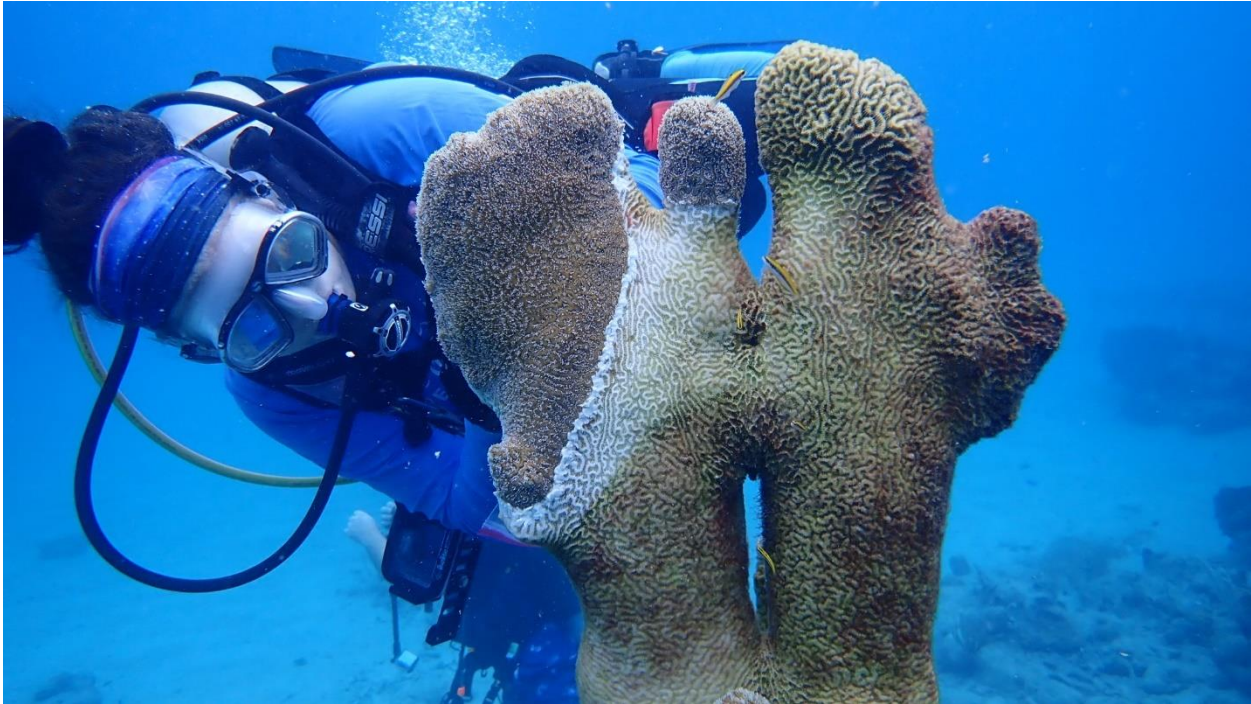
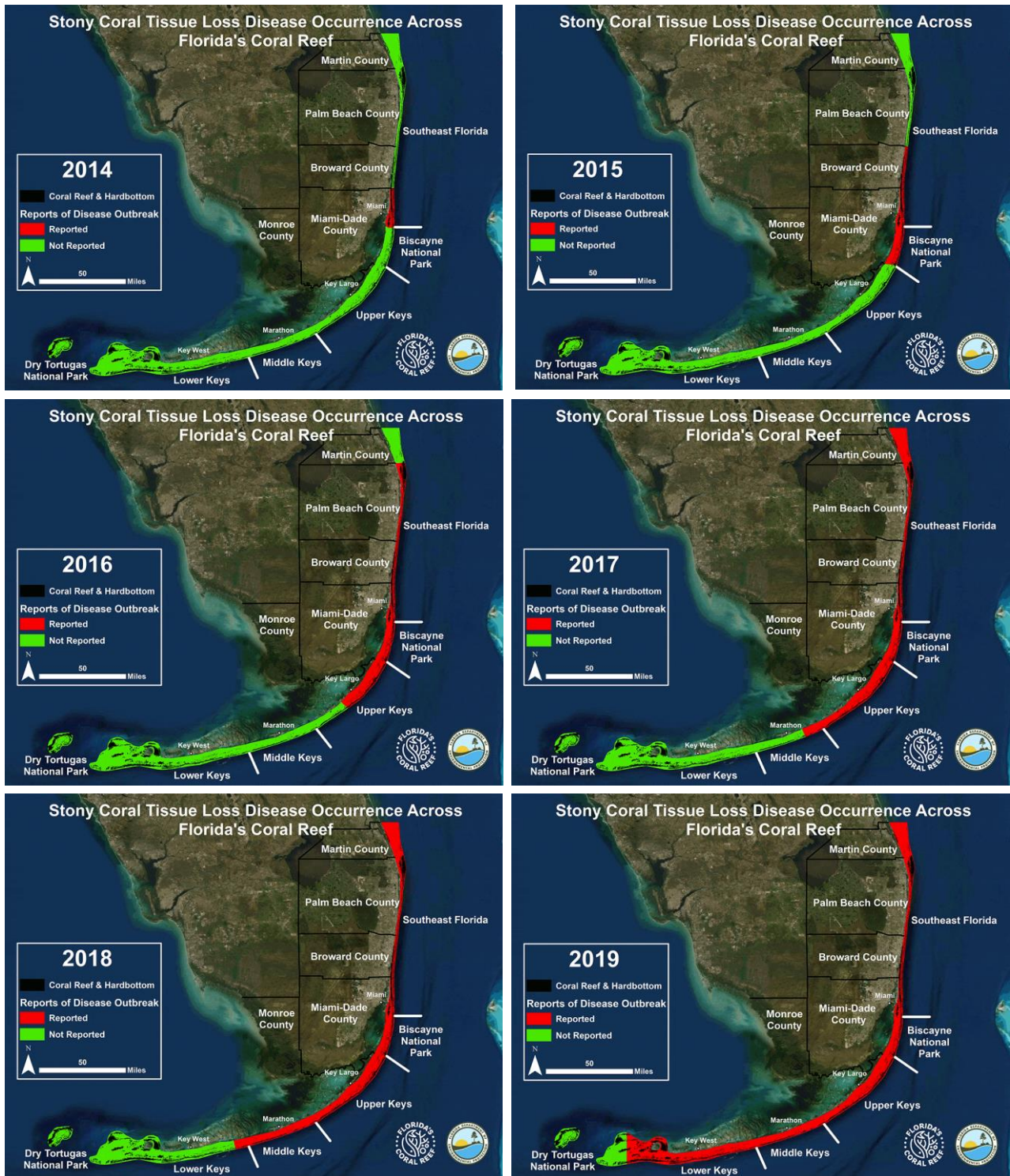


Photo by Leslie Henderson

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

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



***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.

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.

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 Development of guidelines for the management of protected areas and species	Convention on Biological Diversity (CBD) Aichi Target 10 CDB Aichi Target 11 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 Development of guidelines for the management of	CBD Aichi Target 10 CDB Aichi Target 11 SDG 14.2

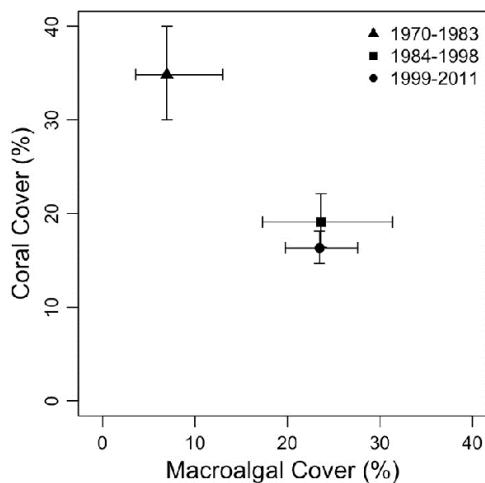
Indicator	Status	Trend	Data Quality	Major findings or other comments	Related SPAW Protocol Focus	Related Multi-Lateral Environmental Agreement (MEA) Target/Reporting Area
					protected areas and species	
Macroalgal cover	● Poor	↗ Increasing	■ ■ ■ Mixed	In general, across the wider Caribbean macroalgal cover is increasing, resulting in a net negative shift in community composition on reefs.	Conservation and sustainable use of marine and coastal ecosystems Development of guidelines for the management of protected areas and species	CBD Aichi Target 10 CDB Aichi Target 11 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 CDB Aichi Target 11 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 CDB Aichi Target 11 SDG 14.2
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 CDB Aichi Target 11 SDG 14.2
Abundance of key macro-invertebrate species	● Mixed/Fair?	↘ ↗ Mixed	■ ■ ■ Mixed	<i>Diadema</i> 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 CDB Aichi Target 11 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 CDB Aichi Target 11 SDG 14.2

Indicator	Status	Trend	Data Quality	Major findings or other comments	Related SPAW Protocol Focus	Related Multi-Lateral Environmental Agreement (MEA) Target/Reporting Area
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.)	CDB 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	CDB Aichi Target 5
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 CDB 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 CDB 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 CDB 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 Ecosystems¹⁶. 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 fish¹⁷ (ICRI 2019))
- Direct physical impacts (e.g. vessel groundings)

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

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.

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).

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

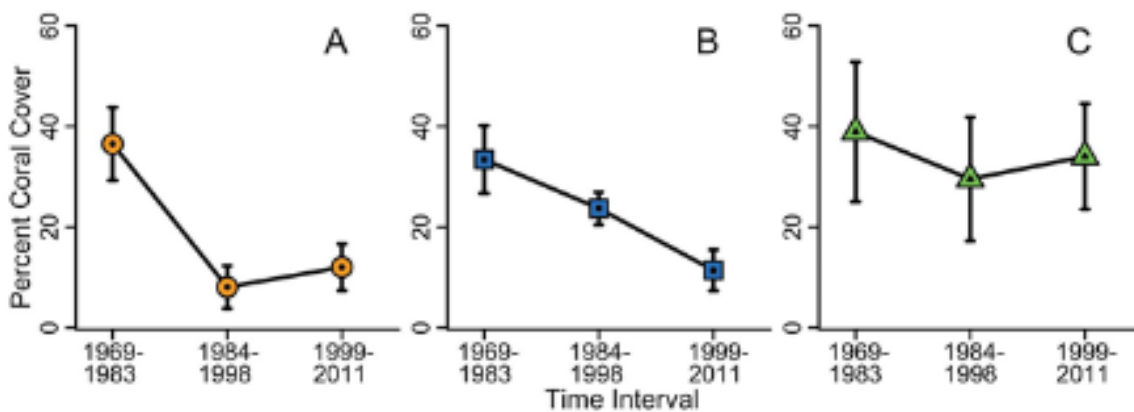
From this data, Jackson et al. (2014) have determined that reefs within the wider Caribbean with the highest levels of coral cover share certain similarities, namely: lesser impacts from land-based sources of pollution; existence of fisheries regulations and effective enforcement; lower frequency of 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. 2024

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. 2034

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)
Macroalgal 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 countries¹⁸ 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, 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 Antilles¹⁹ scored the sub-region 2.5 on the RHI (see Table 4.3).

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/>

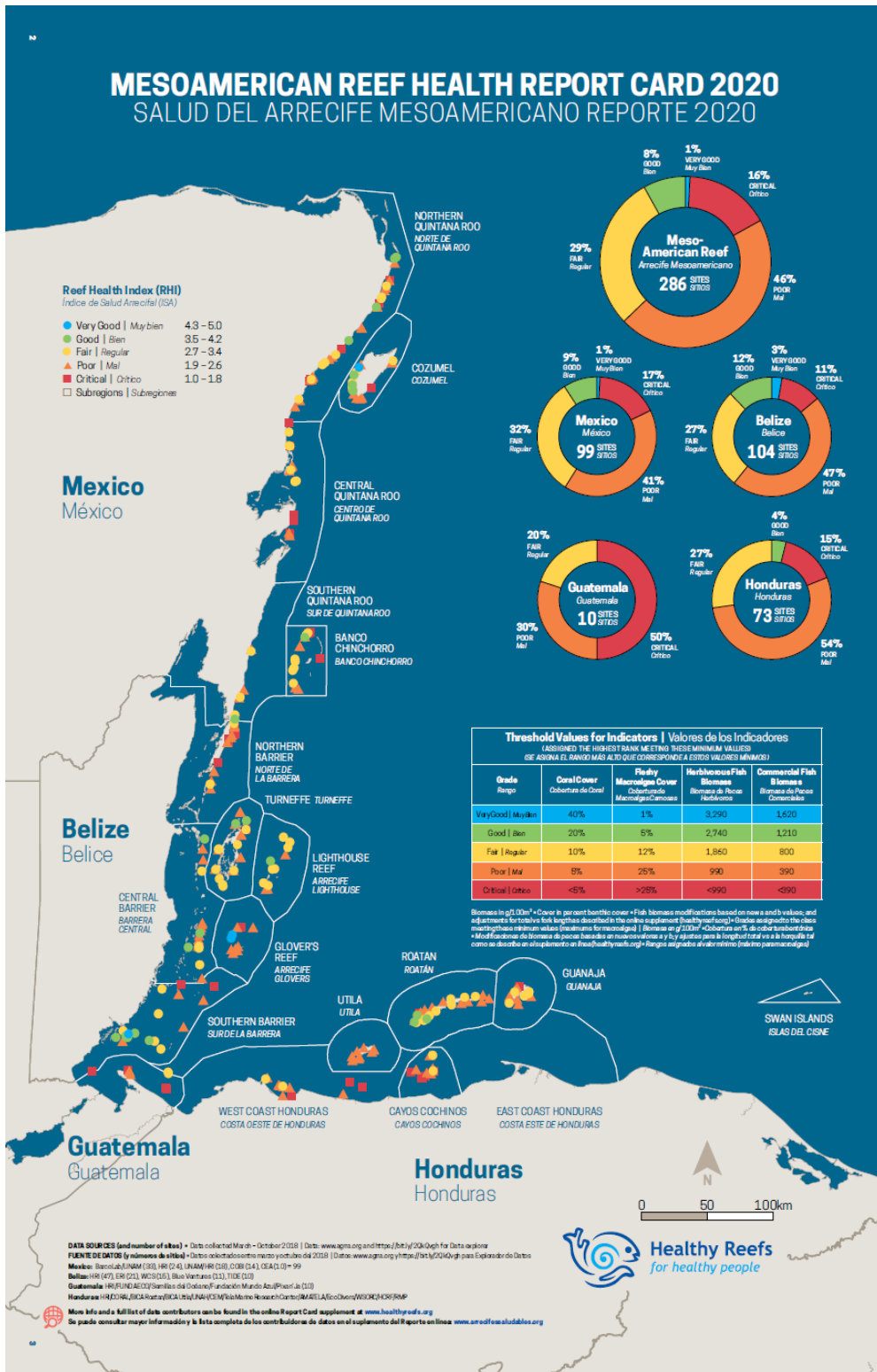
¹⁹ Assessments were conducted for Dominican Republic, Haiti and Jamaica <http://www.caribnode.org/tools/reef-assess/region/1283/>

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

Figure 4.5 2020 Mesoamerican Reef Health Report Card



Source: Excerpted from www.healthyreefs.org

The Nature Conservancy (TNC) prepared report cards²⁰ 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, Dominican 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.

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 Species²¹ 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*

Coral Species	IUCN Red List Status
<i>Acropora cervicornis</i>	Critically Endangered
<i>Acropora palmata</i>	Critically Endangered
<i>Orbicella annularis</i>	Endangered
<i>Orbicella faveolata</i>	Endangered
<i>Millepora striata</i>	Endangered
<i>Agaricia lamarcki</i>	Vulnerable
<i>Dendrogyra cylindrus</i>	Vulnerable
<i>Dichocoenia stokesii</i>	Vulnerable
<i>Mycetophyllia ferox</i>	Vulnerable
<i>Oculina varicosa</i>	Vulnerable
<i>Orbicella franksi</i>	Vulnerable
<i>Agaricia tenuifolia</i>	Near Threatened
<i>Porites branneri</i>	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. cervicornis*). 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.

²¹ <http://www.iucnredlist.org>

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 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.

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.

4.2.3 Resilient 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).

Figure 4.6 Moray eel hiding among *Orbicella* coral colonies



Photo by Leslie Henderson

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).

4.3 Mangroves

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 km², 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 km²), 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 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 km² (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 km² in Anguilla and 40 km² 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).

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.

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 habitats²², 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+

²² Governance was identified as a root cause of issues in the Transboundary Diagnostic Analyses conducted by the CLME Project (2009-2014) which developed the CLME+ SAP.

Project in implementation of the CLME+ SAP. This includes development of a voluntary partnership consisting of community and statutory agencies, public and private institutions, entities and/or influential individuals, co-operating together as the Global Partnership for the Sustainable Management, Use and Protection of the Caribbean and North Brazil Shelf Large Marine Ecosystems (CLME+ region)²³.

It is envisaged that this CLME+ Partnership 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 governance. The proposed thematic scope for the activities of the CLME+ Partnership is governance and 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. It is proposed that the CLME+ Partnership will be a wider alliance that is centred around a core membership, comprised of the countries that have formally endorsed the CLME+ SAP and key organisations with a formal mandate on the marine environment of the CLME+ region. A CLME+ SAP Interim Coordination Mechanism²⁴ has already been established as a limited grouping of key inter-governmental organisations with a formal mandate on the marine environment of the CLME+ region (see Table 5.1). Proposals for establishment of the Permanent Coordination Mechanism for the CLME+ SAP and the CLME+ Partnership and wider CLME+ Alliance linked to this (see Figure 5.1) have been developed (Fanning et al. 2019).

Table 5.1 Members of the Interim Coordination Mechanism of the proposed CLME+ Partnership

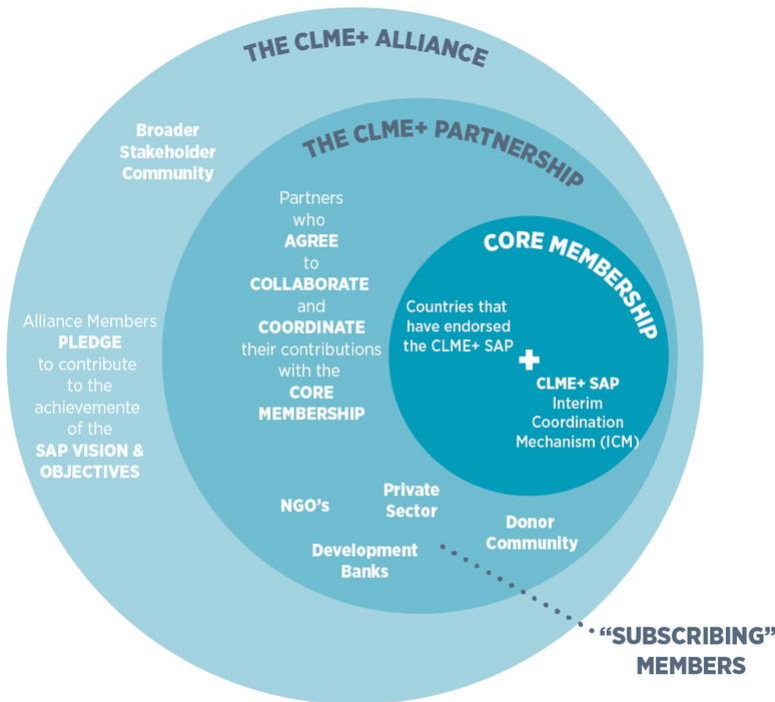
CLME+ Interim Coordination Mechanism members
The United Nations Environment Programme (UNEP) represented by its Caribbean Regional Coordinating Unit (UNEP CAR/RCU)
The Food and Agriculture Organization of the United Nations (FAO) on behalf of the Western Central Atlantic Fishery Commission (WECAFC)
The 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

²³ <https://clmeplus.org/partnership-alliance/>

²⁴ <https://clmeplus.org/interim-coordination-mechanism-icm/>

Figure 5.1 Structure of the proposed CLME+ Partnership



Source: <https://clmeplus.org/partnership-alliance/>

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.

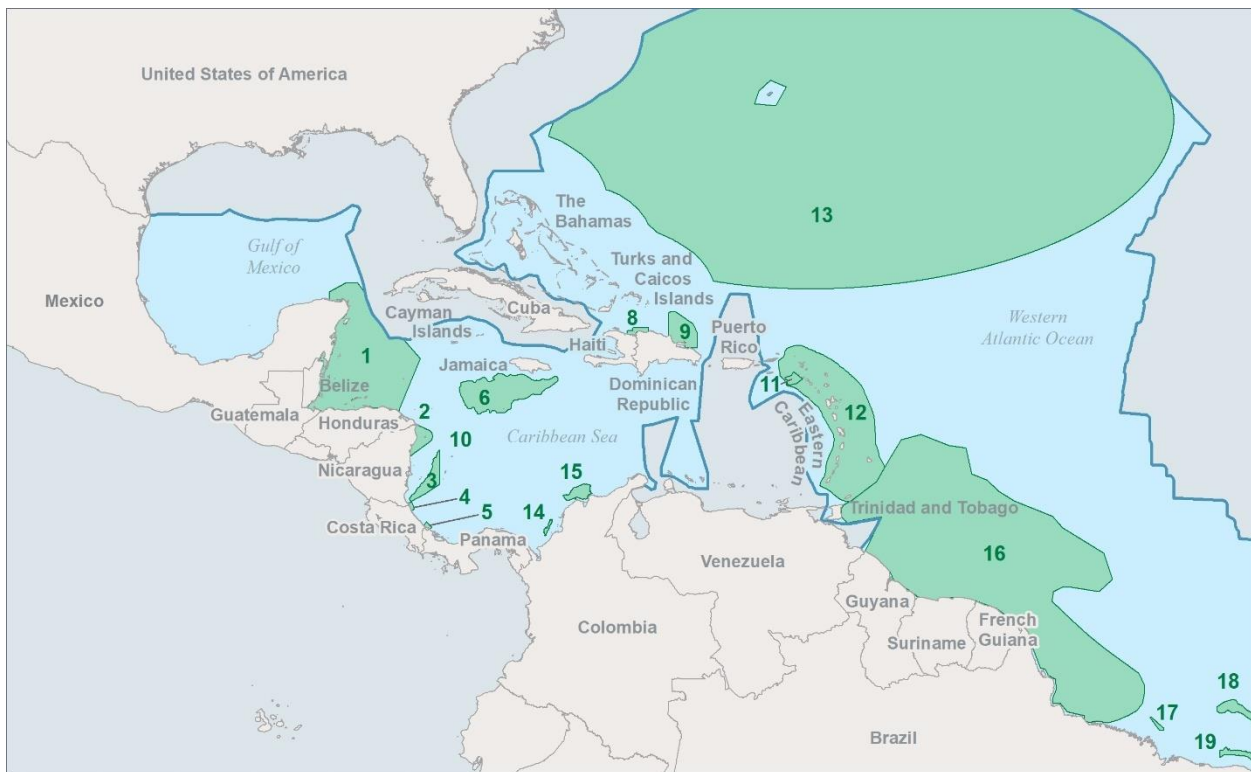
A key framework that has been developed is the CLME+ People Managing Oceans: Civil Society Action Programme for Sustainable Management of the Shared Living Marine Resources of the Caribbean and North Brazil Shelf Large Marine Ecosystem (CLME+ CSAP), which is aligned with the CLME+ SAP (CANARI 2018). 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).

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.

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.

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 Lucia	Pitons Management Area
USA	Everglades National Park

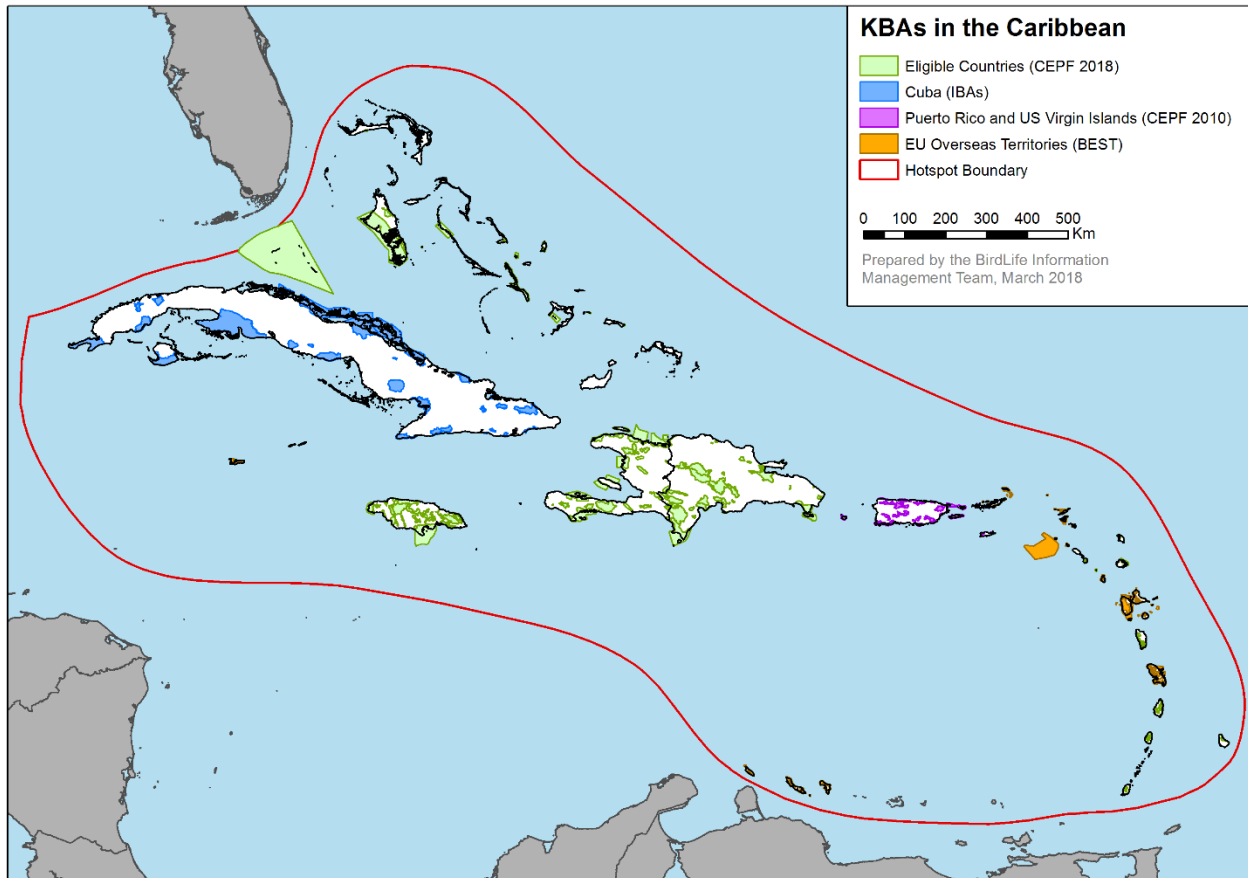
Source: <https://whc.unesco.org/en/list/?type=natural>

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 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 Areas²⁵, 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

²⁵ <http://www.keybiodiversityareas.org/>

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.

Figure 5.3 KBAs in the Caribbean Islands Biodiversity Hotspot



Source: Critical Ecosystem Partnership Fund 2019

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 km ²	143,096 km ²	2,114%
Gulf of Mexico	6,671 km ²	290,795 km ²	4,259%
North Brazil Shelf	3,312 km ²	40,957 km ²	1,137%
Total	16,446 km ²	474,848 km ²	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)²⁶, 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%.

²⁶ www.caribbeanchallengeinitiative.org

Box 5.1 Recent Marine Protected Area Declarations in the Wider Caribbean

<p>2015</p> <ul style="list-style-type: none">• 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.
<p>2016</p> <ul style="list-style-type: none">• 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.
<p>2017</p> <ul style="list-style-type: none">• 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.
<p>2018</p> <ul style="list-style-type: none">• 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 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)²⁷. 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 Institution 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

²⁷ <https://www.gcfi.org/initiatives/mpa-capacity-program/>

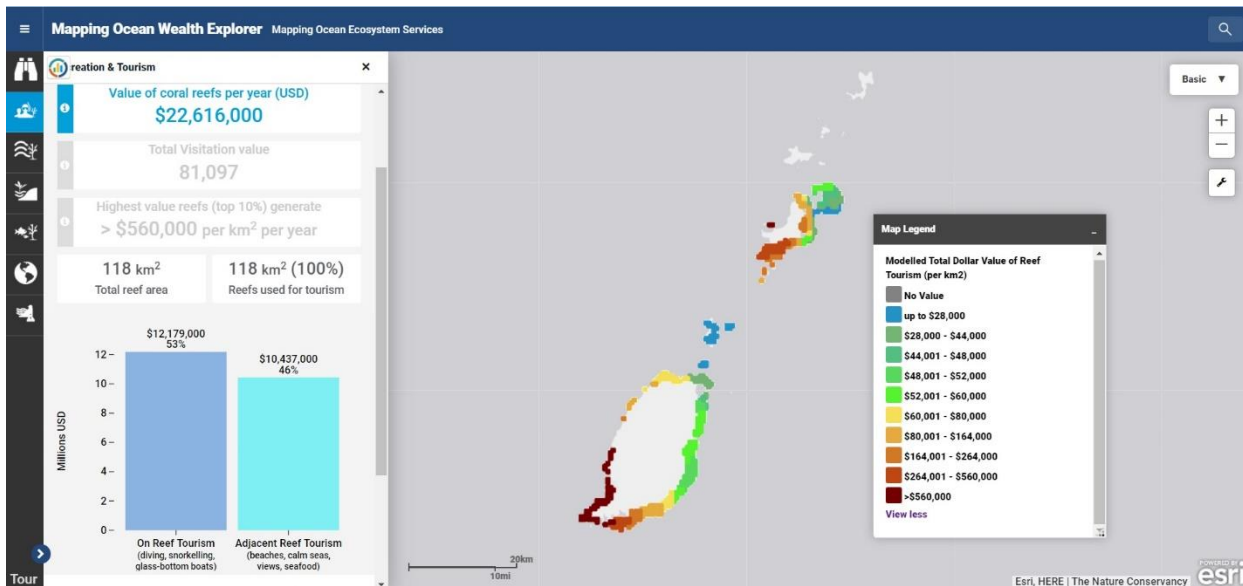
coral reef resource management and the establishment and improved management of MPAs, to better understand the economic value of these systems and inform post-hurricane restoration efforts including supporting coral nursery work. The mapping effort in the Caribbean is serving as a pilot project for the technology, which would then be rolled out to support coral reef management institutions worldwide. 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 Atlas²⁸ 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.

²⁸ <https://caribbeanscienceatlas.tnc.org>

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 Allen Philanthropies, Planet, Carnegie Science, Hawai'i Institute of Marine Biology) intend to map the world's reefs by 2020.²⁹

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

²⁹ <http://allencoralatlas.org/>

ecosystems. This included assessing blue carbon potential, local community benefits, ecosystem-based solutions, and policy, regulations and financing for conservation.³⁰ 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.

³⁰ <https://nbslmegef.wordpress.com/>

Box 5.3: Countries and territories that are implementing coral restoration projects

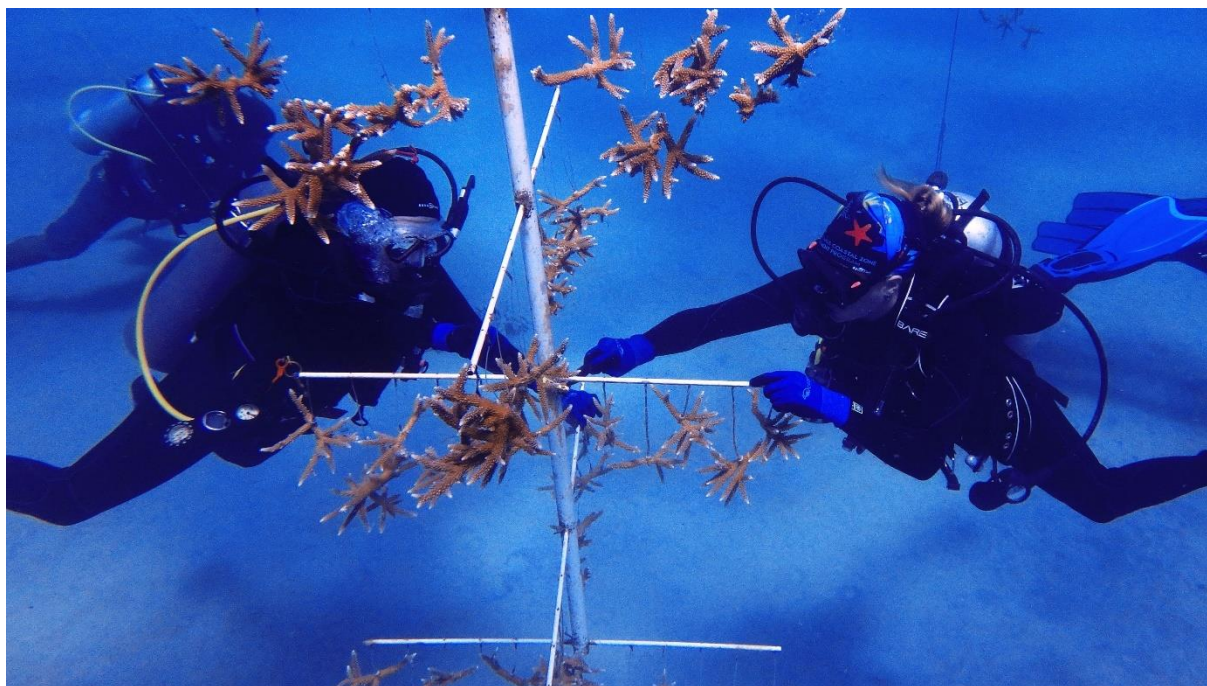
Barbados	Dominican Republic	Netherlands Antilles
Belize	Florida	Saint Lucia
Bonaire	Grenada	Trinidad and Tobago
Colombia	Honduras	Turks and Caicos
Cuba	Jamaica	USVI
Curacao	Mexico	

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, 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 Foundation³¹, the Guy Harvey Ocean Foundation³² and Virgin Unite³³.

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

³¹ <https://sandalsfoundation.org/>

³² <https://guyharvey.com/pages/ocean-foundation>

³³ <https://www.virgin.com/unite/>

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.³⁴

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.³⁵ 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.³⁶

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,

³⁴ [https://www.nature.org/content/dam/tnc/nature/en/documents/The Nature Conservancy Mexico CoastalManagementTrust Factsheet.pdf](https://www.nature.org/content/dam/tnc/nature/en/documents/The%20Nature%20Conservancy%20Mexico%20CoastalManagementTrust%20Factsheet.pdf)

³⁵ 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.

³⁶ <http://www.efj.org.jm/>

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. Additional 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. ³⁷
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. ³⁸
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. ³⁹

³⁷ <https://www.pactbelize.org/>

³⁸ <http://fcg.org.gt/>

³⁹ <https://marfund.org/en/founding-members/>

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)⁴⁰. 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 Barbuda	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/>

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.⁴¹ 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.⁴²

⁴⁰ Accessed on April 13, 2020 at <https://www.caribbeanbiodiversityfund.org/>

⁴¹ <https://www.cepf.net/our-work/biodiversity-hotspots/caribbean-islands>

⁴² <https://www.cepf.net/our-work/biodiversity-hotspots/mesoamerica>

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)⁴³. Current funding windows are under the EU-funded Powering Innovations in Civil Society and Enterprises for Sustainability in the Caribbean (PISCES⁴⁴) project being implemented by CANARI and the GEF-funded StewardFish⁴⁵ 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.⁴⁶

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.⁴⁷

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,

⁴³ 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).

⁴⁴ <https://canari.org/pisces/>

⁴⁵ <https://www.thegef.org/project/developing-organizational-capacity-ecosystem-stewardship-and-livelihoods-caribbean-small>

⁴⁶ <https://action.biopama.org/>

⁴⁷ <https://undpbb.exposure.co/the-blue-lab>

contingently recoverable grant resources, blue levies and insurance investments (Caribbean Development Bank 2018).

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 approaches⁴⁸.

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).

⁴⁸ Taking place under the Caribbean Region Oceanscape Project (CROP) in the OECS <https://oecs.org/en/crop>

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.
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 compliance 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 approach for development to improve sustainable 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 projects 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 sustainable public and private investment in the waters of OECS members. Activities include development of coastal and marine spatial plans and national coastal blue growth master plans.

Project/Initiative (Timeline)	Implementing Agencies	Target Countries	Description
OECS Green-Blue Economy Strategy and Action Plan (2019-2020)	OECS Commission 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 mangrove 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.
International Blue Carbon Initiative	IUCN, UNESCO IOC, Conservation International	Throughout Central and South America	Blue Carbon A-Z: From Small Projects to Policy Implementation ⁴⁹ initiative implemented by the <i>Centro Agronómico Tropical de Investigación y Enseñanza</i> (CATIE) provides blue carbon scientific and political advising services on carbon stock inventories, livelihoods and vulnerability, assessment of land-use dynamics and associated 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).

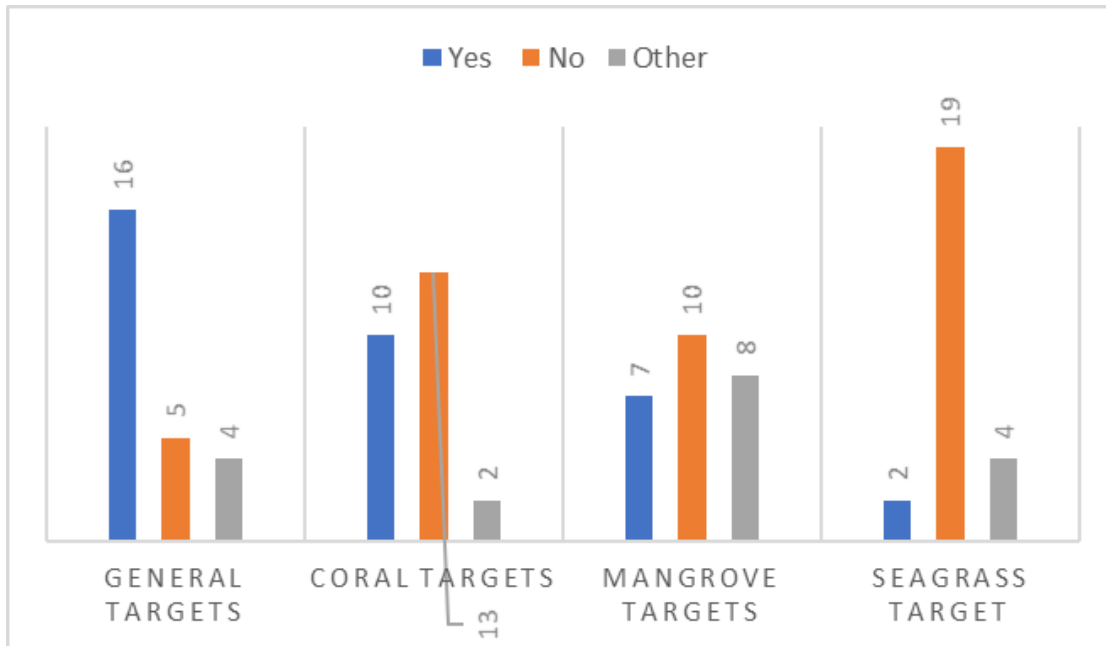
Nevertheless, National Biodiversity Strategies and Action Plans (NBSAPs), are the main vehicles for national implementation of the Convention on Biological Diversity. A review of the NBSAP targets for 25 wider Caribbean countries (see Appendix 8) to ascertain how marine conservation, and specifically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

- Targets are most frequently articulated for marine ecosystems/habitats in general.

⁴⁹ <https://www.thebluecarboninitiative.org/blue-carbon-activities/2019/2/1/blue-carbon-a-z-from-small-projects-to-policy-development-latin-america>

- 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).

Figure 5.6 NBSAP Targets for marine biodiversity



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

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



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 plan⁵⁰ 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.
- (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.

⁵⁰ 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

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.

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
<ul style="list-style-type: none"> • Current and accurate GIS mapping of benthic habitats is lacking. • Local and traditional knowledge on biodiversity is not being collected and there is no repository for this. • Knowledge about the status of key species, for example, bony fishes and key macro-invertebrate species (e.g. lobster and conch) is inadequate. • Data is lacking to properly characterise and assess the condition/health of the three ecosystems across the region. 	<ul style="list-style-type: none"> • The lack of basic, comparable data on coral reef habitat extent, 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). • More research is needed to determine the nature and scope of the ecological changes across the different coastal and marine ecosystems due to Sargassum blooms. • More research is needed to correlate potential mercury sources with fish contamination levels, and mercury body burden with dietary habits in the region. • The immunotoxicology and long-term impacts on ecosystems due to oil spills is not yet fully understood. • Comprehensive information on the incidence, distribution, trends, causative agents, and mechanisms of transmission of diseases affecting coral reef ecosystems is lacking. 	<ul style="list-style-type: none"> • The lack of adequate coral data hinders definition of KBAs triggered by corals, despite there being threatened species in areas at high risk. • There is a significant gap in the information available to determine the variability and value of services provided by seagrasses. • 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. • 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.

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 financial⁵¹ 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

⁵¹ 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.

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.
- (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.

References

- Andrew, M. 2018. *Exploring opportunities for transformation to inclusive, sustainable and resilient economies in the Eastern Caribbean*. Technical Report No. 404. Port of Spain, Trinidad and Tobago: CANARI.
- Arias-González, J.E., Fung, T., Seymour, R.M., Garza-Pérez, J.R., Acosta-González, G., Bozec Y-M. and Johnson, C.R. (2017). A coral-algal phase shift in Mesoamerica not driven by changes in herbivores fish abundance. *PLoS ONE* 12(4): e0174855. <https://doi.org/10.1371/journal.pone.0174855>
- Arkema, K.K., Verutes, G.M., Wood, S.A., Clarke-Samuels, C., Rosado, S., Canto, M., Rosenthal, A. et al. (2015). Embedding ecosystem services in coastal planning leads to better outcomes for people and nature. *PNAS Proceedings of the National Academy of Sciences of the United States of America* 112 (24) 7390-7395. <https://doi.org/10.1073/pnas.1406483112>
- Australian Institute of Marine Sciences (2002). *Status of coral reefs of the world: 2002*. Wilkinson, C. (ed.). Townsville, Queensland: AIMS.
- Baker, S., Paddock, J., Smith, A., Unsworth, R., Cullen-Unsworth, L. and Hertler, H. (2015). An ecosystems perspective for food security in the Caribbean: Seagrass meadows in the Turks and Caicos Islands. *Ecosystem Services* 11(2015), 12-21. <https://doi.org/10.1016/j.ecoser.2014.07.011>
- Ballantine, D.L. and Ruiz, H. (2011). *Metapeyssonnelia milleporoides*, a new species of coral-killing red alga (Peyssonneliaceae) from Puerto Rico, Caribbean Sea. *Botanica Marina* 54(1), 47-51. <https://doi.org/10.1515/bot.2011.003>
- Ballantine, D.L., Ruiz, H., Lozada-Troche, C. and Norris, J.N. (2016). The genus *Ramicrusta* (Peyssonneliales, Rhodophyta) in the Caribbean Sea, including *Ramicrusta bonairensis* sp. nov. and *Ramicrusta monensis* sp. nov. *Botanica Marina* 56 (6), 417-431. <https://doi.org/10.1515/bot-2016-0086>
- Barron, M.G. Ecological impacts of the Deepwater Horizon oil spill: implications for immunotoxicity. *SAGE journals* 40 (2), 315-320. <https://doi.org/10.1177/0192623311428474>
- Beck, M., Losada, I., Menéndez Fernández, P., Reguero, B. & Diaz-Simal, P., Fernández, F. (2018). The global flood protection savings provided by coral reefs. *Nature Communications*. 9 (2186). <https://www.researchgate.net/deref/http%3A%2F%2Fdx.doi.org%2F10.1038%2Fs41467-018-04568-z>
- Beller, W.S., D'Ayala, P.G. and Hein, P. (1990). Sustainable Development and Environmental Management of Small Islands. *Man and the Biosphere Series*. Paris: UNESCO and New York: Parthenon Publishing Group. 5 (1990).
- Bender, M.A., Khutson, T.R., Tuleya, R.E., Sirutis, J.J., Vecchi, G.A, Garner, S.T. and Held, I.M. (2010). Modeled impact of anthropogenic warming on the frequency of intense Atlantic Hurricanes. *Science* 327(5964), 454-458. [10.1126/science.1180568](https://doi.org/10.1126/science.1180568)

- Bland, L.M., Keith, D.A., Miller, R.M., Murray, N.J. and Rodriguez, J.P. (eds.) (2017). *Guidelines for the application of IUCN Red List of Ecosystems Categories and Criteria, Version 1.1*. Gland: IUCN.
- Bostrom-Einarsson, L., Ceccarelli, D., Babcock, R.C., Bayraktarov, E., Cook, N., Harrison, P. et al. (2019). *Reef Restoration and Adaptation Program: Current Practices*. A report provided to the Australian Government by the Reef Restoration and Adaptation Program.
- Bongaerts, P., Ridgway, T., Sampayo, E.M. and Hoegh-Guldberg, O. (2010). Assessing the deep reef refugia hypothesis: focus on Caribbean reefs. *Coral Reefs*, 29(2), 309 – 327.
- Bozec Y., Alvarez-Filip, L. and Mumby, P.J. (2014). The dynamics of architectural complexity on coral reefs under climate change. *Global Change Biology* 21(1), 223-235. <https://doi.org/10.1111/gcb.12698>.
- Bramanti, L., Lasker, H.R. and Edmunds, P.J. (2017). An encrusting peysonnelids preempts vacant space and overgrows corals in St. John, U.S. Virgin Islands. *Reef Encounter* 32, 68-70.
- Brandt, M.E. and McManus, J.W. (2009) Disease incidence is related to bleaching extent in reef-building corals. *Ecology* 90(10), 2859–2867.
- Branoff, B., Cuevas, E. and Hernández, E. (2018). *Assessment of Urban Coastal Wetlands Vulnerability to Hurricanes in Puerto Rico*. San Juan: University of Puerto Rico-Rio Piedras.
- Bruckner, A.W. (2009). The global perspective on incidence and prevalence of coral diseases. In *Coral health and disease in the Pacific: Vision for Action*. Galloway, S.B., Bruckner, A.W. and Woodley, C.M. (eds.). Silver Spring, MD: National Oceanic and Atmospheric Administration. Chapter 2. 90-121. NOAA Technical Memorandum NOS NCCOS 97 and CRCP 7.
- Burke, L. and Maidens, J. (2004). Reef at risk in the Caribbean. World Resources Institute. https://www.researchgate.net/publication/272791685_Reef_at_Risk_in_the_Caribbean
- Burke, L., Reyntar, K., Spalding, M. and Perry, A. (2011). *Reefs at Risk Revisited*. Washington, DC: World Resources Institute (WRI). https://pdf.wri.org/reefs_at_risk_revisited.pdf
- Bustamante, G., Vanzella, A., Glazer, R. and Collado-Vides, L. (2018). *The evolution of the Caribbean Marine Protected Area Management Network and Forum (CaMPAM): 20 years of the regional, multidimensional program for strengthening MPA practitioners*. *Gulf and Caribbean Research* 29, GCFI 1-9.
- Bustamante, M., Helmer, E.H., Schill, S., Belnap, J., Brown, L. K., Brugnoli, E. et al. (2018) Direct and indirect drivers of change in biodiversity and nature’s contributions to people. In *IPBES regional assessment report on biodiversity and ecosystem services for the Americas*. Rice, J., Seixas, C.S., Zaccagnini, M.E., Bedoya-Gaitán, M. and Valderrama, N. (eds.). Bonn: Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Chapter 4. 295-435.
- Camp, E.F., Suggett, D.J., Gendron, G., Jompa, J., Manfrino, C. and Smith, D.J. (2016). Mangrove and seagrass beds provide different biogeochemical services for corals threatened by climate change. *Frontier Marine Science* 3(52). <https://doi.org/10.3389/fmars.2016.00052>.

Caribbean Community (2018). *The State of Biodiversity in the Caribbean Community: A Review of Progress Towards the Aichi Biodiversity Targets*. Georgetown.

Caribbean Coastal Marine Productivity (2001). *CARICOMP Methods Manual Levels 1 and 2- Manual of Methods for Mapping and Monitoring of Physical and Biological Parameters in the Coastal Zone of the Caribbean*. Kingston: CARICOMP Data Management, Centre for Marine Sciences, University of the West Indies and St. Petersburg: Florida Institute of Oceanography, University of South Florida.
https://biogeodb.stri.si.edu/physical_monitoring/downloads/caricomp_manual_2001.pdf

Caribbean Conservation Association (1991). *Environmental Guidelines for Caribbean Planners*. Barbados: Organisation of Eastern Caribbean States, United Nations Development Programme and United Nations Centre for Human Settlements.

Caribbean Development Bank (2018). *Financing the Blue Economy: A Caribbean Development Opportunity*. Bridgetown.

Caribbean Natural Resources Institute. (2016). *Effective support for Caribbean civil society for biodiversity conservation and rural development: Results and recommendations from the Critical Ecosystem Partnership Fund 2010-2016*. Barataria. Policy Brief 22.

Caribbean Natural Resources Institute. (2018). *People managing oceans. Civil Society Action Programme for the Sustainable Management of the Shared Living Marine Resources of the Caribbean and North Brazil Shelf Large Marine Ecosystems (CLME+ C-SAP) 2018-2030*. Barataria: CANARI.

Caribbean Tourism Organization. (2015). Latest Statistics 2015- Final. CTO.
https://www.onecaribbean.org/wp-content/uploads/Lattab15_FINAL.pdf

Carilli, J.E., Norris, R.D., Black, B.A., Walsh, S.M. and McField, M. (2009). Local stressors reduce coral resilience to bleaching. *PLoS ONE* 4(7), e6324.

Carpenter, R.C. (1990). Mass mortality of *Diadema antillarum* – Long term effects on sea urchin population dynamics and coral reef algal communities. *Marine Biology* 104, 67-77.

Carrillo, L., Lamkin, J.T., Johns, E.M., Vásquez-Yeomans, L., Sosa-Cordero, F., Malca, E. *et al.* (2017). Linking oceanographic processes and marine resources in the western Caribbean Sea Large Marine Ecosystem Subarea. *Environmental Development* 22, 84-96.
<https://doi.org/10.1016/j.envdev.2017.01.004>.

CARSEA (2007). Caribbean Sea Ecosystem Assessment (CARSEA). *A sub-global component of the Millennium Ecosystem Assessment (MA)*. Agard, J., Cropper, A. and Garcia, K. (eds.). Caribbean Marine Studies. Special Edition, 2007.

Cavender-Bares, J., Arroyo, M.T.K., Abell, R., Ackerly, D., Ackerman, D., Arim, M. *et al.* (2018). Status and trends of biodiversity and ecosystem functions underpinning nature's benefit to people. In *IPBES regional assessment report on biodiversity and ecosystem services for the Americas*. Rice, J., Seixas, C.S., Zaccagnini, M.E., Bedoya-Gaitán, M. and Valderrama, N. (eds.). Bonn: Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Chapter 3. 171-293.

CEPAL-Centro Latinoamericano y Caribeño de Demografía (2019). *Tendencias Recientes de la Población de América Latina y el Caribe*. Centro Latinoamericano y Caribeño de Demografía (CELADE) and División de Población de la Comisión Económica para América Latina y el Caribe (CEPAL).

https://www.cepal.org/sites/default/files/static/files/dia_mundial_de_la_poblacion_2019.pdf.

Chollett, I., Collin, R., Bastidas, C., Cróquer A., Gayle, P.M.H., Jordán-Dahlgren, E. et al. (2017). Widespread local chronic stressors in Caribbean coastal habitats. *PLoS ONE* 12(12), e0188564. <https://doi.org/10.1371/journal.pone.0188564>.

Choat, J.H., Feitosa, C., Ferreira, C.E., Gaspar, A.L., Padovani-Ferreira, B. and Rocha, L.A. (2012). *Scarus guacamaia*. *The IUCN Red List of Threatened Species*.

<https://dx.doi.org/10.2305/IUCN.UK.2012.RLTS.T19950A17627624.en>. Accessed 03 March 2020.

Christianen, M.J.A., Smulders, F.O.H., Engel, M.S., Nava, M.I., Willis, S., Debrot, A.O. et al. (2018). Megaherbivores may impact expansion of invasive seagrass in the Caribbean. *Journal of Ecology* 107(1), 45-57. <https://doi.org/10.1111/1365-2745.13021>.

Civil Society Consultative Working Group (2013). *Civil Society and Sustainable Development: Initial Discussion Paper for the 3rd International Conference on Small Island Developing States (SIDS 2014)*.

Bridgetown: Caribbean Policy Development Centre.

http://www.fdpi.org/wp-content/uploads/2013/11/Caribbean-CSCWG-Discussion-Paper_Aug-2013.pdf.

Coll, M., Schmidt, A., Romanuk, T. and Lotze, H.K. (2011). Food-web structure of seagrass communities across different spatial scales and human impacts. *PLoS ONE* 6(7), e22591.

<https://doi.org/10.1371/journal.pone.0022591>.

Cooper, G. and Renard, Y. (2011). *Impacts of hotel siting and design on biodiversity in the insular Caribbean: a situation analysis*. A report prepared as part of the IUCN Business and Biodiversity Programme and the IUCN Caribbean Initiative project "Integrating Biodiversity in the Caribbean Hotel Sector". Gland: IUCN.

Conservation International (2008). *Economic Values of Coral Reefs, Mangroves, and Seagrasses: A Global Compilation*. Arlington, VA: Center for Applied Biodiversity Science, Conservation International.

Coulston, M.L.P. (1987). *Pilot Experimental Seagrass Transplantation Project: South Shore, St. Croix, U. S. Virgin Islands*. Washington Island Resources Foundation and Virgin Islands Port Authority.

Crabbe, M.J.C. (2012). From citizen science to policy development on the coral reefs of Jamaica. *International Journal of Zoology* 2012, 102350. <https://doi.org/10.1155/2012/102350>.

Critical Ecosystem Partnership Fund (2019). *Ecosystem Profile: The Caribbean Islands Biodiversity Hotspot*. Arlington, VA: Critical Ecosystem Partnership Fund

<https://canari.org/wp-content/uploads/2017/08/cepf-caribbean-ecosystem-profile-december-2019.pdf>.

D'Angelo, C. and Wiedenmann, J. (2014). Impacts of nutrient enrichment on coral reefs: new perspectives and implications for coastal management and reef survival. *Current Opinion in Environmental Sustainability* 7, 82-93.

<https://doi.org/10.1016/j.cosust.2013.11.029>.

Danielsen, F., Pirhofer-Walzl, K., Adrian, T.P., Kapijimpanga, D.R., Burgess, N.D., Jensen, P.M. et al. (2013). Linking public participation in scientific research to the indicators and needs of international environmental agreements. *Conservation Letters, a journal of the Society for Conservation Biology* 7(1). <https://doi.org/10.1111/conl.12024>.

de Leon, R., Vane, K., Bertuol, P., Chamberland, V.C., Simal, F., Imms, E. and Vermeij, M.J.A. (2013). Effectiveness of lionfish removal efforts in the southern Caribbean. *Endangered Species Research* 22 (2), 175-182.

Dewsbury, B., Bhat, M. and Fourqurean, J.W. (2016). A review of seagrass economic valuations: Gaps and progress in valuation approaches. *Ecosystem Services* 18 (2016), 68–77. <http://dx.doi.org/10.1016/j.ecoser.2016.02.010>.

Doyle, E., Wusinich-Mendez, D., Frew, S., Glazer, R. and Mahung, C. (2017). An update on marine protected area management capacity in the Caribbean, 2011-2017. 70th Gulf and Caribbean Fisheries Institute Conference. 6-10 November 2017. Merida.

Duarte, C., Dennison, W., Orth, R. and Carruthers, T. (2008). The Charisma of Coastal Ecosystems: Addressing the Imbalance. *Estuaries and Coasts*. 31, 233-238. [10.1007/s12237-008-9038-7](https://doi.org/10.1007/s12237-008-9038-7).

Eakin, C.M., Morgan, J.A., Heron, S.F., Smith, T.B., Liu, G., Alvarez-Filip, L. et al. (2010) Caribbean corals in crisis: record thermal stress, bleaching, and mortality in 2005. *PLoS ONE* 5(11): e13969. <https://doi.org/10.1371/journal.pone.0013969>.

Eckrich, C.E., Peachey, R.B.J. and Engel. M.S. (2011). Crustose, calcareous algal bloom (*Ramicrusta* sp.) overgrowing scleractinian corals, gorgonians, a hydrocoral, sponges and other algae in Lac Bay, Bonaire, Dutch Caribbean. *Coral Reefs* 30(1),131-131. <https://doi.org/10.1007/s00338-010-0683-5>.

Eckrich, C.E. and Engel. M.S. (2013). Coral overgrowth by an encrusting red alga (*Ramicrusta* sp.): a threat to Caribbean reefs? *Coral Reefs* 32, 81-84. <https://doi.org/10.1007/s00338-012-0961-5>.

Edmunds, P.J., Zimmerman, S.A. and Bramanti, L. (2019). A spatially aggressive peyssonnelid algal crust (PAC) threatens shallow coral reefs in St. John, US Virgin Islands. *Coral Reefs* 38 (2019), 1329-1341. <https://doi.org/10.1007/s00338-019-01846-0>.

Ellison, A., Farnsworth, E. and Moore, G. (2010). *Pelliciera rhizophorae*. *The IUCN Red List of Threatened Species*. <http://dx.doi.org/10.2305/IUCN.UK.2010-2.RLTS.T178833A7621318.en>.

Fanning, L., Fenzl, N., Interwies, E., Klein, J., Mahon, R., Petersen, A. et al. (2019). *Proposals for a permanent Coordination Mechanism and a Sustainable Financing Plan for Ocean Governance in the Wider Caribbean Region*. Barcelona: Centre of Partnerships for Development (GlobalCAD). http://gefcrew.org/carrcu/18IGM/10SPAWCOP/Ref-Docs/CAD_CLME+_PCM-en.pdf.

Fanning, L., Mahon, R., McConney, P. and Almerigi, S. (2011). The symposium on marine EBM in the Wider Caribbean Region. In *Towards Marine Ecosystem-based Management in the Wider Caribbean*. Fanning, L., Mahon, R., and McConney, P. (eds.). MARE Publication. Amsterdam: Amsterdam University Press. Chapter 6. 13-26.

Fischer, A. and Grimes, S. (2016). Overview. In *UNESCO IOC and UNEP. Open Ocean: Status and Trends, Summary for Policy Makers*. Nairobi: United Nations Environment Programme (UNEP). Chapter 5.1. <http://www.geftwap.org/publications/open-ocean-spm>.

Fish, M. (2012). Wider Caribbean Region. In *Climate and Conservation Landscapes and Seascape Science, Planning, and Action*. Hilty J.A., Chester, C.C. and Cross M.S. (eds.). Island Press/ Center for Resource Economics.

Florida Department of Environmental Protection (2019). *Stony Coral Tissue Loss Disease Response*. <https://floridadep.gov/rcp/coral/content/stony-coral-tissue-loss-sctl-disease-response>.

Fonseca, M. and Bell, S. (1998). Influence of Physical Setting on Seagrass Landscapes Near Beaufort, North Carolina, USA. *Marine Ecology-progress Series - MAR ECOL-PROGR SER*. 171. 109-121. <http://dx.doi.org/10.3354/meps171109>.

Food and Agricultural Organization of the United Nations (2007a). The World's Mangroves 1980-2005: A thematic study prepared in the framework of the Global Forest Resources Assessment 2005. *FAO Forestry Paper* 153.

Food and Agriculture Organization of the United Nations (2007b). *Mangroves of North and Central America 1980-2005: Country reports*. Forest Resources Assessment Programme, Working Paper 138. Rome.

Food and Agriculture Organization of the United Nations and Department of Marine Resources Nassau, The Bahamas (2016). *Fisheries and Aquaculture in The Bahamas: A Review*. Nassau.

Food and Agriculture Organization of the United Nations. (2014). *The State of World Fisheries and Agriculture Opportunities and Challenges*. Rome.

Gardner, L. (2003). *Preliminary Assessment of Tourism Sector in the Context of Physical Alterations and Destruction of Habitats (PADH) in the Wider Caribbean Region*. The Hague: UNEP/GPA Coordination Office.

Gardner, T.A., Cote, I.M., Gill, J.A., Grant, A. and Watkinson, A.R. (2003). Long-term region-wide declines in Caribbean corals. *Science* 301, 958–960. <https://doi.org/10.1126/science.1086050>.

Gladfelter, W.B., Gladfelter, E.H., Monahan, R.K., Ogden, J.C. and Dill, R.D. (1977). Environmental studies of Buck Island Reef National Monument, St. Croix, USVI. National Park Service Rept. p.140.

Gill, D., Mascia, M., Ahmadiya, G., Glew, L., Lester, S.E., Barnes, M. et al. (2017). Capacity shortfalls hinder the performance of marine protected areas globally. *Nature*. 543 (2017) 665-669. <https://doi.org/10.1038/nature21708>.

Giri, C., Ochieng, E., Tieszen, L., Zhu, Z., Singh, A., Loveland, T. et al. (2011). Status and distribution of mangrove forests of the world using earth observation satellite data. *Global Ecology and Biogeography* 20 (2011), 154–159. <https://doi.org/10.1111/j.1466-8238.2010.00584.x>.

Gladfelter, W.B. (1982). White-band disease in *Acropora palmata*: implications for the structure and growth of shallow reefs. *Bulletin Marine Science* 32, 639-643.

Goldstein, J.S., Matsuda, H., Takenouchi, T. and Butler, M.J. (2008). The complete development of larval Caribbean Spiny Lobster *Panulirus argus* (Latreille, 1804) in culture. *Journal of Crustacean Biology* 28(2), 306–327. <https://doi.org/10.1163/20021975-99990376>.

Gombos, M., Arrivillaga, A., Wusinich-Mendez, D., Glazer, B., Frew, S., Bustamante, G. et al. (2011). *A Management Capacity Assessment of Selected Coral Reef Marine Protected Areas in the Caribbean*. Commissioned by the National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (CRCP), the Gulf and Caribbean Fisheries Institute (GCFI) and by the UNEP-CEP Caribbean Marine Protected Area Management Network and Forum (CaMPAM). pp. 269.

Gore, S., Wynne, S.P. and Myers, A. (2018). UK Overseas Territories in the Northeast Caribbean: Anguilla, British Virgin Islands, Montserrat. In *World Seas: An Environmental Evaluation Volume I: Europe, The Americas and West Africa*. Second Edition. Sheppard, C. (ed.) Chapter 23. 549-565. <https://doi.org/10.1016/B978-0-12-805068-2.00027-9>.

Gower, J., Young, E. and King, S. (2013). Satellite images suggest a new Sargassum source region in 2011. *Remote Sensing Letters* 4(8), 764- 773.

Grober-Dunsmore, R. and Keller, B.D. (eds.) (2008). Caribbean connectivity: Implications for marine protected area management. *59th Annual Meeting of the Gulf and Caribbean Fisheries Institute: Proceedings of a Special Symposium*. Belize City, 9-11 November 2006. Silver Spring, MD: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries. *Marine Sanctuaries Conservation Series* ONMS-08-07. <https://nmssanctuaries.blob.core.windows.net/sanctuaries-prod/media/archive/science/conservation/pdfs/carib.pdf>

Guannel G., Arkema, K., Ruggiero, P. and Verutes, G. (2016). The power of three: coral reefs, seagrasses and mangroves protect coastal regions and increase their resilience. *PLoS ONE* 11(7), e0158094. <https://doi.org/10.1371/journal.pone.0158094>.

Harvell, D., Aronson, R.B., Baron, N., Connell, J., Dobson, A.P., Ellner, S. et al. (2004). The rising tide of ocean diseases: unsolved problems and research priorities. *Frontiers in Ecology Environment* 2(7), 375-382. [https://doi.org/10.1890/1540-9295\(2004\)002\[0375:TRTOOD\]2.0.CO;2](https://doi.org/10.1890/1540-9295(2004)002[0375:TRTOOD]2.0.CO;2)

Hamilton, S.E. and Casey, D. (2016). Creation of a high spatio-temporal resolution global database of continuous mangrove forest cover for the 21st century (CGMF-21). *Global Ecology and Biogeography* 25, 729–738.

Heileman, S. (2011). *CLME Project reef and pelagic ecosystems Transboundary Diagnostic Analysis (TDA)*. Cartagena: Caribbean Large Marine Ecosystem and Adjacent Areas (CLME) Project.

Herr, D., Agardy, T., Benzaken, D., Hicks, F., Howard, J., Landis, E. et al. (2015). *Coastal “blue” carbon. A revised guide to supporting coastal wetland programs and projects using climate finance and other financial mechanisms*. Gland: IUCN.

HJR Reefscaping (2015). *The ecology of the red algae Ramicrusta textilis, its dynamic with corals and the evaluation of possible management strategies to minimize its threat to coral reefs around Puerto Rico*. Puerto Rico Department of Natural and Environmental Resources.

Hughes, T. P., Graham, N.A.J., Jackson, J.B.C., Mumby, P.J, and Steneck, R.S. (2010). Rising to the challenge of sustaining coral reef resilience. *Trends in Ecology and Evolution* 25(11), 619-680.

Huxham, M., Whitlock, D., Githaiga, M. and Dencer-Brown, A. (2018). Carbon in the Coastal Seascape: How Interactions Between Mangrove Forests, Seagrass Meadows and Tidal Marshes Influence Carbon Storage. *Current Forestry Reports* 4(2), 101–110. <https://doi.org/10.1007/s40725-018-0077-4>.

Institute of Marine Affairs (2016). *State of the Marine Environment Trinidad & Tobago – 2016*. Chaguaramas: Government of the Republic of Trinidad and Tobago. <https://www.planning.gov.tt/sites/default/files/State%20of%20the%20Marine%20Environment%20%28SOME%29%20Report%202016%20%28IMA%29.pdf>

Interamerican Association for Environmental Defense (2020). Letter of recommendation of inclusion of herbivores fish species. March 11, 2020

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (2018). *The IPBES regional assessment report on biodiversity and ecosystem services for the Americas*. Bonn: Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://ipbes.net/sites/default/files/2018_americas_full_report_book_v5_pages_0.pdf.

International Coral Reef Initiative (2019). *Recommendation on addressing the decline of herbivorous fish populations for improved coral community health throughout the Tropical Eastern Pacific, the Eastern and Western Atlantic, and the Greater Caribbean Region*. 34th ICRI Meeting. Australia, December 2019. <https://www.icriforum.org/wp-content/uploads/2020/05/ICRIGM34-Recommendation-herbivorous-fish.pdf>

International Maritime Organization (2020). BWM Convention and Guidelines. <http://www.imo.org/en/OurWork/Environment/BallastWaterManagement/Pages/BWMConventionandGuidelines.aspx>

International Maritime Organization (2020). Particularly Sensitive Sea Areas. <http://www.imo.org/en/OurWork/Environment/PSSAs/Pages/Default.aspx>.

International Maritime Organization (2020). Parties to the London Convention and Protocol. <http://www.imo.org/en/OurWork/Environment/LCLP/Documents/Parties%20LC%20and%20LP%20Oct%202017.pdf>.

International Maritime Organization (2006). *Revised Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas*. 6 February. A.982(24). [http://www.imo.org/blast/blastDataHelper.asp?data_id=25322&filename=A982\(24\).pdf](http://www.imo.org/blast/blastDataHelper.asp?data_id=25322&filename=A982(24).pdf).

International Monetary Fund, Western Hemisphere Department (2019). *2019 Article IV Consultation— Press Release; Staff Report; and Statement by the Executive Director for Guyana*. Washington, D.C. IMF

Country Report No. 19/296. <https://www.imf.org/en/Publications/CR/Issues/2019/09/16/Guyana-2019-Article-IV-Consultation-Press-Release-Staff-Report-and-Statement-by-the-48678>.

Intergovernmental Panel on Climate Change (2019). *Special Report: Special Report on the Ocean and Cryosphere in a Changing Climate Chapter 4: Sea Level Rise and Implications for Low Lying Islands, Coasts and Communities*. Available at: https://report.ipcc.ch/srocc/pdf/SROCC_FinalDraft_Chapter4.pdf

International Union for Conservation of Nature (2019). The IUCN Red List of Threatened Species. <http://www.iucnredlist.org>. Accessed September 2019.

Isaac, V. and Ferrari, S. (2016). Assessment and management of the North Brazil Shelf Large Marine Ecosystem. *Environmental Development*. 22. <https://doi.org/10.1016/j.envdev.2016.11.004>.

Island Resources Foundation (1993). *Great Pond and Great Pond Bay Area of Particular Concern and Area of Preservation and Restoration: A Comprehensive Analytic Study*. St. Thomas, United States Virgin Islands. United States Virgin Islands: Department of Planning and Natural Resources.

Jackson, J.B.C., Donovan, M.K., Cramer, K.L. and Lam, W. (eds.) (2014). *Status and Trends of Caribbean Coral Reefs: 1970-2012*. Gland: Global Coral Reef Monitoring Network, IUCN.

Jameson, S.C., Stevens, K. and Bennett, R.C. (2018). Nicaragua: Caribbean Coast. In *World Seas: An Environmental Evaluation 2nd Edition. Volume I: Europe, The Americas and West Africa*. Sheppard, C. (ed.). Chapter 31. 725-741. <https://doi.org/10.1016/B978-0-12-805068-2.00032-2>.

Juman, R. and Ramsewak, D. (2013). Status of Mangrove Forests in Trinidad and Tobago, West Indies. In *Caribbean Journal of Science* 47(2-3), 291-304. <https://doi.org/10.18475/cjos.v47i3.a18>.

Kandasamy, K. and Alikunhi, N.M. (2011). Tropical coastal ecosystems: rarely explored for their interaction! *Ecologia* 1(1), 1-22. <https://scialert.net/abstract/?doi=ecologia.2011.1.22>.

Keith, D.A., Rodríguez, J.P., Rodríguez-Clark, K.M., Nicholson, E., Aapala, K., Alonso, A., Asmussen, M. et al. (2013). Scientific foundations for an IUCN Red List of ecosystems. *PLoS ONE* 8(5): e62111. <https://doi.org/10.1371/journal.pone.0062111>

Keith, D. and Spalding, M. (2013). Scientific foundations for an IUCN Red List of Ecosystems. *PLoS ONE Supplementary material*. [10.1371/journal.pone.0062111.s002](https://doi.org/10.1371/journal.pone.0062111.s002)

Kington, K. and Robertson, D. R. (2018). *A NEW Alien Fish Species Discovered in Trinidad, this is NOT Another Lionfish Talk!* 72nd Annual Meeting of the Gulf and Caribbean Fisheries Institute. Punta Cana, 4-8 November 2019.

Klatt, B.J., García Márquez, J.R., Ometto, J.P., Valle, M., Mastrangelo, M.E., Gadda, T. et al. (2018). *Current and future interactions between nature and society. In IPBES regional assessment report on biodiversity and ecosystem services for the Americas*. Rice, J., Seixas, C.S., Zaccagnini, M.E., Bedoya-Gaitán, M. and Valderrama, N. (eds.). Bonn: Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. Chapter 5. 538-643.

- Knutson, T., Camargo, S.J., Chan, J.C.L., Emanuel, K., Ho, C.H., Kossin, J., Mohapatra, M. et al. (2019a). Tropical cyclones and climate change assessment: Part I, Detection and attribution. *Bull. Amer. Meteorol. Soc.* 100 (10), 1987–2007. <https://doi.org/10.1175/BAMS-D-18-0189.1>
- Knutson, T. Camargo, S.J., Chan, J.C.L., Emanuel, K., Ho, C.-H., Kossin, J., Mohapatra, M. et al. (2019b). Tropical cyclones and climate change assessment: Part II, Late 21st century projections. *Bull. Amer. Meteorol. Soc.* 101 (3), E303–E322. <https://doi.org/10.1175/BAMS-D-18-0194.1>
- Krauss, C. (2017). With a major oil discovery, Guyana is poised to become a top producer, 13 January. <https://www.nytimes.com/2017/01/13/business/energy-environment/major-oil-find-guyana-exxon-mobile-hess.html>. Accessed 4 September 2020.
- Leotaud, N., Girvan, A. and Jattansingh, S. (2019). Making ‘losers’ the new Blue Economy ‘winners’. In Caribbean Blue Economy: policy and practice. Clegg, P., Mahon, R., McConney, P. and Oxenford, H. (eds.). New York: Routledge.
- Lessios, H.A., Cubitt, J.D., Robertson, D.R., Shulman, M.L., Parker, M.R., Garrity, S.D. and Levings, S.C. (1984). Mass mortality of *Diadema antillarum* on the Caribbean coast of Panama. *Coral Reefs* 3(4), 173–182.
- Lessios, H.A. (1988). Mass mortality of *Diadema antillarum* in the Caribbean: What have we learned? *Annual Review of Ecology Systematics* 19,371–393.
- Linares, C., Ralph, G., Carpenter, K., Cox, N., Robertson, D.R., Harwell, H. et al. (2017). *The Conservation Status of Marine Bony Shorefishes of the Greater Caribbean*. Gland: IUCN.
- Locker, S.D., Armstrong, R.A., Battista, T.A., Rooney, J.J., Sherman, C. and Zawada, D.G. (2010). Geomorphology of mesophotic coral ecosystems: current perspectives on morphology, distribution, and mapping strategies. *Coral Reefs* 29, 329–345.
- Love, M., Baldera, A., Yeung, C. and Robbins, C. (2013). *The Gulf of Mexico Ecosystem: A Coastal and Marine Atlas*. New Orleans, Louisiana: Ocean Conservancy, Gulf Restoration Center.
- Macintyre, I.G. (1997). *Re-evaluating the role of crustose algae in the construction of coral reefs*. In Proceedings of the 8th International Coral Reef Symposium Vol. 1. Lessios, H.A. and Macintyre, I.G. (eds.). Balboa: Smithsonian Tropical Research Institute. 725–730.
- Macreadie, P. I., Baird, M. E., Trevathan-Tackett, S. M., Larkum, A. W. D., and Ralph, P. J. (2014). Quantifying and modelling the carbon sequestration capacity of seagrass meadows—A critical assessment. *Mar. Pollut. Bull.* 84, 430–439. doi: 10.1016/j.marpolbul.2013.07.038
- Mahon, R., Cooke, A., Fanning, L. and McConney, P. (2013). *Governance arrangements for marine ecosystems of the Wider Caribbean Region*. CERMES Technical Report 60. Bridgetown: CERMES.
- Mahon, R and L. Fanning. (2019a). Regional ocean governance: Polycentric arrangements and their role in global ocean governance. *Marine Policy* 107. <https://doi.org/10.1016/j.marpol.2019.103590>.

- Mahon, R and L. Fanning. (2019b). Regional ocean governance: Integrating and coordinating mechanisms for polycentric systems. *Marine Policy* 107. <http://dx.doi.org/10.1016/j.marpol.2019.103589>
- Manzello, D., Enochs, I., Melo, N., Gledhill, D. and Johns, E. (2012). Ocean Acidification Refugia of the Florida Reef Tract. *PLoS one* 7. <https://doi.org/10.1371/journal.pone.0041715>
- Masters, J. (2012). *CRFM Statistics and Information Report - 2010*. Belize and St. Vincent and the Grenadines: Caribbean Regional Fisheries Mechanism (CRFM) Secretariat. http://www.crfm.int/images/Rev_CRFM_Statistics_and_Information_Report_2010_revised_June_2014_for_website.pdf.
- Mendoza-Alfaro, R. and Alvarez-Torres, P. (2012). Gulf of Mexico large marine ecosystem: resources at risk from climate change. In *Frontline Observations on Climate Change and Sustainability of Large Marine Ecosystems*. Sherman, K. and McGovern, G. (eds.). Washington DC: United Nations Development Programme. 135-169.
- McClanahan, T.R. (2015). Biogeography versus resource management: how do they compare when prioritizing the management of coral reef fish in the south-western Indian Ocean? *Journal of Biogeography* 42, 2414-2426.
- McField, M., Kramer, P., Alvarez-Filip, L., Drysdale, I. Flores, M., Petersen, A. and Soto, M. (2018). *2018 Mesoamerican Reef Report Card. Healthy Reefs Initiative*. 10.13140/RG.2.2.19679.36005.
- McField, M., Kramer, P., Giró Petersen, A., Soto, M., Drysdale, I., Craig, N. and Rueda Flores, M. (2020). *2020 Mesoamerican Reef Report Card. Healthy Reefs Initiative*.
- McLeod, E., Anthony, K.R.N., Mumby, P.J., Maynard, J., Beeden, R., Graham, N.A.J. et al. (2019). The future of resilience-based management in coral reef ecosystems. *Journal of Environmental Management* 233, 291-301. <https://doi.org/10.1016/j.jenvman.2018.11.034>.
- McShine, H. (1995). *Manual for Incorporation of Coastal and Marine Considerations into Physical Planning. Draft Final Report*. United Nations Centre for Human Settlements and the Organisation of Eastern Caribbean States.
- Mercer, J., Kelman, I., Alftan, B. and Kurvits, T. (2012). Ecosystem-Based Adaptation to Climate Change in Caribbean Small Island Developing States: Integrating Local and External Knowledge. *Sustainability* 4(8), 1908-1932. <https://doi.org/10.3390/su4081908>
- Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Synthesis*. Washington DC: Island Press.
- Miller, J., Waara, R., Muller, E. and Rogers, C.S. (2006). Coral bleaching and disease combine to cause extensive mortality on reefs in the U.S. Virgin Islands. *Coral Reefs* 25(3), 418.
- Miller, J., Muller, E., Rogers, C., Waara, R., Atkinson, A., Whelan, K.R.T. et al. (2009). Coral disease following massive bleaching in 2005 causes 60% decline in coral cover on reefs in the US Virgin Islands. *Coral Reefs* 28(4), 925–937.

Miloslavich, P., Díaz, J.M., Klein, E., Alvarado, J.J., Díaz, C., Gobin, J., Escobar-Briones, E. et al. (2010). Marine biodiversity in the Caribbean: regional estimates and distribution patterns. *PLoS one* 5(8): e11916. <https://doi.org/10.1371/journal.pone.0011916>

Ministry of Planning and Development (2017). *Biodiversity Strategy and Action for Trinidad and Tobago 2017-2022*. Government of the Republic of Trinidad and Tobago.

Morgan, K. and Kench, P. (2016). Parrotfish erosion underpins reef growth, sand talus development and island-building in the Maldives. *Sedimentary Geology* 341 (2016), 50-57. <https://doi.org/10.1016/j.sedgeo.2016.05.011>.

Mtwana Nordlund, L., Jackson, E., Nakaoka, M., Samper-Villarreal, J., Beca-Carretero, P. and Creed, J. (2017). Seagrass ecosystem services – What's next?. *Marine Pollution Bulletin*. 134, 145-151. <https://doi.org/10.1016/j.marpolbul.2017.09.014>

Mtwana Nordlund, L., Koch, E.W., Barbier, E.B. and Creed, J.C. (2016). Seagrass ecosystem services and their variability across genera and geographical regions. *PLoS ONE* 11(10), e0163091. <https://doi.org/10.1371/journal.pone.0163091>.

Muller, E., Rogers, C., Spitzack, A. and van Woesik, R. (2008). Bleaching increases likelihood of disease on *Acropora palmata* (Lamarck) in Hawksnest Bay, St John, US Virgin Islands. *Coral Reefs* 27(1), 191–195.

Mumby, P.J., Edwards, A.J., Arias-Gonzalez, J.E., Lindeman, K.C., Blackwell, P.G., Gall, A. et al. (2004). Mangroves enhance the biomass of coral reef fish communities in the Caribbean. *Nature* 427 (6974), 533-536. <https://doi.org/10.1038/nature02286>.

Muñoz Sevilla, N.P. and Le Bail, M. (2017). Latin American and Caribbean regional perspective on Ecosystem Based Management (EBM) of Large Marine Ecosystems goods and services. *Environmental Development* 22, 9-17. <https://doi.org/10.1016/j.envdev.2017.01.006>.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B. and Kent, J. (2000). Biodiversity hotspots for conservation priorities. *Nature* 403, 853–858. <https://doi.org/10.1038/35002501>.

Nagelkerken, I., Buchan, K., Smith, G.W., Bonair, K., Bush, P., Garzon-Ferreira, J. et al. (1997). Widespread disease in Caribbean Sea fans: I. Spreading and general characteristics. In *Eighth International Coral Reef Symposium*. Lessios, H. and Macintyre, I.G. (eds.). Smithsonian Tropical Research Institute, Balboa, Republic of Panama. Volume 1. 679-682.

Nagelkerken, I., Robert, C., Van der Velde, G., Dorenbosch, M., Riel, M.C., Morinière, E. and Nienhuis, P. (2002). How important are mangroves and seagrass beds for coral-reef fish? The nursery hypothesis tested on an island scale. *Marine Ecology Progress Series* 244, 299-305. <https://doi.org/10.3354/meps244299>.

National Marine Fisheries Service (2018). *Fisheries Economics of the United States, 2016*. U.S. Department. of Commerce, NOAA Tech. Memo. NMFS-F/SPO-187, p. 243.

National Ocean Economics Program (2018). Ocean Economy Data.
<https://oceanomics.org/Market/ocean/oceanEcon.asp>.

National Ocean Service-Office of Coastal Management (2018). *Final Evaluation Findings: U.S. Virgin Islands Coastal Management Program, December 2007 to August 2017*. National Oceanic and Atmospheric Administration, United States Department of Commerce.
<https://coast.noaa.gov/data/czm/media/usvi-cmp.pdf>

Natural Resources Institute (1999). *Proceedings of the Caribbean Workshop on Marine Biodiversity*. Montego Bay 27-29 October 1998. Government of the United Kingdom and Government of Jamaica.

Norse, E.A. (ed.) (1993). *Global Marine Biological Diversity: A Strategy for Building Conservation into Decision Making*. Washington: Island Press.

Ogden, J.C. (1977). Estimates of carbonate sediment production by some common fish and sea urchins in the Caribbean. Frost, S. and Weiss, M. (eds.). *Studies in Geology #4. Caribbean Coral Reefs - Holocene and Ancient*, AAPG. 281-285. <https://doi.org/10.1306/St4393C21>.

Olinger, L.K., Heidmann, S.L., Durdall, A.N., Howe, C., Ramseyer, T., Thomas, S.G. et al. (2017). Altered juvenile fish communities associated with invasive *Halophila stipulacea* seagrass habitats in the U.S. Virgin Islands. *PLoS ONE* 12(11): e0188386. <https://doi.org/10.1371/journal.pone.0188386>.

Ortiz-Lozano, L., Gutiérrez-Velázquez, A., Colmenares-Campos, C., Aja-Arteaga, A., Ramos-Castillo, V., and Olivera-Vázquez, L. (2019). *Arrecifes sumergidos en el Corredor Arrecifal del Suroeste del Golfo de México. Segundo Informe*. Ciudad de México: Centro Mexicano de Derecho Ambiental (CEMDA). http://www.cemda.org.mx/wp-content/uploads/2019/07/Arrecifes-sumergidos-en-el-corredor-arrecifal-del-Suroeste-del-Golfo-de-México-Segundo-Informe-julio-2019_final.pdf.

Oxenford, H., Roach, R., Brathwaite, A., Nurse, L., Goodridge, R., Hinds, F. et al. (2008). Quantitative observations of a major coral bleaching event in Barbados, Southeastern Caribbean. *Climatic Change* 87(3): 435–449. <https://doi.org/10.1007/s10584-007-9311-y>.

Oxenford, H.A., Roach, R. and Brathwaite, A. (2010). Large scale coral mortality in Barbados: a delayed response to the 2005 bleaching episode. Proceedings of the 11th International Coral Reef Symposium. Ft. Lauderdale, Florida, 7-11 July 2008. 505–509.

Pariona, A. (2017). Top 10 countries most reliant on tourism, 1 August.
<https://www.worldatlas.com/articles/top-10-countries-most-reliant-on-tourism.html>.

Patterson, K.L., Porter, J.W., Ritchie, K.B., Polson, S.W., Mueller, E., Peters, E.C. et al. (2002). The etiology of white pox, a lethal disease of the Caribbean elkhorn coral, *Acropora palmata*. *PNAS* 99(13), 8725-8730. <https://doi.org/10.1073/pnas.092260099>.

Patil, P.G. and Diez, S.M. (2016). *Grenada - Blue growth coastal master plan (English)*. Washington, D.C.: World Bank Group. <http://documents.worldbank.org/curated/en/358651480931239134/Grenada-Blue-growth-coastal-master-plan>.

Patil, P.G., Viridin, J., Diez, S.M., Roberts, J. and Singh, A. (2016). *Toward A Blue Economy: A Promise for Sustainable Growth in the Caribbean; An Overview*. Washington D.C.: The World Bank.

Pearce, D.W. and Turner, R.K. (1990). *Economics of Natural Resources and the Environment*. Hertfordshire: Harvester Wheatsheaf.

Phillips, T., Chakallal, B. and Romahlo, L. (2011). Management of the Shrimp and Groundfish Fisheries of the North Brazil Shelf. In *Towards Marine Ecosystem-based Management in the Wider Caribbean*. Fanning, L. Mahon, R. and McConney, P. (eds.). Amsterdam: Amsterdam University Press. MARE Publication Series No. 6, 213-225.

Primavera, J.H., Friess, D.A., Van Lavieren, H. and Yip Lee, S. (2018). The Mangrove Ecosystem. In *World Seas: An Environmental Evaluation, Volume III: Ecological Issues and Environmental Impacts*. Second Edition. Sheppard, C. (ed). Academic Press. Chapter 1. 1-34. <https://doi.org/10.1016/B978-0-12-805052-1.00001-2>.

Private Sector Commission (2019). *Economic Reports: A Review of the Real Sector of Guyana's Economy 2017*. <http://psc.org.gy/resources/economic-reports/>.

Project Seagrass (2018). Seagrass Spotter Map. <https://seagrassspotter.org/map>. Accessed 19 October 2018.

Pueschel, C.M. and Saunders, G.W. (2009). *Ramicrusta textilis* sp. nov. (Peyssonneliaceae, Rhodophyta), an anatomically complex Caribbean alga that overgrows corals. *Phycologia* 48(6), 480-491. <https://doi.org/10.2216/09-04.1>.

Ram, J., Ramrattan, D. and Frederick, R. (2019). *Measuring the Blue Economy: The System of National Accounts and Use of Blue Economy Satellite Accounts*. CDB Working Paper No. 2019/02. Bridgetown: Caribbean Development Bank.

Rodríguez-Ramírez, A., Garzón-Ferreira, J., Batista Morales, A., Gil-Agudelo, D., Gómez, D. Gómez-Campo, K. *et al.* (2010). Temporal patterns in coral reef, seagrass and mangrove communities from Chengue bay CARICOMP site (Colombia): 1993-2008. *Revista de biología tropical* 58(3), 45-62.

Ramsar Convention on Wetlands (2018). *Global Wetland Outlook: State of the World's Wetlands and their Services to People*. Gland: Ramsar Convention Secretariat.

Ramsar Convention on Wetlands (2020). Caribbean Wetlands Regional Initiative. https://www.ramsar.org/sites/default/files/documents/library/americas_cariwet_en.pdf.

Ramsar Convention Secretariat (2018). Ramsar Caribbean Regional Initiative: Annual Report for year 2016 and Plan for Year 2017. <https://www.ramsar.org/document/annual-report-for-year-2016-and-plan-for-year-2017-caribbean-wetlands-regional-initiative>. Accessed 17 October 2018.

Reaka-Kudla, M.L. (2005). Biodiversity of Caribbean coral reefs. In *Caribbean Marine Biodiversity*. Miloslavich, P. and Klein, E. (eds.). Lancaster, PA: Des Tech Publishers. 259-276.

- Rebolledo, A.P. and Collin, R. (2018). Thermal tolerance of the zoea I stage of four Neotropical crab species (Crustacea: Decapoda). *Zoologia (Curitiba)* 35, 1-5. <https://doi.org/10.3897/zoologia.35.e14641>.
- Rees, J. (1990). *Natural Resources: Allocation, Economics and Policy*. Second Edition. London: Routledge. <https://doi.org/10.4324/9781315112770>.
- Redding, J.E., Myers-Miller, R.L., Baker, D.M., Fogel, M., Raymundo, L. and Kim, K. (2013). Link between sewage-derived nitrogen pollution and coral disease severity in Guam. *Marine Pollution Bulletin* 73(1), 57-63.
- Reyes Bonilla, H. (2018). *Ecological importance of herbivores fish, distribution and abundance. Recognizing the need for legal tools for the conservation of herbivores fishes*. Virtual Seminar, 12 December 2018. Autonomous University of Baja California Sur. <https://aida-americas.org/es/blog/seminario-reconociendo-la-necesidad-de-herramientas-legales-para-la-conservacion-de-peces-herbivoros>
- Reynolds, P.L. (2018). Seagrass and seagrass beds, April. <https://ocean.si.edu/ocean-life/plants-algae/seagrass-and-seagrass-beds>.
- Roberts, C.M., McClean, C.J., Veron, J.E.N., Hawkins, J.P., Allen, G.R., McAllister, D.E. et al. (2002). Marine Biodiversity Hotspots and Conservation Priorities for Tropical Reefs. *Science* 295(5558), 1280-1284.
- Robertson, D.R. and Cramer, K.L. (2014). Defining and Dividing the Greater Caribbean: Insights from the Biogeography of Shorefishes. *PLoS ONE* 9(7), e102918. <https://doi.org/10.1371/journal.pone.0102918>
- Rocha, L.A., Pinheiro, H.T., Shepherd, B., Papastamatiou, Y.P., Luiz, O.J., Pyle, R.L. and Bongaerts, P. (2018). Mesophotic coral ecosystems are threatened and ecologically distinct from shallow water reefs. *Science*. 361(6399), 281-284. doi:10.1126/science.aaq1614
- Rodrigue, J-P. and Ashar, A. (2015). Transshipment hubs in the New Panamax Era: The role of the Caribbean. *Journal of Transport Geography*. 51, 270-279. <https://doi.org/10.1016/j.jtrangeo.2015.10.002>.
- Rice, J., Seixas, C.S., Zaccagnini, M.E., Bedoya-Gaitán, M. and Valderrama, N. (eds.) (2018). *The regional assessment report on biodiversity and ecosystem services for the Americas*. Bonn: Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.
- Rogers, C.S., Willette, D.A. and Miller, J. (2014). Rapidly spreading seagrass invades the Caribbean with unknown ecological consequences. *Frontiers in Ecology and the Environment* 12(10), 546-547. <https://doi.org/10.1890/14.WB.016>.
- Romañach, S., DeAngelis, D., Koh, H., Li, Y., Teh, S., Raja Barizan, R. and Zhai, L. (2018). Conservation and restoration of mangroves: Global status, perspectives, and prognosis. *Ocean & Coastal Management* 154, 72-82.
- Rosenberg, E. and Loya, Y. (eds.) (2004). *Coral Health and Diseases*. New York: Springer-Verlag.

Rothenberger, P., Blondeau, J., Cox, C., Curtis, S., Fisher, W.S., Garrison, V. et al. (2008). The State of Coral Reef Ecosystems of the U.S. Virgin Islands. In *The State of Coral Reef Ecosystems of the United States and Pacific Freely Associated States*. Waddell, J.E. and Clarke, A.M. (eds.). Silver Spring, MD: NOAA/NCCOS Center for Coastal Monitoring and Assessment's Biogeography Team. NOAA Technical Memorandum NOS NCCOS 73. 29-73.

Ruiz, H. and Ballantine, D.L. (2004). Occurrence of the seagrass *Halophila stipulacea* in the Tropical West Atlantic. *Bulletin of Marine Science* 75(1), 131–135.

Sachlikidis, N.G., Jones, C. and Seymour, J. (2010). The effect of temperature on the incubation of eggs of the tropical rock lobster *Panulirus ornatus*. *Aquaculture* 305, 79-83.
<https://doi.org/10.1016/j.aquaculture.2010.04.015>.

Salem, M.E. and Mercer, D.E. (2012). The Economic Value of Mangroves: A Meta-Analysis. *Sustainability* 4, 359-383. <https://doi:10.3390/su4030359>.

Saunders, M.I., Atkinson, S., Klein, C.J., Weber, T. and Possingham, H.P. (2017). Increased sediment loads cause non-linear decreases in seagrass suitable habitat extent. *PLoS ONE* 12(11), e0187284.
<https://doi.org/10.1371/journal.pone.0187284>.

Scarano, F.R., Garcia, K., Diaz-de-Leon, A., Queiroz, H. L., Rodríguez Osuna, V., Silvestri, L.C. et al. (2018). Options for governance and decision-making across scales and sectors. In *IPBES regional assessment report on biodiversity and ecosystem services for the Americas*. Rice, J., Seixas, C.S., Zaccagnini, M.E., Bedoya-Gaitán, M. and Valderrama, N. (eds.). Bonn: Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. 644-721.

Scheibling, R.E., Patriqui, D.G. and Filbee-Dexter, K. (2018). Distribution and abundance of the invasive seagrass *Halophila stipulacea* and associated benthic macrofauna in Carriacou, Grenadines, Eastern Caribbean. *Aquatic Botany* 144, 1-8. <https://doi.org/10.1016/j.aquabot.2017.10.003>.

Schuhmann, P.W. (2011). *Regional Governance Framework for the CLME project Deliverable 4: The Valuation of Marine Ecosystem Goods and Services in the Caribbean*. Cave Hill: Centre for Resource Management and Environmental Studies (UWI-CERMES).
<https://clmeplus.org/app/uploads/2020/02/CLME-marine-resource-valuation-2011-11-17.pdf>

Sealey, K.S. and Logan, A. (2018). The Commonwealth of the Bahamas. In *World Seas: An Environmental Evaluation Volume I: Europe, The Americas and West Africa*. Second Edition. Sheppard, C. (ed.). *Elsevier*. Chapter 25. 591-615. <https://doi.org/10.1016/B978-0-12-805068-2.00030-9>.

Sealey, K.S., Wood, K. and Logan, A. (2018). The Turks and Caicos Islands. In *World Seas: An Environmental Evaluation Volume I: Europe, The Americas and West Africa*. Second Edition. Sheppard, C. (ed.). *Elsevier*. Chapter 26. 617-635. <https://doi.org/10.1016/B978-0-12-805068-2.00031-0>.

Secretariat of the Convention on Biological Diversity (2014). *Ecologically or Biologically Significant Marine Areas (EBSAs): Special places in the world's oceans. Volume 2: Wider Caribbean and Western Mid-Atlantic Region*. Quebec: Secretariat of the Convention on Biological Diversity.

Serafy, J.E., Shideler, G.S., Araújo, R.J. and Nagelkerken, I. (2015). Mangroves enhance reef fish abundance at the Caribbean regional scale. *PLoS one* 10. <https://doi.org/10.1371/journal.pone.0142022>

Sheppard, C. (ed.) (2018). *World Seas: An Environmental Evaluation 2nd Edition. Volume I: Europe, The Americas and West Africa*. Academic Press.

Sippo, J.Z., Maher, D.T., Tait, D.R., Holloway, C. and Santos, I.R. (2016). Are mangroves drivers or buffers of coastal acidification? Insights from alkalinity and dissolved inorganic carbon export estimates across a latitudinal transect. *Global Biogeochemical Cycles* 30 (5), 753-766. <https://doi.org/10.1002/2015GB005324>

Smith, G. and Burkhardt, D. (2017). *Socio-economic Study of the Fisheries Sector in Suriname*. WWF Guianas.

Smith, T.B., Nemeth, R.S., Blondeau, J., Calnan, J., Kadison, E. and Herzlieb, S. (2008). Assessing Coral Reef Health Across Onshore to Offshore Stress Gradients in the USVI. *Marine Pollution Bulletin* 56, 1983-1991.

Smith, T.B., Kadison, E., Henderson, L., Gyor, J., Brandt, M.E., Calnan, J.M. et al. (2012) *The United States Virgin Islands Territorial Coral Reef Monitoring Program. 2011 Annual Report*. United States Virgin Islands: University of the Virgin Islands.

Smith, T.B., Gyory, J., Brandt, M.E., Miller, W.J., Jossart, J. and Nemeth, R.S. (2015). Caribbean mesophotic coral ecosystems are unlikely climate change refugia. *Global Change Biology* 22, 2756-2765. <https://doi.org/10.1111/gcb.13175>

Smith, T.B., Holstein, D.M. and Ennis, R.S. (2018). Disturbance in mesophotic coral ecosystems and linkages to conservation and management. In *Coral Reefs of the World: Mesophotic Coral Ecosystems*. Loya, Y., Pugliese, K.A. and Bridge, T. (eds.). Springer.

Spalding, M., Green, E. and Ravilious, C. (2001) *World atlas of coral reefs*. California: UNEP World Conservation Monitoring Centre and University of California Press.

Spalding, M., Burke, L., Wood, S.A., Ashpol, J. and Hutchison, J. (2017). Mapping the global value and distribution of coral reef tourism. *Marine Policy* 82, 104-113.

Steneck, R.S., Mumby, P.J., MacDonald, C., Rasher, D.B. and Stoyke, G. (2018). Attenuating effects of ecosystem management on coral reefs. *e* 4(5), eao5493. <https://doi.org/10.1126/sciadv.aao5493>

Sustainable Development Unit (2017). *Revised National Biodiversity Strategy and Action Plan (2015 - 2020)*. Government of Saint Vincent and the Grenadines

Sutherland, K.P., Porter J.W. and Torres, C. (2004). Disease and immunity in Caribbean and Indo-Pacific zooxanthellae corals. *Marine Ecology Progress Series* 266, 273-302. <https://www.int-res.com/articles/meps2004/266/m266p273.pdf>

Talaue-McManus, T. and Estevanez, M. (2016). Socio-economics: Examining Socio-economic Dimensions of Risk and Vulnerability among coastal Inhabitants of Large Marine Ecosystems. In *IOC-UNESCO and UNEP Large Marine Ecosystems: Status and Trends*. Nairobi: UN Environment Programme. 21–61.

Technical Support Services, Inc. (1996). *National Policy for the Conservation of Seagrasses*. Natural Resources Conservation Authority and Government of Jamaica.

Thorhaug, A., Miller, B., Jupp, B. and Booker, F. (1985). Effects of a variety of impacts on seagrass restoration in Jamaica. *Marine Pollution Bulletin* 16 (9), 355-360. [https://doi.org/10.1016/0025-326X\(85\)90086-4](https://doi.org/10.1016/0025-326X(85)90086-4).

Toorman, E.A., Anthony, E., Augustinus, P.G.E.F., Gardel, A., Gratiot, N., Homenauth, O. et al. (2018). Interaction of mangroves, coastal hydrodynamics and morphodynamics along the coastal fringes of the Guianas. In *Threats to Mangrove Forests*. Makowski, C. and Finkl, C. (eds.). *Coastal Research Library* 25, 429-473. https://doi.org/10.1007/978-3-319-73016-5_20.

Transboundary Waters Assessment Programme (2018). *One Shared Ocean*. <http://onesharedocean.org/>.

Trotman, A., Gordon, R.M., Hutchinson, S.D., Singh, R. and McRae-Smith, D. (2009). Policy responses to GEC impacts on food availability and affordability in the Caribbean community. *Environmental Science & Policy* 12(4), 529-541. <https://doi.org/10.1016/j.envsci.2009.02.001>

Trevathan-Tackett, S.M., Macreadie, P.I., Sanderman, J., Baldock, J., Howes, J.M. and Ralph, P.J. (2017). A Global Assessment of the Chemical Recalcitrance of Seagrass Tissues: Implications for Long-Term Carbon Sequestration. *Front. Plant Sci.* <https://doi.org/10.3389/fpls.2017.00925>

Turner, R.E. and Rabalais, N.N. (2018). *The Gulf of Mexico*. In *World Seas: An Environmental Evaluation Volume I: Europe, The Americas and West Africa*. Second Edition. Sheppard, C. (ed.). Elsevier. Chapter 18. 445-464. <https://doi.org/10.1016/B978-0-12-805068-2.00022-X>.

United Nations Development Programme (2015). *CLME+: Catalysing Implementation of the Strategic Action Programme for the Sustainable Management of shared Living Marine Resources in the Caribbean and North Brazil Shelf Large Marine Ecosystems Project Document*. UNDP. <https://info.undp.org/docs/pdc/Documents/H21/PIMS%205247%20CLME+%20final%20ProDoc%2031%20March%202015.docx>.

Economic Commission for Latin America and the Caribbean (2018). *Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean*. Status of Signatures. <https://www.cepal.org/en/escazuuagreement/countries>.

United Nations Environment Programme (1997). *Coastal Tourism in the Wider Caribbean Region: Impacts and Best Management Practices*. CEP Technical Report No. 38. Kingston: UNEP Caribbean Environment Programme.

United Nations Environment Programme. (2014). *Emerging issues for Small Island Developing States. Results of the UNEP Foresight Process. Results of the UNEP/UN DESA Foresight Process*. Nairobi: UNEP.

United Nations Environment Programme (2019). *State of the Cartagena Convention Area Report: An Assessment of Marine Pollution from Land-Based Sources and Activities in the Wider Caribbean Region*. Report presented to the Fourth Meeting of the Contracting Parties (COP) to the Protocol Concerning Pollution from Land-Based Sources and Activities (LBS) in the Wider Caribbean Region. Roatan, Honduras, 4 June 2019.

United Nations Environment Programme- Caribbean Environment Programme (2016). *GCRMN-Caribbean Guidelines for Coral Reef Biophysical Monitoring*. UNEP-CEP. http://www.car-spaw-rac.org/IMG/pdf/gcrmn-caribbean_guidelines.unep_depi_car_wg38.inf17-en.pdf.

United Nations Environment Programme- Caribbean Environment Programme (2017). *GCRMN-Caribbean Guidelines for Integrated Coral Reef Monitoring*. UNEP-CEP. http://www.car-spaw-rac.org/IMG/pdf/gcrmn_carib_social_science_guideline_cop.pdf.

United Nations Environment Programme- Caribbean Environment Programme (2018). *Sargassum White Paper- Sargassum Outbreak in the Caribbean: Challenges, Opportunities and Regional Situation*. Kingston: UNEP-CEP.

United Nations Environment Programme World Conservation Monitoring Centre (2016). *The State of Biodiversity in Latin America and the Caribbean: A mid-term review of progress towards the Aichi Biodiversity Targets*. Cambridge: UNEP-WCMC.

United Nations Human Settlements Programme (2012). *The state of Latin American and Caribbean cities 2012- Towards a new urban transition*, Nairobi: UN-Habitat.

United Nations Industrial Development Organization Project Coordination Unit (2011). *Integrated Assessment and Management of the Gulf of Mexico Large Marine Ecosystem: Transboundary Diagnostic Analysis*. Global Environment Facility (GEF) and UNIDO.

van Tussenbroek, B.I., Cortes, J., Collin, R., Fonseca, A.C., Gayle, P.M.H., Guzmán, H.M. et al. (2014). Caribbean-Wide, Long-Term Study of Seagrass Beds Reveals Local Variations, Shifts in Community Structure and Occasional Collapse. *PLoS one* 9(3), e90600. <https://doi.org/10.1371/journal.pone.0090600>.

Veron, J.E.N., Stafford-Smith, M.G., Turak, E. and DeVantier, L.M. (2016). Corals of the World. <http://www.coralsoftheworld.org/page/overview-of-coral-distributions/?version=0.01>. Accessed 05 November 2018.

Wang, M., Hu, C., Barnes, B., Mitchum, G., Lapointe, B. and Montoya, J. (2019). The Great Atlantic Sargassum belt. *Science* 365, 83-87.

Wear, S. and R.V. Thurber. (2015). Sewage pollution: mitigation is key for coral reef stewardship. *Annals of the New York Academy of Sciences* 1355(1), 15-30.

Wege, D.C. and Anadon-Irizarry, V. (2008). *Important Bird Areas in the Caribbean: Key Sites for Conservation*. BirdLife International.

Weil, E., Smith, G.W. and Gil-Agudelo, D.L. (2006). Status and progress in coral reef disease research. *Diseases of Aquatic Organisms* 69, 1-7.

Whelan, K.R.T., Miller, J., Sanchez, O. and Patterson, M. (2007). Impact of the 2005 coral bleaching event on *Porites porites* and *Colpophyllia natans* at Tektite Reef, US Virgin Islands. *Coral Reefs* 26, 689-693. <https://link.springer.com/content/pdf/10.1007/s00338-007-0241-y.pdf>

Wiener, J. (2014). Rapid Assessment of Haiti's Mangroves 2014. Fondation pour la Protection de la Biodiversité Marine.

Wilkinson, C. (2004). *Status of coral reefs of the world: 2004. Volume 1*. Townsville, Queensland: Australian Institute of Marine Science.

Wilkinson, C. and Souter, D. (eds.) (2008). *Status of Caribbean Coral Reefs after Bleaching and Hurricanes in 2005*. Townsville: Global Coral Reef Monitoring Network and Reef and Rainforest Research Centre.

Willette, D.A., Chalifour, J., Dolfi Debrot, A.O., Sabine Engel, M., Miller, J., Oxenford, H.A. et al. (2014). Continued expansion of the trans-Atlantic invasive marine angiosperm *Halophila stipulacea* in the Eastern Caribbean. *Aquatic Botany* 112(2014), 98-102. <https://doi.org/10.1016/j.aquabot.2013.10.001>.

Willette, D.A. and Ambrose, R.F. (2009). The distribution and expansion of the invasive seagrass *Halophila stipulacea* in Dominica, West Indies, with a preliminary report from St. Lucia. *Aquatic Botany* 91(2009), 137-142. <http://dx.doi.org/10.1016/j.aquabot.2009.04.001>.

Yong, E. (2019). Why Waves of Seaweed Have Been Smothering Caribbean Beaches. The Atlantic. <https://www.theatlantic.com/science/archive/2019/07/great-atlantic-sargassum-belt-here-stay/593290/>. Accessed 1 December 2019.

Zaldívar-Jiménez, M., Herrera-Silveira, J., Teutli-Hernández, C., Comín, F., Andrade, J., Molina, C. and Ceballos, R. (2010). Conceptual Framework for Mangrove Restoration in the Yucatán Peninsula. *Ecological Restoration* 28(3), 333-342. <http://www.jstor.org/stable/43443265>.

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 Strategic Action Plans (2020-2035) (in development)	https://www.oecs.org/our-work/environmental-sustainability/biodiversity-and-ecosystems-management
Regional Strategy for Mangrove Management, 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 macro-algal cover (%)	Most recent MA cover (%)	Change MA cover (%)	Parrotfish biomass after 1999 (g/m ²)
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

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 macro-algal cover (%)	Most recent MA cover	Change MA cover (%)	Parrotfish biomass after 1999 (g/m ²)
													(%)	(%)		
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
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

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 macro-algal cover (%)	Most recent MA cover	Change MA cover (%)	Parrotfish biomass after 1999 (g/m ²)
													(%)	(%)		
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
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

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 macro-algal cover (%)	Most recent MA cover (%)	Change MA cover (%)	Parrotfish biomass after 1999 (g/m ²)
													(%)	(%)		
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

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 macro-algal cover (%)	Most recent MA cover	Change MA cover (%)	Parrotfish biomass after 1999 (g/m ²)
													(%)	(%)		
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
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		Turumote	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

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 macro-algal cover (%)	Most recent MA cover	Change MA cover (%)	Parrotfish biomass after 1999 (g/m ²)
													(%)	(%)		
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
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
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

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 macro-algal cover (%)	Most recent MA cover (%)	Change MA cover (%)	Parrotfish biomass after 1999 (g/m ²)
90		Morrococoy	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)						
<i>Bulimulidae</i>	<i>Orthalicus reses reses</i>	Stock Island, Florida tree snail	Escargot arboricole	Caracol terrestre Sotck Island	1991	NE
Class/ Classe/Clase: OSTEICHTHYES						
<i>Percidae</i>	<i>Etheostoma okaloosae</i>	Okaloosa darter			1991	LC
	<i>Etheostoma rubrum</i>	Bayou darter			1991	EN
Class/ Classe/Clase: AMPHIBIA						
Order/ Ordre/ Orden: ANURA						
<i>Bufo</i>	<i>Anaxyrus houstonensis</i> (formerly <i>Bufo houstonensis</i>)	Houston toad			1991	EN
	<i>Peltophryne lemur</i>	Puerto Rican Crested Toad Ridge-headed Toad		Sapo concho	1991	CR
<i>Eleutherodactylidae</i> (formerly included in <i>Leptodactylidae</i>)	<i>Eleutherodactylus barlagnei</i>	Barlagne Robber frog	Hylode de Barlagne		1991	EN
	<i>Eleutherodactylus jasperi</i>	Golden coqui		Coqui dorado	1991	CR
	<i>Eleutherodactylus johnstonei</i>	Johnstone's Robber Frog	Hylode de Johnstone	<i>coquí antillano</i>	1991	LC
	<i>Eleutherodactylus martinicensis</i>	Martinique Robber frog	Hylode de la Martinique		1991	NT
	<i>Eleutherodactylus pinchoni</i>	Pinchon's Piping Frog	Hylode de Pinchon		1991	EN
	<i>Eleutherodactylus limbatus</i> (formerly <i>Sminthillus limbatus</i>)	Habana robber frog			1991	VU
<i>Hylidae</i>	<i>Phyllodytes auratus</i> (formerly <i>Amphodius auratus</i>)	Golden tree frog El Tucuche golden frog			1991	CR
Order/ Ordre/ Orden: CAUDATA						
<i>Plethodontidae</i>	<i>Phaeognathus hubrichti</i>	Red Hills salamanders			1991	EN
Class/ Classe/Clase: REPTILIA						
Order/ Ordre/ Orden: CROCODYLIA						
<i>Alligatoridae</i>	<i>Melanosuchus niger</i>	Black caiman	Caiman noir	Caimán negro	1991	NE
<i>Crocodylidae</i>	<i>Crocodylus acutus</i>	American crocodile	Crocodile américain	Cocodrilo americano cocodrilo narigudo Cocodrilo de Tumbes	1991	VU
	<i>Crocodylus intermedius</i>	Orinoco crocodile	Crocodile de l'Orénoque	Cocodrilo del Orinoco, Caimán del Orinoco	1991	CR
	<i>Crocodylus moreletii</i>	Morelet's crocodile / central american crocodile	Crocodile de Morelet	Cocodrilo de Morelet cocodrilo mexicano o de pantano	1991	LC
Order/ Ordre/ Orden: SQUAMATA						
<i>Boidae</i>	<i>Chilabothrus inornatus</i> (formerly <i>Epicrates inornatus</i>)	Puerto rican boa	Boa de Puerto Rico	Boa o culebrón De Puerto Rico	1991	LC
	<i>Chilabothrus monensis granti</i> (formerly <i>Epicrates monensis granti</i>)	Virgin Islands tree boa	Boa arboricole des Iles Vierges – Pas de nom commun trouvé	Boa de la cordillera O de las Islas Virgenes	1991	NE
	<i>Chilabothrus monensis monensis</i> (formerly <i>Epicrates monensis monensis</i>)	Mona Island boa	Boa de l'île Mona	Boa o culebrón de Mona	1991	EN
<i>Colubridae</i>	<i>Nerodia clarkii taeniata</i> (formerly <i>Nerodia fasciata taeniata</i>)	Atlantic saltmarsh snake			1991	NE
<i>Dactyloidae</i> (formerly included in <i>Iguanidae</i>)	<i>Anolis roosevelti</i>	Culebra Island Giant Anole			1991	CR
<i>Iguanidae</i>	<i>Cyclura carinata</i>	Turks and Caicos rock iguana, Bahamas Rock Iguana, Turks and Caicos Ground Iguana	Iguane terrestre Des îles Turks et Caicos	Iguana de Turcas y Caicos	1991	CR
	<i>Cyclura collei</i>	Jamaica Ground Iguana, Jamaican Iguana, Jamaican Rock Iguana	Iguane terrestre De la Jamaïque	Iguana jamaïquina	1991	CR
	<i>Cyclura cychlura</i>	Northern Bahamian Rock Iguana			1991	VU
	<i>Cyclura nubila</i>	Cuban Ground iguana	Iguane terrestre de Cuba	Iguana cubana	1991	VU
	<i>Cyclura pinguis</i>	Anegada Rock iguana	Iguane terrestre De l'île Anegada	Iguana de Puerto Rico Iguana de Anegada	1991	CR

<i>Cyclura ricordii</i>	Ricord's rock iguana	Iguane de Ricord	La Iguana Ricordi	1991	CR
<i>Cyclura rileyi</i>	San Salvador iguana, Central Bahamian Rock Iguana	Iguane terrestre Des Bahamas	Iguana de Bahamas	1991	EN

	<i>Cyclura stejnegeri</i>	Mona Rhinoceros Iguana, Mona Ground Iguana, Mona Island Iguana	Iguane de Mona	Iguana de Mona	1991	EN
Scincidae	<i>Eumeces egregius</i>	Mole Skink			1991	LC
	<i>Neoseps reynoldsi</i>	Florida sand skink			1991	VU
Sphaerodactylidae (formerly included in Gekkonidae)	<i>Sphaerodactylus micropithecus</i>	Monito Gecko Monito Dwarf Gecko		Salamanquita de Monito	1991	EN
Teiidae	<i>Ameiva polops</i>	St. Croix Ground Lizard			1991	CR
Typhlopidae	<i>Typhlops guadeloupensis</i>	Guadeloupe blind snake	Typhlops de Guadeloupe		1991	NE
Order/ Ordre/ Orden: TESTUDINES						
Cheloniidae	<i>Caretta caretta</i>	Loggerhead sea turtle	Tortue caouanne	Cayuma, Tortuga-marina caguama	1991	VU
	<i>Chelonia mydas</i>	Green sea turtle	Tortue verte	Tortuga verde	1991	EN
	<i>Eretmochelys imbricata</i>	Hawksbill turtle	Tortue imbriquée	Tortuga de carey	1991	CR
	<i>Lepidochelys kempii</i>	Kemp's Ridley turtle	Tortue de Kemp	Tortuga lora	1991	CR
	<i>Lepidochelys olivacea</i>	Olive ridley turtle	Tortue olivâtre	Tortuga Golfina, Olivacea	1991	VU
Dermochelyidae	<i>Dermochelys coriacea</i>	Leatherback sea turtle	Tortue luth	Tortuga laúd	1991	VU
Emyidae	<i>Graptemys oculifera</i>	Ringed map turtle	Tortue annelée		1991	VU
	<i>Pseudemys alabamensis</i>	Alabama red-bellied turtle		Tortuga de vientre rojo De Alabama	1991	EN
Testudinidae	<i>Gopherus polyphemus</i>	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	<i>Caprimulgus noctitherus</i>	Puerto Rican nightjar	Angoulevant de Puerto Rico	Guabairo, Chotacabras portorriqueño	1991	EN
Order/ Ordre/ Orden: CHARADRIIFORMES						
Charadriidae	<i>Charadrius melodus</i>	Piping Plover	Pluvier siffleur, Gravelot siffleur	Chorlo chiflador Frailecillo silbador	1991	NT
Laridae	<i>Sternula antillarum antillarum</i> (formerly <i>Sterna antillarum antillarum</i>)	Least Tern	Petite sterne	Charrancito americano	1991	NE
	<i>Sterna dougallii dougallii</i>	Roseate Tern	Sterne de Dougall	Charrán rosado	1991	NE
Scolopaciidae	<i>Numenius borealis</i>	Eskimo curlew	Courlis esquimau	Zarapito Boreal	1991	CR
Order/ Ordre/ Orden: CICONIIFORMES						
Ciconiidae	<i>Jabiru mycteria</i>	Jabiru	Jabiru d'Amérique	Cigüeña jabirú , tuyuyu	1991	LC
	<i>Mycteria americana</i>	Wood stork	Tantale d'Amérique	Tántalo Americano	1991	LC
Order/ Ordre/ Orden: COLUMBIFORMES						
Columbidae	<i>Patagioenas inornata wetmorei</i> (formerly <i>Columba inornata wetmorei</i>)	Puerto Rican plain pigeon	Pigeon simple de Puerto Rico	Torcaza boba de Puerto Rico	1991	NE
Order/ Ordre/ Orden: FALCONIFORMES						
Accipitridae	<i>Chondrohierax uncinatus</i>	Hook-billed Kite	Milan bec-en-croc	Gavilán pico gancho	1991	LC
	<i>Haliaeetus leucocephalus</i>	Bald Eagle	Pygargue à tête blanche	Águila cabeza blanca	1991	LC
	<i>Harpia harpyja</i>	Harpie Eagle	Harpie féroce	Águila Arpia	1991	NT
	<i>Rostrhamus sociabilis plumbeus</i>	Everglade Snail kite	Milan des marais	Caracolero común	1991	NE
Falconidae	<i>Falco femoralis septentrionalis</i>	Northern Aplomado Falcon	Faucon aplomado	Halcón aleto	1991	NE
	<i>Falco peregrinus</i>	Peregrine Falcon	Faucon pèlerin	Halcón peregrino	1991	LC
	<i>Caracara plancus</i> (formerly <i>Polyborus plancus</i>)	Southern crested Caracara	Caracara huppé	Carancho Caracara quebrantahuesos	1991	LC
Order/ Ordre/ Orden: GALLIFORMES						
Cracidae	<i>Aburria pipile</i> (formerly <i>Pipile pipile</i>)	Trinidad Piping Guan	Pénélope siffleuse	Pava de Trinidad	1991	CR
Phasianidae	<i>Tympanuchus cupido attwateri</i>	Attwater's Greater Prairie-Chicken	Tétras cupidon d'Attwater	Gallo de las praderas De Attwater	1991	NE
Order/ Ordre/ Orden: GRUIFORMES						
Gruidae	<i>Grus americana</i>	Whooping Crane	Grue blanche	Grulla trompetera	1991	EN
	<i>Grus canadensis nesiotis</i>	Sandhill Crane	Grue canadienne	Grulla canadiense	1991	NE
	<i>Grus canadensis pulla</i>	Sandhill crane	Grue canadienne	Grulla canadiense	1991	NE
Order/ Ordre/ Orden: PASSERIFORMES						
Cardinalidae	<i>Passerina ciris</i>	Painted bunting	Passerín nonpareil	Azulillo pintado	2017	NT
Corvidae	<i>Aphelocoma coerulescens coerulescens</i> (formerly <i>Aphelocoma coerulescens cyanotis</i>)	Florida scrub jay	Geai à gorge blanche	Chara floridana	1991	NE
	<i>Corvus leucognaphalus</i>	White-necked Crow	Cornielle d'Hispaniola	Cuervo de cuello blanco	1991	VU
Emberizidae	<i>Ammodramus maritimus mirabilis</i>	Cape Sable Seaside sparrow	Bruant maritime du Cap Sable		1991	NE
	<i>Ammodramus savannarum floridanus</i>	Florida Grasshopper Sparrow	Bruant sauterelle de Floride	Gorrión sabanero Pechileonado de Florida	1991	NE
Fringillidae (formerly included in Emberizidae)	<i>Carduelis cucullata</i>	Red Siskin	Tarin (chardonneret) rouge du Vénézuéla	Cardenalito	1991	NE
	<i>Cinlocerthia ruficauda</i>	Brown Trembler	Trembleur brun	Cocobino Pardo	1991	LC

Mimidae	<i>Ramphocinclus brachyurus</i>	White-Breasted Thrasher	Moqueur à gorge-blanche	Cuitlacoche Pechiblanco	1991	EN
Parulidae (formerly included in Emberizidae)	<i>Vermivora bachmanii</i>	Bachman's warbler	Paruline de Bachman	Bijirita de Bachman	1991	CR
	<i>Setophaga kirtlandii</i> (formerly <i>Dendroica kirtlandii</i>)	Kirtland's Warbler	Paruline de Kirtland	Reinita de Kirtland	1991	NE
Turdidae	<i>Catharus bicknelli</i>	Bicknell's Thrush	Grive de Bicknell	Zorzal/ tordo de Bicknell	2014	VU
Order/ Ordre/ Orden: PELECANIFORMES						
Pelecanidae	<i>Pelecanus occidentalis</i>	Brown Pelican	Pélican brun	Pelicano Pardo	1991	LC
Order/ Ordre/ Orden: PICIFORMES						
Picidae	<i>Picoides borealis</i>	Red-Cockaded Woodpecker	Pic à face blanche	Pico de Florida	1991	NT
Order/ Ordre/ Orden: PROCELLARIIFORMES						
Hydrobatidae	<i>Hydrobates pelagicus</i>	European Storm-Petrel	Océanite tempête	Paño europeo	1991	LC
Procellariidae	<i>Pterodroma hasitata</i>	Black-capped Petrel	Pétrel diabolín	Petrel de Cornilla negra Petrel Antillano	2014	EN

	<i>Puffinus Iherminieri</i>	Audubon's Shearwater	Puffin d'Audubon	Pardela de Audubon	1991	LC
Order/ Ordre/ Orden: PSITTACIFORMES						
Psittacidae	<i>Amazona arausiaca</i>	Red necked parrot / Amazon	Amazone de Bouquet	Amazona Cabenazul	1991	VU
	<i>Amazona barbadensis</i>	Yellow-shouldered Amazon	Amazone à épaulettes jaune	Amazona de Espalda Amarilla	1991	VU
	<i>Amazona guildingii</i>	St Vincent Amazon	Amazone de Saint-Vincent	Amazona de San Vicente	1991	VU
	<i>Amazona imperialis</i>	Imperial Amazon	Amazone impériale	Amazona imperial	1991	EN
	<i>Amazona leucocephala</i>	Cuban Amazon, Rose-throated parrot	Amazone de Cuba	Amazona cubana	1991	NT
	<i>Amazona versicolor</i>	St Lucia Amazon	Amazone de Sainte-Lucie	Amazona de Santa Lucía	1991	VU
	<i>Amazona vittata</i>	Puerto Rican Amazon	Amazone de Puerto Rico	Amazona de Puerto Rico	1991	CR
	<i>Ara macao</i>	Scarlet Macaw	Ara rouge	Guacamayo macao	1991	LC
Class/ Classe/Clase: CHONDRICHTHYES						
Order/ Ordre/ Orden: PRISTICIFORMES						
Pristidae	<i>Pristis pectinata</i>	Smalltooth sawfish	Poisson-scie trident	Pez sierra peine	2017	CR
	<i>Pristis pristis</i>	Largetooth sawfish	Poisson-scie	Pez sierra	2019	CR
Class/ Classe/Clase: MAMMALIA						
Order/ Ordre/ Orden: CARNIVORA						
Canidae	<i>Speothos venaticus</i>	Bush dog	Chien des buissons, Chien des bois	Perrito Venadero	1991	NT
Felidae	<i>Leopardus pardalis</i> (formerly <i>Felis pardalis</i>)	Ocelot	Ocelot	Ocelote	1991	LC
	<i>Leopardus tigrinus</i> (formerly <i>Felis tigrina</i>)	Oncilla, tiger cat	Oncille	Leopardo tigre (formerly Gato tigre)	1991	VU
	<i>Leopardus wiedii</i> (formerly <i>Felis wiedii</i>)	Margay	Margay	Margay	1991	NT
	<i>Puma yagouaroundi</i> (formerly <i>Felis yagouaroundi</i>)	Jaguarundi	Jaguarondi	Yaguarundi	1991	LC
Phocidae	All spp.				1991	EXCTINT
Mustelidae	<i>Pteronura brasiliensis</i>	Giant otter	Loutre géante du Brésil	Lobo del rio	1991	EN
Ursidae	<i>Tremarctos ornatus</i>	Spectacled Bear	Ours à lunettes	Oso de Anteosjos	1991	NE
Order/ Ordre/ Orden: CETACEA (All spp)						
Balaenopteridae	<i>Balaenoptera musculus</i>	Blue whale	Rorqual bleu	Ballena azul	1991	EN
	<i>Balaenoptera physalus</i>	Fin whale	Rorqual commun	Rorcual común, ballena de aleta	1991	EN
	<i>Balaenoptera borealis</i>	Sei whale	Rorqual boréal	Ballena sei	1991	EN
	<i>Balaenoptera edeni</i>	Bryde's whale	Rorqual tropical (de Bryde)	Ballena de Bryde,	1991	DD
	<i>Megaptera novaeangliae</i>	Humpback whale	Baleine a bosse	Ballena jorobada	1991	LC
	<i>Balaenoptera acutorostrata</i>	Common minke whale	Petit Rorqual	Ballena minke	1991	LC
Balaenidae	<i>Eubalaena glacialis</i>	North Atlantic right whale	Baleine franche des Basques	Ballena franca del norte	1991	EN
Physeteridae	<i>Physeter macrocephalus</i>	Sperm whale	Cachalot	Cachalote	1991	VU
	<i>Kogia breviceps</i>	Pygmy sperm whale	Cachalot pygmée	Cachalote pigmeo	1991	DD
	<i>Kogia Simia</i> (formerly <i>Kogia simus</i>)	Dwarf sperm whale	Cachalot nain	Cachalote enano	1991	DD
Ziphiidae	<i>Ziphius cavirostris</i>	Cuvier's beaked whale	Baleine à bec de Cuvier	Ballena de Cuvier	1991	LC
	<i>Mesoplodon europaeus</i>	Gervais' beaked whale	Baleine à bec de Gervais	Ballena de pico de Gervais	1991	DD
	<i>Mesoplodon densirostris</i>	Blainville's beaked whale	Baleine à bec de Blainville	Ballena de pico de Blainville	1991	DD
	<i>Mesoplodon mirus</i>	True's beaked whale	Mésoplodon de True	Ballena de pico de True	1991	DD
	<i>Mesoplodon bidens</i>	Sowerby's beaked whale	Mésoplodon de Sowerby	Ballena de pico de Sowerby	1991	DD
	<i>Orcinus orca</i>	Killer whale	Orque	Orca	1991	DD
Delphinidae	<i>Feresa attenuata</i>	Pygmy killer whale	Orque pygmée	Orca pigmea	1991	DD
	<i>Pseudorca crassidens</i>	False killer whale	Fausse orque	Orca falsa	1991	DD
	<i>Globicephala macrorhynchus</i>	Short-finned pilot whale	Globicéphale tropical	Calderón de aleta corta	1991	DD
	<i>Peponocephala electra</i>	Melon-headed whale	Péponocéphale	Delfín cabeza de melón	1991	LC
	<i>Lagenodelphis hosei</i>	Fraser's dolphin	Dauphin de Fraser	Delfín De Fraser, Borneo	1991	LC
	<i>Stenella attenuata</i>	Pantropical spotted dolphin	Dauphin tacheté pantropical	Delfín manchado pantropical	1991	LC
	<i>Stenella frontalis</i>	Atlantic spotted dolphin	Dauphin tacheté atlantique	Delfín manchado del Atlántico	1991	DD
	<i>Stenella longirostris</i>	Spinner dolphin	Dauphin à long bec	Delfín rotador	1991	DD
	<i>Stenella clymene</i>	Clymene dolphin	Dauphin de clymène	Delfín de clymen	1991	DD
	<i>Delphinus delphis</i>	Short-beaked Common Dolphin	Dauphin commun	Delfín común de pico corto	1991	LC
	<i>Tursiops truncatus</i>	Common bottlenose dolphin	Grand dauphin	Delfín nariz de botella	1991	LC
	<i>Stenella coeruleoalba</i>	Striped dolphin	Dauphin bleu et blanc	Delfín listado	1991	LC
	<i>Grampus griseus</i>	Risso's dolphin	Dauphin de Risso	Delfín de Risso	1991	LC
	<i>Steno bredanensis</i>	Rough-toothed dolphin	Steno rostré, steno à rostre étroit	Delfín de dientes rugosos	1991	LC

	<i>Sotalia fluviatilis</i>	Tucuxi	Sotalie	Tucuxi	1991	DD
Order/ Ordre/ Orden: CHIROPTERA						
Molossidae	<i>Tadarida brasiliensis</i>	Brazilian Free-tailed Bat	Molosse du Brésil	Murciélago cola de ratón	1991	LC
Mormoopidae	<i>Pteronotus davyi</i>	Davy's naked-backed bat	Ptéronote de Davy, Chauve-souris à dos nu	Murciélago de espalda desnuda	1991	LC
Phyllostomidae	<i>Ardops nicholli</i>	Tree Bat	Ardops des Petites Antilles		1991	LC
	<i>Brachyphylla cavernarum</i>	Antillean Fruit-eating Bat	Brachyphylle des Antilles		1991	LC
	<i>Chiroderma improvisum</i>	Guadeloupe Big-eyed Bat	Chiroderme de la Guadeloupe		1991	EN
Vespertilionidae	<i>Eptesicus guadeloupensis</i>	Guadeloupe Big brown bat	Sérotine de la Guadeloupe	Gran murciélago Marrón de Guadalupe	1991	EN
Order/ Ordre/ Orden: CINGULATA (formerly: EDENTATA)						
Dasypodidae	<i>Priodontes maximus</i> (formerly <i>Priodontes giganteus</i>)	Giant armadillo	Tatou géant	Armadillo gigante	1991	VU
Order/ Ordre/ Orden: LAGOMORPHA						

<i>Leporidae</i>	<i>Sylvilagus palustris hefneri</i>	Lower keys marsh rabbit			1991	CR
Order/ Ordre/ Orden: DIDELPHIMORPHIA (formerly MARSUPIALIA)						
<i>Didelphidae</i>	<i>Chironectes minimus</i>	Water Opossum, Yapok	Opossum aquatique, yapock	Cuica de agua, Tlacuache acuático	1991	LC
Order/ Ordre/ Orden: PRIMATES						
<i>Atelidae</i> (formerly: <i>Cebidae</i>)	<i>Alouatta palliata</i>	Mantled Howler Monkey	Singe hurleur à manteau	Mono congo	1991	LC
Order/ Ordre/ Orden: RODENTIA						
<i>Capromyidae</i>	<i>Mesocapromys angelcabrerai</i> (formerly <i>Capromys angelcabrerai</i>)	Cabrera's hutia			1991	EN
	<i>Mesocapromys auritus</i> (formerly <i>Capromys auritus</i>)	Large-Eared hutia		Jutía rata	1991	EN
	<i>Mysateles garridoi</i> (formerly <i>Capromys garridoi</i>)	Garrido's hutia		Jutía de Garrido	1991	CR
	<i>Mesocapromys nanus</i> (formerly: <i>Capromys nanus</i>)	Dwarf hutia	Hutia nain	Jutía enana	1991	CR
	<i>Mesocapromys sanfelipensis</i> (formerly <i>Capromys sanfelipensis</i>)	San Felipe Hutia		Jutía de la Tierra	1991	CR
<i>Dasyproctidae</i>	<i>Dasyprocta guamara</i>	Orinoco agouti		Guamara	1991	NT
<i>Cricetidae</i> (formerly included in <i>Muridae</i>)	<i>Neotoma floridana smalli</i>	Key Largo Woodrat			1991	NE
	<i>Peromyscus gossypinus allapaticola</i>	Cotton mouse	Souris de coton		1991	NE
	<i>Peromyscus polionotus</i> (formerly <i>Peromyscus polionotus allophrys</i> <i>Peromyscus polionotus ammobates</i> <i>Peromyscus polionotus niveiventris</i> <i>Peromyscus polionotus phasma</i> <i>Peromyscus polionotus trissyllepsis</i>)	Oldfield Deer mouse/mouse			1991	LC
Order/ Ordre/ Orden: SIRENIA (All spp)						
<i>Trichechidae</i>	<i>Trichechus manatus</i>	West Indian manatee	Lamantin des Antilles	Manatí antillano	1991	VU
Class/ Classe/Clase: ANTHOZOA						
Order/ Ordre/ Orden: SCLERACTINIA						
<i>Acroporidae</i>	<i>Acropora cervicornis</i>	Staghorn coral	Corne de cerf	Coral cuerno de ciervo	2014	CR
	<i>Acropora palmata</i>	Elkhorn coral	Corne d'élan	Coral cuerno de alce	2014	CR
<i>Faviidae</i>	<i>Montastraea annularis</i>	Boulder star coral	Corail étoile massif		2014	EN
	<i>Montastraea faveolata</i>	Mountainous star coral	Corail étoile massif		2014	EN

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	Coastal/Mar Coastal	T/CB	SF	SGF	MPA mgmt	M/M	R	ER	Gov/Pol	Sust L	DB	Govt	Civ Soc	Private		
Caribbean Aqua-Terrestrial Solutions (CATS) Programme 2013 -2017	Caribbean Public Health Agency (CARPHA) OECS 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		
CCI and CBF 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. www.caribbeanchallengeinitiative.org 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		
CARIBNODE 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. http://www.caribnode.org	Antigua and Barbuda Dominica Dominican Republic				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	Coastal/Mar Coastal	T/CB	SF	SGF	MPA mgmt	M/M	R	ER	Gov/Pol	Sust L	DB	Govt	Civ Soc	Private
			Grenada Haiti Jamaica Saint Kitts and Nevis Saint Lucia Saint Vincent and the Grenadines																	
Caribbean Coral Strategy 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.																		
Caribbean Marine Protected Area Management Network and Forum (CaMPAM) Ongoing	UNEP-CEP/SPAW 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. Maintains the Marine Protected Areas Database http://campam.gcfi.org/CaribbeanMPA/CaribbeanMPA.php	Wider Caribbean				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	Coastal/Mar Coastal	T/CB	SF	SGF	MPA mgmt	M/M	R	ER	Gov/Pol	Sust L	DB	Govt	Civ Soc	Private
CANARI Coastal and Marine Livelihoods and Governance Programme 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. CANARI has developed the People Managing Oceans: Civil Society Action Programme of the CLME+ SAP. www.canari.org	Insular Caribbean				x	x			x					x	x			
Caribbean and North Brazil Shelf Large Marine Ecosystem Project (2015-2020) Strategic Action Programme (CLME+ SAP) 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	

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	Coastal/Mar Coastal	T/CB	SF	SGF	MPA mgmt	M/M	R	ER	Gov/Pol	Sust L	DB	Govt	Civ Soc
Coastal Zone Management Trust	State Government of Quintana Roo, Mexico; TNC	<p>A trust fund (Fideicomiso in Spanish) that receives taxes collected by the government from local hotel owners and the tourism industry.</p> <p>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.</p> <p>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.</p>	Mexico	x					x						x			x	
<p>Critical Ecosystem Partnership Fund (CEPF)</p> <p>2019 – to be confirmed/ announced</p>	<p>Conservation International</p> <p>[Regional Implementation Team for new investment to be identified]</p>	<p>Supports the development of conservation strategies in biodiversity hotspots focusing on KBAs.</p> <p>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.</p>	Antigua and Barbuda; The Bahamas; Barbados; Dominica; the Dominican Republic; Grenada; Haiti; Jamaica; Saint Lucia; St. Kitts and Nevis; and St. Vincent				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	Coastal/Mar Coastal	T/CB	SF	SGF	MPA mgmt	M/M	R	ER	Gov/Pol	Sust L	DB	Govt	Civ Soc
			and the Grenadines																
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
Eastern Caribbean Marine Managed Areas Network (ECMMAN) Project 2013-2017	TNC OECS Secretariat, Social and Sustainable Development Division; UNEP SPAW-Regional Activity Centre (RAC) through CaMPAM;	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	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	

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	Coastal/Mar Coastal	T/CB	SF	SGF	MPA mgmt	M/M	R	ER	Gov/Pol	Sust L	DB	Govt	Civ Soc	Private
	CRFM through the Caribbean Network of Fisherfolk Organisations (CNFO)	mechanisms on marine and coastal resources, and sustainable financing.																		
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		
Global Coral Reef Restoration Project	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	Curaçao, Mexico, U.S. Virgin Islands.	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	Coastal/Mar Coastal	T/CB	SF	SGF	MPA mgmt	M/M	R	ER	Gov/Pol	Sust L	DB	Govt	Civ Soc	Private
Ongoing		restoration initiative. The project started in the Caribbean in 2017 and is planned to expand into the Pacific region after its initial phase.																		
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		
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	
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 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	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			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	Coastal/Mar Coastal	T/CB	SF	SGF	MPA mgmt	M/M	R	ER	Gov/Pol	Sust L	DB	Govt	Civ Soc	Private
Regional Initiative (CARIWET)	Committee. (Coordinated by Jamaica and Cuba)	added in 2016, and the work plan was extended to 2024 (Ramsar Convention Secretariat, 2018).																		
Regional Activity Centre for the Protocol Concerning Specially Protected Areas and Wildlife for the Wider Caribbean Region (SPA-W-RAC)	UNEP-CEP, CaMPAM, GCFI, Wider Caribbean Sea Turtle Conservation Network (WIDECASST), World Commission on Protected Areas (WCPA)	Implements the SPAW Protocol	Wider Caribbean	x	x	x	x	x			x					x			x	
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. 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												United Nations Educational, Scientific and Cultural Organization (UNESCO) Man and the Biosphere (MAB) Programme	
	Cartagena Convention & Oil Spills Protocol	SPAW Protocol	LBS Protocol	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
Antigua and Barbuda	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
The Bahamas	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	
Barbados	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓	✓	✓
Belize	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Brazil				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Colombia	✓	✓		✓	✓	✓	✓		✓	✓		✓	✓	✓
Costa Rica	✓		✓	✓	✓	✓	✓	✓	✓	✓			✓	✓
Cuba	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Dominica	✓			✓	✓	✓	✓			✓		✓	✓	✓
Dominican Republic	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
France	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Grenada	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	
Guatemala	✓			✓	✓	✓	✓		✓	✓		✓	✓	✓
Guyana	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	
Haiti						✓				✓			✓	✓
Honduras	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Jamaica	✓		✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓

	TREATY														
STATE	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												
Mexico	✓			✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
Netherlands	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Nicaragua	✓			✓	✓	✓	✓		✓	✓		✓	✓	✓	
Panama	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
St. Kitts and Nevis	✓			✓	✓	✓	✓			✓	✓	✓	✓	✓	
Saint Lucia	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
St. Vincent and the Grenadines	✓	✓		✓	✓	✓	✓			✓		✓	✓		
Suriname				✓	✓	✓	✓		✓	✓		✓	✓		
Trinidad and Tobago	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	
United Kingdom	✓			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
United States of America	✓	✓	✓				✓		✓	✓		✓	✓	✓	
Venezuela	✓	✓		✓	✓	✓	✓		✓	✓		✓	✓	✓	

Appendix 6

Sites Listed under the Ramsar Convention

	Countries to confirm these contain coral reefs, mangroves and/or seagrass beds
	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 Spiritus	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

Country Name	Ramsar sites	Date of designation	Region,province,state	Area (ha)
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				
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

Country Name	Ramsar sites	Date of designation	Region,province,state	Area (ha)
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
Montserrat				
Nicaragua	Cayos Miskitos y Franja Costera Inmediata	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 Ciénaga 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 25⁵² countries from the CLME+ SPAW Region.

Country	LME	Ecoregion	NBSAP Submission	NBSAP 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	

⁵² Excludes Overseas Territories and the United States.

Country	LME	Ecoregion	NBSAP Submission	NBSAP 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
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
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	No, but activities	Yes, but these are monitoring programmes for	Yes	Yes

Country	LME	Ecoregion	NBSAP Submission	NBSAP 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
								addressing mangroves	addressing seagrass	Climate Change and pollution not biodiversity		
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	
Nicaragua	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
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

Country	LME	Ecoregion	NBSAP Submission	NBSAP 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
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