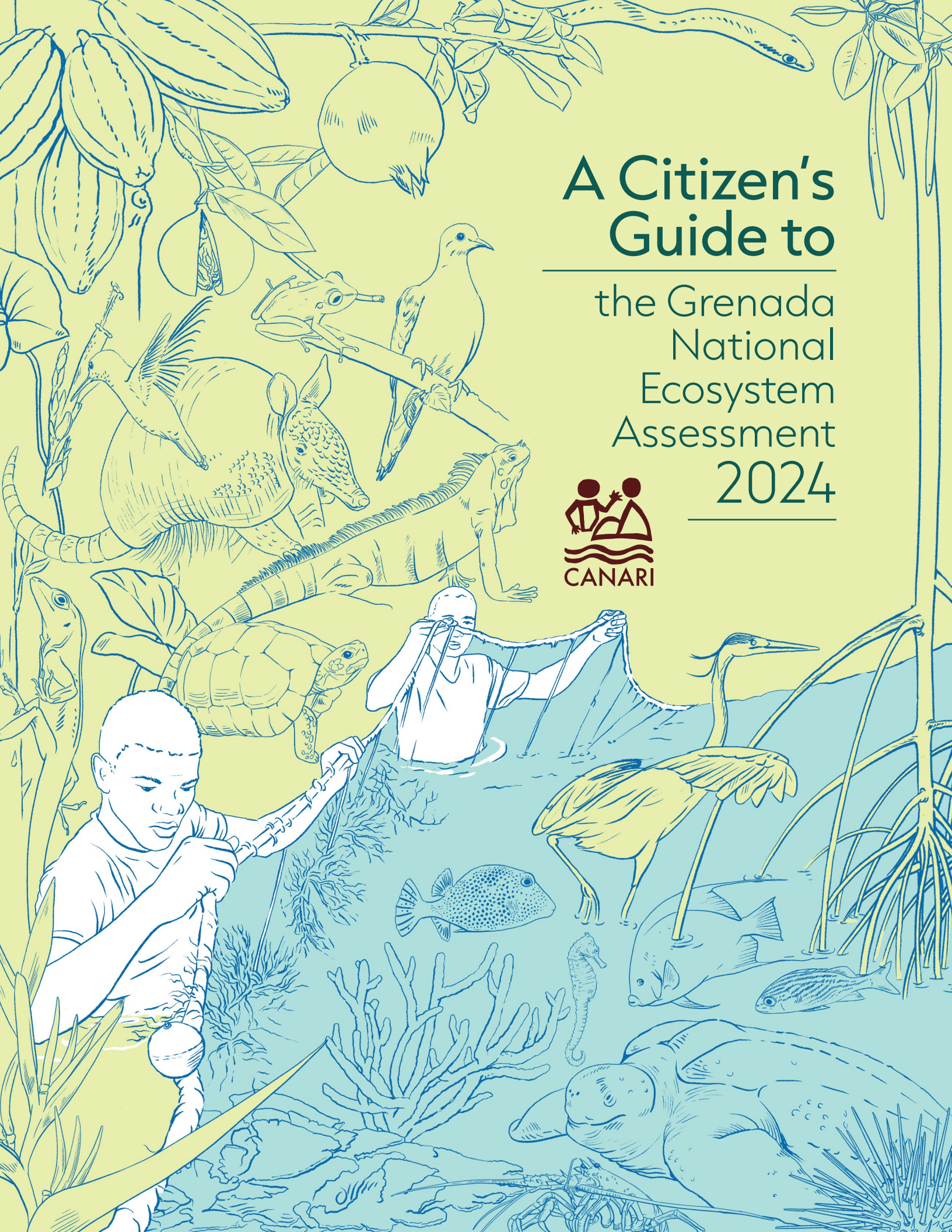
A Citizen's Guide to

the Grenada National Ecosystem Assessment 2024

CANARI



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This document has been produced by the Caribbean Natural Resources Institute (CANARI) under the project on "Capacity building and knowledge products to enhance the use and uptake of the National Ecosystem Assessment of the tri-island state of Grenada, Carriacou and Petite Martinique." This project is funded Global Environment Facility through the Integrating Water, Land and Ecosystems Management in Caribbean Small Island Developing States (GEF-IWEco) Project implemented by the United Nations Environment Programme (UNEP), under which Grenada is a beneficiary.

Preface

Recognising that "real and genuine action on the ground is what really matters" is the strength of civil society organisations, as they are being called upon to participate in diverse spaces, and at various levels of power and authority in decision making processes and implementation with respect to actions and interventions to realise sustainable futures. This Citizen's Guide is a significant measure to strengthen the capacity of civil society organisations to enhance their voice and participation in these spaces, both decision making and implementation.

It is significant that the Grenada National Ecosystem Assessment has not only taken into account the needs of the policy makers but also the needs of civil society organisations engaged in various environmental management activities and the broader, interested civil society sector at large. The facilitator of the process of assessment on behalf of the Government of Grenada, the Caribbean Natural Resources Institute (CANARI), must be congratulated for positively responding to the request/recommendation of the civil society stakeholders. Funds had to be sourced separately in order to realise this commitment.

It is anticipated that the production of this Citizen's Guide sets a precedent so that, in the future, in recognition of the important roles of both civil society and the policy makers, the needs of both will be equally considered in the conduct of these assessment exercises.

Civil society organisations and citizens must now keep their commitment to use the document to its fullest extent to guide their contributions both in actions and in words.

Civil Society Co-chair of the Grenada National Ecosystem Assessment – Sandra Ferguson

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List of Acronyms

CANARI	Caribbean Natural Resources Institute
CARICOM	Caribbean Community
CBD	Convention on Biological Diversity
CH_4	Methane
CO_2	Carbon dioxide
CSO	Civil society organisation
CSA	Climate-smart agriculture
EBSA	Ecologically and Biologically Significant Marine Areas
EEZ	Exclusive Economic Zone
FADs	Fish Aggregating Devices
GDP	Gross Domestic Product
IAS	Invasive Alien Species
IBA	Important Bird Area
ICCO	International Cocoa Organization
IKI	International Climate Initiative
ILK	Indigenous and local knowledge
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
kt	Kilotonnes
M	Million
M&E	Monitoring and evaluation
MEAs	Multilateral environmental agreements
MPA	Marine Protected Area
MOALFC	Ministry of Agriculture & Lands, Forestry, Marine Resources & Cooperatives
NBSAP	National Biodiversity Strategy and Action Plan
NCP	Nature's Contributions to People
NEA	National Ecosystem Assessment
NGO	Non-governmental organisation
NTFP	Non-Timber Forest Products
OBIS	Ocean Biodiversity Information System
OECD	Organisation for Economic Co-operation and Development
OECS	Organisation of Eastern Caribbean States
PES	Payment for Ecosystem Services
SCUBA	Self Contained Underwater Breathing Apparatus
SIDS	Small Island Developing States
SLM	Sustainable land management
SST	Sea surface temperature
tC	Total carbon
tCO2	Total carbon dioxide
tCO2e	Tonnes of carbon dioxide equivalent
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNEP-WCMC	United Nations Environment Programme World Conservation Monitoring Centre
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
VME	Vulnerable Marine Ecosystems

1. Introduction

The development of Grenada's National Ecosystem Assessment (NEA) was undertaken by the Government of Grenada through a process facilitated by the Caribbean Natural Resources Institute (CANARI) from 2019 to 2023. This process was characterised by the contributions of many stakeholders, including technical officers from the Environment Division and other State agencies, local, regional and international experts, representatives of civil society organisations (CSOs), and local communities. It is hoped that the process followed for the development of the NEA, especially the high level of stakeholder engagement and incorporation of local knowledge, can serve as a blueprint for undertaking similar exercises in other Caribbean countries, and in other parts of the globe.

A special aspect of the development process was the decision to produce this Citizen's Guide to the NEA. In early stakeholder discussions, representatives of civil society (Figure 1) requested the development of a product that would package the NEA document into a format that can allow for easy extraction and communication of information relevant to their environmental management activities. In response to this request, CANARI sought funding from the Global Environment Facility Integrating Water, Land and Ecosystems Management in Caribbean Small Island Developing States (GEF-IWEco) project implemented by the United Nations Environment Programme (UNEP), under which Grenada is a beneficiary. This resulted in the GEF-IWEco project on "Capacity building and knowledge products to enhance the use and uptake of the National Ecosystem Assessment of the tri-island state of Grenada, Carriacou and Petite Martinique", the outputs of which include this Guide as well as communications capacity building for civil society to effectively use and promote the information in the Grenada NEA.

The Guide provides synopses of the content of each chapter of the NEA, but with general re-organisation of the content where relevant and where this may improve flow, readability and promote 'connectedness' of information. It is hoped that the Citizen's Guide will be utilised to the full extent available, in order to promote continuous improvement and wise decision-making regarding Grenada's natural environment and its citizens' sustainable futures. The Guide does not replace the NEA document; rather, it aims to facilitate the uptake of the NEA by civil society: assisting in further dissemination of information to various audiences; providing data for use in informed engagement activities; and proposing ideas for action agendas of individual groups. Users of the guide are encouraged to review the main document if additional information is needed. In particular, users can access the references and sources of data in this Citizen Guide from the main NEA document. The main NEA document in turn can be accessed online at https://canari.org/grenada-ecosystem-assessment-linking-science-and-policy/ and cited as:

Agard, J., St. Louis, A., and Boodram, N. (eds.) (2023) *Grenada National Ecosystem Assessment*. St. Georges, Grenada: Government of Grenada; Barataria, Trinidad and Tobago: Caribbean Natural Resources Institute.

The Citizen's Guide begins with a short description of the main NEA document and then describes the following ecosystems: Agricultural and Agroecosystems, Coastal, Deep Ocean, Freshwater,

Figure 1. First civil society meeting for the Grenada NEA. (Photo credit:CANARI)

Forest and Offshore Islands. Information is presented on each ecosystem's status, economic, social and intrinsic value, threats and issues, trends, and information gaps. Each ecosystem's assessment also includes a section on maximising ecosystem services which expands on possible policy, technology and governance actions that can help conserve and sustainably manage ecosystems, in turn protecting, supporting and enhancing the services these ecosystems provide to Grenadians.

The Guide also includes specific sections on genetic resources, climate resilience, descriptions of future scenarios and has a final concluding section elaborating on holistic options for maximising ecosystem services for all ecosystem types, paying special attention to protecting genetic resources and ensuring climate resilience.

In the appendices, the Guide collates lists which may be useful to civil society focusing on multilateral agreements, and related laws and policies relevant to ecosystem management in Grenada.

2. The Grenada National Ecosystem Assessment

An ecosystem assessment is a social process through which scientific findings about the causes of ecosystem change, their consequences for human well-being, and the possible management and policy options to address these changes are evaluated. Ecosystem assessments can play an important role in synthesising and communicating complex information and can both inform and influence decision making processes. National Ecosystem Assessments (NEAs) provide information on the status and trends on biodiversity and ecosystem services in a given country, their drivers of change, the impacts of those drivers now and in the future, and the effectiveness of interventions and responses.

Ecosystem assessments also provide information on the value of genetic and ecosystem resources, as well as accompanying ecosystem services in one or more of the following four categories: provisioning, regulation, cultural and supporting (Figure 2). Some of those services are 'direct' in that they are consumed, utilised or experienced by human populations. Others are 'indirect' in that they are the valued outcomes or positive (if sometimes intangible) effects of maintaining intact ecosystems and a rich store of genetic and ecosystem biodiversity. Provisioning services, such as food, water and land and the regulatory services they provide–are felt both directly and indirectly. Cultural services and key constituents of well-being such as mental health, recreation, tourism and spiritual experiences are all supported by protecting habitats for species and genetic diversity.

Whether direct or indirect, intermediate or final, these services are interconnected and, as such, any increase in our knowledge of these services–and the connections among them–will help Grenadians make the valuations and decisions essential to securing our natural stock for future generations.

The value of the aforementioned services can be thought of through the lenses of instrumental, intrinsic or relational values. Instrumental values, sometimes perceived as 'economic' values, are the easiest to determine in monetary terms since they are often traded in the market (e.g. export data or market price). Unlike instrumental value, intrinsic value refers to nature's value beyond its 'usefulness' to humans. Many people value ecosystems simply for their diversity, wildness, beauty and wonder. Lastly, relational values examine value in terms of community and well-being of individuals that is not traded in the market or substituted e.g. Indigenous peoples' sense of belonging created through their livelihood, hunting or agriculture which is tied to specific geographic locations. Nature's Contributions to People (NCP) is a related concept that refers to the positive and negative contributions of living nature (diversity of organisms, ecosystems, and their associated ecological and evolutionary processes) to people's quality of life (Table 1). NCP provides multiple units of valuation, including scientific knowledge and Indigenous ecological knowledge, and does not limit values to one unit of measurement.

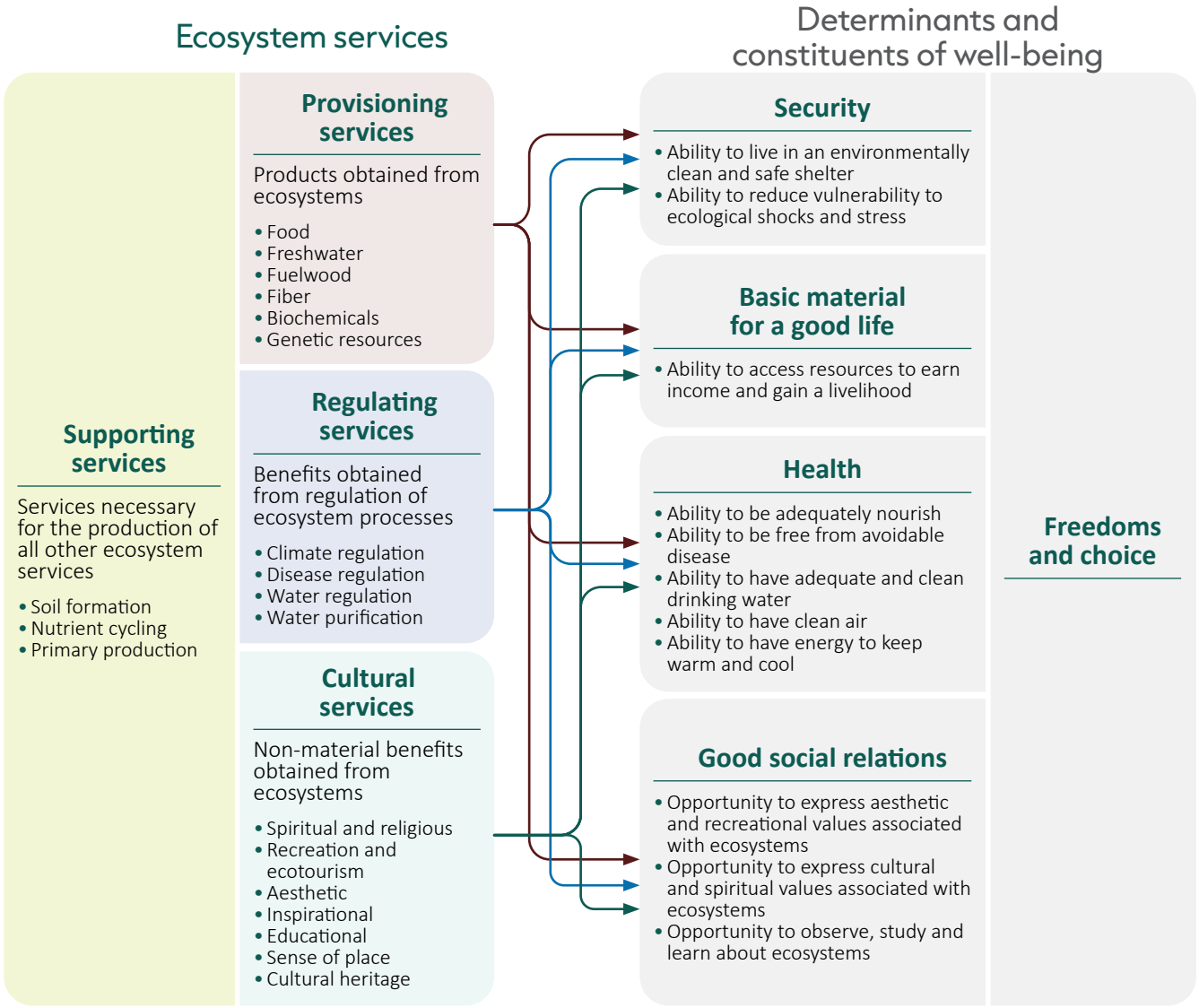


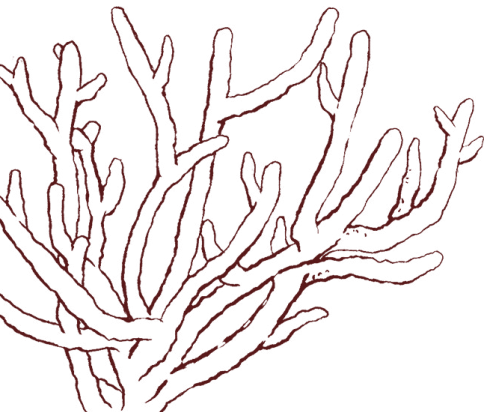
Figure 2. Ecosystem services and human well-being (Millennium Ecosystem Assessment, 2003)

Table 1. Comparison of ecosystem services and NCP value assessment

	Ecosystem services	NCP
Definitions	The benefits humans derive from ecosystems – the support of sustainable human well-being that ecosystems provide	The contributions, both positive and negative, of living nature (diversity of organisms, ecosystems, and their associated ecological and evolutionary processes) to people's quality of life
Type of values assessed	Instrumental values Intrinsic values	• Relational values • Instrumental values • Intrinsic value
Unit of valuation (possibility of aggregation)	Value monism – Single value unit, often monetary unit, enabling values to be aggregated into one unit	Value pluralism – Plural unit of valuation, including both scientific knowledge as well as Indigenous ecological knowledge; not allowing values to be aggregated into one unit
Main purpose of assessment	To convey the significance of the value of ecosystems to policy makers	To incorporate the central and pervasive role played by culture in determining our relationship with ecosystems and to incorporate Indigenous ecological knowledge held by various stakeholders in the policy making process

The Grenada NEA provides information on the status, trends and threats facing Grenada's forest, coastal, marine, deep ocean, freshwater, and agricultural ecosystems. Further, it gives an overview of the economic and other values these ecosystems and services provide to human well-being. The assessment also considers the impact of climate change on these ecosystems and the importance of ecosystems for climate resilience in Grenada, with a special focus on the adaptive capacity of ecosystems, households and businesses, and gender relations. Finally, the assessment outlines ways in which the country has maximised or can maximise the provision and continuance of ecosystem services, including national policy decisions and actions.

The Grenada NEA was funded by the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety, and Consumer Protection, with technical support from the NEA Initiative at the United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC), which is part of the Biodiversity and Ecosystem Services Network (BES-Net), working in partnership with the United Nations Development Programme (UNDP) and the United Nations Educational, Scientific and Cultural Organization (UNESCO).



3. Status, trends, threats, and value of ecosystems

This section of the Citizen's Guide provides information on the status, trends, threats, and the value of various ecosystems in Grenada. It also describes options to conserve and maximise the goods and services provided by each ecosystem including potential policy responses. Each ecosystem's information is presented in turn as follows:

- Agriculture and Agroecosystems
- Coastal Ecosystems
- Deep Ocean Ecosystems
- Forest Ecosystems
- Freshwater Ecosystems
- Offshore Island Ecosystems

Agriculture and Agroecosystems

Agriculture and agroecosystems refer to ecosystems where original natural or cultivated forest landscapes are modified for human food production.

These systems provide habitat for both native and domesticated fauna and incorporate plants e.g. fruit trees and vegetables.

 Crop production	• Fruit trees are often used on Grenadian farms for windbreaks for short-term crops, as well as environmental and economic purposes (e.g. harvest of fruits, seeds, plant materials). • Historically, forests were repurposed to grow major export crops like banana, nutmeg and cocoa.
 Poultry	• Local egg production is the mainstay of the poultry industry. The market is made up of 98% chicken eggs. • Chicken is the main meat produced locally. There are smaller local markets for turkey, quail and duck. Poultry meat supply does not meet local demand. Demand is largely supplied through imports. Medium and small-scale chicken meat production is the norm. • Small-scale production of turkey meat peaks around the Christmas season. • Duck farming is carried out across the island year-round. There is generally a low demand for this meat.
 Livestock	• There is no agricultural zoning in Grenada; livestock farming is sporadic across the country. • Pig farming is small scale (1–5 pigs) in enclosures at households, or large-scale (5–500 pigs) in concrete penned housing. The raw materials used in pig ration production are imported. • In sheep and goat farming, the animal is tied to a tree or kept in stalls on a rotating basis. On Carriacou, animals are left to roam freely and/or released on uninhabited lands. Animals are mainly reared for meat production; milk and cheese are produced on a smaller scale. • Cattle production is not extensive, with only small (1–10) to medium (10–100) herd sizes. Cattle are fed through a grass 'cut and carry' system and are also fed agricultural by-products from corn and vegetable farming.

Apiculture

- Approximately 1,400 beehives are managed by 40 beekeepers.
- An average of 18kg of honey/hive is produced per year.
- Trade in honey is small-scale; Barbados is a major market.

Table 2. Food type quantities met by local production

Food	Fruits	Vegetables including carrots	Eggs	Poultry	Roots and tubers	Herbs	Pork (fresh)	Lamb (fresh)	Beef and beef products
Demand met by local production (%)	93	50	100	13–25	30	95	75	10	5

Agroecosystems cover 12,485ha in Grenada as estimated in 2014. See Figure 3 below.

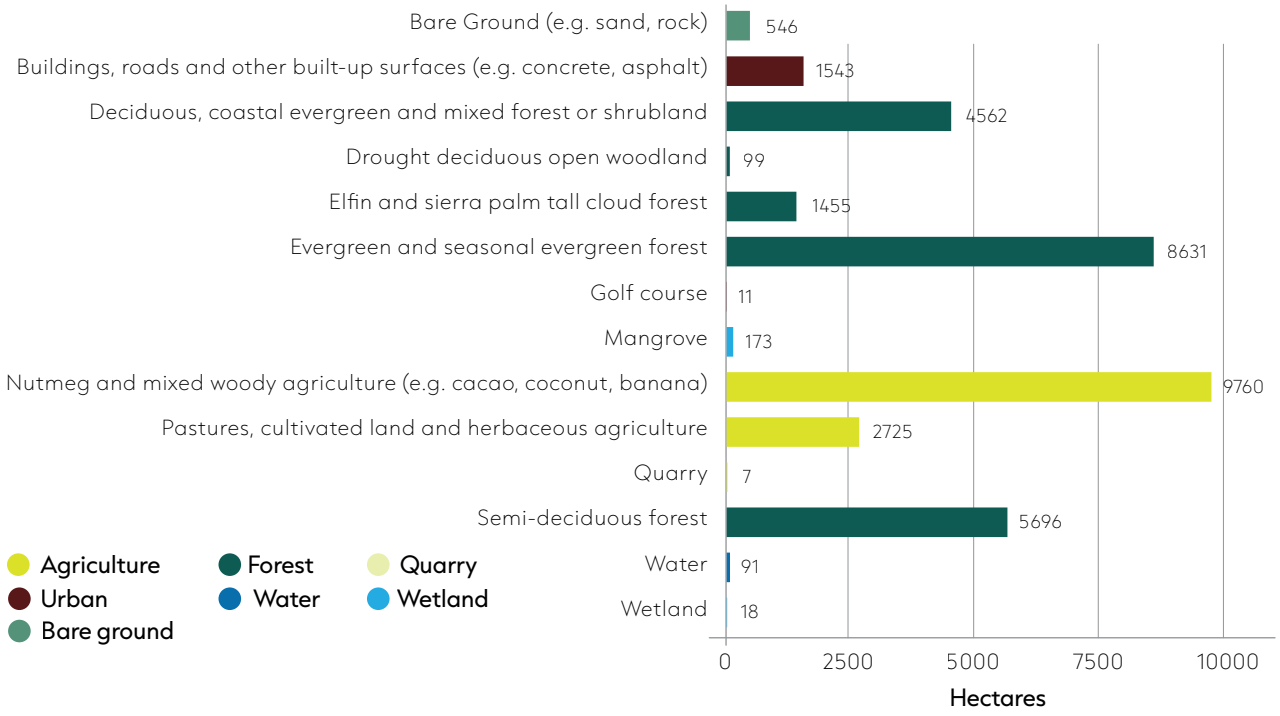


Figure 3. Aggregate Land Use in 2014 from the British Geological Survey (CHARIM, 2014). The data were created using Earth Observation satellite data for 2014. These data only include mainland Grenada

Value of Agroecosystems

Socio-economic development in Grenada relies heavily on the agricultural sector. The Government of Grenada values agroecosystem products as goods for food, and genetic resources for exploration and benefit sharing. Healthy agroecosystems are also important for climate resilience.

Crop value

Exported fruit tree products were valued at US$0.03 M **(EC$0.08 M)** for **14 tonnes** in 2019

A conservative estimate of the agroprocessing sector is US$3.9 M **(EC$10.6 M)** per **year**

The **agricultural sector** accounts for around **11%** of the country's **labour force**. Production of the major export crops are a significant source of income, especially for male producers

Approximately **39%** of the registered agroprocessors consist of **spice**, **craft** and **cosmetic** vendors; **64%** of agroprocessors are **women**

Nutmeg and mace	• Grenada is the world's second largest producer of nutmeg, and the 12th largest exporter of nutmeg, mace, and cardamon. • Estimate of 2017-2019 export value: nutmeg (seed)- US$8.03 M (EC$21.70 M); and mace - US$5.38 M (EC$14.53 M). • Value-added commodities from by-products of nutmeg estimated at US$2.47–4.04 (EC$6.68–10.90) per 30g.
Cocoa	• Cocoa is a high value product recognised by the International Cocoa Organization (ICCO) as 100% fine flavour. • Approximately 85% of Grenada's cocoa is exported to Europe. • Estimated value of cocoa exports in 2019 was US$3.28 M (EC$8.86 M). • Local manufacture estimated at 91,000kg of chocolate in 2019; sales estimated at US$1.11 M (EC$3 M). • Diversification in product range creates employment for locals and added revenue.
Soursop	• One of Grenada's most lucrative agricultural sub-sectors. Generates significant foreign exchange earnings; attracts investment by farmers, exporters, processors and buyers. • Priority crop for food and nutrient security and improving smallholder livelihoods. • Grenada is the only country which can export fresh soursop to the USA market because of the absence of key pests. • Demand for soursop has increased in recent years. In 2017, 486,500kg of fruit were exported, gaining a total revenue of US$2.67 M.

- Agrotourism estimated value: US$25 (EC$67.56)/hour/tour (1-15 persons), based on willingness to pay.
- Grenada can benefit from a conservative estimate of approximately US$200,000 (EC$540,510)/year in revenues from carbon pricing with an increase as nutmeg and mixed woody agriculture stands mature.

Table 3. Quantity of carbon sequestration (tCO_2/ha/tree over 20 years) potential for various crops

Crop	Trees/ha (spacing)	Carbon Sequestration (tCO_2e)
Nutmeg	123 (9m x 9m)	0.3480
Cocoa	730 (3.7m x 3.7m)	0.0696
Banana	730 (3.7m x 3.7m)	0.1590

Value of animal products

Important associated products from bees include bee pollen, wax, royal jelly, propolis, and venom. A 148ml bottle of honey costs ~US$13 (~EC$35), a single hive can bring in US$1,664 (~EC$4497)/hive/year in honey. A large bottle (750ml) can cost up to US$27.78 (EC$75)/bottle.

Threats and Issues

Land clearing	• Clearing of lands for commercial production (over 75% of total land space) is a significant threat to biodiversity. • Clearing and cultivation of areas near rivers can exacerbate erosion of soils into rivers and lakes especially on steep slopes, sometimes causing landslides.
Pollution	• Pesticides, herbicides and fertilisers used on farmlands, leach into rivers during heavy rainfall negatively impacting downstream habitats; can even impact reefs. • Health regulations are not heavily enforced, and pig farms can be found in residential areas near rivers. Wash-off from many pig farms enters rivers and streams directly.
Water	• Lack of a reliable water supply is a major challenge on Carriacou and Petite Martinique.
Climate change concerns	• National drought management plan (2019) is yet to be adopted. • Insufficient access to improved and drought resistant crop and livestock varieties. • Climate-driven loss/reduction in species-specific pollinators of native species. Declining pollinator diversity and abundance have negative effect on agricultural production. • More intense, unpredictable rains can cause leaching of nutrients from soil, flower loss, increased root rot and other crop diseases. Intense rains can increase soil erosion and fertiliser runoff which can threaten surface water quality and reef health. • Existing drains cannot cope with an increased frequency of extreme flood events. • Sea level rise can increase coastal habitat salinity threatening 3% of agricultural lands. • Habitat conversion from wildfires will reduce ecosystem resilience to climate change. • Women farmers face specific challenges coping with these combined stressors especially in the absence of external support, labour and time-saving technologies.

Trends

- Nutmeg and mixed-wood agricultural landscapes support higher densities, abundances and diversity of land birds; agricultural lands could be important for some land bird species that are neither seed nor nectar-feeding.
- The poultry industry does not have a significant negative impact on the environment. Overall environmental impact of small ruminant and cattle farming is mild to moderate. A small percentage of pig farmers recycle waste products for biogas production.
- Niche production of quail and duck eggs is trending upwards. There are plans for large-scale poultry meat production (1000+ birds slaughtered).
- In 2019, the food import bill of Grenada was US$350 M (EC$945.89 M). Imported food accounts for approximately 70% of foods consumed locally.
- Hurricanes are exacerbating an already negative trend in food production since the 1960s, suggesting poor resilience and adaptive capacity at a systemic level.
- Despite the economic shift from agriculture to tourism, the two sectors are intertwined with a wide variety of fruits, vegetables and traditional root crops supplied to resort areas.
- Grenada has used its spice identity to create a niche tourism product that promotes distinct, place-based characteristics; offers a variety of historical plantations, sugar mills, rum distilleries, spice plantations, and festivals further linking agrotourism to heritage tourism.

Information Gaps

- Monitoring of outflows from agroecosystems is not done on a regular basis.
- Data on recreational/leisure use of agroecosystems is not available.
- Small-scale farmers lack critical resources to manage the negative impacts of climate change.

Maximising agroecosystem services

Across Grenada, agroecosystems are interconnected with other ecosystems (terrestrial, freshwater and marine systems). These interconnected dynamics must be considered in ecosystem management and decision making.

Agroecosystem services can be maximised with appropriate:

- Knowledge response e.g. educating farmers and entrepreneurs on the impacts of agrochemicals, best management practices in agricultural processes, making available safer agrochemical options, strengthening knowledge transfer between stakeholders, generating data to support management of agroecosystems and strengthening the technical capacity of the Ministry of Agriculture & Lands, Forestry, Marine Resources & Cooperatives (MOALFC) extension services staff.
- Legislative and policy response e.g. an adequate policy framework to address agrochemical pollution; regulations to ensure monitoring and compliance, defining agroecosystems as multifunctional and shared spaces; linking climate change, disaster risk reduction, biodiversity, land use, and food security; gender sensitivity; integrating dimensions of equity and justice to support agricultural livelihoods; strengthening legislation to give more decision making power to communities and cooperatives.
- Institutional and governance response e.g. capacity building to create adequate infrastructure/resources, technical staff/expertise; integrated resource management with all relevant ministries/divisions working together, sharing resources and knowledge; improving co-management of agroecosystems; improving land use, land tenure management; integrating nature-based solutions framework to improve delivery of ecosystem services.
- Technology and practices response e.g. promotion and use of safer chemical options; incentives for sustainable farming practices;

stringent water quality monitoring; encouraging and incentivising organic farming; improving access to water quality data; smart greenhouses, vertical farming, climate-smart agriculture (CSA) practices; germplasm bank to protect local genetic resources; livelihood protection policy insurance schemes and other risk mitigation schemes.

Within the agriculture sector, sustainable land management (SLM) initiatives entail the knowledge transfer and implementation of CSA practices by farmers via the MOALFC. Germplasm banks for spices created by the MOALFC help conserve and protect local plant genetic resources. These initiatives enable capacity for agroecosystems to produce healthy food while at the same time maintaining regulating, supporting and cultural services. This creates economic value for agriculture stakeholders and can generate positive stakeholder relational values e.g. pride, responsibility, stewardship and sense of community.

Potential financial and economic opportunities that can support the sustainable management of agroecosystems include: sustainable supply chain development; participation in carbon markets and participation in ecosystem certification schemes (e.g. fair trade).

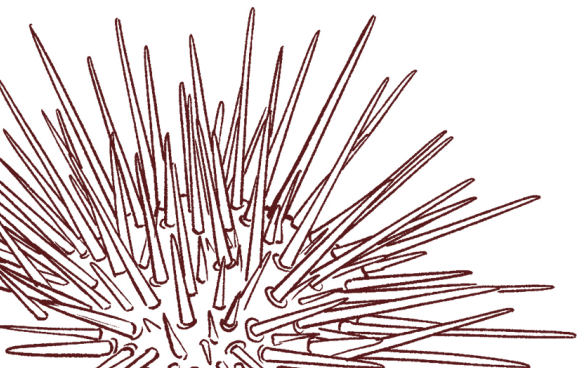
Coastal ecosystems

Coastal ecosystems in this Guide include: beaches, mangroves, seagrasses and coral reefs.

Beaches

Mainland Grenada has numerous beaches as do Carriacou, Petite Martinique and several small offshore islands. Beaches on the windward side of the islands are generally unprotected while those on the leeward side are more sheltered. Telescope Beach and Marquis Beach, located on the windward side of Grenada are, however, protected by coral reefs. Grenada's beaches are important sites for recreation, tourism, and fish landing.

FAUNA	• Important nesting sites for leatherback turtles (*Dermochelys coriacea*), green turtles (*Chelonia mydas*), hawksbill turtles (*Eretmochelys imbricata*) and iguanas. Marine turtles are protected under Article 17 of the *2001 Fisheries (Amendment) Regulations*. • Beaches support several species of resident and migratory birds; beaches are used by birds for foraging, roosting, and nesting. • Approximately 110 species of birds, some categorised as resident and breeding endemic to the Lesser Antilles and West Indies, have been sighted on or near beaches in Grenada.
FLORA	• Native and imported seamoss (marine algae) are grown and harvested in the shallow waters of various beaches and sheltered bays in Grenada. Seamoss harvest in Grenada is regulated under the *Grenada Fisheries Act (1986)* within the broad definition of 'fish'. • Several plant species aid in beach sediment stabilisation: buttonwood (*Conocarpus erectus*), white mangrove (*Laguncularia racemosa*), seagrape (*Coccoloba uvifera*), manchineel (*Hippomane mancinella*) and beach morning glory (*Ipomoea sp.*).



Mangroves

Mangroves are present in Grenada (181ha), Carriacou (101ha) and the Grenadine islands of Isle de Ronde, Isle de Caille, Saline Island, and White Island (11ha). Most mangroves on the island of Grenada are found along the southern and eastern coasts. Mangrove habitat types include basin (181ha), fringe (65ha) and littoral/back (42ha). Local boaters use the mangroves e.g. at Tyrell Bay in Carriacou to secure their boats during severe weather events.

Mangrove habitat types in Grenada include:

- Fringe – located at edge of water bodies and frequently flooded by tides.
- Riverine – located at edge of rivers.
- Basin – occur in inland areas and are less frequently flooded by tides. Organic matter accumulates in sediment creating anoxic (no oxygen) conditions.
- Scrub – low productivity and few, scattered trees.
- Littoral – located within the intertidal zone of the coast.

FAUNA	• Important roosting, nesting and foraging habitats for several species of birds, many of which utilise these areas as temporary stopovers during their long-term migrations. • Used by some terrestrial bird species for short-term foraging or longer-term habitat. • The Grenada Bank tree Boa (*Corallus grenadensis*), a nocturnal snake endemic to Grenada and the Grenadines, has been documented in mangrove habitats. • Mangrove-associated fauna harvested for human consumption including mangrove oysters (*Crassostrea rhizophorae*), and flat tree oysters (*Isognomon alatus*). The harvesting of oysters is regulated by legislation. • Mangroves are habitat for several species of crabs e.g. mangrove root crab (*Goniopsis cruentata*), mangrove tree-climbing crab (Aratus pisonii), grapsid crab (Sesarma rectum), *Uca* spp., *Cardisoma guanhumi*, and *Callinectes* spp.
FLORA	• Red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans, Avicennia schaueriana*), white mangrove (*Laguncularia racemosa*), buttonwood (*Conocarpus erectus*) and mangrove fern (*Acrostichum aureum*).

Seagrasses

Seagrasses can be found along all coasts of Grenada, Carriacou and Petite Martinique.

SEAGRASS SPECIES	• Paddle grass (*Halophila decipiens*), shoal grass (*Halodule wrightii*), manatee grass (*Syringodium filiforme*), and turtle grass (*Thalassia testudinum*). • Transoceanic invasive *Halophila stipulacea* was reported at Flamingo Bay, Grenada in 2002, with suggested introduction via fouled anchors of pleasure yachts. Later, also recorded at Dragon Bay, Beausejour Bay and on the leeward coast of Carriacou.

FAUNA	• Important habitat, nursery, and foraging ground for numerous marine organisms. • In Carriacou, seagrasses provide an important habitat for diverse filter-feeding macroinvertebrate fauna (sponges, ascidians, bivalves, ophiuroids) and echinoderm grazers e.g. sea urchins (*Tripneustes ventricosus*) and sea stars (*Oreaster reticulatus*). • Green sea turtles (*Chelonia mydas*) and hawksbill turtles (*Eretmochelys imbricata*) are associated with seagrass beds and are known to forage in nearshore waters.

White sea urchins (*Tripneustes ventricosus*), or 'sea eggs', feed mainly upon turtle seagrass (*Thalassia testudinum*) and algae. In Grenada and Carriacou, they are often found in seagrass beds or reefs. Sea egg harvesting started as a subsistence fishery and thrived in the 1980s- early 1990s but collapsed in 1994 due to overharvesting; it was closed in 1995 and re-opened in 2015.

Queen conch (*Aliger gigas*) juveniles utilise seagrass beds. Queen conch is consumed by locals, marketed as a delicacy in the tourist industry, and exported to nearby countries e.g., Trinidad and Barbados. Subsidiary legislation in Grenada restricts harvesting 'immature conch' (size and weight limits) but there is currently no closed season.

Coral reefs

Grenada's total reef area is an estimated 150–160km². Fringing and patch reefs are present along all coasts of Grenada, while bank barrier reefs are present along the eastern coasts of Carriacou and Petite Martinique. On Grenada's east coast between Telescope Point and Marquis Island, there is a barrier-type reef. Several of Grenada's offshore islands have associated coral reefs that receive substantial nutrients circulated from land to sea by seabirds through guano and spillover effects.

CORALS	• There are an estimated 54 species of Scleractinia corals (reef forming/building corals) found in Grenada. • 11 species are on IUCN's Red List of Threatened Species: two are critically endangered, two species are endangered; one species is near threatened; six species are vulnerable.
OTHER FAUNA	• All export species (of fish) except yellowfin tuna are caught from coral reefs or nearshore marine areas. • The long-spined black sea urchin (*Diadema antillarum*) performs a critical role as an algal grazer on coral reefs, making grazed substrate available for colonisation by crustose coralline algae, reef-building corals and other benthic organisms. In the 1980s mass mortality of its populations on coral reefs in the Caribbean resulted in a significant 'phase shift'- macroalgae increased and live hard coral cover decreased. Recent studies have recorded *Diadema antillarum* on reefs in southwest Grenada, suggesting some evidence of population recovery. • The Caribbean spiny lobster (*Panulirus argus*) is a commercially important species harvested for consumption in Grenada. Adult lobsters utilise coral reefs for foraging and as a primary habitat. The lobster fishery in Grenada accounts for 1% of the total catch but is a significant contributor in terms of value. Subsidiary legislation in Grenada 1) restricts the harvesting of undersized, moulting and egg-carrying lobsters; 2) specifies the methods; and 3) closed season (May 1st to August 31st) for harvesting.

Value of coastal ecosystems

Commercial fishery
• Sixty species were harvested from the marine environment (pelagic, coastal and non-fish reef species) from 1978 to 2017: a total of 78.7kt valued at US$680.70 M (EC$1,839.63 M), with an annual increase from 1.9kt to 2.7kt. • The average cost per kg of fish also steadily increased, from US$1.98 (EC$5.35) in 1978, to US$4.88 (EC$13.18) in 2017, highlighting an increasing dependence on marine fisheries and economic or instrumental value. • The export fishery is 27% of the size of the production fishery (total fish caught locally) bringing in approximately US$5.41 M (EC$14.62 M) in revenue within the same period. • The 40-year revenue generated from coral reef fisheries (US$41.20 M/EC$111.24 M) was second to large pelagic species (US$188.50 M/EC$508.95 M); coral reef fisheries are a key revenue generator. • Yellowfin tuna: 30% of total harvest; 38% of revenue generated at US$2.63 (EC$7.11)/kg over the 40-year period. • Spiny lobster: Total landing of 0.82 million kg at US$8.12 (EC$21.94)/kg
Queen conch fishery
• Queen conch, (*Aliger gigas*), is a small-scale coastal fishery for Grenada. In 2017, close to 24,000kg of conch (locally called 'lambi') products were harvested by 90–105 fishers. • Price ranges of conch products vary; these include 100% cleaned meat at US$24 –66 (~EC$66-178.20) per kg), operculum at US$35 (~EC$95) per kg, US$30–45 (~EC$81,122) per shell (retail), and rare conch pearls US$2,000–7,000 (EC$5,405–18,918) per carat. • While there is great potential for the conch industry, there is the risk of species depletion. • The queen conch is of cultural importance to Grenada. It is considered a delicacy and consumption of raw conch meat is considered by some as an aphrodisiac.
Recreational fishing, tours and tourism
• Tourism represents 56% of Grenada's Gross Domestic Product (GDP) and close to 50% of employment. Grenada receives close to 500,000 tourists annually. Most of Grenada's major resorts are coastal and rely on coastal amenity services such as beaches, and their associated regulating services (e.g. coastal protection). • Coral reefs play a charismatic and important role in tourism, as an attraction and for visitors who come to Grenada specifically for snorkelling, diving and boating. Tourists spend significant resources directly in accommodation, dive certification, equipment rental, boat rental and guide fees. An estimated total value of coral reef associated tourism on the south coast of Grenada to the Grenadian economy is approximately US$20,112,457 (EC$54,354,920.67) per year. This figure is believed to be an underestimate of the overall value of these reefs, largely due to the lack of valuation data. • Estimated revenue for turtle tours in 2017 was US$19,764 (EC$53,416), with a slight decline by 8.5% in 2019 (US$18,072/EC$48,843). The cost of tours increased by US$10 (EC$27) in 2022. Tour guides typically generate between US$37–56 (~EC$100–150)/tour; wardens earn between US$19–28 (~EC$50–75) per night.

Craft
• Shells found on beaches and lionfish spines are used to make a variety of jewellery (chains, earrings, bracelets) priced at US$3.70–10.00 (EC$10–27)/ piece. Shells are used to make wind chimes (US$7.41–11.11/EC$20–30), and as decorative pieces in arts and crafts.
Marine natural products
• There is potential to utilise marine natural products in pharmaceuticals (medicinal drugs), nutraceuticals (food with health benefits), and cosmeceuticals (cosmetic products with health benefits). With over 2,500 marine species, Grenada presents an untapped potential. In particular, marine algae, sponges and molluscs are key in research and development of drugs. • The revenue generated from products such as whale and krill oils is unknown. • Seamoss (Gracilaria sp.) farming in Grenada occurs on a small scale. Seamoss is believed to boost the immune system. It contains 92 minerals, is rich in vitamins and amino acids and is considered as a super food. In the Caribbean it is thought to be an aphrodisiac. Grenadian processing facilities package and bottle seamoss products from local and imported harvests. Revenue generated from the industry is underreported, however, prices in Carriacou range between US$5.56 (EC$15.00) (~250ml) and US$16.67 (EC$45.00) (~750ml).
Ecosystem goods and services
• Grenada has approximately 181ha of mangroves and receives at least US$3,764,334 (EC$10,173,301) in service values from mangroves. • Mangroves and seagrasses can sequester carbon, nearly 40 times more than terrestrial systems. Mangroves are important for climate resilience by allowing faster recovery after hurricane episodes. Other functions include nutrient recycling and filtration, soil retention, provision of critical habitats for feeding and breeding, and the provision of nursery areas for commercially important fish and crabs. • Mangrove species are used within some communities for sources of timber, firewood, charcoal, dyes, and in some cases traditional medicine. Farming, fishing, crab hunting and bee keeping are indirect livelihoods dependent on ecosystem services provided by the existence of healthy mangroves. • Mangrove species are important sources of food for pollinators and bees feeding on black mangroves produce a dark honey which is valued for its high quality. • Seagrasses such as Thalassia can provide 10 litres/day of oxygen – a major contributor to aquatic oxygen. • A recent compilation of Natural Capital Accounts for Grenada estimated the value natural hazard protection provided by coastal reefs to be approximately US$485.47 M (EC$1,312 M) per year in 2016 using a 'damage-cost avoided' valuation approach. • Marine protected areas (MPAs) contribute significantly to wellbeing through ecosystem services. Net benefits (through direct and indirect use) generated by MPAs were estimated to be between US$1.07-2.52 M (EC$2.9-6.8 M) each year.

Threats and Issues

Coastal ecosystems are threatened by local factors, including coastal development e.g. for tourism, overfishing, disease and predators, pollution, eutrophication, sedimentation, and de-oxygenation. Other threats include hurricanes that damage reefs and threaten coastal residents, coral bleaching caused by increasing sea surface temperatures and ocean acidification.

Poaching and extraction	• Sea turtles are hunted and poached for their shells; an estimated 782 sea turtles per year are caught, the majority of which are green and hawksbill turtles. • Shells are used for decorations and jewellery, and meat and eggs are taken for consumption. The eggs of all nesting species are considered a delicacy. Despite not being a lucrative trade, turtle meat and products are reportedly consumed at social events.
Disease	• Apart from anthropogenic stressors, hatch success of leatherback turtle nests in Grenada was shown to be impacted by pathogens. • Recent studies conducted in shallow and deep-water habitats in Grenada have reported incidences of various coral diseases.
Sea level rise	• Rising sea levels can have negative impacts on coral reefs, seagrass beds and mangroves. Abrupt changes in the cycle of inundation frequency and duration could result in the death of seaward mangroves, exposing some species to salinities and sedimentation rates that they cannot tolerate. Mangrove die-offs along the coast will result in simultaneous changes in species composition inland. • Low-lying areas, sandy beaches and cays are susceptible to erosion, resulting in loss of sea turtle and seabird nesting habitat, and intertidal foraging opportunities for numerous bird species, such as waterbirds and shorebirds.
Physical development	• Physical development (e.g. resorts, hotels, marinas) within the coastal zone has resulted in loss of coastal vegetation. • Human activities to facilitate coastal development have threatened the ecological well-being of beaches. Changes in beach profiles and sediments can influence spatial distribution of turtle nests and impact the hatching success of nests. • Any natural or anthropogenic factors that result in a loss of mangrove vegetation will subsequently impact mangrove-associated fauna.
Sand mining	• Sand has been mined from Grand Anse, Beausejour, Palmiste, Duquesne, Telescope, Content (Grenada); Harvey Vale, Hillsborough, Lauriston, Jew Bay, Mt. Pleasant/Grandbay (Carriacou). Sand removal has led to beach erosion and destruction of habitats for birds and turtles. • A 1995 estimate put beach sand extraction at 39,757–49,696m^3/yr. Legal sand mining continued, due to a lack of alternatives, and insufficient enforcement of existing regulations to limit the activity. As recently as 2018, illegal sand mining was identified as an issue in the Gouyave, Levera and Bathway areas.
Weather events	• Storm surges have resulted in the loss of sediments from beaches, physical damage to coral reefs and damage to mangrove vegetation. • During rainfall events, land-based runoff that contains sediments, and nutrients, can pose a threat to seagrasses as the former reduces the availability of sunlight and subsequently disrupts photosynthesis while the latter can result in eutrophication.

Trends

Export fishery has been declining since 2015 and coincides with markedly lower catches. Several species have shown declines in landings in recent years: black fin tuna, wahoo, Atlantic bonito, snapper and conch. It is uncertain if this is due to declining stock, effort or target, coupled to improper wild stock management. Landings in lobster have significantly increased.

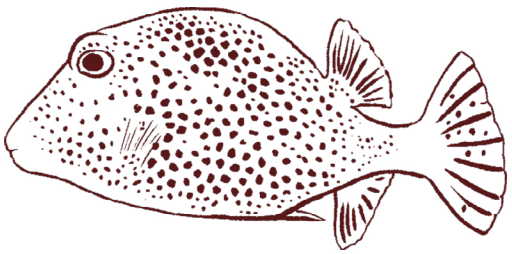
- Grenada's fisheries sector is the largest exporter nationally, exporting high value species like tuna, lobster, and conch. In 2016, roughly 87% of fishery exports went to the USA (mainly yellowfin tuna), and 9.8% to the European Union. The total export earnings peaked in 2016, valued at US$7.3 M (~EC$19.7 M) earnings then declined in 2017 to US$6 M (~EC$16.2 M).
- Recent losses in mangrove cover to accommodate coastal development in 2020 would suggest a declining trend in mangrove cover, even with small-scale restoration projects around Grenada.

Information Gaps

- Fishery landing data are collected only at 10 primary landing sites; there are however, 36 secondary landing sites (including beaches or bays) where no data are collected. This affects estimates of landing and local consumption rates of important species such as sea urchins, lobster, and conch.
- The recreational values of fishing e.g. joy for the sport, lowered stress, appreciation for the environment, are difficult to account for.
- The revenue generated from the seamoss, whale and krill oil industries is currently unknown.
- On record, Grenada has already 11 natural products from marine organisms. However, the revenue generated from these products is currently unreported.
- Many in the society recognise that beach sand mining is a risk to both mined beaches and premier tourist beaches like Grand Anse. However, there is a disconnect between the understanding of the problem and stopping this negative activity.

Maximising coastal ecosystem services

Coastal and marine ecosystems in the tri-island state of Grenada provide critical provisioning, regulating, supporting and cultural services. Many of these services are important for the social and economic well-being of Grenadians. However, several natural and anthropogenic factors have threatened these ecosystems in the past and continue to do so. In an attempt to address these issues, there have been several responses by the Government of Grenada which have included: 1) becoming signatories of several multilateral environmental agreements (MEAs) (Appendix 1); 2) drafting relevant national policies and action plans (Appendix 2); and 3) utilising legislative approaches to address specific issues (Appendix 3). To date, the Government of Grenada has designated several MPAs which currently account for about 26km² or nearly 0.1% of the Exclusive Economic Zone (EEZ). Several coastal/marine species that are harvested for human consumption in Grenada are on the International Union for the Conservation of Nature (IUCN) Red List. Existing primary and subsidiary legislation in Grenada specifically address unsustainable harvesting of some of these species by imposing complete bans on harvesting, closed seasons, restrictions on size and weight of organisms that can be harvested and specifying fishing methods that are allowed for certain species.



Deep ocean ecosystems

Grenada has a land area of only 340km², but the EEZ (territorial waters) cover more than 27,426km². Grenada's open and deep ocean are home to many species, including commercially important and highly valuable species. The vast majority of Grenada's deep ocean however remains unexplored. The limited exploration that has occurred indicates that Grenada's deep ocean abounds with habitats that could be considered Vulnerable Marine Ecosystems (VMEs) or Ecologically and Biologically Significant Marine Areas (EBSAs) (i.e., coral and sponge gardens, methane seeps). The most well-known area of Grenada's deep ocean is around the active submarine volcano, Kick-'em-Jenny, with which numerous biological communities are associated.

Open ocean and deep ocean

Open ocean

The open ocean is that part of the ocean which is outside of coastal areas, lying above the continental shelf. The open ocean is comprised of many layers or zones pertaining to the depth of water from the surface.

Deep ocean

The deep ocean refers to that part of the open ocean which is at or below 200m. In comparison to the upper layers, the deep ocean is dark, cold, and contains life forms which have adapted to these conditions.

FAUNA	• There are 473 deep-sea records for Grenada on Ocean Biodiversity Information System (OBIS); 156 species were collected between 1879 and 2014. • Several of the collected species are deep-sea stony corals, black coral, octocorals, sponges and species of foraminifera. The first starfish bed was found in the Antilles region off the coast of Carriacou. The study of this bed was important for understanding the taphonomy (process of fossilisation) and evolution of Antillean echinoderms. • Over 30 species of seabirds have been recorded in Grenadian waters; seabirds feed on zooplankton, squid and larger fish year-round in waters surrounding Grenada and the Grenadines. Between April-September, seabird diversity and abundance increase with the return of several breeding species (e.g. brown noddy, laughing gull, bridled tern). • Grenada has a very low marine mammal diversity.

Value of deep ocean ecosystems

Present value	• There are an estimated 233 species of marine fish species in Grenada many of which are of high economic value. Sixty (60) species were harvested between 1978 to 2017, representing a total of 78.7kt valued at US$681.34 M (EC$1,839.6 M). The average cost per kg of fish increased, from US$0.41-6.51 (EC$1.10-17.60) in 1978, to US$6.51-11.20 (EC$17.60-30.27) in 2017. • Valuation for yellowfin tuna, Caribbean spiny lobster and other key fish species is described in the Coastal Ecosystems section.
Potential for growth	• In 2018, a market analysis exploring the potential to increase exports of yellowfin tuna found that with an investment of US$362,500 (EC$979,674) into primarily the yellowfin tuna fleets, investors could earn an internal rate of return up to 28%. Over 5-years this would increase fisherfolk income by US$1.1 M (EC$2.97 M).

Threats and Issues

Pollution	• 80% of the pollution in the Caribbean Sea is due to land-based sources; in the Grenadine islands this includes litter, greywater, and sediment. Areas with high population densities have higher land-based point source marine pollution. • Petroleum hydrocarbons on Grenadian beaches threaten the aesthetic quality of the environment and negatively impact beach fauna, in addition to disrupting recreation, tourism, and fishery activities.
Climate Change	• Sea surface temperature (SST) will be 0.9-1.1°C warmer on average in the coming 50 years, compared to the preceding five decades. Salinity is anticipated to increase by as much as 0.8psu in 2070-2090 compared to the historic reference period. The pH of the global ocean surface is expected to decrease due to increase in CO_2 concentration in the atmosphere. The change is reflected in pH decrease of 0.1 for the 2006-2055 period versus the previous five decades. • Contemporary (1955–2005) climate velocities (the speed and direction that a species at a given point in space would need to move to remain within its climatic niche) are faster in the deep ocean than at the surface. While mitigation could limit climate change threats for surface biodiversity, deep-ocean biodiversity faces an unavoidable escalation in climate velocities. • Total chlorophyll mass and primary organic carbon production by all phytoplankton types will decline around Grenada by 2050-2099; this will influence the pattern of diversity in harvested pelagic fish. • Tunas readily adjust their distribution depending on prevailing conditions and local food availability. Poleward shifts in distribution for 20 out of 22 tuna stocks between 1958-2004 in the northern hemisphere were reported; further (larger) shifts are expected in the future and could take fishery resources beyond the reach of most small-scale fishing vessels in Grenada. • Large tuna, billfishes may be forced to aggregate closer to the surface by a rising oxygen minimum layer in deep ocean. This could increase catchability (in the short-term) but threaten long-term stock sustainability through over-fishing. • Migration patterns, distribution and/or abundance of cetaceans like whales and dolphins could be altered because of changes in SST; prey species of marine mammals are anticipated to be impacted by changes in environmental conditions. • Blooms of toxic microalgae are expected to increase with warming temperatures, affecting water quality and increasing risks to human health. Ciguatera fish poisoning (most common non-bacterial cause of human illness associated with seafood consumption globally), is associated with bioaccumulation in some commercially exploited fish species in Grenada. Distribution and abundance of the organisms that produce these toxins reportedly correlate positively with seawater temperature. • Climate change impacts on fishery production or yields could have wide-ranging implications for the economy. Models suggest a 7-12% decline in fishery catch potential by mid-century; longer-term prospects are uncertain. Grenada is one of the vulnerable small island states because of high dependence on marine resources and limited access to financial resources for adaptation.
Impacts of FADs	• Fish Aggregating Devices (FADs) are used in Grenada, Carriacou and Petite Martinique but can lead to growth overfishing (harvesting of immature fish). The government has yet to model potential biological and ecological implications of FAD fishing.

Trends

- There has been an increasing dependence on marine fisheries in Grenada over the past four decades, as well as an increasing economic or instrumental value.
- SSTs have significantly increased over the last decades; this is projected to increase by 0.9-3.1°C by the end of the century across all emission scenarios, with implications for storm activity, sea level rise and ocean productivity.
- Over the past half century, the ocean below 200m has experienced warming, oxygen loss and acidification. Food supply to the deep seafloor has been impacted by declines in oceanic plankton productivity at certain localities and this could affect the productivity of benthic food-webs.

Information Gaps

- The deep ocean is known to be a sink for pollution, but little is known about the extent of pollution and the impact on oceanic flora and fauna.
- Apart from fisheries catch, there is no monitoring of pelagic or deep-sea biotas. Absence of monitoring makes it difficult to assess the true impacts of FADs.
- There are gaps in the country's treaty framework. In some cases, implementation of these international obligations has fallen short of the requirements of the relevant treaties.

Maximising deep ocean ecosystem services

Grenada is signatory to the Convention on Biological Diversity since 2004. As part of the Programme of Work on Protected Areas, Grenada indicated a desire to protect 25% of the nearshore environment. Several legal instruments were adapted that allowed establishment of the marine protected area system and included the *Fisheries (Marine Protected Areas) Orders (SRO#3, 1990*), *the Beach Protection Act Cap 29*, and *the National Parks and Protected Areas Act Cap 203*. Some MPAs were designated including Woburn Clarks Court Bay Marine Park, Grand Anse MPA, Moliniere-Beausejour Marine Park and Sandy Island/Oyster Bed MPA.

Several coastal/marine species harvested for human consumption in Grenada are on the IUCN Red List. Existing primary and subsidiary legislation address the unsustainable harvesting by imposing complete bans on harvesting of certain species, closed seasons, restrictions on size and weight of organisms that can be harvested, and specifying fishing methods that are allowed for certain species.

Forest ecosystems

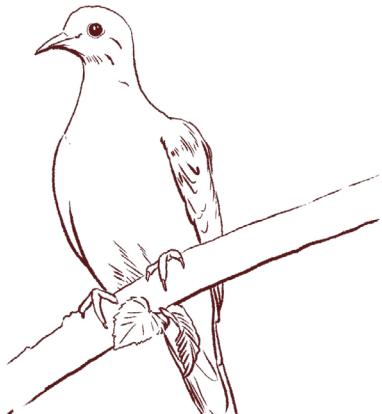
Grenada's forest vegetation, not inclusive of Carriacou and Petite Martinique or other offshore islands, covers approximately 58% of its surface. Forests are comprised of four broad classes: 1) Dry Scrub Woodlands (7,386ha in 2014); 2) Rainforests (5,696ha in 2014); 3) Mountain Thicket, Elfin Woodland and Palm Break (8,631ha in 2014); and 4) Forested Wetlands. These plant communities span varying conditions, ranging from cool temperatures in high mountainous areas with constant rainfall (20°C, 4000mm) to warm temperatures with less rainfall (27°C, 1000mm) towards the coast.

FAUNA	
Birds	• The only endemic land bird species, the Grenada dove (*Leptotila wellsi*), is critically endangered and limited to two subpopulations in the island's south dry and moist forests. The Grenada hook-billed kite, (*Chondrohierax uncinatus mirus*) is a rare endemic subspecies; Antillean broad-winged hawk is a widely abundant regional endemic subspecies. The Grenada flycatcher (*Myiarchus nugator*), bananaquit (*Coereba flaveola*), and Lesser Antillean tanager (*Stilpnia cucullate*) are regional endemics, ubiquitous on the island.
Mammals	• There are 15 known native mammalian species, including four terrestrial species and 11 bats. Each of Grenada's non-flying terrestrial mammals is a game species. • The Mona monkey (*Cercopithicus mona* ssp.) is a charismatic megafauna that Grenada's tourism industry capitalises on through viewings within its natural habitat. • Elevated species richness among bats was linked to habitat diversity and climate, thus a likely indicator of habitat quality. A 1970 report gave a detailed record of 11 native species, more recent accounts show upwards of 13 species found from 1967 to 1989.
Amphibia	• Four terrestrial amphibian species are documented. The Grenada frog (*Pristamantis euphronides*) is endemic to the island.
Reptiles	• Two snake species and one lizard species are endemic to the island of Grenada and the region of Grenada, St. Vincent, and the Grenadines respectively. The Grenada tree boa (*Corallus grenadensis*) is found throughout Grenada's forested areas with a population density that decreases with elevation. A nocturnal species, it likely plays a functional role in ecological pest control. The Grenada bank blind snake (*Amerotyphlops tasymicris*), is an endemic species, with endangered status.

Terrestrial Protected Areas are one of Grenada's tools to increase the 20% of its natural resources that are protected under the Caribbean Challenge. Gazetted Protected Areas include: 1) Grand Etang Forest Reserve; 2) Annandale Forest Reserve; 3) Grand Bras Forest Reserve; 4) Levera Ramsar Area; 5) High North Forest Reserve (Carriacou); 6) Mt. Moritz Forest Reserve; 7) Mt. Gazo Forest Reserve; 8) Mt. St. Catherine Forest Reserve; and 9) Mt. Hartman National Park and Dove Sanctuary.

Value of forest ecosystems

Wild flora or plant species are those that need no human intervention for propagation or survival in a habitat or an ecosystem. Much of the economic value of these species is generated from the sale of timber and related industries, or from the use of edible and medicinal plants. These unmanaged plant species play a pivotal role in the livelihoods of those persons involved in timber production, charcoal production, home-based and small-scale value-added industries (e.g. making handicrafts, provision of food products), bush/herbal medicines and ecotourism.



Timber resources	• Species harvested for lumber include mahogany (*Swietenia mahogani*), white cedar (*Tabebuia pallida*), galba (*Calophyllum* sp.), maruba (*Simarouba amara*) and bullet (*Manilkara bidentata*). Mahogany is sold at US$11.10 (~EC$30)/m; white cedar, blue mahoe and pine are each sold at US$8.50 (EC$22.96)/m. • Materials (logs, panels, boards) and products (e.g. doors, windows, furniture, decking, flooring, pallet wood) from timber are used locally and for export. Small tables can cost up to US$185 (EC$500), dining sets US$304–1,296 (EC$820–3,500), and beds US$331–741 (EC$895–2,000). • Fuelwood was reported to have had 40,000m³ of harvest in 1992. Fuelwood and charcoal are utilised for food preparation in rural poor communities.
Non-timber forest products	• Non-Timber Forest Products (NTFPs) consist of goods of biological origin other than wood, as well as services derived from forests and allied land uses. These include food, fodder, medicines, perfumes, cosmetics, dyeing, tanning, utensils, handicrafts, construction, materials, ornamentals and exudates. • NTFPs are important for livelihoods in local communities allowing for direct and indirect employment, however revenue generated from these is unaccounted for. Products (e.g. waxes, gums, resin, tannin, leaves, bamboo) are heavily used in crafts, handicrafts, and house construction. • Red mangrove (*Rhizophora mangle)* is used for posts and poles, firewood, charcoal, and tannin extracts. These tannins are suitable for leatherwork as they do not break down by fermenters; tannin production of 12,619kg (2008) and 27,697kg (2009) were reported.
Craft and cottage industry	• Screwpine (*Pandanus utilis*) dried leaves are used to craft baskets, mats, hats and bags. Bamboo (an invasive species) is used in house construction, fisheries (to make crab traps) and crafts (lampshades, tablemats, baskets, and soap dishes). Other species used in handicraft are wild coffee (*Colubrina arborescens),* hoopvine *(Trichostigma octandrum)*, mimosa (*Vachellian macracantha*), larouman grass stem (*Ischnosiphon arouma*), latanye leaves (*Coccothrinax barbadensis*) and donkey eye *(Mucana pruriens)*. Revenue from these products is largely unknown. • Guaba (*Inga edulis*), like several mangrove species, is used for charcoal production. • Value-added edible goods from forest resources are more in demand within the tourism sector. Examples of edible goods are fruits of the jamun *Syzygium* spp. (*S. cumini, S. jambos, S. malaccense*) used for making pies, preserves, jams and drinks. Mammee apple (*Mammea americana*) flowers are used to make local liquor.
Ecosystem services	• Wild forest ecosystems have important intrinsic or indirect values. Ecosystem services provided by forests and trees include climate regulation, erosion control, crop protection, water supply, carbon sequestration and shade, aesthetics and habitat provision for food and wildlife. There are no reports that have attempted to place a value to these key functions but the intrinsic importance of these genetic resources is potentially millions of US/EC dollars. • Contribution of endemic species to ecosystem maintenance is not well understood, however they form a unique ecological identity of Grenada, and as genetic resources they provide an intrinsic value and deserve special attention for conservation.

Traditional medicines and local cuisine	• Medicinal plants and plants of economic value generate income by sales of plant saplings for cultivation in home gardens, plant parts as crude medicines or value-added products (soaps or essential oils generated from plant parts). Medicinal plants are also economically important as bush/herbal teas and medicines. Due to the informal trade involved, economic value is undetermined and likely undervalued by a large estimate. • Plant species used in the bush/herbal medicine system hold important cultural value. This system has Carib, Arawak, African and European influences and forms a major part of the Grenadian cultural identity. About 150 medicinal plant species have been recorded from Grenada. The system of getting medicines or recipes from herbalists forms an important cultural relationship that encourages exchange of knowledge and maintenance of social relationships. • Edible plants used in Grenadian cuisine are a part of its cultural identity and thus hold higher value than just economic potential. These plants include chandon beni (*Eryngium foetidum*) and dasheen (*Colocasia esculenta*). Other examples include *Pimenta spp*. used in seasoning, and the edible fruits of *Syzygium* spp. that are used for making pies, preserves, jams and drinks.
Cultural value	• Donkey eye (*Mucana pruriens*), is used in the spice necklace offered to tourists in Grenada and thus is of cultural value. Cultural value is also seen in the use of plants for folklore practices e.g. using seeds of *Abrus precatorius* (crab eye) in lamps for good luck; seeds of balloon vine (*Cardiospermum microcarpum)* are used to ward off snakebites. • Group activities around plant species (e.g. picking edible fruits together as a family activity) are hard to put a dollar value on but these plants indirectly contribute to the maintenance of relationships through shared recreational activities.
Ecotourism	• Trees and forests in Grenada are economically important for their role in ecotourism and recreation. Hunting is an important subsistence activity. • The economic value of forest genetic resources as an entire ecosystem can be indirectly estimated from willingness to pay, and income generated from tourism. • The cost of tours conducted in Grenada ranges between US$7.41-22.22 (EC$20 – 60) per person. Tours generate income for local guides and contribute to Grenada's GDP. Between the period 2016 – 2020, Grand Etang and Annandale generated a total revenue of US$586,166.26 (EC$1,582,648.90) through the sales of visitor entrance fees (exclusive of private tours).

Table 4. Examples of crafts made from forest trees and their price range

Genetic resource	Use	General price range
Bamboo	Cups, baskets	US$6–28 (EC$15–75)
Dry cocoa pods	Earring and chains	US$4–6 (EC$10–15)
Palm leaves, dry	Basket weaving	US$6–17 (EC$15–45)
Calabash (Crescentia cujete)	Bowls/cups	US$6–9 (EC$15–25)
Donkey eye (Mucuna sp.)	Chains, bracelets, earrings	US$6–28 (EC$15–75)

Carbon sequestration provided by forests

Terrestrial forests, including mangroves, are important for carbon sequestration. Estimates of carbon accumulation suggest that total carbon (tC) fixation for Grenada exceeds 8,000tC/ha/yr, where Annadale and Grand Etang Forest Reserve contribute 4406tC/ha/yr followed by mangroves (2850tC/ha/yr). This suggests that these forested areas are the most valuable, considering that valuation estimates of US$20 (EC$54) per metric tonne result in net carbon fixation benefits of US$88,037 (EC$237,924)/year.

Erosion Control

The Gouyave and St. John's watersheds are susceptible to flooding each year during storms and hurricanes. As St. John's is more urbanised, it experiences more severe flooding events due to a larger area of non-permeable surfaces which reduce water infiltration into the soil and increases run-off.

Watersheds and water provision services

- Forest ecosystems play a critical role in water supply management through moisture retention. Most watercourses in Grenada start in upper forested watersheds and have significant riparian nutrient input, making forest ecosystems inseparable from freshwater supply and its associated ecosystem services.
- Limited information on the value of freshwater supplied by forest ecosystems exists, however one study in 2010 estimated the value of water benefits provided by the Annandale/Grand Etang Forest Reserve to be US$1,209,794 (EC$3,266,445) from a production of 1,033.69 million gallons.

Bioprospecting

- There is a wealth of possible entrepreneurship opportunities based on the utilisation and/or extraction of natural products from particular species. Some products from fruits, seeds and leaves are commonly known, popularly sold but generally not recorded in terms of annual income streams in the local and international markets. In comparison, bioprospecting, is even less known, even though potentially much more lucrative in terms of national revenue sources.
- Genetic value should include revenues gained through symbolic use or marketing strategies that use national icons and generate commerce through cultural and artistic expressions e.g. imagery on clothing, stamps, local money, billboards, and iconic and endemic species (spices and the Grenada dove).

Threats and Issues

Invasive species	• Johnstone's whistling frog (*Eleuthrodactylus johnstonei*) is considered invasive and is widespread across most habitat types. It is thought that this species competes with the Grenada frog (*Pristamantis euphronides*), which was once widespread, but is now restricted to undisturbed forests.
Storms	• Natural events such as storms and hurricanes have resulted in defoliation, blowdowns, and in some cases, complete levelling of vegetation in Grenada and its offshore islands.
Deforestation	• Between 2000 and 2012, Grenada ranked in the top 10 countries for deforestation rates in the world, with an average annual rate of 0.29%. Researchers studying land-based sources of pollution in Carriacou noted deforestation as a source of erosion and sedimentation.

Climate change	• Regional Climate Models for the southern Caribbean suggest a decline in rainfall in the early rainy season. Plants are cued to produce fruit and leaves by the first rains at the end of the dry season; a delay or decline in these rainfall events will result in a delay in these productive periods. Reduced rainfall can result in more arid conditions in areas that previously supported evergreen tree species and an increase in percentage cover of forest classes dominated by deciduous and semi-deciduous trees.

Trends

- The Grenada frog population is showing a declining trend due to Chytridiomycosis caused by the chytrid fungus. With cumulative effects of habitat loss and competition by the invasive whistling frog, the Grenada frog has been deemed an endangered species.
- The Grenada tree boa is in decline from habitat loss due to development with an estimated 7500 ± 500 remaining individuals.

Information Gaps

- Population trends for the nine-banded armadillo and Robinson's mouse opossum have not been studied in Grenada; there are no known studies on habitat preferences or behaviours on the island.
- The Forestry Division regulates hunting activity on non-flying terrestrial mammals relying on open (October to December) and closed seasons (throughout the rest of the year); however, the efficacy of this system is disputable without continuous, standardised monitoring.
- With the paucity of Grenada blind snakes and continued degradation in areas where they occur, this species should be reassessed and its status possibly changed to critically endangered.
- Given the lack of available published data, it is difficult to assign monetary economic value for specific species sourced from the wild forest areas of Grenada.
- Annual revenue from timber is not recorded; data on income from NTFPs for handicraft is not recorded; currently no data are available on the economic value of charcoal and fuelwood. Due to the informal form of trade involved in herbal medicine, the economic value of these plant species is undetermined and likely undervalued by a large estimate.
- Monetary value of bioprospecting is not known though it is expected to be high.

Maximising forest ecosystem services

The existing body of knowledge on terrestrial ecosystem services is patchy. There are some initiatives and studies that provide a baseline e.g. *National Assessment Report* (2010*), Convention on Biological Diversity (CBD) 5th Assessment Report* (2014) and the *National Biodiversity Strategy and Action Plan (NBSAP)* (2016-2020). These studies suggest a strong need to address issues such as habitat degradation, pollution, sustainable use, and invasive alien species (IAS). Climate change exacerbates all these threats and thus solutions for these threats also need to be viewed through a climate adaptation lens.

Freshwater ecosystems

Grenada is divided into 71 watersheds. There are no permanent streams on Carriacou, Petite Martinique or any of the offshore islands. Freshwater habitats are dominated by lotic habitats originating as small streams in upper elevations. Typical substrata consist of boulders, rocks and cobbles. Some streams remain narrow all the way to the sea, while others merge to form larger rivers as they approach the coast. Streams have considerable riparian input (leaves, etc.), especially at the upper elevations, where they run primarily through forested areas. The most significant lentic habitat is Grand Etang Lake, a crater lake which empties into the Great River. There are several small ponds at low elevations, and Grenada also has several geothermal springs.

Freshwater terms

Lotic: flowing freshwater systems e.g. rivers and streams.

Lentic: standing or slow moving bodies of freshwater e.g. ditches, ponds, seasonal ponds, marshes and lakes.

Riparian: a riparian zone is the interface between the land and a river, stream, lake or pond.

FAUNA	
 Fish	• Grenada's freshwater habitats support 19 native fish species. Some of these species are primarily marine or estuarine, though spending at least some time in freshwater areas. There are 6-7 known exotic fish species.
 Amphibia	• Only one native amphibian species is known – the endemic frog *Pristimantis euphronides.* This species is found in Grenada's Forest Reserves but does not spend any part of its life cycle in streams. • Exotic amphibians include *Eleutherodactylus johnstonei* (also on Carriacou), *Leptodactylus validus* and *Rhinella marina.* The exotic Cuban treefrog, *Osteopilus septentrionalis*, was recently recorded.
 Invertebrates	• More than ten species of native decapod crustaceans can be found in rivers and streams; several of these are harvested for food. At least 10 species of freshwater snails have been documented, including the exotic species *Melanoides tuberculata*, which is described as "abundant and widespread" in Grenada.

Value of freshwater ecosystems

Habitat	• 71 watersheds and several lakes and ponds support a wide range of freshwater fauna. There is minimal direct value (instrumental) data currently available for freshwater species. However, several organisms within Grenada's freshwater systems have been identified as having either a direct contribution to livelihoods (instrumental), ecologically (intrinsic), or cultural (relational) value. The measurable genetic value of freshwater fauna is mainly related to trade, ecotourism, and the potential for bioprospecting.

Services	• Freshwater supply supports the maintenance of genetic and fisheries resources. • Non-consumptive services provided by freshwater supply include dilution and transport of waste, nutrient cycling, biodiversity, aquatic habitat, transportation corridor, and aesthetics and recreation.
Domestic and industrial water supply	• Freshwater supply supports irrigation for agriculture and drinking water (both abstraction and direct consumption by communities). • 98% of the island's water supply comes from surface water with distribution through gravity from high elevation surface water. • Water demand increases in the dry season because of tourism and irrigation. Demand is approximately 45,000m³ per day in the rainy season and 54,600m³ per day in the dry season. There are approximately 29 water supply facilities; 23 are surface abstraction points and 6 ground water boreholes. Mean water production ranges from 31,800m³ per day in the dry season to 54,600m³ per day in the wet season. Groundwater is used in the dry season; three main boreholes produce approximately 3,013m³ per day. Some hotels in the tourism sector use reverse osmosis and a few companies, such as Grenada Breweries, abstract water directly through boreholes.

Threats and Issues

Overharvesting of species	• Data on the distribution and abundance of native freshwater fish populations are lacking; but it is likely that overharvesting and other factors have led to a decline in several species. The goby *Sicydium plumeiri* (titiree) was historically harvested in large quantities as juveniles attempted to migrate upstream; the current prevalence of the practice is unknown. Recreational and subsistence fishing takes place in various rivers, Grand Etang Lake and Levera Pond; likely focused on exotic tilapia and native crayfish.
Physical development	• Several of Grenada's freshwater species have life cycles that involve migrating between the sea and freshwater streams; these species are vulnerable to any developments that obstruct their passage up or downstream, preventing the completion of their life cycle.
Invasive alien species (IAS)	• In freshwater ecosystems, there are six known invasive fishes: koi, guppy and swordtail are reported from Grand Etang Lake and are suspected to have negative effects on the native community; two species of tilapia (*Oreochromis* spp.) and the mosquitofish (*Gambusia* sp.) are reported from Levera Pond. • The amphibian assemblage of Grenada is dominated by introduced species. It seems likely that the introduced frog *E. johnstonei* may replace the critically endangered Grenada frog in human-altered areas. The Cuban treefrog, *Osteopilus septentrionalis*, has been recorded – although not yet established. The exotic snail *Melanoides tuberculata* is described as "abundant and widespread" in Grenada.

Pollution

- Erosion and siltation from land clearing impact freshwater ecosystems. This is an issue for domestic water quality and quantity, as sedimentation of reservoirs reduces their capacity; e.g. Grand Etang Lake is shrinking partly due to sedimentation; up to 80% (estimated) of the dam in the Annandale watershed is filled with silt.
- Land-based runoff that contains sediments and nutrients, can pose a threat to seagrasses; sediment reduces availability of sunlight and subsequently disrupts photosynthesis while nutrients can result in eutrophication.
- Farmed land is treated with pesticides, herbicides and fertilisers which leach into rivers during heavy rainfall. This has implications for all habitats from source to sea and can impact reefs.
- Inappropriate livestock practices have led to the washing of nutrients into nearby rivers and bacterial pollution from pig farms. Surveys in 2014 and 2017 in the Beausejour watershed found that most sites had levels of the bacteria *Enterococci* and *Escherichia coli* exceeding the recommended levels.
- Freshwater pollutants from domestic activities include detergents and soaps from laundry, and engine oil from cars.
- Poorly treated sewage has an impact on both environmental and public health. Sewage contains high levels of nutrients and pathogenic microorganisms, the latter of which may impact the health of persons using polluted water for recreational, agricultural, or domestic purposes. The 2011 Grenada census indicates that 60.6% of the households are equipped with indoor toilets, but only 4% of households were connected to a sewer and the remainder were either using septic systems (57.8%) or pit latrines (30.3%).
- Waste from industry and landfills may enter rivers. Areas of concern are food, beverage and agroprocessing waste. Solid waste is disposed of at Perseverance, Salle, Beausejour and Dragon Bay Rivers.

Trends

No specific trends are noted.

Information Gaps

- Only a few studies have been done on the population dynamics of freshwater species. The status of the *Sicydium* sp. fishery is unknown. Anecdotal evidence suggests declining bio-indicator species (e.g., crayfish), but this is not confirmed as there is no consistent monitoring.
- There is no periodic monitoring of freshwater systems for chemical pollutants.
- There is no known data available on recreational/ leisure use of freshwater ecosystems.

Maximising freshwater ecosystem services

Mechanisms for maximising services include:

- Addressing threats from agrochemical pollution, sewage (greywater/faecal contamination), sedimentation and industrial waste.
- Improving public awareness and education: There is a role for academia in creating and transmitting knowledge and providing technical assistance. The transmission of knowledge should commence from early education and incorporate information on the importance of freshwater ecosystems and services. The teaching process should incorporate integrative learning, to ensure the understanding of the cross-sectoral linkages. This may facilitate collaborative solutions whereby resources can be pooled to find and refine solutions.
- Increasing communication, incorporating technology: These can improve access to data and highlight the importance and value of transparency in managing freshwater systems.

- Community engagement: Engaging communities in freshwater resources management allows for buy-in and ownership of responsibilities.
- Coordination of the governance institutions: Greater coordination among key ministries, agencies and organisations that play a role in watershed management will improve the impact of their efforts. The main frameworks adopted by the government for freshwater resources management include the *Grenada National Water Policy*, the *Grenada Integrated Water Resource Management Plan* and the draft Grenada Water Legislation.

Offshore island ecosystems

There are approximately 60 uninhabited islands, islets, cays and rocks around the three islands that make up Grenada. These range in size from <1-265ha with a cumulative surface area of ~600ha. Each of these islands is found on the relatively shallow Grenada Bank, the majority of which are considered part of the transboundary Grenadines archipelago shared between Grenada and St. Vincent and the Grenadines which is recognised as a biodiversity hotspot. Many of these offshore islands have ecologically unique characteristics.

Most of these islands are of volcanic origin with wave-cut cliffs and rocky outcrops. Beaches are typically shell sand, coral sand or black volcanic sand. Some of the islands are former volcanic plugs and feature unique formations, such as the striking polygonal columnar basalt formations e.g. on White and Mushroom/Cola Islands. Rainfall throughout the entire Grenadines, including the offshore islands, is very low in comparison to mainland Grenada. Sandy and coral sand beaches exist on several islands, such as Sandy Island (Carriacou), Jack Adan, Saline, Frigate, Mabouya and Sandy Island (Grenada); large boulders are common on many islands.

FLORA	• Terrestrial areas of these islands have shallow soils dominated by dry forest, scrub, cacti, shrubs, grasses, and xerophytic vegetation, several also have coastal mangrove forests. • Vegetative communities on most of the offshore islands appear less disturbed, with inaccessible islands being the most intact. Many species of flora have been introduced to islands, especially those that were previously cultivated. Terrestrial vegetation community types on the offshore islands include: grassland, marsh, mangrove, coastal scrub, cactus thorn scrub and dry/coastal forest. Stands of *Croton* sp., *Cordia* sp., *Leucaena* sp. and *Logwood-Acacia* thickets are common. • Marine vegetation includes a variety of seagrasses.
FAUNA	• Some of the most spectacular and productive coral reefs surround the offshore islands, given limited impact of sewage, pesticides, and marine pollution as compared to the main islands. • Isle de Ronde and Saline islands have seasonal salt ponds that provide important habitat for resident and migratory birds and are sites for 'salt picking' by nearby island residents. • Rocky intertidal zones of offshore islands are sites for collecting whelks *(Cittarium pica)*. • More than 120 species of breeding, non-breeding resident, migratory, restricted-range and regionally endemic birds have been recorded at offshore islands as have five bat species, and a variety of regionally endemic reptile species. The Grenadines pink rhino iguana (*Iguana iguana insularis*) subspecies has been confirmed on Mabouya Island. • The offshore islands provide critical nesting and foraging habitats for hawksbill *(Eretmochelys imbricata)*, loggerhead *(Caretta caretta)*, and green turtles *(Chelonia mydas)*, the surrounding waters support leatherback turtles *(Dermochelys coriacea)* during their inter-nesting phases. Green turtle nesting appears to be rare, and there is no documented nesting by loggerhead or olive ridley turtles *(Lepidochelys olivacea)*.

Value of offshore ecosystems

The offshore, uninhabited islands support breeding of colonies for at least nine species of breeding seabirds at colonies that meet the global and regional BirdLife International Important Bird Area (IBA) criteria, meaning they host at least 1% of the global or regional breeding population for a particular species. Gulls, terns and noddies nest primarily between May-August annually, other species like boobies and tropicbirds nest year-round. The offshore islands provide important nesting habitat for other species as well as foraging and resting areas for migrating shorebirds, land birds and waterbirds. The Sandy Island Oyster Bed Marine Protected Area and Jack A-Dan are highly important non-breeding feeding and roosting areas for brown pelicans in Grenada and Saint Vincent and the Grenadines.

Table 5. Global/Regional important seabird colonies in the Grenada Grenadines

Name of island	Seabird colony meets IBA criteria	Species triggering IBA qualification
Petit Tante	Global	Red-footed booby
Diamond Rock	Regional	Red-billed tropicbird, brown booby, red-footed booby, laughing gull
Frigate Island	Regional	Audubon's shearwater, red-billed tropicbird, laughing gull
La Tante	Regional	Red-footed booby
Diamond Rock + Les Tantes	Global	Red-billed tropicbird, brown booby
Les Tantes + Brothers/Sisters (Upper and Lee Rock)	Regional	Red-billed tropicbird, brown booby

Seabirds circulate nutrients between terrestrial and coastal/marine ecosystems, contributing to surrounding intertidal and coral reef health, enhancing fisheries productivity, and influencing terrestrial floral and faunal communities.

In the past, several of the offshore islands were important sites for cultivation, livestock grazing, agroprocessing and coastal defence, the remains of which exist as ruins of old buildings, derelict structures (e.g. storerooms, house foundations and coastal batteries) and altered terrestrial ecosystems. Isle de Ronde currently has semi-permanent habitation involving fishing and small-scale agriculture, several others are popular sites for recreational day trips, with some additionally used for fishing camps.

Threats and Issues

Physical development	Many offshore islands are privately owned and listed on the international real estate market. Development proposals are often incompatible with the local environment, native flora and fauna and can cause irreversible changes to island ecosystems and extirpations of native fauna.
Climate change	Terrestrial habitats could be considerably altered due to changes in vegetation which will largely affect nesting seabirds. Species may experience reduced nesting success and survival with warmer SSTs due to a change in prey species availability. With lower survival in previously productive areas, seabirds may undergo change in their distributions, which is likely to affect terrestrial plants and coral reefs with reduced nutrient spillover provided to these ecosystems by seabird colonies. Other bird species that use specific vegetation types on offshore islands for nesting may experience a lowered availability of suitable habitat with the loss of nutrient provided by the relocated seabirds. Low-lying areas, sandy beaches and cays are susceptible to reduction in size due to sea-level rise, resulting in loss of sea turtle and seabird nesting habitat, and intertidal foraging opportunities for numerous bird species, such as waterbirds and shorebirds.

Trends

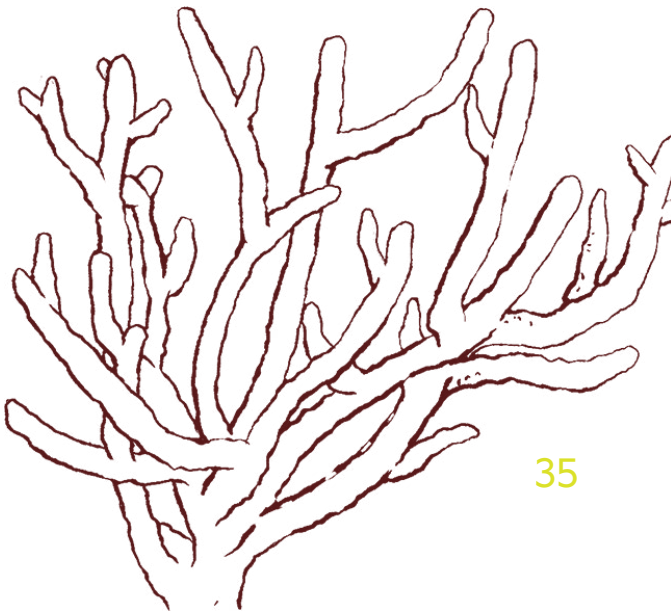
No specific trends are noted.

Information Gaps

Information on invertebrate diversity on offshore islands is scant. Many islands have not been inventoried for their biodiversity. Recent discoveries of endemics on other Grenadine islands highlight the potential for the discovery of additional endemic, regionally endemic species and/or relict populations formerly more widespread on main islands.

Maximising offshore island ecosystem services

Relevant approaches have been addressed under the Coastal and Forest Ecosystem sections above.



4. Genetic resources

Most of the instrumental value of genetic resources is tied to their current and potential use. This potential use, or possible bioprospecting holds significant promise for example: 1) future direct revenue; 2) development of new drugs and other products to address key developmental challenges including combating disease; and 3) food security through sustainable agriculture practices. Given the largely untapped potential and paucity of knowledge of Grenada's genetic resources, it is important to conserve and protect them now, to ensure continued access for future use and potential.

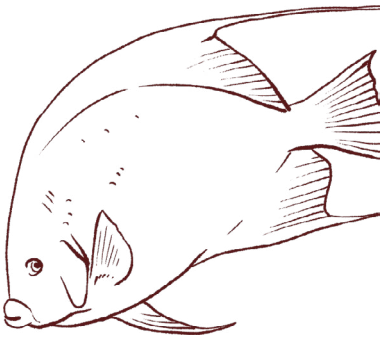
The contribution and impact to intrinsic and relational values are also important. Natural disaster impacts are of increasing concern, with a struggle to keep up with the velocity of impacts due to environmental issues such as climate change. Impacts of excessive global CO_2 emissions and climate change on terrestrial and marine genetic resources need consideration. Climate change impacts affect reproduction and growth of plants, animals and microbes, and also impacts abiotic substrates (soils, marine benthos) on which living organisms depend. It is important that genetic resources are well understood to cope with these impacts.

The introduction of non-native species and loss of plant and animal genetic resources are issues threatening endemic genetic resources. The impact of IAS has received increasing attention and has greater significance with interest in blue economy and marine genetic resources. Identifying and maintaining genetic variability for breeding programs is also important where local genetic stock is the cornerstone of unique niche markets suited to local conditions.

Maximising genetic resources

Grenada's genetic resources may have many potential uses and can provide opportunities to derive economic and social benefits from harvesting, forming a niche economic sector. Measures must be considered to safeguard the country from biopiracy and illegal bioprospecting. Being a party to the *Nagoya Protocol* offers Grenada a framework to better manage genetic stock and forge partnerships for transparent use and harvesting. The *Environmental Management Bill* 2007 can create a basic framework for holistic management with an objective of access and benefit sharing. Regulations need to be drafted under an overarching approved *Environment Management Act* to provide further specificity towards the implementation of fair and equitable benefits from sustainable utilisation of resources.

Green and blue environmental bonds are used as debt repayment/swap instruments to reduce sovereign debt and simultaneously provide cash flow for conservation. Their design and purpose will be context specific and tailored to national needs. Bond instruments should, over time, generate principal and interest that can be returned to investors, while nations like Grenada keep the initial bond cash flow. These bonds are not a panacea and may come with investment challenges such as lack of clarity about bond structure, absence of viable local projects and strong governance structures.



5. Ecosystems and climate resilience

The United Nations Framework Convention on Climate Change (UNFCCC) refers to climate change as "a change in climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable periods of time". From the 1950s and onward, evidence suggests explicit increases in atmospheric levels of greenhouse gases, particularly carbon dioxide (CO_2) and methane (CH_4), compared to prior millennia. Increasing levels of greenhouse gases stem from human activity resulting in an increase in global average temperatures well above pre-industrial levels. This is referred to as anthropogenic global warming.

Key pathways to addressing human-induced climate change are established within climate change mitigation and adaptation measures. The Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming (2018) defines mitigation as "a human intervention to reduce emissions or enhance the sinks of greenhouse gases" and adaptation in human systems as "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities". Therefore, for countries to become 'climate resilient', they need to employ an array of mitigation and adaptation measures.

Key impacts - Current and anticipated

Today, nearly all countries across the globe have committed to limiting global warming to 2°C above pre-industrial levels with further ambitions of well below 1.5°C. Small islands collectively contribute less than 1% of global emissions but face disproportionate risk from climate change impacts. The cost of inaction in addressing climate change for Caribbean Small Island Developing States (SIDS) is projected to grow every 25 years by at least 5% of GDP from 2025. Even under a global temperature scenario of 1.5°C, the combined and interactive nature of the key climate risks facing small islands mean that habitability is at significant risk. Some impacts of climate change in the Wider Caribbean including Grenada are:

- *Increasing temperatures and longer droughts*: Mean annual temperatures are projected to increase between 0.9-1.3°C by 2050. In the eastern Caribbean, droughts are projected to increase in frequency and duration; moderate to severe droughts occurring 26% of the time. An increasingly dry trend is projected by 2050, with rainfall decreasing by 20% (May-July) and 20-30% (August-December).
- *Reduced freshwater availability:* Freshwater availability is expected to decrease further as groundwater recharge reduces, river flows are lowered, and increased siltation occurs in dams.
- *Increased extreme weather events and intensification*: Hurricane intensity is projected to increase, with 80% increase in category 4-5 hurricanes over the next 80 years. Grenada's climate change projections suggest potential increase in tropical storm intensity and sea surface temperatures.
- *Increased risks due to sea level rise*: Low lying coastal areas account for the highest population densities and concentration of critical infrastructure. Projected increases (0.5-0.6m) threaten coastal aquifers and communities. With a 1m sea level rise, 29% of major resorts are projected to suffer from some level of inundation, with 49% destroyed or damaged. Grenada's projected losses include 1% of total land and roads, 3% of agricultural land, 8% of turtle nesting sites, 11% of major resorts and 100% of ports.
- *Changes in biological activity:* Shift in species range with implications for pest, diseases and invasive species, decline in wild pollinators in tropical dry forest habitats, and increased stress within freshwater systems.

Addressing threats, building resilience

Ecosystem resilience refers to the ability of the system to continue its functioning amid and recover from a perturbation. Resilient ecosystems provide multiple benefits, social and economic well-being. For example, among other societal and cultural benefits, coral reefs, mangroves, seagrass, and beaches provide protection against storm surges. Community resilience is closely interlinked with ecosystem resilience. Human actions which drive changes in land use, hydrology, nutrient cycles or increase pollution can reduce ecosystem resilience, especially when synergised with changing climate conditions. Undiversified economies can lock in patterns of behaviour which continue as stressors to ecosystems; community resilience increases through diversification.

Grenada's coastal ecosystems are already experiencing some of the effects of climate change, through damages from severe storms and other extreme events, increasing ocean temperature and more subtle changes in rainfall patterns. Future expected shifts in distribution of tuna stocks could take fishery resources beyond the reach of most small-scale fishing vessels in Grenada. As seas become warmer due to climate change, blooms of toxic microalgae are expected to increase, affecting water quality, presenting a health risk to humans. Fish are one of the few products for which the island is self-sufficient; however, it is possible that the abundance and productivity of deep-water fish species might be affected by climate change as eggs and larvae would be vulnerable to changes in ocean currents and SST change. In addition, previously shallow-water species may shift their distribution into deeper waters, to avoid high temperatures near the coast.

The impacts of climate change on terrestrial systems for Grenada's human population are potentially far reaching. These include for example: the high cost of insurance and abatement of damage from hurricanes and other extreme weather events; significant productivity loss due to heat exposure of workers in deforested areas; loss of cultural practices (e.g. those associated with freshwater systems). Observed post-hurricane forest loss changes in abundance and composition of NTFPs suggest that an increase in hurricane intensity would decrease species' resilience. This could lead to disproportionately negative impacts for vulnerable groups whose livelihoods depend upon these species.

An increase in vector-borne diseases is predicted across the Caribbean, due to climatic changes. Existing societal inequalities, such as the vulnerability of rural or poor communities, women, or minority groups, are likely to be exacerbated. Resource conflicts and internal/external migration due to scarce resources are increasingly likely due to climate change. Negative impacts of weather-related disasters erode natural capital and reduce the overall wealth and competitiveness of nations.

While habitat degradation and invasive species present more immediate threats to threatened species than climate change, risk of climate change impacts from storms, droughts and flooding are likely to exacerbate existing stressors. Hurricanes have had significant socio-economic impact, including on built infrastructure, cost of recovery at national and individual levels, public health, food production, livelihoods and the state of education. Extreme storm surges drive increased coastal erosion risks including beach loss; changes in coastal profiles would transform coastal tourism with implications for local employment and economic wellbeing. Impacts of ecosystem degradation are greatly exacerbated by climate change (and may lead to impacts on other services). The projected increased hurricane intensity could greatly diminish the adaptive capacity within these systems.

Responses

To effectively address climate change impacts on Grenada's ecosystems and improve resiliency, responses can take place on many levels, including national governance and policy responses, institutional and sectoral systems, and socio-economic interventions.

At the national level, a multisectoral approach is needed for harmonising policies among sectors and reducing overlaps and gaps to address adaptation and

integration of ecosystem services provided by forests and watersheds into national governance, national and sectoral land use planning, sector policies and legal frameworks. Mainstreaming climate change and promoting whole landscape approach to land use planning, all government projects, planning and initiatives are viewed through an adaptation lens. Interagency coordination, improved institutional capacity, availability and access to resources, incentives, and national support programmes provide mechanisms to support implementation.

At the local level, incentives and access to financing mechanisms are needed as small local actions can promote ownership of climate adaptation with island-wide cumulative benefits. Enhanced awareness and understanding is needed among practitioners and decision makers of climate resilient agriculture, sustainable land management techniques and practices integrated with biodiversity and forest conservation.

Access to long-term monitoring and evaluation (M&E) data is critical for developing successful, long-term sustainable adaptation actions that government agencies need to address in national budgeting, planning and capacity development. Interpretation of this data will inform policy which in turn will later influence behavioural change and, among others, will include legislation and enforcement, education and capacity building, and transparency and accountability tools.

Grenada has been implementing policy directives which seek to increase climate change resilience including: increasing coastal and marine areas protected under the Grenada Protected Areas System. Other actions include community co-management of coastal forest afforestation and mangrove restoration (Grenada's south, east and north coasts) to provide alternative livelihoods and build awareness around sustainable use; restoration of coral reefs (Grand Anse, Carriacou); and building resilient coastal communities by having them play leading roles in conservation, restoration and management of coastal ecosystems.

An effective intervention is to reduce or remove other pressures such as overfishing and habitat degradation by creating MPAs. At the local scale, adaptive capacity in the fishing industry and coastal communities can be strengthened by training (e.g. business skills, safety at sea). Awareness raising and good science communication are fundamental to provide communities with knowledge to adapt to climate change. Filling knowledge gaps on long-term monitoring of climate, biodiversity, species and ecosystems is important. Regional partnerships should be established with meteorological institutes and climate modellers to provide projections at a spatial scale useful to risk assessment and disaster planning.

6. Maximising ecosystem services

The ecosystem-level review of nature's services that underpin Grenada's wellbeing and economy, highlights inherent dynamic, complex and interconnected patterns. Energy and nutrient flows link freshwater, agricultural, terrestrial, marine and coastal systems. The value of trans-sectoral responses is recognised, acknowledging interconnections and that stakeholders do not experience these values as siloed sectors but as a system of outcomes. Developing locally relevant policy frameworks and economic responses that cross sectors is key. Potential response options that support, enhance and amplify the delivery of ecosystem services in Grenada, lean heavily on the framework of response options classified as:

- Foundational (responses related to the generation and distribution of knowledge- including Indigenous and local knowledge [ILK])
- Enabling (including policy, laws, institutions, governance and social attitudes)
- Instrumental (including markets, incentives, technology, practices and voluntary actions)

International, regional and national frameworks and obligations

Grenada has a comprehensive national policy framework and is signatory to a number of multilateral environmental agreements (MEAs) which have direct implications for management of natural and human impacted ecosystems and their ecosystem services. International obligations commit the country to work programmes arising from multilateral instruments with important policy and economic impacts on Grenada, relevant to ecosystem services management and delivery. Grenada is also part of several regional agreements, with some of them having important implications for the management of the island's ecosystem goods and services.

Despite this comprehensive web of international obligations, there are gaps in the country's treaty framework, with Government yet to sign onto some agreements. In some cases, implementation of obligations has fallen short of the requirements of relevant treaties. Inability to fully implement treaty obligations and/or participate in the multilateral processes represents a missed opportunity to leverage potential sources of administrative and technical capacity, secure funding for national or regionally focused projects and programmes, and participate in information generation and sharing processes central to management of ecosystem services. Multiple benefits of Grenada's engagement with MEAs can only be fully realised with adequate human resource assigned to international processes, transparent communication and engagement of local stakeholders, and timely integration of obligations into laws, policies, programmes and plans.

Building a multisectoral response

Response options should provide for holistic thinking across the sectors of the economy where:

- building relationships across national community sectors and actors can improve buy in, decision making and implementation effectiveness and lead to improvement in quantity and quality of ecosystem services obtained by Grenadians; and
- emphasising a shift from a solely economic sectoral lens to an approach that emphasises relationships and networks of stakeholders can provide new ways to improve management of ecosystem services that are particularly relevant for the small tri-island state of Grenada.

Management of Grenada's terrestrial ecosystem services requires clear identification of the existing knowledge base and the priority for filling gaps. Efforts to improve sustainable livelihoods and environmental governance are central to learning, improving and enhancing responses. Leveraging communities recognises the societal context for environmental decisions: social values and attitudes associated with ecosystems and their services that enable acceptance and adoption of responses.

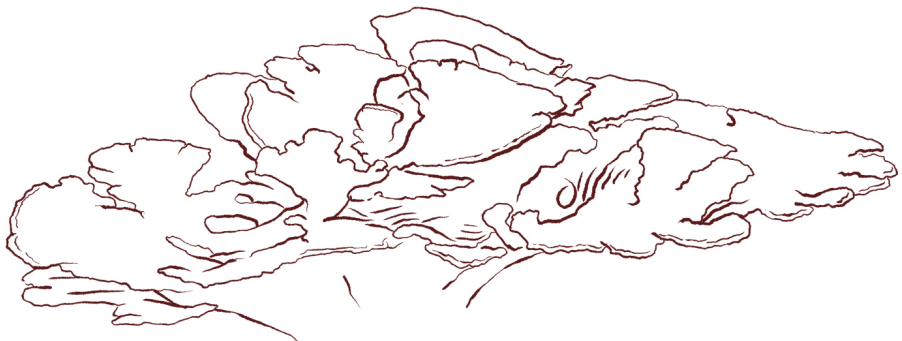
Financial mechanisms

Natural ecosystems provide significant tangible inputs to the economy but State investment in ecosystem services is limited. Diverse, innovative financing approaches are needed to go beyond traditional grant financing, encompassing instruments like return based investments (microfinance, peer to peer investing, sovereign bonds), risk management tools, (environmental insurance, pay for success vehicles), deposit-refund schemes, compensation and offsets. The State can take several approaches to broaden income streams to support improved ecosystem services management, including integrating Natural Capital Accounting in fiscal decision making, payment for ecosystem services and use of blue and green bonds. Debt for nature swaps may provide an avenue for some fiscal relief. Complexities and opportunities of new/emerging finance tools and existing barriers to implementation mean that success depends upon building partnerships among government, private sector, education, NGOs and individual landowners.

Policy review

A coordinated, multisectoral approach to policies, laws and regulations with a focus on integrating ecosystem services into governance and sectoral planning, policies and frameworks would address some challenges with institutional capacity by promoting interagency coordination, sharing of personnel, knowledge, technical capacity and equipment, to enable evidence-based and informed decision making.

Mainstreaming ecosystem services across national policies and plans provides an enabling environment for developing new ecosystem service-based services, markets and education systems. A cost-effective approach may be to amend policies, adding ecosystem services to relevant objectives. A key step is multisectoral review of approved and draft policies to ensure that ecosystem services used and affected by policies are explicitly addressed, proposing specific text for amendments, a work programme for drafting and State consideration. Recurrent across sectors is the need for (re-)investment in human capacity, knowledge generation, monitoring of the state and management of ecosystem services and monitoring and enforcement of national regulations. Priorities include land tenure, waste management, agrochemical misuse, transparency in decision making at all levels, stakeholder participation in knowledge-generation, governance and ecosystem services management.



7. Future scenarios for Grenada

The implementation of response options to sustainably manage ecosystems and their services can positively impact the future of Grenada. The actions of civil society can also influence the future. Thinking about what the future may look like, can help guide these actions and response options e.g. through scenario building.

Scenarios are an exploration of different plausible futures, and the opportunities and challenges they could present. The objective is not to 'get the future right', but to expand and reframe the range of plausible developments. By exploring alternative pathways, the inherent uncertainty that is a feature of trying to plan for future events is catered for. Scenarios can be used when: the future is uncertain and unpredictable; there are multiple possible futures or a longer-term perspective is needed. Scenarios time horizons can be up to 50 years or longer; both qualitative and quantitative methods can be used; and there is no 'right' answer. Good scenarios are based on the analysis of change factors and enable critical uncertainties to be identified. They represent alternative possible outcomes and they can take on different forms.

Scenarios were developed for the Grenada NEA through a process of capacity building, stakeholder engagement and expert feedback drawing on trends, previous experiences, and emerging changes. These scenarios were named Grenada Greens, Grenada Goes and Grenada Grows as summarised below and described in detail in Chapter 7 of the Grenada NEA.

Grenada Greens

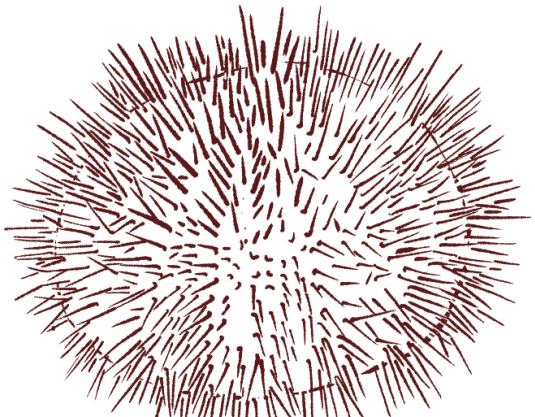
In this scenario there is a move at a global level towards sustainability and inclusive development with human well-being garnering greater focus and investment. There is low material growth and reduced energy intensity and resource use.

Grenada Goes

Grenada is now faced with major social, economic, and environmental challenges that, if not addressed could result in continued loss of development gains acquired during the period 2020-2030.

Grenada Grows

The 2030s and 2040s for Grenada are marked by cycles of social, economic, and environmental vulnerability. By 2050, because of urgent changes to the world order, Grenada has entered a period of growth becoming resilient to global and regional environmental, political and economic challenges. An integrated focus on sustainable ecosystem management characterises the 2050s growth period.



Reference

Agard, J., St. Louis, A., and Boodram, N. (eds.) (2023) *Grenada National Ecosystem Assessment*. St. Georges, Grenada: Government of Grenada; Barataria, Trinidad and Tobago: Caribbean Natural Resources Institute.

Glossary

Anthropogenic global warming	Global warming which is attributed to human causes.
Bioaccumulation	The gradual accumulation over time of a substance (usually a contaminant) in an organism.
Biodiversity (Biological diversity)	The variety and variability of life forms on earth or in a given area.
Bioprospecting	A systematic and organised search for useful products derived from biological resources including plants, animals and microorganisms that can be developed further for commercialisation and overall benefits for society.
Carbon markets	A carbon market is a trading system in which carbon credits are bought and sold. One tradable carbon credit equals one tonne of Carbon Dioxide, or the equivalent amount of a different greenhouse gas reduced, sequestered or avoided. Companies and individuals can offset their greenhouse gas emissions by acquiring credits from projects focused on carbon reduction and capture.
Ciguatera fish poisoning (ciguatera)	Ciguatera is a food-borne illness which is acquired by consuming fish which is contaminated by toxins produced by algae found at coral reefs. The algal toxins can accumulate in fish that feed on reef fish and the toxins cannot be destroyed by cooking.
Climate-smart agriculture	Climate-smart agriculture is an integrated approach to land management – cropland, livestock, forests and fisheries – that addresses the interlinked challenges of food security and climate change. This approach aims at achieving three main outcomes: increased productivity, enhanced resilience (reducing vulnerabilities to drought, pests and disease and climate-related risks and shocks) and reduced emissions.
Climate velocity	Climate velocity is a vector that describes the speed and direction that a point on a gridded map would need to move to remain static in climate space. From an ecological perspective, climate velocity can be conceptualised as the speed and direction in which a species would need to move to maintain its current climate conditions under climate change.
Climatic niche	A climatic niche is the set of environmental conditions under which a particular species of organism is able to persist.
Crustose coralline algae	Crustose coralline algae are hard algae which contain calcium carbonate within their cell walls. These algae perform vital roles in producing and stabilising reef structures.
Disaster risk reduction	Disaster risk reduction is the concept and practice of reducing disaster risks through systematic efforts to analyse and reduce the causal factors of disasters.
Echnioderm	An echinoderm is a marine invertebrate organism belonging to the animal phylum Echinodermata (‘spiny skin’). This group includes sea urchins, starfish, sand dollars and sea cucumbers among others.
Ecosystem certification schemes	There are three different ways to define certification of ecosystem services: 1) Certification of payment for ecosystem services (PES) schemes to demonstrate they are ‘sustainable’ in terms of economic, social and environmental impacts; 2) Certification of PES schemes to demonstrate that they actually deliver ecosystem services from land use/ management (i.e. verification of service delivery); and

	3) Certification that existing PES schemes or certification schemes e.g. carbon, timber etc. provide additional ecosystem services, other than what is being paid for e.g. watershed services from land-based carbon offset projects.
Ecosystem services	Ecosystem services are benefits people obtain from ecosystems, usually in one or more of four categories: provisioning, regulating, cultural or supporting. Provisioning refers to products obtained from ecosystems such as food, water, land, fibre, biochemicals and genetic resources. Regulating services refer to benefits obtained from regulation of ecosystem processes such as climate and water purification. Cultural benefits are non-material benefits obtained from ecosystems such as recreation, tourism, spiritual experiences, aesthetic and heritage benefits. Supporting services are necessary for the production of all ecosystem services such as soil formation, primary production and nutrient cycling.
Endemic species	An endemic species is one whose geographic range or distribution is confined to a single given area.
Exclusive Economic Zone	The United Nations Convention on the Law of the Sea (UNCLOS) defines an Exclusive Economic Zone (EEZ) as generally extending 200 nautical miles from the shore, within which the coastal state has the right to explore and exploit, and the responsibility to conserve and manage both living and non-living resources.
Fair trade	Fair trade is an approach to business and to development based on dialogue, transparency, and respect that seeks to create greater equity in the international trading system.
Fish Aggregating Devices	Fish Aggregating Devices (FADS) are floating objects that are designed and strategically placed to attract pelagic fish.
Foraminifera	Foraminiferans are microscopic, single-celled organisms which are encased in complex shells built from minerals in seawater. Foraminiferans can be found floating in the water column (planktonic forms) or living on the seafloor (benthic species). After their death, their shell casings accumulate in ocean sediments.
Gender sensitivity	Gender sensitivity is the act/process of being aware of the ways in which people think of gender, giving consideration to socio-cultural norms and discriminations in order to acknowledge the rights, roles and responsibilities of women and men in the community and the relationships between them.
Genetic resources	Genetic resources refers to any biological material which contains genes and/or metabolic material that may be derived from genes.
Invasive alien species	Invasive alien species (IAS) are plants, animals, pathogens and other organisms that are non-native to an ecosystem, and which may cause economic or environmental harm or adversely affect human health.
Macroalgae (seaweed)	Marcoalgae are macroscopic, multicellular marine algae. They are essential primary producers for maintaining the marine ecosystem, with microalgae.
Meiofauna	Meiofauna are a diverse assemblage of minute invertebrates generally associated with the benthos (bottom) of streams and rivers.
Microbiome	The microbiome is the collection of all microbes, such as bacteria, fungi, viruses, and their genes, that naturally live on and inside of the human body.

Nearshore	The nearshore area refers to the region of the sea or seabed relatively close to a shore.
Pelagic fish	Pelagic fish inhabit the water column, not near the bottom or the shore, of coasts, open oceans, and lakes.
Riparian nutrient input	Plant habitats and communities along the riverbanks are called riparian vegetation; riparian nutrient input therefore refers to entry of nutrients from terrestrial plants on riverbanks into rivers.
Scleractinia coralline algae	Scleractinia coralline algae are found associated with Scleractinia ('stony') corals and are typically encrusting and are fed upon by sea urchins, parrot fish, limpets and other reef-dwelling organisms.
Smart greenhouse	A smart greenhouse is a self-regulating, micro-climate controlled environment used for optimal plant growth. The system offers an option for sustainable food security in the face of challenges presented by climate change, environmental pollution and limited arable land availability.
Sustainable land management	The United Nations defines sustainable land management (SLM) as "the use of land resources, including soils, water, animals and plants, for the production of goods to meet changing human needs, while simultaneously ensuring the long-term productive potential of these resources and the maintenance of their environmental functions".
Sustainable supply chain	Supply chain sustainability refers to companies' efforts to consider environmental and human impacts of their products' journey through the supply chain, from raw materials sourcing to production, storage, delivery and all transportation links in between. The goal is to minimise environmental harm (from factors like energy usage, water consumption, waste production) with a positive impact on people and communities in and around their operations.
Taphonomy	Taphonomy is the study of the processes by which organic remains (plant, animal) become preserved or fossilised.
Vertical farming	Vertical farming is the practice of growing crops in vertically stacked layers, rather than horizontally as in traditional farming. The practice enables larger crop yield per unit area where land space is limited, often with environmental control for optimum crop growth and yield in an enclosed structure.

Appendices

Appendix 1. Selected MEAs relevant to ecosystem protection in Grenada

Topic	Selected MEAs relevant to ecosystem protection	Grenada's membership
Biodiversity, species, and fisheries	Convention on Biological Diversity (1992)	09/11/1994
	Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973)	28/11/1999
	International Plant Protection Convention (1979 Revised Text) (1979)	04/04/1991
	International Convention for the Conservation of Atlantic Tunas (1966)	05/10/2017
	Agreement on Port State Measures to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated (IUU) Fishing (2009)	16/08/2016
Caribbean	Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (1983)	16/09/1987
	Agreement Establishing the Caribbean Community Climate Change Centre (2002)	27/01/2006
	Agreement Establishing the Caribbean Environmental Health Institute (1980)	31/08/1988
Caribbean	Agreement Establishing Common Fisheries Surveillance Zones of Participating Member States of the Organisation of Eastern Caribbean States (1991)	01/03/1991
	Convention Establishing the Sustainable Tourism Zone of the Caribbean (2001)	06/11/2013
	Agreement Establishing the Caribbean Regional Fisheries Mechanism (2002)	04/02/2002
Climate and ozone protection	United Nations Framework Convention on Climate Change (1992)	09/11/1994
	Statute of the International Renewable Energy Agency (2009)	15/07/2011
	Paris Agreement under the United Nations Framework Convention on Climate Change (2015)	04/11/2016
	Convention for the Protection of the Ozone Layer (1985)	29/06/1993
Habitat and world heritage	United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa (1994)	26/08/1997
	Convention on Wetlands of International Importance Especially as Waterfowl Habitat (1971)	22/09/2012
	Convention for the Protection of the World Cultural and Natural Heritage (1972)	13/11/1998
Climate change	Framework Agreement on the establishment of the International Solar Alliance	15/11/2016

Topic	Selected MEAs relevant to ecosystem protection	Grenada's membership
Fisheries	Convention on Fishing and Conservation of the Living Resources of the High Seas	29/04/1958
	Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas	24/11/1993
	Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (UN Fish Stocks Agreement)	04/08/1995
General	Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters	25/06/1998
	Agreement on the establishment of the Global Green Growth Institute	20/06/2012
Habitat	Agreement for the Establishment on a Permanent Basis of a Latin- American Forest Research and Training Institute	18/11/1959
Oceans	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter	29/12/1972
	International Convention for the Prevention of Pollution from Ships	02/11/1973
	International Convention on Oil Pollution Preparedness, Response and Cooperation	30/11/1990
	International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea	03/05/1996
	International Convention on the Removal of Wrecks	18/05/2007
	International Convention on Civil Liability for Bunker Oil Pollution Damage (2001)	26/10/2018
	International Convention on the Control of Harmful Anti-Fouling Systems on Ships (2001)	26/10/2018
	International Convention for the Control and Management of Ships' Ballast Water and Sediments (2004)	26/10/2018
	International Convention for the Safe and Environmentally Sound Recycling of Ships	15/05/2009
Pollution	Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade	10/09/1998
	Convention on Persistent Organic Pollutants	22/05/2001
	Minamata Convention on Mercury	10/10/2013

Topic	Selected MEAs relevant to ecosystem protection	Grenada's membership
Species	Convention on the Conservation of Migratory Species of Wild Animals	23/06/1979
	Inter-American Convention for the Protection and Conservation of Sea Turtles	01/12/1996
	International Treaty on Plant Genetic Resources for Food and Agriculture	03/11/2001
	Agreement for the Establishment of the Global Crop Diversity Trust	01/04/2004

Appendix 2. Selected environmentally relevant national policies and plans

2003	National Waste Management Strategy
2009	Draft Protected Area System Plan
2011	National Energy Policy
2011	Land and Marine Management Strategy for Grenada
2013-2018	Food and Nutrition Policy and Plan of Action for Grenada
2014-2024	Gender Equality Policy and Action Plan
2015	National Adaptation Strategy and Action Plan for the water sector in Grenada, Carriacou and Petite Martinique
2003-2021	National Physical Development Plan
2015	Integrated Coastal Zone Management Policy for Grenada, Carriacou and Petite Martinique
2015	Lionfish Action Plan
2015-2030	Grenada National Agricultural Plan
2016-2020	National Biodiversity Strategy and Action Plan (NBSAP)
2017-2021	National Climate Change Policy for Grenada, Carriacou and Petite Martinique
2017	National Climate Change Adaptation Plan (NAP) for Grenada, Carriacou and Petite Martinique
2018	(Draft) Grenada National Land Policy
2018	Revised Forest Policy for Grenada, Carriacou and Petite Martinique
2019	(Draft) Grenada Drought Management Plan
2019	Grenada Integrated Water Resources Management Plan
2019	National Sustainable Development Plan 2020-2035 Grenada
2020	Grenada National Water Policy
2022-2024	Medium-Term Action Plan (MTAP) Programme of Action for Economic Recovery, Transformation and Resilience

Appendix 3. Selected environmental legislation

The legislative framework for protected area management includes a number of laws. Those listed below are central to the designation and regulation of Grenada's protected areas:

- *Abatement of Litter Act (2015)*
- *Birds and Other Wildlife (Protection) Act*
- *Environmental Management Act (Draft, 2005)*
- *Fisheries Act (1986) and subsequent Statutory Rules and Orders for Marine Protected Areas.*
- *Forest Land Act (1984)*
- *Forest, Soil and Water Conservation Act (1958)*
- *National Heritage Protection Act (1990)*
- *National Parks and Protected Areas Act (1990 amended in 1991, 2007 and 2009)*
- *National Water and Sewerage Authority Act (1990)*
- *The Pesticide Control Act Cap 238 (1973)*
- *Physical Planning and Development Control Act (2016)*
- *Wild Animals and Birds Sanctuary Act (1928)*

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