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Environmental Profile

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**COUNTRY
ENVIRONMENTAL
PROFILE**

Prepared Under the Aegis Of:

THE CARIBBEAN CONSERVATION ASSOCIATION
St. Michael, Barbados

On Behalf Of:

THE GOVERNMENT OF GRENADA
Ministry of External Affairs, Agriculture, Lands,
Forestry, Tourism, and Legal Affairs

With the Technical Support Of:

THE ISLAND RESOURCES FOUNDATION
St. Thomas, U.S. Virgin Islands

And

THE GRENADA NATIONAL TRUST
St. George's, Grenada

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Regional Development Office/Caribbean
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FOREWORD

One of the most serious threats to sustainable economic growth in the Caribbean is the increasing degradation of the region's natural ecosystems and a concurrent deterioration in the quality of life for Caribbean people. The task of reversing this unfortunate trend requires better knowledge and understanding of the region's unique environmental problems and the development of appropriate technologies and public policies to lessen and even prevent negative impacts on our fragile resource base.

In an attempt to provide such a framework, the Caribbean Conservation Association, with funding provided by the United States Agency for International Development and with the technical assistance of the Island Resources Foundation, has produced a series of Country Environmental Profiles for six Eastern Caribbean countries -- Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, St. Lucia, and St. Vincent and the Grenadines.

Even though these documents do not claim to be encyclopedic in their treatment of individual sectors and issues, each Profile represents the most current and comprehensive information base assembled to date on environmental and conservation issues that affect, and are affected by, the development process in the Profile countries.

Each document addresses key environmental problems, constraints, and policy directions as these were identified and fleshed out by a team of researchers and writers, in collaboration with a local coordinating committee. Each Profile also identifies and examines a variety of opportunities and planning tools which may prove useful in meeting environment/development goals in the future. All of this information should play a significant role in informing and influencing ecologically-sound development planning in the region, and should provide a basis for improved decision-making -- both immediate as well as long-term. This may best be accomplished by using the data to define priorities (in view of related benefits and costs), to pursue in-depth analysis of issues, and to undertake necessary follow-on activities in such a way that they are mutually reinforcing. In short, action emanating from the recommendations contained in the Profile might best be undertaken within a comprehensive environmental management framework, rather than from a piecemeal, project-oriented perspective.

The Caribbean Conservation Association is very pleased to be able to make this contribution to development planning in the region.

Calvin A. Howell
Executive Director
Caribbean Conservation Association

(April 1991)

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Overall project management for the Grenada Country Environmental Profile Project was provided by the Caribbean Conservation Association (CCA) under the direction of Acting Executive Director, Mr. Calvin Howell.

Technical guidance in preparation of the Profile was the responsibility of the Island Resources Foundation (IRF). Dr. Edward L. Towle, President of the Foundation, is the Team Leader for the Profile Project in the Eastern Caribbean; Judith A. Towle, IRF Vice President, is the Editor of the CEP Report Series; and Mr. Robert Teytaud served as Deputy Team Leader for the Profile Project in Grenada.

Grenada Government liaison for the CEP effort was the Ministry of External Affairs, Agriculture, Lands, Forestry, Tourism, and Legal Affairs. Signator of the Project Memorandum of Understanding between the Grenada Government and the Caribbean Conservation Association was Ms. Pamela Steele, then Permanent Secretary of the Ministry. Local project coordination in Grenada was implemented through the offices of the Grenada National Trust, Mr. Andrew Bierzynski, President. Ms. Tessa Johnson served as project secretary on behalf of the Trust and provided expert assistance to both in-country and visiting researchers. The in-country advisory and technical review committee for the Grenada Profile Project was ably chaired by Mr. Charles H. Francis, Land Use Officer in the Ministry of Agriculture.

Staff at the U.S. Agency for International Development, Caribbean Regional Development Office in Barbados facilitated implementation of the Grenada Profile Project, in particular, Mission Environmental Officer, Rebecca Niec, whose support has been appreciated throughout this effort by both CCA and IRF.

Many other organizations and individuals gave valuable and much appreciated assistance during the course of the project. The OAS Integrated Development Project Office in Grenada, headed by Mr. Richard Huber, was especially helpful in providing documents and reports based on its three-year program in Grenada. Particular recognition is also due to members of the Grenada National Technical Committee, whose names appear on the following page and whose role in the project is discussed in more detail in the Introduction.

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(February 1990)

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Section 9	LAND USE, PLANNING, DEVELOPMENT CONTROL	Robert Teytaud
Section 10	NATIONAL PARKS AND PROTECTED AREAS	Robert Teytaud
Section 11	PROTECTION OF HISTORICAL HERITAGE	Judith Towle
Section 12	INSTITUTIONAL FRAMEWORK	Judith Towle, Alister Hughes
Section 13	SUMMARY	Edward Towle, Robert Teytaud

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ACRONYMS USED IN THE COUNTRY ENVIRONMENTAL PROFILE

ART	Agency for Rural Transformation
BDD	British Development Division
CARDI	Caribbean Agricultural Research and Development Institute
CARICOM	Caribbean Community
CCA	Caribbean Conservation Association
CDB	Caribbean Development Bank
CEHI	Caribbean Environmental Health Institute
CEP	Country Environmental Profile
CERMES	Center for Resource Management and Environmental Studies
CFTC	Commonwealth Fund for Technical Cooperation
CIDA	Canadian International Development Agency
CSC	Commonwealth Science Council
CTO	Caribbean Tourism Organization (formerly Caribbean Tourism Research and Development Center)
CTRC	Caribbean Tourism Research and Development Center (now Caribbean Tourism Organization)
CWC	Central Water Commission
CZM	Coastal Zone Management
ECNAMP	Eastern Caribbean Natural Area Management Program (renamed as Caribbean Natural Resources Institute, CANARI)
EDF	European Development Fund
EEC	European Economic Community
EHD	Environmental Health Department
EHO	Environmental Health Officer
EIA	Environmental Impact Assessment
FAD	Fish Aggregating Device
FAO	Food and Agriculture Organization of the United Nations
FSR	Farming Systems Research
GBCS	Grenada Banana Cooperative Society
GCA	Grenada Cocoa Association
GCNA	Grenada Cooperative Nutmeg Association
GDB	Grenada Development Bank
GDP	Gross Domestic Product
GESL	Grenada Electricity Services, Ltd.
GFC	Grenada Farms Corporation
GHA	Grenada Hotel Association
GMFC	Grenada Model Farms Corporation
GNT	Grenada National Trust
GOG	Government of Grenada
GRENLEC	Grenada Electricity Services, Ltd.
GTZ	German Agency for Technical Co-operation (Deutsches Gessellschaft fur Technische Zusammenarbeit)
HIAMP	High Impact Agricultural Marketing and Production (USAID)
ICBP	International Council on Bird Preservation
ICOD	International Center for Ocean Development (Canada)
IDB	Inter-American Development Bank
IDC	Industrial Development Corporation
IDRC	International Development Research Center
IFAD	International Fund for Agricultural Development
IICA	Inter-American Institute for Cooperation on Agriculture

IRF	Island Resources Foundation
IUCN	International Union for the Conservation of Nature and Natural Resources
LDCA	Land Development Control Authority
LPG	Liquid Propane Gas
MSCMS	Minor Spice Cooperative Marketing Society
NCS	National Conservation Strategy
NDF	National Development Foundation
NGO	Non-Government Organization
NHA	National Housing Authority
NRSE	New and Renewable Sources of Energy
NSTC	National Science and Technology Council
OAS	Organization of American States
OECS	Organization of Eastern Caribbean States
OECS-NRMP	Organization of Eastern Caribbean States-Natural Resources Management Project
OLADE	Latin American Energy Organization
PADF	Pan American Development Foundation
PAHO	Pan American Health Organisation
PCB	Pesticide Control Board
PPU	Physical Planning Unit
PRG	People's Revolutionary Government
TFR	Total Fertility Rate
TVA	Tennessee Valley Authority
UNDP	United Nations Development Program
UNDTCD	United Nations Department of Technical Co-operation for Development
UNEP	United Nations Environment Program
USAID	U.S. Agency for International Development
USEPA	U.S. Environmental Protection Agency
UWI	University of the West Indies
WHO	World Health Organization
WIDECAST	Wider Caribbean Sea Turtle Conservation Network
WINBAN	Windward Islands Banana Growers Association
WWF	World Wildlife Fund

ABBREVIATIONS USED IN THE COUNTRY ENVIRONMENTAL PROFILE

ac	acre	kW	Kilowatt
BOD	biochemical oxygen demand	kWh	Kilowatt-hour
cm	centimeter	l/s	liters per second
EC\$	Eastern Caribbean Dollar	lb	pound
ft	foot	m	meter
g	gram	MGD	million gallons per day
gpd	gallons per day	mi	mile
ha	hectare	ML	millions of liters
in	inch	mm	millimeter
kg	kilogram	MW	megawatt
km	kilometer	TJ	Terajoule
kn	knot	TOE	Tonnes of Oil Equivalent
kV	Kilovolt	US\$	American Dollar (US\$1.00 = EC\$2.67)

**CONVERSION CO-EFFICIENTS BETWEEN IMPERIAL MEASURES AND WEIGHTS
AND THE METRIC SYSTEM**

	<u>IMPERIAL</u>	<u>METRIC SYSTEM</u>
LENGTH	1 inch 0.39370 inch 1 yard 1.094 yards 1 mile 0.6214 mile 1 fathom (6 feet)	2.540 centimetres 1 centimetre 0.91440 metre 1 metre 1.609 kilometres 1 kilometer 1.829 metres
AREA	1 square foot 10.6 square feet 1 acre 2.471 acres 1 square mile 0.386 square mile	0.093 square metre 1 square metre 0.405 hectare 1 hectare 2.59 square kilometres 1 square kilometer
VOLUME	1 pint 1.76 pints 1 gallon 0.220 gallon 1 cubic foot 35.31 cubic feet	0.568 litre 1 litre 4.546 litres 1 litre 0.028 cubic metre 1 cubic metre
WEIGHT	1 pound 2.205 pounds 1 long ton 1 short ton 0.9842 long ton 1.102322 short ton	0.4536 kilogram 1 kilogram 1016 kilograms 907.185 kilograms 1 tonne (1,000 kilograms) 1 tonne (1,000 kilograms)
TEMPERATURE	Conversion F to C: subtract 32 and divide by 1.8	Conversion C to F: multiply by 1.8 and add 32

INTRODUCTION

Preparation of Country Environmental Profiles (CEPs) has proven to be an effective means to help ensure that environmental issues are addressed in the development process. Since 1979, the U.S. Agency for International Development (USAID) has supported Environmental Profiles in USAID-assisted countries, principally in Latin America and the Caribbean. CEPs completed to date have provided:

(1) a description of each country's natural resource base, including a review of the extent and economic importance of natural resources and changes in the quality or productivity of those resources;

(2) a review of the institutions, legislation, policies and programs for environmental planning, economic development and natural resource management;

(3) identification of the major issues, conflicts or problems in natural resource management and opportunities for effective responses.

Profiles have highlighted gaps in the existing information base, influenced the design and funding of development programs, pinpointed weaknesses in regulatory or planning mechanisms, and illustrated the need for changes in policies. Most importantly, the process of carrying out a profile project has in many cases served to strengthen local institutions and to improve their capacity for incorporating environmental information into development planning.

PROFILES FOR THE EASTERN CARIBBEAN

Country Environmental Profiles have been prepared for several countries in the Wider Caribbean Region, including Panama, Belize, the Dominican Republic, Haiti, and Jamaica. The potential utility of CEPs in the Eastern

Caribbean sub-region (essentially the OECs countries) has been a subject of discussion since the early 1980's. The need for the profiling process to begin in those countries was reaffirmed during a seminar on Industry, Environment and Development sponsored by the Caribbean Conservation Association (CCA) and the University of the West Indies in August 1986.

Shortly thereafter, USAID entered into a Cooperative Agreement with CCA for preparation of a series of CEPs for the Eastern Caribbean. It was decided to begin the profile process in the country of St. Lucia as a pilot project, to be followed by profiles for Grenada, Antigua, Dominica, St. Kitts-Nevis and St. Vincent.

Early in 1987, CCA and the Island Resources Foundation (IRF), of St. Thomas, U.S. Virgin Islands, entered into an agreement whereby it was determined that IRF would provide technical assistance and support to CCA in the execution of the profile project in the Eastern Caribbean. The Executive Director of the Caribbean Conservation Association is the CEP Project Director, while the President of the Island Resources Foundation serves as CEP Project Manager/Team Leader.

THE GRENADA COUNTRY ENVIRONMENTAL PROFILE

In 1989, a Memorandum of Understanding (MOU) was signed by CCA and the Government of Grenada (GOG) for the purpose of executing a Country Environmental Profile in Grenada, with the Ministry of External Affairs, Agriculture, Lands, Forestry, Tourism, and Legal Affairs the designated counterpart agency for the Government. At that time, the Grenada National Trust was also designated by CCA and GOG as the local implementing and coordinating organization in Grenada for the CEP project.

A National Technical Committee was formed as an advisory, technical information, and review body for the CEP project in Grenada.

The Committee is comprised of representatives from GOG agencies and private sector organizations with responsibilities for or expertise about environmental issues in the country. Individuals not representing a particular group but with appropriate expertise were also included in the CEP Technical Committee membership.

The first meetings of the Committee were held in 1988, predating the signing of the project MOU, and the group has met consistently throughout the project. The Committee has assisted the technical writing team from Island Resources Foundation in the formulation of the CEP report outline; in the identification of critical environmental issues; in providing technical input at various stages of the writing process, as well as additional references and source materials not already in the IRF library; and in the review of documents prepared by the IRF technical writing team.

A CEP project office was established by the National Trust during the course of the Profile effort in Grenada. An in-country library of reference materials was established at this location, with documents provided by Island Resources Foundation and members of the Committee. This collection now forms the nucleus of a National Trust environmental library which will outlive the Profile Project.

ORGANIZATION OF THE GRENADA CEP REPORT

As determined by the Grenada CEP National Technical Committee and the IRF technical writing team, this Profile has been organized in thirteen primary sections.

SECTION ONE provides background information on the general environmental setting of the country and also briefly reviews the historical and cultural background. This is fol-

lowed by a demographic overview in SECTION TWO and a discussion of the economic context in SECTION THREE.

SECTION FOUR begins a review of the country's natural resource base, including a discussion of primary environmental issues within each of four key resource sectors.

The Profile moves on to examine primary economic sectors, beginning with agriculture in SECTION FIVE, key industries and energy issues in SECTION SIX and concluding with tourism in SECTION SEVEN. Environmental pollution is the subject of SECTION EIGHT.

The role of land use planning, development control, parks, and other protected areas programs is examined in SECTIONS NINE, TEN, AND ELEVEN.

SECTION TWELVE focuses on the institutional framework for environmental management in Grenada, including an overview of key agencies and organizations with resource management and development responsibilities.

The final chapter of the Profile, SECTION THIRTEEN, summarizes the key environmental issues and problems facing Grenada and makes recommendations to enhance the achievement of a sustainable balance between resource development on the one hand and resource conservation and resource management on the other.

A comprehensive bibliography of source materials dealing with natural resource development and environmental management is found at the end of the Profile. Most references cited deal specifically with Grenada or with the Eastern Caribbean sub-region. It is the most thorough assemblage of such reference material on Grenada to be published to date.



Bathway Beach, northeast coast of Grenada. Throughout the Caribbean, broad stable beaches like this attract development, but tourism facilities require careful planning to minimize adverse environmental impacts. At such beaches, all sand mining should be prohibited and illegal sand removal severely penalized. However, alternative sand mining locations – where mining activities will have less detrimental impacts on natural systems – also need to be identified and then rigorously monitored.

SECTION 1 INTRODUCTION AND BACKGROUND

1.1 ENVIRONMENTAL SETTING

1.1.1 Landscape and Our Changing Perspective

The original European explorers and colonizers of Grenada were nearly unanimous in noting the island's beauty, its lush tropical forests, and varied topography. From the rain-fed, wet mountaintop areas of the main island of Grenada, dwarfed forests (called "elfin woodlands") stretched downslope to merge with lush montane rain forests, which, in turn, gave way along the coastlines to more diverse lowland dry forests, mangroves, lagoons, rocky headlands, beaches and bays with fringing coral reefs. In the four centuries since the time of European colonization, Grenada has been largely transformed from this once densely forested state to a mostly agricultural landscape. Along the way, due to its successful, specialized production of nutmeg and mace, the island acquired a reputation and nickname unique in the region, where it has come to be known as "the Spice Island".

Despite centuries of agricultural cultivation and recent tourism development, Grenada still retains some of its mountaintop forests and coral reefs, over 450 species of flowering plants and 150 species of birds, and broad expanses of pleasing, still mostly undamaged landscape vistas. The nation also has a diversity of cultural resources: Carib (Amerindian) archaeological sites; historical sites spanning over 400 years of human drama and socio-economic activity (including forts, sugar mills, rum distilleries and estate houses); and examples of fast-disappearing traditional West Indian ways of life (such as spice-producing estates, remote artisanal fishing communities and a traditional boat-building industry).

However, the nation's accelerated population growth and development over the past several decades has placed ever-increasing pressures on these natural and cultural resources. While largely beneficial, development has had a variety of adverse, mostly un-

desirable impacts on the environment, including:

- increases in soil erosion
- pollution and sedimentation of rivers, water supplies and coastal waters
- hydrological regime imbalances reflected in flooding and decreased availability of water
- declines in agricultural and fisheries production
- loss of wildlife habitat
- the continued deterioration of historic and archaeological sites.

At the same time there is an increasing demand for better recreational opportunities and environmental education programs for Grenada's population and a demand for a greater variety of natural and cultural attractions for both nationals and tourists.

Competing demands for landscape use are more and more common, while complaints by one resource user about the impacts of other users and their waste products are also more frequent and increasingly more difficult to manage. But as a former planner in Grenada so cogently observed, the landscape of Grenada warrants a management strategy commensurate with its value as a national resource. The risk is in under-valuing this remarkable, common resource, and by doing so, inadvertently allowing it to deteriorate and devolve into a second rate, diminished habitat for Grenadians of the next generation.

1.1.2 Climate

The normal climate of an oceanic region at the latitude of Grenada is a humid tropical marine type, with little seasonal or diurnal (daily) variation and a fairly constant, strong ("trade") wind out of the east. This regional climate is affected mainly by the

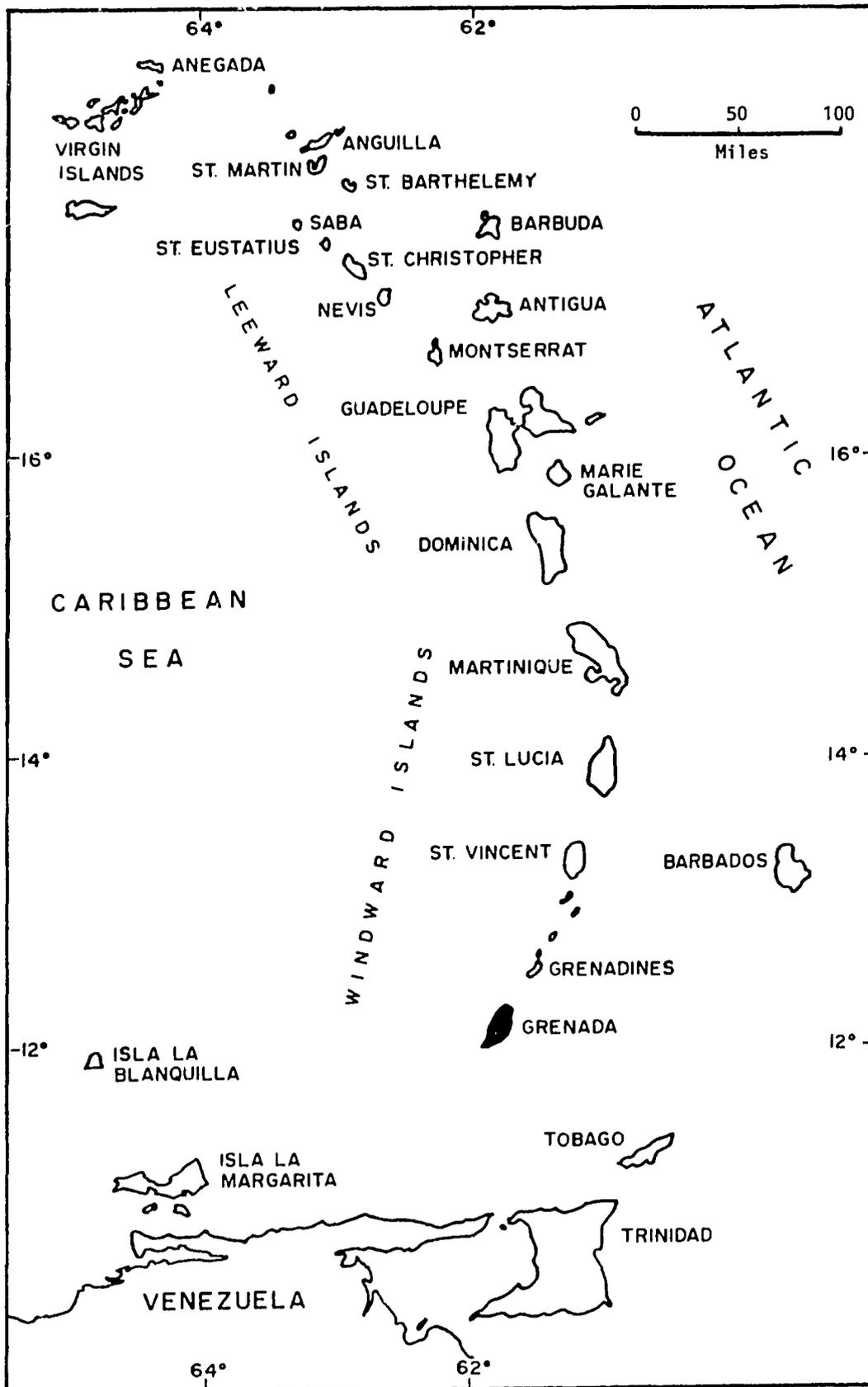


Figure 1.1(1). General map of Eastern Caribbean, showing location of Grenada.

GRENADA

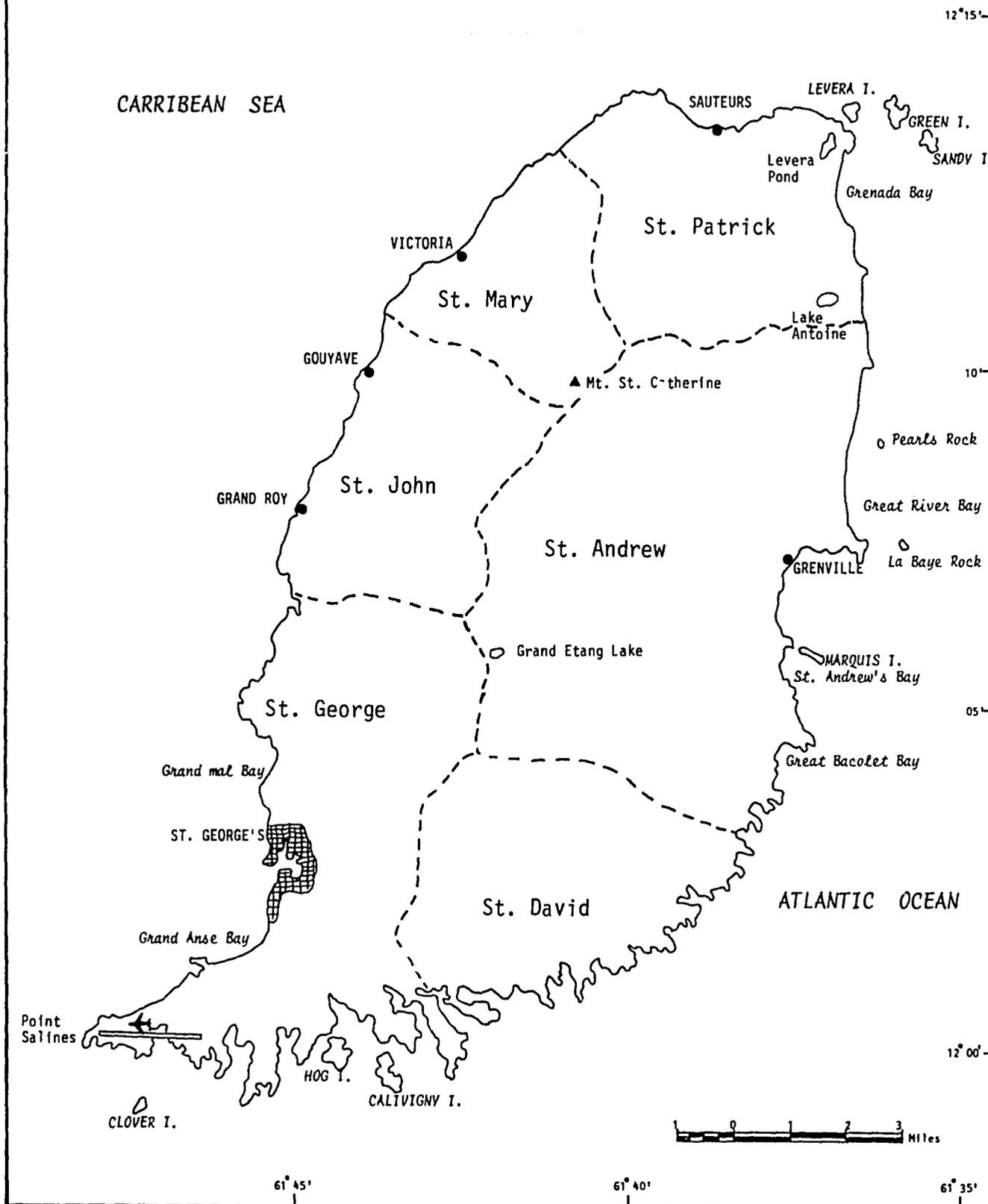


Figure 1.1(2). Country location map, island of Grenada.

GRENADA'S "VITAL STATISTICS"

Grenada, located at the southern end of the Lesser Antillean island chain (approximately 90 miles north of Trinidad), is the largest of the three main islands which make up the nation of Grenada, the other two being *Carriacou* and *Petit Martinique* in the Grenada Grenadines. There are also a number of small islands, islets and rocks which lie offshore from the main islands. (See Figures 1.1(1) - 1.1(4).)

Location	Latitude: 11 degrees 58 minutes/12 degrees 13 minutes North Longitude: 61 degrees 20 minutes/61 degrees 35 minutes West
Area/Grenada	21 miles long and 12 miles wide 120 sq. miles or 78,000 acres (312 sq. km or 31,200 ha)
Area/Carriacou	(15 miles to the north of Grenada) 13 sq. miles or 8,500 acres (34 sq. km or 3,400 ha)
Area/Petit Martinique	(2.4 miles east of Carriacou) 0.9 sq. miles or 575 acres (2.3 sq. km or 230 ha)
Total Land Area	133 sq. miles or 86,500 acres (346 sq. km or 34,600 ha)
Population	100,000 (but see Chapter 2), largely concentrated in the southwestern part of the main island near the capital of <i>St. George's</i> ; largest villages: <i>Grenville</i> , <i>Gouyave</i> , <i>Sauteurs</i> , <i>Victoria</i> and <i>Hillsborough</i> (Carriacou)
Economic Activities/Grenada	Agriculture, tourism, small manufacturing sector
Economic Activities/Satellite Islands	Inter-island trade, fishing, livestock raising, subsistence agriculture, boat-building
Primary Crops	Cocoa, nutmeg and bananas
Secondary Crops	Coconuts, sugar cane, citrus
Tourism Industry	Centered around the southwestern part of Grenada, with most of the tourism plant concentrated in the area of Grand Anse Beach
Airport	New (1984) international airport at Point Salines in the southwestern corner of Grenada which replaced much smaller Pearls Airport on the east coast
Major Port	<i>St. George's</i> ; other ports of entry: <i>Hillsborough</i> in Carriacou and <i>Grenville</i> in Grenada
Physical Features/Grenada	Apart from some limestone in the north, the island is volcanic. It is mountainous and thickly wooded, with numerous streams and rivers. The central mountain mass consists of a number of ridges, some of which contain crater basins. Mount <i>St. Catherine</i> (2,749 ft/840 m) is the highest peak. There are several outstanding beaches.
Carriacou and Petit Martinique	Both islands are volcanic mountain peaks with shallow and highly eroded soils.

subtropical cyclone belt and the intertropical convergence zone. The location of these two meteorological systems varies in a cyclical pattern, and their movement gives a seasonal character to the weather. Rain tends to be showery and is distributed roughly into a drier season from January to May and a wetter season from June to December. There is some risk of hurricanes from June to December; however, Grenada lies just south of the path of most tropical storms and is only rarely affected by hurricanes (see Section 1.1.6 below).

THE LOCAL CLIMATE

High islands like Grenada manufacture their own local weather, creating a range of microclimates which varies greatly with height, location and orientation on any given island. Grenada has several mountain masses, one rising to 2,749 ft. (840 m) at Mount St. Catherine, which cause a marked upward de-

flection of the westerly moving moisture-laden air. This rising sea air is cooled by expansion, and the moisture is condensed so that "orogenic" cloud formations and often heavy precipitation result. A typical feature of central mountain peaks in the Eastern Caribbean islands is a cap of "trade wind clouds" which masks their summits day after day and is only occasionally dissipated in very still or very dry weather.

Typical of small tropical islands, the temperature of Grenada at sea level is generally rather high with little seasonal, diurnal or locational variation due to the damping or stabilizing effect of the ocean mass. Monthly temperature data for Pearls Airport and Point Salines Airport (both close to sea level) are displayed in Table 1.1(1). Temperature records for the higher elevations in Grenada do not appear to be readily available, but Beard (1949) suggests an average of 21 to 22 degrees C between monthly means of 19 to 24 degrees C with very high humidity, no frost

Table 1.1(1). Mean monthly and annual average maximum temperatures (degrees C).

MONTH	TEMPERATURE Pearls Airport (1976-1981)	TEMPERATURE Point Salines Airport (1986-1987)
January	29.7	28.3
February	28.9	29.7
March	28.5	30.2
April	29.6	33.3
May	30.3	31.3
June	29.8	30.6
July	29.7	30.6
August	30.1	30.8
September	30.4	30.6
October	30.4	30.9
November	29.9	30.4
December	29.2	30.1
ANNUAL AVERAGE:	29.65	30.56

Source: Adapted from Grenada Facts and Figures, 1982 and GOG Annual Abstract, 1987.

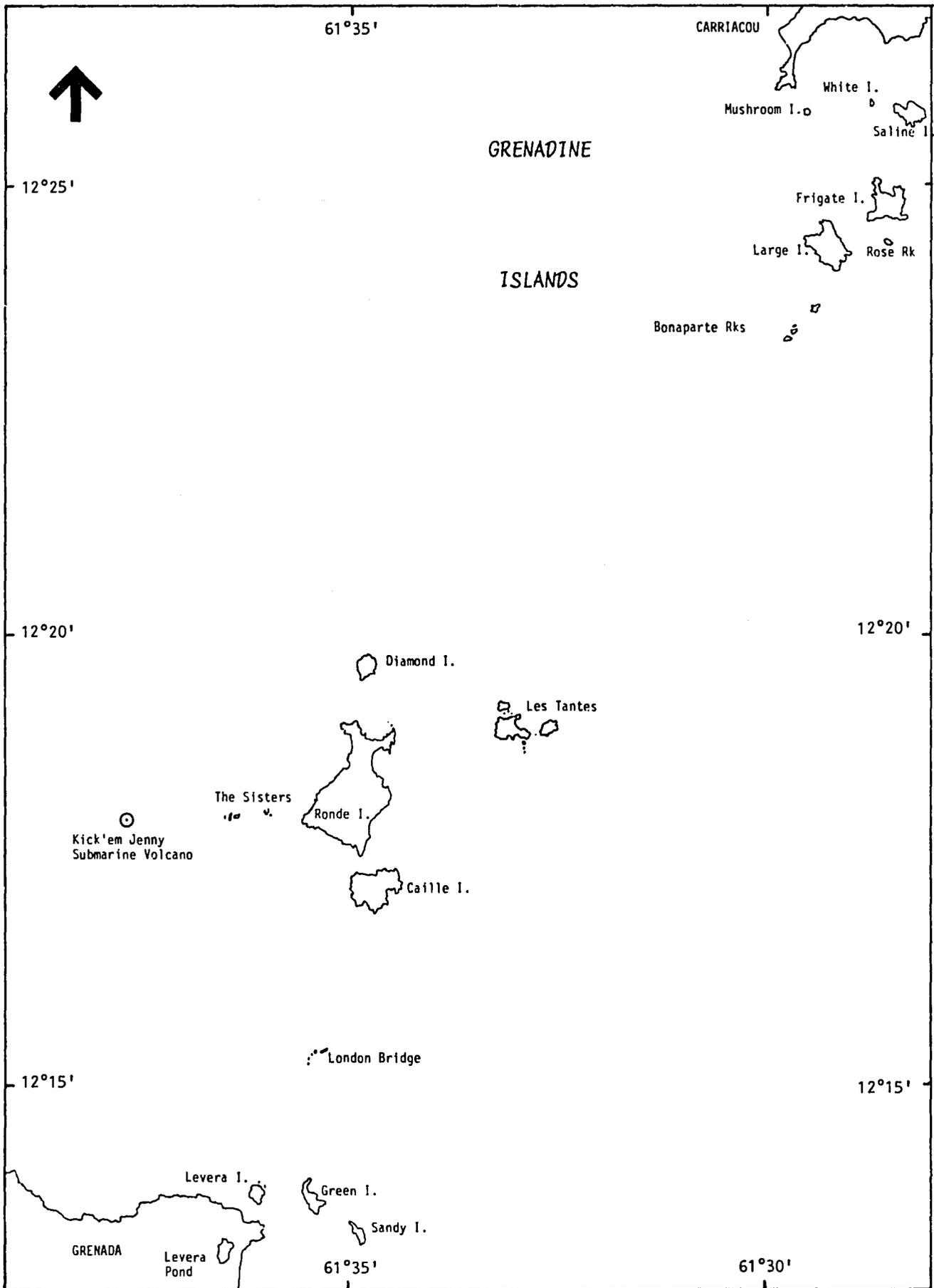


Figure 1.1(3). Location map of Grenada and the Grenadines.

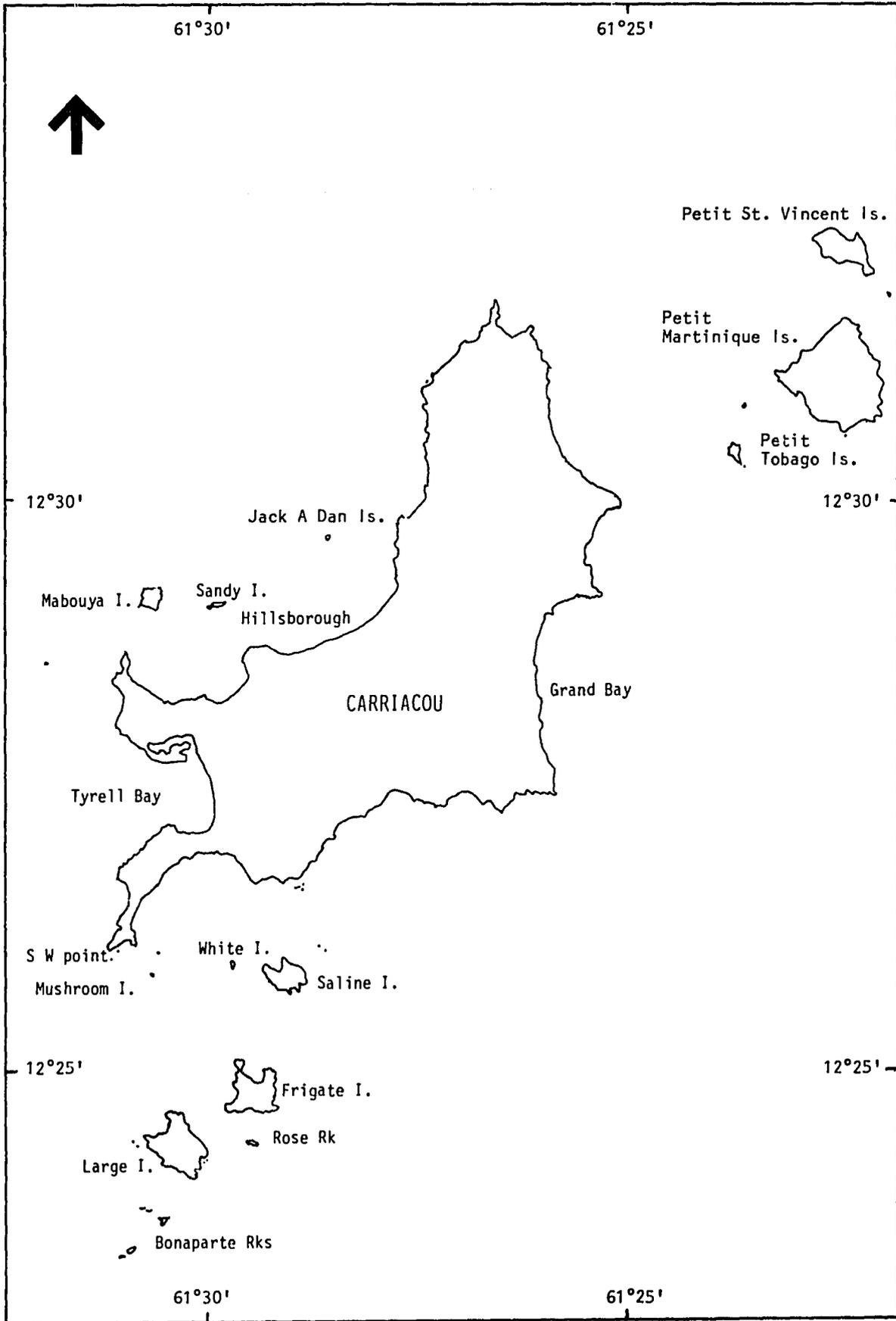


Figure 1.1(4). Location map of Carriacou.

and little sunshine. As a rule of thumb, the temperature falls with altitude above sea level at a rate of one degree C drop per 100 meters in elevation. This method of estimating upland temperature at a given altitude is very approximate, but it is useful in classifying environmental units and in working out evapotranspiration rates.

The Windward Island group of which Grenada is a part is located within the belt of "trade winds" famous among seamen for their directional reliability and generally predictable schedule. These winds move westerly along the southern edge of the Atlantic-Azores sub-tropical high pressure zone and approach Grenada from directions between east-north-east to east-south-east. Changes in this wind regime are mostly caused by the annual seasonal (vernal and autumnal) shift in the declination of the sun from the equator, with stronger, more northerly winds being common from December to May. Disturbances to this system can be induced by the passage of so-called "easterly waves" in the upper atmosphere and other low pressure systems during the "wet season."

The extremes of Grenada's wet and dry season rainfall regime and its temporal and spatial pattern create wide variations in annual precipitation at different locations. For the island as a whole, the period of lowest rainfall occurs generally in winter, when the so-called Bermuda high pressure cell extends its sphere of influence southward, bringing attention to its arrival by forcing a pronounced shift of the ubiquitous trade winds from the southeast to out of the northeast. These "Christmas winds," as they are known to seamen, also bring clear, relatively dry conditions to Grenada from mid-December to early May.

Island-wide average rainfall data are presented in Section 4.2 (see Table 4.2(1) and Figure 4.2(1) which show the spatial variation in rainfall distribution). Grenada's rainfall is highest in the hilly or mountainous part of the country; for example Grand Etang, located at an altitude of 1980 ft. (600 m), normally receives about 153 inches (3880 mm) of rain a year. Rainfall intensities are frequently greater than 50 mm/hr. and maximum intensities of 112-132 mm/hr. have been reported

(Eschweiler, 1932a). By contrast, most of the valleys and coastal plains are relatively dry, with annual precipitation averaging about 40 inches (990 mm) at Point Salines. These are, therefore, the areas of the country with the most sun, the fewest clouds and both Atlantic and Caribbean sea frontage and exposure, making them attractive to the tourism industry.

1.1.3 Topography

The interior of Grenada is dominated by mountain peaks, steep ridges, and deep narrow valleys. The volcanic geology of the interior is the dominant factor that produced this landscape. A single north-south trending ridge is also the major watershed of the island (Figure 1.1(5)). Grenada's principal peak, Mount St. Catherine, is 833 m (2,749 ft.) high and is located in the northern half of the island.

Carriacou rises to a height of only 297 m (980 ft.) at High North, while Petit Martinique attains an altitude of 226 m (745 ft.).

The coastal periphery of Grenada presents a landscape which is much more subdued than the interior. The western side of the island displays a more rugged aspect as the central ridge is nearer to the coast on that side; the slopes are gentler on the east, and there are some fairly extensive coastal plains. The topography of the southwestern and northeastern parts of the island consists of low hills.

With the exception of the harbors at St. George's and Halifax, the west coast consists of a series of shallow bays separated by headlands, as do the north and northeast coasts. The southeast coast south of Telescope Point and the south coast westerly to Point Salines are deeply indented with many small bays backed by mangrove swamps.

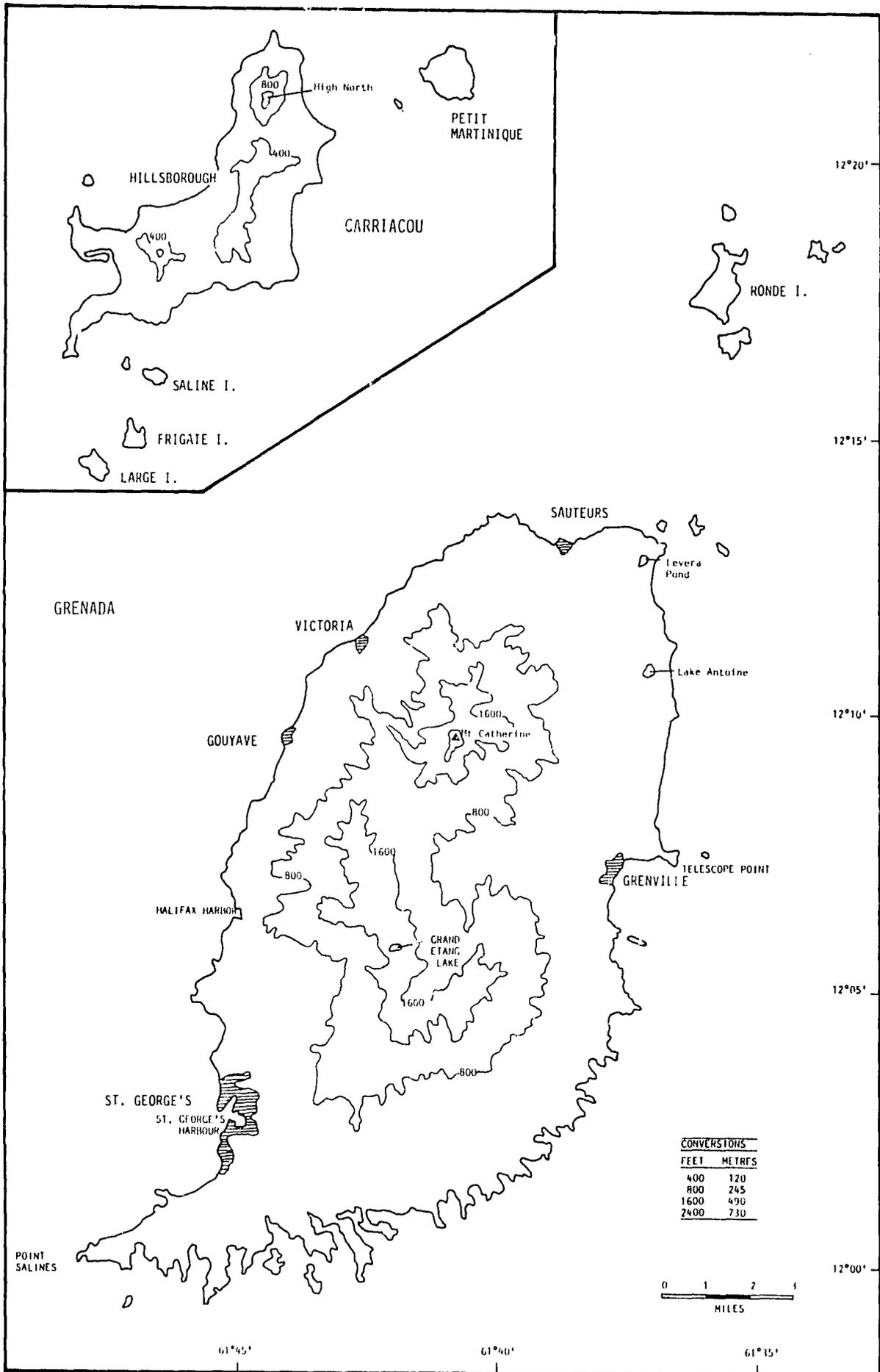


Figure 1.1(5). Topography of Grenada and Carriacou, elevation in feet (source: Weaver, 1989).

1.1.4 Geology and Soils

GEOLOGY OVERVIEW

The Caribbean's Antillean arc of islands is geographically young, probably not exceeding 50 million years, and is predominantly volcanic in origin. Grenada and the associated undersea ridge upon which it is perched are located near the edge of what is known as the Caribbean Tectonic Plate (see Figure 1.1(6)). Tectonic plates are mobile; they behave like rafts of solid crust floating on the less dense fluid materials of the underlying mantle layer of the earth. Their movements are apparently related to the convection "currents" in the mantle.

The Caribbean Plate is bounded by the North American Plate to the north and

east, the South American Plate to the south, and the Cocos Plate to the west and southwest. The North American Plate moves to the west relative to the Caribbean Plate, while the Cocos Plate subducts towards the northeast. There is little relative displacement between the Caribbean and South American Plates at this time in geologic history.

The eastern boundary of the Caribbean Plate is a subduction zone in which the North American Plate passes under the Caribbean Plate and into the mantle where melting occurs. The melted plate material forms magmas which, when extruded as lava by volcanos, have resulted in the formation of the islands of the Antillean Arc.

At the present time the active tectonic or mountain forming process has all but

Table 1.1(2). Eastern Caribbean volcanic phenomena.

St. Lucia Soufriere	caldera with domes and solfataric activity, most recent eruption about 50,000 years ago
Kick'em Jenny	submarine basaltic volcano north of Grenada , more or less continuous activity
St. Vincent Soufriere	andesite-basaltic volcano (1,325 m), four historic eruptions (1812, 1902, 1971, 1979), all with emission of lavas
Montagne Pelee Martinique	four historic eruptions (1792, 1851, 1902, 1929); the first two were phreatic (hot water discharge) the last two magmatics
Dominica "Valley of Desolation"	near the recent Micotin volcano; solfataric activity (boiling lake 80 m in diameter), one historic eruption in 1880
Guadeloupe Soufriere	numerous recent phreatic eruptions preceded by one magmatic eruption in 1600 +/-50 years
Montserrat Soufriere Hills	solfataric activity, most recent eruption 20,000 - 40,000 years ago
St. Kitts Mt. Misery (now Mt. Liamuiga)	solfataric activity; one phreatic eruption in 1843

Source: Migeot and Hadwen, 1986.

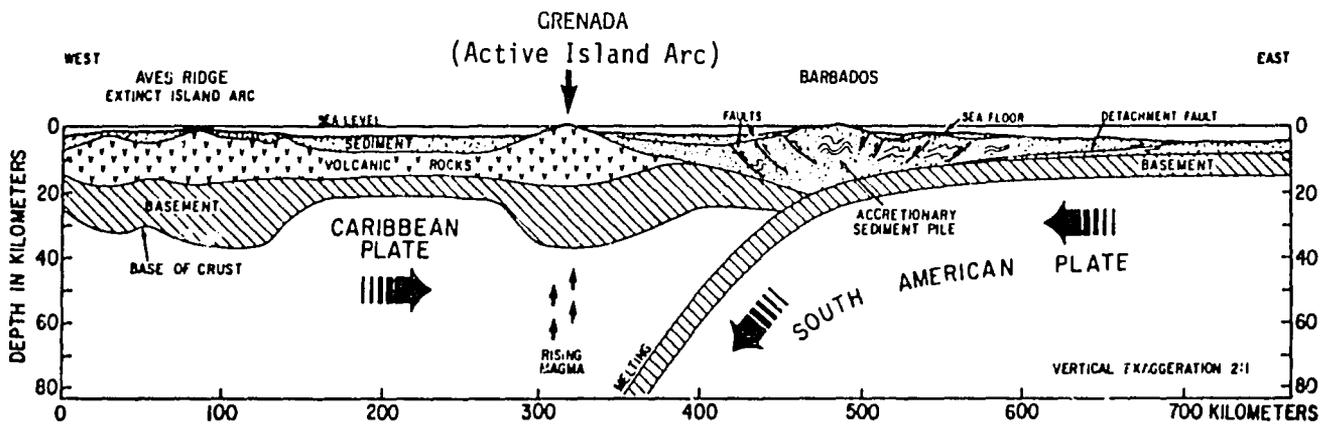
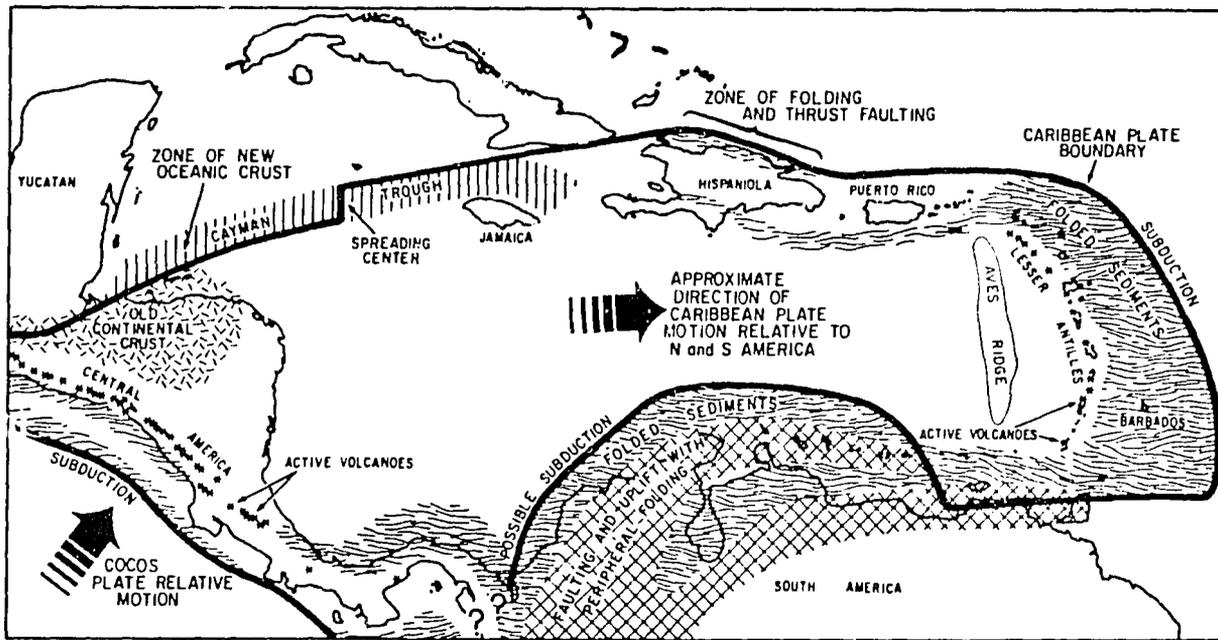


Figure 1.1(6). Above: Geological features of the active boundary zone of the Caribbean plate (source: Dillon, et al., 1987).

Below: The eastern margin of the Caribbean plate at the location of Barbados and Grenada. Cross section showing the Caribbean plate being underthrust by the South American plate. Figure adapted from Dillon, et al., 1987.

ceased in the region, except for St. Vincent's Soufriere which last erupted in 1979 and the underwater volcano north of Grenada known as Kick 'em Jenny. But within the arc, there are still eight active volcanic sites on as many islands, plus gas vents, fumaroles, steam vents, one boiling lake, and a few near-surface hot spots that have promising geothermal energy potential (Table 1.1(2)).

Kick 'em Jenny is the only known active submarine volcano in the Lesser Antilles, as well as the most active volcano in these islands. The first known eruption was in 1939; since then it has erupted in 1943, 1953, 1965, 1966, 1972, 1974 and 1977 (Francis, 1988). It is located in the southern (Grenada) Grenadines at 12.30 degrees N and 61.63 degrees W, about one and a half kilometers west of the Sister Rocks (see Figure 1.1(3)). The summit lies at a depth of about 160 m.

The volcano has no connection with nearby Diamond Island, for which the name "Kick 'em Jenny" is given on some charts. Caille Island, just to the south of Ronde Island, is the most recently emerged island in the Lesser Antilles. It is very close to Kick 'em Jenny and was probably formed from a similar submarine volcano within the last thousand years (Francis, 1988).

Several geological studies have been conducted in Grenada; the most useful general works are by Martin-Kaye (1958), Arculus (1976) and Jackson (1970). The following section on the geologic history of Grenada has been condensed (with minor revisions) from GOG/OAS (1988d), based on the paper by R. Arculus (1976). Table 1.1(3) summarizes the most probable chronology of geologic events, and Figure 1.1(7) shows the location of major geological units.

The geologic history of Grenada began approximately 38 million years ago in the upper Eocene Period. At that time, there was only a shallow sea where Grenada now exists. Grenada's oldest known rocks are the sediments deposited during this period which are now called the Tufton Hall Formation. Volcanic activity during and following the deposition of the Tufton Hall Formation deformed and uplifted the rock, resulting in the folding

and faulting which can be seen today just north of Levera Beach.

The oldest of the volcanic rock series are the andesite domes of northern Grenada, which formed in the Miocene Period (26-5 million years ago). These andesite domes (Mount Alexander, Mount Rodney, Mount William) have been estimated by radiometric dating to be 21 million years old.

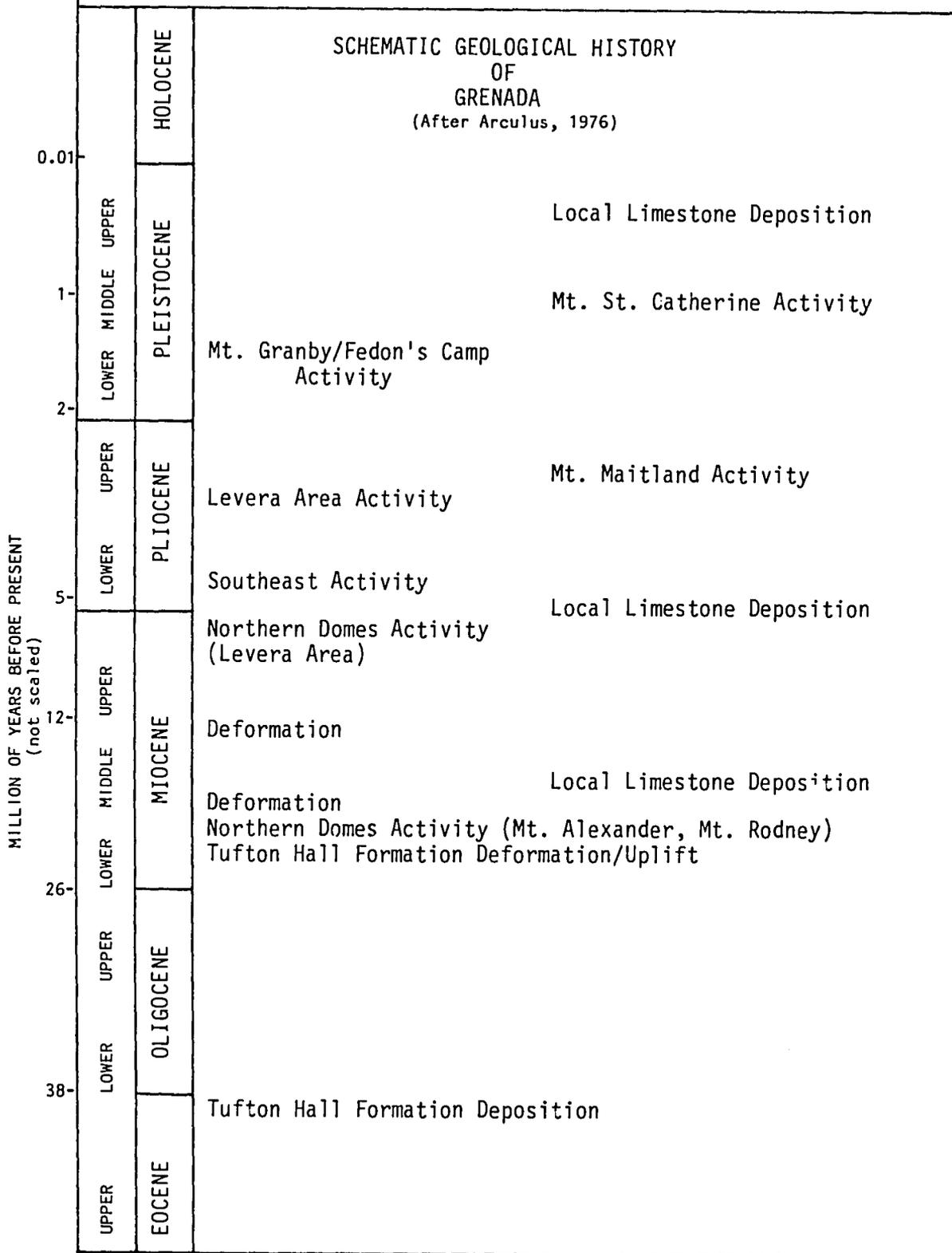
The Pliocene Period (5-2 million years ago) witnessed the beginning of Grenada's most intense volcanism. In the southeast of the island, basaltic lava flows estimated at 3.5 million years old are interlayered with reworked volcanic sediments. In the north and central parts of the island, major eruptions re-occurred in the Pliocene and continued into the Pleistocene Period. The final stages of this activity formed the andesitic dome summits of Fedon's Camp and Mount Qua Qua and probably ended with the extrusion of basaltic lava on the western ridges of Mount Qua Qua.

The Mount St. Catherine massif represents the youngest major volcanic structure on the island. Activity at this center likely began in the Pliocene and continued throughout the Pleistocene. The large (1.5 km diameter) crater to the southeast of Mount St. Catherine was partially filled in by an andesitic dome which probably concluded the eruptions in the area.

The most recent stage of volcanic activity on Grenada involved the formation of explosion craters throughout the island, most notably at the Lake Antoine, St. George's, and Grand Etang locations. Lake Antoine is a well-preserved crater, and has been described as the best example of a true "tuffaceous ring" on the island. The Carenage of St. George's and the Queen's Park area are other explosive craters from this period.

The Grenadine Islands formed in the late Oligocene Period, sank or eroded away during the Pliocene and were completely submerged during the Pleistocene Period. Since that time a regional uplifting of the sea floor has raised the islands above sea level.

Table 1.1(3). Schematic geological history of Grenada.



Source: GOG/OAS, 1988d.

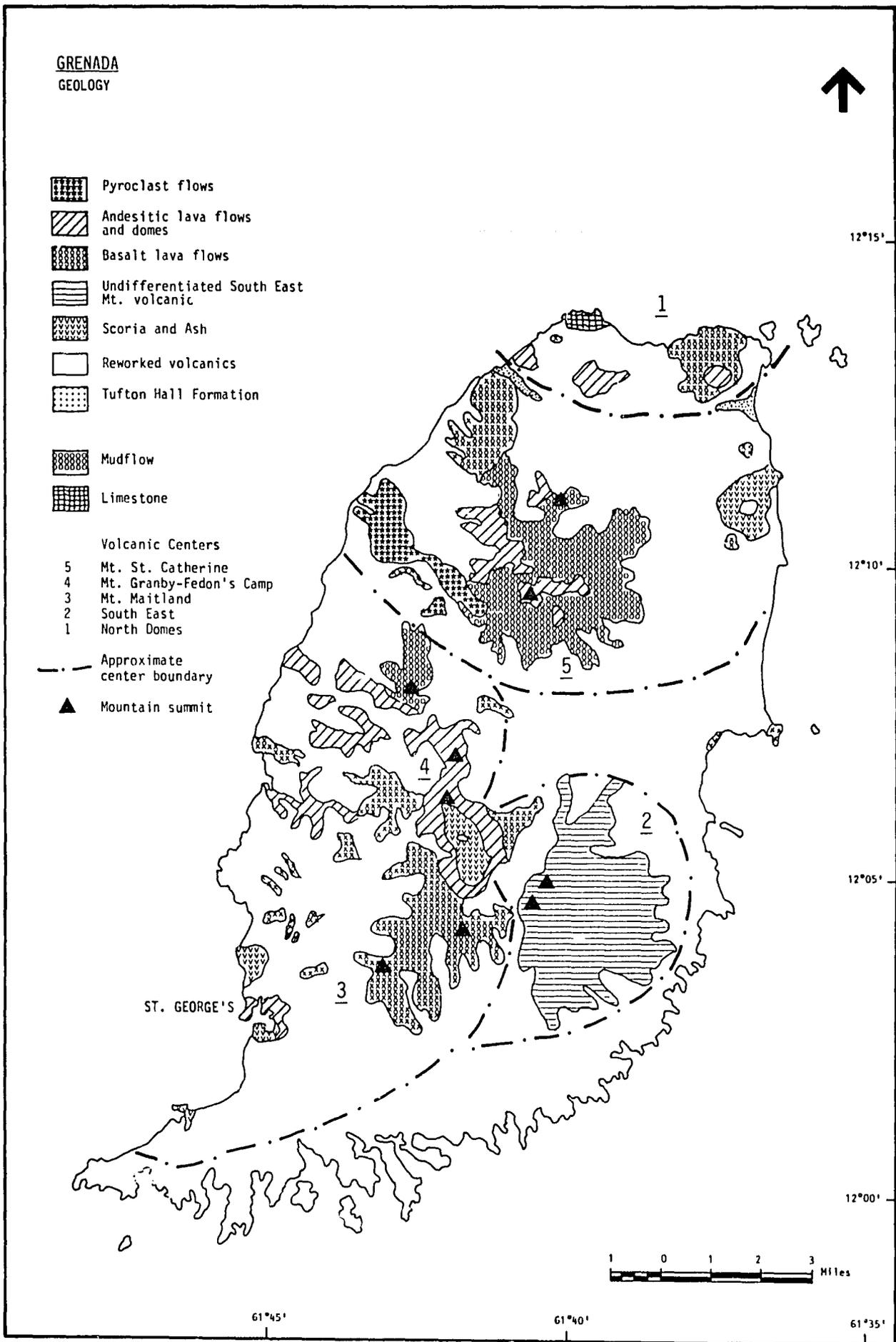


Figure 1.1(7). Geological outline map of Grenada (source: Weaver, 1989).

Carriacou can be divided into two geological zones. The fossiliferous limestone which forms outcroppings in the eastern part of the island is mainly of Miocene age. Volcanic rocks comprising the remaining two-thirds of the island consist of lava flows, lava domes and other volcanic products ranging in age from Miocene to Pliocene.

SOILS OVERVIEW

Vernon, *et al.* (1959) reported on the results of an island-wide soil survey and mapping exercise conducted by his team in 1956-57, which is still the best reference on Grenada's soils. The description of soils in this overview section is summarized mainly from their report.

In Grenada the dominant soil-forming factors are climate and topography. Climate is the most important single factor,

specifically differences in total annual rainfall and in the length of the dry season.

In some areas, the rocks are geologically young, and soils formed from such rocks have not had time to mature. In other areas, recent eruptions during historic times on St. Vincent have added fresh volcanic ash materials to the old soils. This addition of fresh minerals is especially important in the wetter areas characterized by strong weathering and leaching of parent materials. Because of the inputs of fresh ash, the Grenada "red earths," for example, are not comparable to Jamaican soils of similar appearance and origin which have had no recent ash additions.

Soils can be classified in many different ways. Some classifications in common use are based on: (a) geology of the parent rocks; (b) climate and vegetation; (c) measurements of the actual physical and chemical characteristics of the soil; (d) color,

Table 1.1(4). Classification of Grenada's soil series according to the U.S. Dept. of Agriculture's Soil Taxonomy.

SERIES	SUBGROUPS	FAMILY (all families are isohyperthermic)	EXTENT
Belmont (in wetter areas)	Typic Tropudolls	fine, mixed	extensive
Belmont (in drier areas)	Vertic Eutropepts	fine, montmorillonitic	mod. extensive
Bonair	not classified (lack of data)		inextensive
Capitol (in wetter areas)	Oxic Humitropepts	very fine, kaolinitic	extensive
Capitol (in drier areas)	Typic Ustropepts	fine, mixed	mod. extensive
Concord	Typic Chromuderts	fine, montmorillonitic, non-acid	mod. extensive
Hartman	Typic Chromusterts	fine, montmorillonitic, non-acid	mod. extensive
Hope	Cumulic Tropaquolls	very fine, mixed	inextensive
La Tante	not classified (lack of data)		inextensive
Palmiste	Vertic Tropudalfs	very fine, mixed	mod. extensive
Parnassus	Vertic Tropudalfs	very fine, mixed	inextensive
Pearls	not classified (lack of data)		inextensive
Persoverance	Udorhentic Chromusterts	fine, montmorillonitic, non-acid	extensive
Plains	Fluventic Tropudolls	fine loamy, mixed	mod. extensive
Simon	not classified (lack of data)		inextensive
Woburn	Paralithic Vertic Ustropepts	clayey, montmorillonitic	extensive
Woodlands	Vertic Ustropepts	fine, montmorillonitic	inextensive

Source: Smith, 1983.

physical appearance, and stratification of the soil profile as observed in the field; and (e) texture. The classification scheme which has been most used in Grenada (Vernon, *et al.*, 1959) is based largely on a combination of the last two methods.

According to Ternan, *et al.* (1989), the soils of Grenada are dominated by clay loams (84.5 percent), followed by clays (11.6 percent) and sandy loams (2.9 percent). The three major types of clay loam, which between them make up 77.8 percent of the soils, are Woburn, Capitol and Belmont. The important characteristics of the soils are summarized in Appendix B of Vernon, *et al.* (1959). Smith (1983) has correlated the soils of the Commonwealth Caribbean countries, using the terminology of the U.S. Department of Agriculture's Soil Taxonomy (Table 1.1(4)); due to data problems, Smith states that the reliability of the Grenada correlation is poor.

MOUNTAIN AND HILL SOILS

Woburn Clay Loams are lithosolic "brown earth" soils (latosols) which are well drained, shallow, highly erodible, dark brown to gray in color, and usually occur on steep slopes. Some occur over ash and agglomerate, usually in relatively dry coastal areas, and they are characterized by very poor water retention. They are neutral to basic in reaction. The main uses of these moderate-fertility soils are for food crops, poor pasture, cane and bush. Vernon, *et al.* (1959) recommend planting in sugar cane as the principal crop on gentler slopes and drought-resistant grasses and fruit trees on steeper slopes.

The soils of most of the hill slopes in the high rainfall areas are Capitol Clay Loam and Belmont Clay Loam (and their stony and bouldery phases). The former is a brick-red, well-weathered "red earth" (latosol) which usually occurs over highly weathered basic igneous rocks. The latter is a "brown earth" (latosol), usually occurring over basic ash and agglomerate. Both soils are moderately to well drained, with good water retention. Belmont Clay Loam is only moderately

erodible when it occurs on the less extreme slopes, but strict conservation measures are advisable in most areas of Capitol Clay Loam (Vernon, *et al.*, 1959). These soils are mainly used for cocoa, nutmegs, bananas, and food crops. Belmont Clay Loam has the greater natural fertility; when found on relatively gentle slopes, it is a soil with high potential for agriculture.

The rocky, shallow phases of Capitol Clay Loam and Belmont Clay Loam are found mainly in the mountainous areas with very steep slopes and high rainfall. The best use of these soils is for forest, since they are subject to massive erosion when cleared of their natural vegetation; agriculture should be kept to an absolute minimum (Vernon, *et al.*, 1959). Landslips occur often in these areas, causing the loss of the entire shallow soil above the parent material.

Concord Clay Loam (and its stony and bouldery phases) is found partly on ash and agglomerate and partly on colluvial material, usually on moderate to steep slopes. This is a heavy soil with only moderate internal drainage and appears to be almost an intermediate soil between Belmont Clay Loam and Perseverance Clay. Its natural fertility is fairly high and its water retention and resistance to erosion are good, but poor drainage is often a problem. This soil is used in many ways including food crops, cane, fruit trees, pasture, and cocoa.

In the drier areas, at relatively low elevations and mainly around the periphery of Grenada, clays are common. These include a group of moderately to poorly drained heavy soils, usually found over ash and agglomerate. Parnassus Clay and Perseverance Clay (and its stony and bouldery phase) have the poorest drainage and are usually found on gentle to moderate slopes. These are very heavy, tough "shoal" soils with little effective depth, moderate to low natural fertility, but high water retention and resistance to erosion. Agriculturally, they are probably the most difficult soils in Grenada. They are used for food crops, also for cane, some cocoa and much poor pasture and bush.

TERMS USED IN SOIL CLASSIFICATION

Various terms are frequently encountered in descriptions of Grenada's soils.

Texture refers to the relative amounts of different-sized soil particles (i.e., sand, silt and clay) present. Clay soils have a predominance of very fine particles (> 40 percent), sand soils have a predominance of sand-sized particles (> 80 percent) and loam soils are in between. These classes can be subdivided further to cover intermediate soil compositions, e.g., sandy loams or clay loams. Sandy soils are sometimes called "light" and clay soils are called "heavy" -- these terms refer not to weight but to the ease of working the soil.

Shoal is a term used to describe a special type of soil found in the relatively dry areas of all volcanic islands. Actually "shoal" is a kind of parent rock which is made up of cemented volcanic lava material; the cementation process is thought to have taken place under water during a period of submergence. Shoal clay soils are fine-textured, dark brown to grey, and have a poor physical structure. In the dry season they shrink and develop large cracks; in the wet season they become very plastic and sticky.

Alluvial soils are derived from river-transported sediments; *colluvial soils* are derived from materials brought down from neighboring hillsides by gravity.

Latosols are a very broad grouping that includes most of the red, yellow and brown soils of the Caribbean region. These are generally mature soils of moist or wet areas with free or only slightly impeded drainage. They vary from slightly acid to acid in reaction and are usually leached of bases.

Lithosols are very shallow, rocky soils found in steep, hilly areas with stony, rocky or shaly parent materials.

In the special case of Carriacou, with its drier climate, Betish Clay and Top Hill Stony Loam are very shallow soils over steep limestone slopes. These soils are of low to moderate fertility and have very low water retention and high erodibility. They have been severely eroded, and, at present, they mostly support scrub and very poor pasture. The best soil in Carriacou is Belair Stony Clay, but because of past erosion, cultivation must be minimized. The only recommended long-term uses for this soil, as well as Top Hill Stony Loam, are improved pasture where possible and natural forest elsewhere (Vernon, *et al.*, 1959). Recovery will be slow as long as open grazing in the absence of fencing is permitted.

LOWLAND SOILS

Soils along Grenada's coast except near the river mouths tend to be stony,

shallow and infertile. By way of contrast, the best and thickest soils are the alluvial deposits in the lower reaches of the main river valleys. These are the well-drained heavy Woodlands Clay Loam and Plains Clay Loam and the well-drained but lighter Plains Sandy Loam. The first two are alluvial soils of generally high natural fertility and good water retention, and the last two differ mainly in being of poorer structure and water retention. They are nearly all used for sugar cane, bananas and cocoa. Plains Sandy Loam is one of the best soils of Grenada.

In Carriacou the only soils with significant depth, and which occur on reasonably gentle slopes, are Sabizan Clay Loam and Limlair Clay. The future of any cultivation in Carriacou must rest on these soils; therefore, intensive and careful conservation measures such as erosion control, mulching, and crop rotation are recommended (Vernon, *et al.*, 1959). If such

measures are adopted, these soils can be intensively used for good pasture, cotton, food crops and fruit trees.

RESPONSE OF SOILS TO NATURAL AND HUMAN DISTURBANCE

Undisturbed land with mature vegetation is characterized by a more or less efficient chemical exchange between the soil and vegetation components of the ecosystem; plant nutrients are recycled and any losses are made up by weathering and precipitation inputs. Such efficient recycling enables lush rain forests to grow in many areas with remarkably poor soils which are unable to sustain long-term agriculture when the forests are cleared.

However, past generalizations that tropical wet forests are always found on infertile soils and necessarily have tight nutrient cycles are now known not to hold true in certain specific areas. Some tropical soils are inherently more fertile than was previously thought, and not all tropical forests are very efficient at the recycling of nutrients. For example, in Grenada, tropical wet forests once grew on Belmont Clay Loams where nutmeg and cocoa are now planted; these brown earth soils are deep fertile clay loams with a high nutrient-retaining capacity (Ternan, *et al.*, 1989).

Natural disturbances and changes in land use always affect nutrient cycles to some extent, but the situation is complex. Under natural forest, a rapid cycling of nutrients takes place in the litter layer on the ground. A much slower cycling takes place in the above-ground woody tissue of the trees, which at any time contains a large percentage of the ecosystem's plant nutrients. This cycling occurs under tree crops as well, but because tree crops are shallow-rooted, they cycle nutrients less efficiently than natural forest. Disturbance of the vegetation, either by natural agents such as hurricanes or landslides or man-induced disturbances such as clearing or burning, disrupts recycling mechanisms and leads to an increased loss of plant nutrients from the system.

Natural ecosystems are adapted to cope with, and even take advantage of, natural perturbations; but they may be more vulnerable to human disturbances which do not mimic natural events in terms of periodicity, areal extent or intensity. For example, both hurricane damage and clearcutting may cause a decline in soil nutrients in areas where the trees have been felled. However, hurricane damage to forests is often patchy, of variable intensity and is a relatively infrequent event. Diversity is increased as secondary vegetation grows up, and nutrients are returned to the soil relatively rapidly by the rotting of the downed vegetation.

By contrast, when trees are clearcut, there is a permanent loss of nutrients if the felled vegetation is removed as in logging, and an even greater loss if the slash is burned. If the area is replanted in crops or timber plantations, plant diversity is sharply reduced. If herbicides are used to keep planted areas free from weeds, the soil is then much more exposed than it would be under natural conditions. On steep slopes denuded of their cover, accelerated erosion further exacerbates the loss of nutrients by transporting soil downslope. Alterations in the pathways and rates of water flow due to a disturbance can also cause changes in the timing of peak flows and greater flood discharges downstream. When topsoil is lost, the formation of replacement soils is an extremely slow process. It may take an estimated 200 to 700 years to form just 2.5 cm (about one inch) of top soil weighing about 360 tons/hectare.

It is considerations such as these that should command our full attention when soil erosion is unnaturally accelerated by accidental or deliberate, but nonetheless disruptive human activities.

1.1.5 Vegetation

VEGETATION CLASSIFICATION: BEARD'S SYSTEM

In 1942 the British Treasury in London provided funds under a Colonial Development and Welfare plan for a forest re-

source assessment in the Windward and Leeward island group. The assessment was carried out by J.S. Beard, then of the Colonial Forest Service in Trinidad and Tobago. At that time, only Trinidad had a Forestry Department, established in 1901, and no significant forestry research efforts had been previously undertaken in the Lesser Antillean region.

When Beard started his decade of work in the Lesser Antilles, he found that the systems of vegetation classification then in use

lacked any real ecological basis. He therefore proposed a new classification of vegetation (Beard, 1944) which led to publication of his classic monograph, *The Natural Vegetation of the Windward and Leeward Islands* in 1949.

Beard defined his climax natural vegetation types ("formations") on the basis of physiognomy, structure and life-form, and arranged them in several "formation-series" along environmental gradients. Each formation was then subdivided into communities ("associations") on the basis of floristic com-

Table 1.1(5). Mature or "climax" vegetational formations in the Lesser Antilles.

OPTIMAL FORMATION (essentially no dry season, well-drained soils):

Lowland Rainforest

SEASONAL FORMATION-SERIES (wet seasons alternating with dry seasons, well-drained soils):

Evergreen Seasonal Forest
Semi-evergreen Seasonal Forest
Deciduous Seasonal Forest
Thorn Woodland
Cactus Scrub

MONTANE FORMATION-SERIES (mountain climates and soils):

Lower Montane Rainforest
Montane Thicket (Elfin Woodland is a subtype due to wind and soil conditions)

DRY EVERGREEN (INCLUDING LITTORAL) FORMATION-SERIES (constant effective drought regardless of actual rainfall, due to wind and/or excessively drained soils):

Dry Evergreen Rainforest
Dry Evergreen Forest
Dry Evergreen Woodland
Dry Evergreen Thicket
Dry Evergreen Bushland/Rock Pavement Vegetation/Cactus Scrub

SWAMP FORMATION-SERIES (constantly or frequently flooded areas with trees):

Freshwater Swamp
Mangrove Swamp

MARSH FORMATION-SERIES (constantly or frequently flooded areas with herbaceous vegetation):

Freshwater Marsh

Sources: Adapted from Beard, 1944, 1949, 1955; Teytaud, 1988.

position. Lowland Rainforest was held to be the "optimum" expression of vegetational development; the various formation-series represented deviations from the optimum formation along axes of increasing severity of drought (seasonal formations), increasingly poor soil conditions (edaphic formations), etc. (Table 1.1(5)).

ECOSYSTEM CLASSIFICATION: HOLDRIDGE'S LIFE ZONES

A complementary system to Beard's classification of vegetation is the Holdridge scheme of bio-geoclimatic "life zones" (Holdridge, 1967, Holdridge, *et al.*, 1971; Holdridge and Tosi, 1972). This system uses a nomogram which identifies the major bio-climatic zones of the world based on "bio-temperature," potential evapotranspiration and total precipitation. Use of the Holdridge system allows one to place local ecosystems in a worldwide classification framework so that comparisons may be made with other areas.

If all other factors besides precipitation and biotemperature were within "normal" ranges, then each life zone should theoretically support a distinctive "zonal" vegetation type corresponding to one of Beard's seasonal or montane formation-series. However, vegetation responds to other factors (e.g., edaphic conditions, wind exposure, slope and aspect, length and severity of the dry season) in addition to the major climatic determinants shown on the nomogram. Therefore, even undisturbed, mature vegetation at a given site may often be different from the "zonal" or "normal" vegetation for that life zone; Holdridge refers to such subtypes as edaphic, hydric and atmospheric "associations."

Life zone maps can be prepared which are useful for environmental management in places such as Grenada, where the natural vegetation has been severely disturbed, since they are based on the measured or inferred spatial distribution of physical climatic factors. Conversely, observation of the mature natural vegetation can be used to predict broad environmental conditions and the response of an ecosystem to man's manipula-

tion where site-specific climatic data are not available.

A map displaying the Holdridge life zones has not been prepared for Grenada. However, because the climate of St. Lucia is very similar, the life zone map of St. Lucia produced by the OAS (1984) gives a good indication of the zones that are likely to be present in Grenada (Table 1.1(6)).

NATURAL VEGETATION IN GRENADA

The classic description of the vegetation of the Windward and Leeward Islands, including Grenada, was given by Beard in 1949; Howard (1952) described the vegetation of the Grenadines. Weaver (1989) provides a map for Grenada (Figure 1.1(8)) showing the presumed original distribution of Beard's natural ("climax") vegetation types, based on environmental factors. The majority of the climax formations shown on Weaver's map are climatically determined. While edaphic (soil) factors are important, they lack the controlling force of climate, except in the case of the swamp/mangrove formations. In effect, the forest zones or vegetational belts mirror the climatic belts, and this results in a nearly concentric zonation of vegetational types related to the increase of rainfall with altitude above sea level.

Beard characterized the vegetation which existed in Grenada during the 1940's as primarily resulting from man's use of the land during historical times; only in certain small areas was the vegetation relatively unmodified from its natural state. Beard provided a small-scale generalized map (Figure 1.1(9)) showing the major areas of natural vegetation which remained in Grenada at the time of his survey, but he gave no estimates of area. A description of these natural vegetation types, condensed from Beard (1949), is given below.

Rain Forest and Lower Montane Rain Forest. Beard considered these two formations together since in Grenada there was very little difference in floristic composition between very tall forest with the structure of Rain Forest proper and less tall forest approximating Lower Montane Rain

Table 1.1(6). Lesser Antillean life zones (Holdridge's terminology), showing rough correspondence with Beard's formations.

HOLDRIDGE'S LIFE ZONES	BEARD'S CLIMATIC CLIMAX FORMATIONS
Tropical dry forest, transition to tropical very dry forest	Thorn Woodland
Tropical dry forest	Thorn Woodland or Deciduous Seasonal Forest (depending on length of drought)
Tropical moist forest	Semi-Evergreen or Evergreen Seasonal Forest or Rainforest (depending on length of drought)
Subtropical moist forest	Semi-Evergreen or Evergreen Seasonal Forest or Rainforest (depending on length of drought)
Subtropical wet forest	Lower Montane Rainforest
Subtropical wet forest, transition to subtropical rainforest	Montane Thicket or Elfin Woodland
Subtropical rainforest	Montane Thicket or Elfin Woodland

Sources: Adapted from OAS, Life Zones Map for St. Lucia (1984); Beard, 1944, 1949, 1955; Teytaud, 1988.

Forest. The Rain Forest was dominated by Gommier (*Dacryodes excelsa*) and Bagui or Bois Gris (*Licania tematensis*) (Figure 1.1(10)). South of Mount Qua Qua, the forest growth was more diverse and included the last remnant lower montane forests in Grenada. In the sheltered lower elevations, the forest was mature and comparable to the type of rain forest exemplified in the other islands surveyed. Ascending towards the main ridge forest, stature was progressively reduced.

Montane Thicket. Montane Thicket in Grenada covered the summit of the main watershed from Mount Qua Qua south towards Mount Sinai and lesser ridge tops in the area. *Micropholis chrysophylloides* was dominant; nearly all the big trees are of this

species, some of them up to six feet in girth. Composition was probably affected by fellings in the past as in the case of the Rain Forest. There was virtually no shrub layer. Epiphytes seemed to be confined to small orchids and ferns, and while there were few climbers, the forest was extremely mossy. Ground vegetation was knee-high and thick beneath typical Montane Thicket, consisting of seedlings, ferns, and razor grass.

Elfin Woodland and Palm Brake. Beard considered Elfin Woodland and Palm Brake together, as they existed for the most part in an intimate relationship. At the summits of the higher mountains, pure strands of Elfin Woodland were found, a gnarled, mossy, repressed growth of trees about 10 feet

GRENADA
Forest Types

		AREA	
		Km ²	Percent
<u>SUBCLIMAX</u>			
	 Mangrove Woodland	5.3	1.7
<u>CLIMATIC CLIMAX</u>			
Montane	 Elfin Woodland	3.7	1.2
	 Lower Montane Rain Forest	141.1	45.2
Seasonal	 Evergreen & Semi-evergreen Forest	70.8	22.7
	 Deciduous Seasonal Forest	70.2	22.5
	 Cactus Scrub	10.9	3.5
<u>DISTURBANCE CLIMAX</u>			
	 Palm Brake (Hurricane Forest)	10.0	3.2
		312.0	100.0

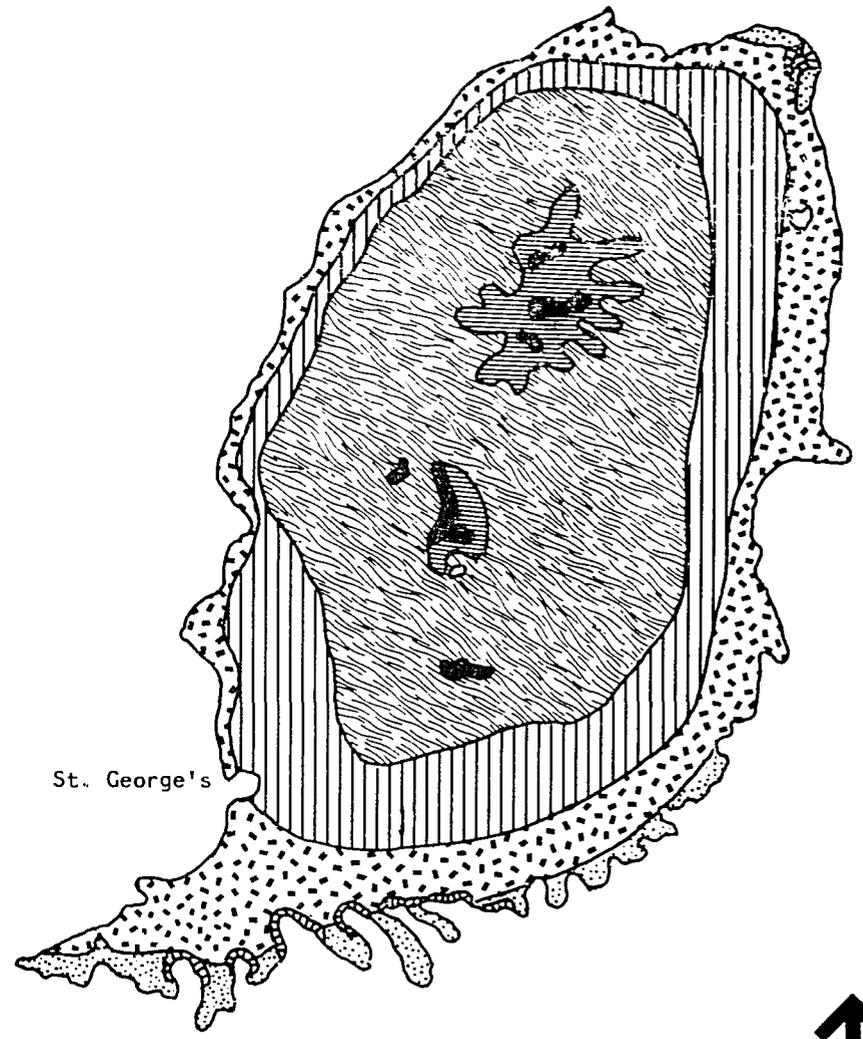


Figure 1.1(8). Distribution of "Climax" forest types in Grenada (source: Weaver, 1989).

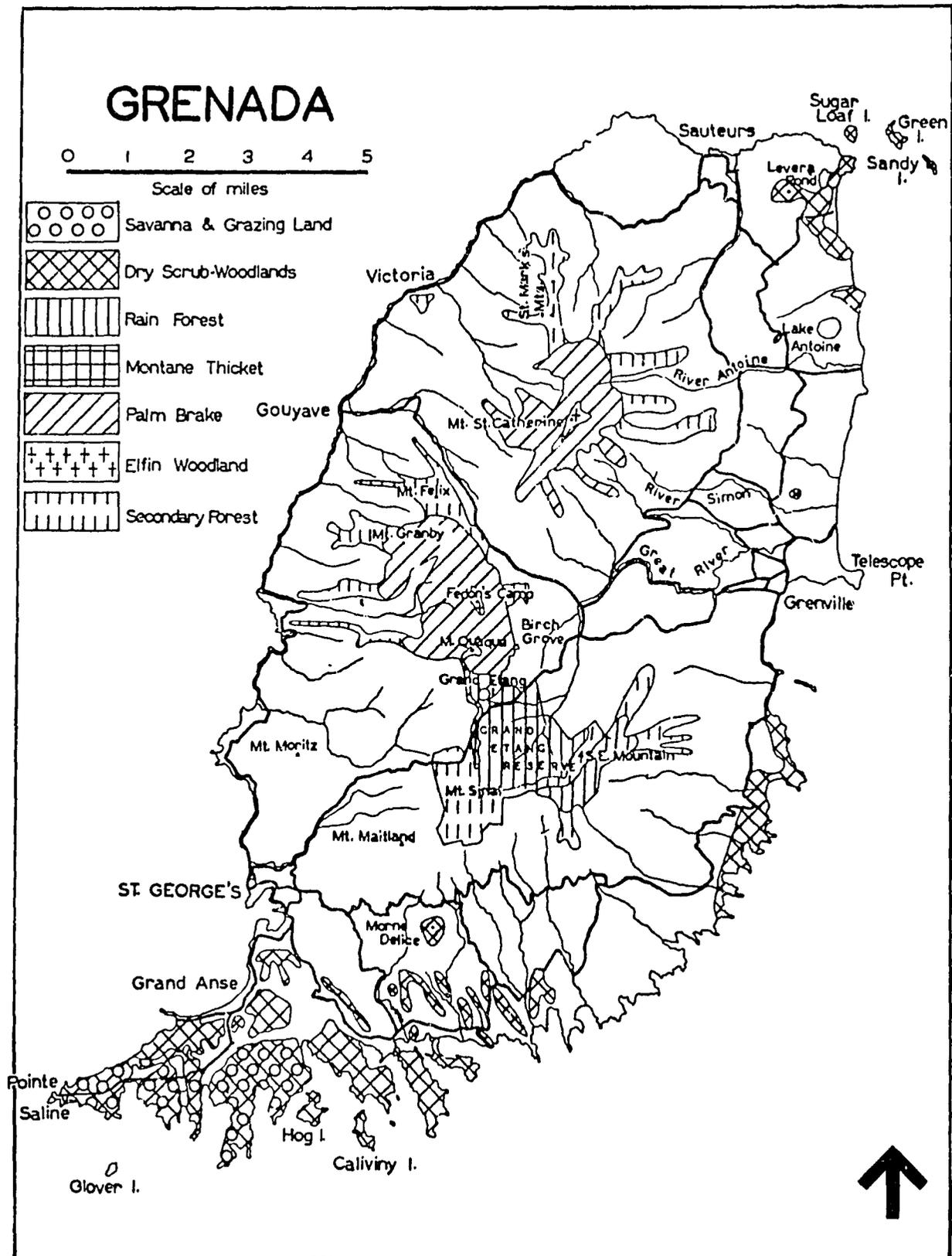


Figure 1.1(9). Vegetation map of Grenada (source: Beard, 1949).

in height. Most Elfin Woodland vegetation was covered with moss, epiphytes and climbers. On the very top of St. Catherine and Fedon's Camp, growth was reduced to waist height.

The Palm Brake was evidently a sub-climax type, due to disturbances such as landslides or storms. Sites where landslides had recently occurred were covered with moss which appeared to stabilize the soil, the next stage being a thicket of small tree ferns or balisier. Other less recent landslides were colonized by Mountain Cabbage, forming a patch of Palm Brake. These successional stages were set in a matrix of Elfin Woodland. On many of the leeward slopes of the southern mountains which had suffered storm damage -- Fedon's Camp, Qua Qua, South-east Mountain -- Montane Thicket was replaced by clumps or groves of Mountain Cabbage palms, sometimes 60-78 feet high and far overtopping the stunted forest.

Evergreen and Semi-evergreen Seasonal Forest. Beard stated that the only example of fairly intact woodland of this type seemed to be that crowning Morne Delice, an isolated, high and conical hill 900 feet in height, two miles inland from the south coast. Tree growth was evidently allowed to remain due to unsuitability of the terrain for cultivation, but was subject to frequent fellings. At the bottom of the hill there were young secondary thickets of mahogany, white cedar, and other pioneer species. This moist forest remnant at Morne Delice still exists, but is currently under threat from piecemeal housing development, charcoaling and conversion to plantation forest.

Deciduous Seasonal Forest/Cactus Scrub. Some low hills near the coastlines were covered with a degraded dry scrub woodland, cactus scrub and acacia bush which probably represented the remnants of a narrow belt of deciduous seasonal forest formation which originally grew here. This forest type had been almost entirely eliminated in Grenada by Beard's time, but still survives (in badly degraded condition) in some areas of the northeast coast and in Carriacou.

Littoral Woodland. Very little remained of the Dry Evergreen Littoral Woodland formation in Grenada. At Levera in the northeast the littoral hedge was formed of buttonwood, *Jacquinia*, and white cedar (in its monophyllous form). The woodland behind also contained sea grape, mampou, manchineel, cocoaplum, and pigeonberry. On the Point Saline peninsula some sandy raised beaches carried pure groves of manchineel up to 50 feet in height.

Swamp. There were some small mangrove swamps, chiefly at Levera Pond in the northeast and at the head of the various deep inlets of the south coast. These contained the usual red mangrove, black mangrove, white mangrove, and button mangrove. *Pterocarpus* freshwater swamp does not occur in Grenada.

Freshwater Marsh. Small areas of freshwater marsh vegetation (e.g., rush and sedges) occurred along the margins of Lake Antoine and Grand Etang Lake.

VEGETATION COVER IN 1982

The most recent map of the actual vegetation cover of Grenada was compiled from interpretation of aerial photography taken in 1982 (map available from Land Use Office, Grenada Ministry of Agriculture). This map (Eschweiler, 1982) shows the various land use types in the early 1980's, including crops and other cultural vegetation, in addition to areas of more-or-less "natural" vegetation. Eschweiler's "Explanatory Note" that accompanies his map lists the following acreage figures for natural vegetation types (N.B. Eschweiler uses categories which are broader than Beard's formations and therefore the two maps are not, unfortunately, directly comparable):

- 4,170 acres of "Montane Rain Forest" (including Beard's Montane Thicket + Elfin Woodland + Palm Brake);

- 5,630 acres of "Closed Evergreen Rain Forest" (including Beard's primary and secondary Rain Forest + Lower Montane Rain Forest);

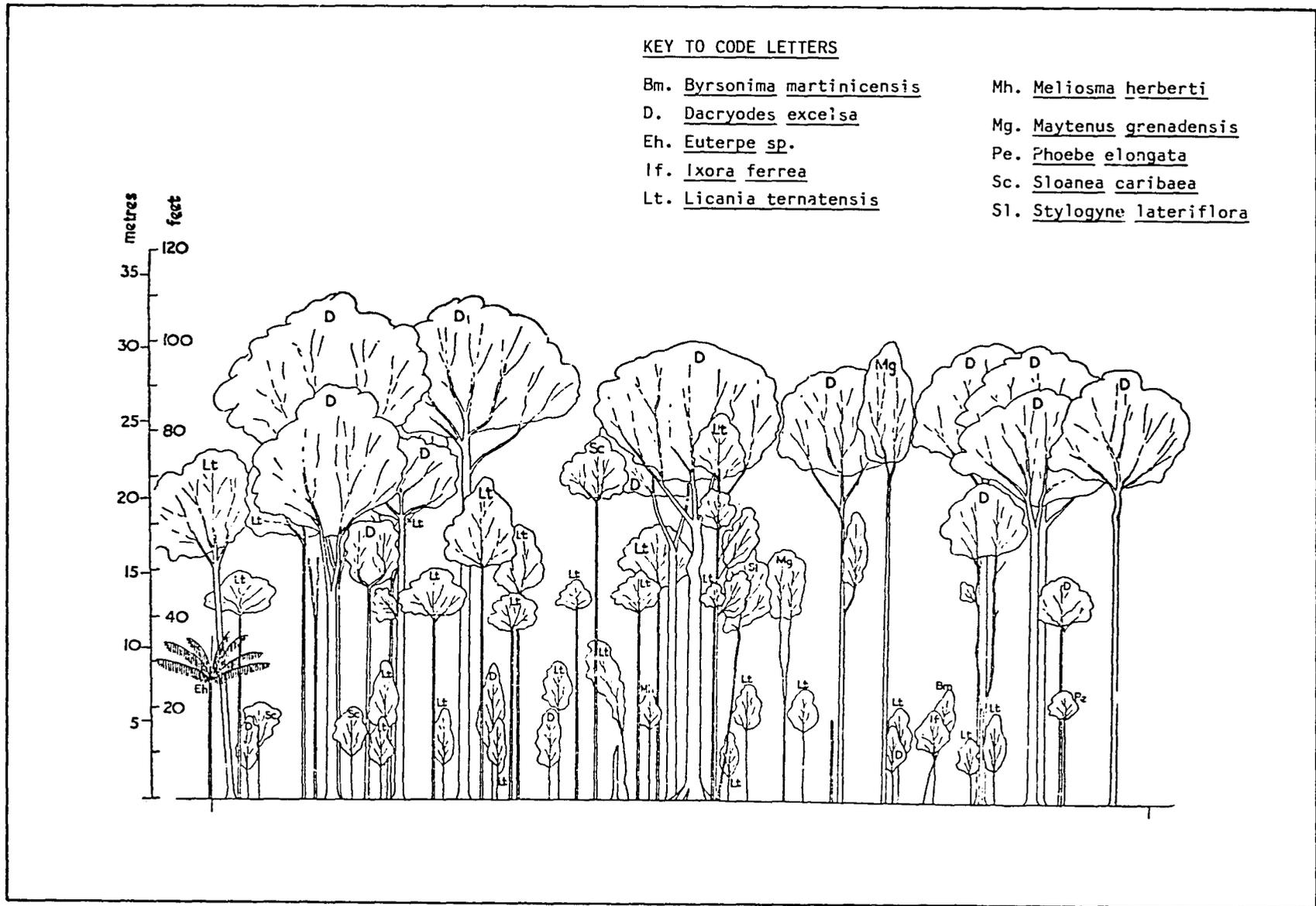


Figure 1.1(10). Profile diagram of Rain Forest at Grand Etang, 1,400 feet in elevation (source: Beard, 1949).

- 4,330 acres of "moist deciduous and semi-deciduous forest" and 7,000 acres of abandoned, "ruinate" cropland and grazing land reverting to secondary re-growth (including Beard's Evergreen and Semi-evergreen Seasonal Forest and Deciduous Seasonal Forest);

- 3,030 acres of "Scrub/Cactus Vegetation, partly natural and partly "ruinate" agricultural land (including Beards's Deciduous Seasonal Forest and Thorn Woodland [and/or Dry Evergreen Thicket]);

- 470 acres of Mangrove Swamp;

- 70 acres of "Inland Swamp."

1.1.6 Natural Hazards

Natural hazards, as the term is used here, include those occasional short-term natural phenomena which have the potential for negative impacts on the physical, economic and social environment of an area. Natural hazards relevant to Grenada include: hurricanes and their associated storm surges and wave action, earthquakes and earthquake-generated ocean waves (tsunamis), volcanic eruptions, landslides and rock-slides and flooding. Man-made and technical disasters will not be included in this section; examples of these include such events as oil spills in harbors and offshore; ship accidents; air crashes; toxic substance accidents on rivers and the sea; and sewage and solid waste disposal accidents.

MAJOR NATURAL HAZARDS

(1) **Volcanic Activity.** Grenada, Petit Martinique, and Carriacou have no record of major volcanic activity in recent history even though they are islands of volcanic origin. The minor volcanic activity associated with Grenada is limited to hot springs which occur in the Mount St. Catherine area and which emit sulfurous water and vapor. The youngest volcanic structures on Grenada, three closely spaced explosion craters associated with

Grand Etang Mountain, are thought to be 12,000 years old (Arculus, 1976).

A submarine volcano, 160 meters below sea level, is located about seven kilometers north of David Point, Grenada (Figure 1.1(3)). This volcano, called "Kick 'em Jenny", is one of the most active in the Lesser Antilles, having erupted at least eight times this century, and some scientists believe it may emerge above sea level during its next eruption. The last eruption occurred in 1977. Seismic activity in the area is being monitored by scientists in Trinidad for indications of renewed activity (OAS, 1988d). Cambers (1985a) also mentions an active fault in the Levera area and that the severe coastal erosion present in that area may be the result of land subsidence.

(2) **Earthquakes.** Grenada's location near the Caribbean Plate margin makes it vulnerable to considerable seismic activity. Earthquakes of magnitude 3.2-3.9 on the Richter scale have been recorded with epicenters less than 50 miles to the south of Grenada (Bacarreza, 1988).

(3) **Hurricanes and Other Storms.** Although Grenada is one of the Windward Islands within the hurricane belt of the Caribbean, it is located just south of the major tropical storm tracks. Therefore, the island is rarely affected by the large storms and hurricanes which are prevalent in the Eastern Caribbean during the June through October hurricane season.

Records show that between 1901 and 1964 twenty-one hurricanes and tropical storms affected the country, but only one hurricane since the turn of the century has passed directly over Grenada (De Souza, quoted in Frederick, 1987a). Other hurricanes passing to the north have caused lesser damage due to wind and heavy rains in 1768, 1780, 1817, 1831, 1832, 1877, 1921 and 1963 (Finisterre and Renard, 1987; Knight, 1946).

In order of decreasing impact, the major causes of damage from hurricanes are: flooding from rainfall, coastal flooding and damage from storm waves, landslides and

THE NIGHT "JANET" INVADED GRENADA *

A "killer" hurricane [named] "Janet" swept in from the Atlantic on the 22nd of September 1955. For several days the forecast had said there was bad weather out there to the east, but few people took it seriously. In those days, Grenada's tourist literature said the island was "outside the hurricane belt". In fact, no living Grenadian resident on the island had experienced a hurricane; there was nobody to describe the coming terror.

During the afternoon of the 22nd, there was a marked increase in the overcast and, by dusk, the wind, which had been light all day, began to increase in velocity. But, even then, Grenadians didn't worry much. The forecast said Barbados and St. Vincent would take the brunt of the blow and Grenada expected only to be brushed lightly by the tail end of the hurricane.

But "Janet" surprised everybody. After striking Barbados, she abandoned her northwest direction and veered southwards towards Grenada, the eye of the hurricane passing between the northern tip of Grenada and the sister island of Carriacou, 20 miles offshore.

The final build-up to this onslaught began shortly after nightfall. Torrential rains poured down, and the island was plunged into darkness as the electricity supply failed. Exceeding 130 miles per hour, the wind increased to a roaring intensity while vivid flashes of lightning rent the sky to the accompaniment of loud peals of thunder.

"Janet" reached her peak before midnight as the eye passed through, but there was no sleep for anyone until well on to morning. Then, with the dawn, Grenadians woke to scenes of devastation beyond their wildest nightmares.

In St. George's, the 850 foot long pier and Customs warehouses had disappeared. It lay at the bottom of the harbour together with millions of dollars worth of merchandise. Hurling by the roaring waters, bags of flour, boxes of foodstuff, cases of general cargo and bales of assorted merchandise lay strewn in untidy heaps on the Carenage roadway encircling the inner harbour.

St. George's is a solidly built city, but it did not escape damage. As compared with other parts of the State, however, that damage was negligible. In the Parishes of St. John's and St. Mark's, the loss was much greater. And the Parish of St. Patrick's and the islands of Carriacou and Petite Martinique took the heaviest blow.

The eye of the hurricane passed very close to those areas, and they experienced the full flurry of "Janet". The destruction was tremendous, and the death toll was highest here. "Janet" killed 114 persons in Grenada, and of these, 32 were in St. Patrick's, 25 in Carriacou and 2 in Petite Martinique.

Throughout the State, thousands were homeless. Communications were knocked out and schools, churches and community centres were razed. Several persons were buried alive as landslides covered their homes under several feet of mud and debris. Others died as structures collapsed and still others were swept out to sea by flood waters of raging rivers.

Seventy-five percent of the nutmeg plantations were destroyed, cocoa and coconut fields took a tremendous beating and the then new banana plantations were completely wiped out.

[More than three decades] have passed since Hurricane "Janet", and the memory has grown dim. There is now a new generation without hurricane experience and lurking in their minds may be hope that Grenada "is outside the hurricane belt".

* Extracted from THE GRENADA NEWSLETTER, September 30, 1969.

winds. Although high winds are hurricanes' most distinctive feature, usually the most damaging winds affect a very small radius (as small as 20 miles) of the entire storm system, whereas torrential rains can be experienced from one edge to the other of a 300 mile diameter storm. Ten inch rains from well-developed tropical storms are not unusual.

(4) **Floods.** Floods may cause property damage, severe erosion and even the loss of life during natural events such as rainstorms and hurricanes. Floods can be the result of downslope rainwater run-off, especially over paved or deforested areas, and/or seawater driven inland by above-normal tides and surges. Additionally, storm surges caused by reduced atmospheric pressure during hurricanes can be augmented by wind-driven waves, swells, and spray.

(5) **Landslides and Rockslides.** Landslides occur when the forces of gravity exceed the strength of the forces holding soil material together, resulting in a mass of soil being pulled downward. Generally, landslides are localized events and depend on the type of soil, the angle of repose and the steepness of the slope at the site. Water in soils contributes to increased landslide risk because the weight of the water is an added stress on the soil mass that is also being lubricated by the water molecules.

ENVIRONMENTAL IMPACTS OF MAJOR NATURAL HAZARDS

[Note: In addition to the information below, the report prepared by Bacarreza (1988) for the Government of Grenada and the OAS identifies specific infrastructure elements and some environmental components at risk from natural hazards in the towns and villages of Grenada.]

(1) **Wind.** Wind damage in Grenada is associated with storms and the rare hurricane that may occur during the hurricane season. The coastal communities with exposed west-facing harbors, buildings and roads as well as the town of St. George's, are susceptible to damage from high velocity winds (Bacarreza, 1988). Wind damage is a critical

risk for developments on west-facing slopes in Sauteurs and Grenville, as it will be for proposed developments along the coastal areas of St. David's Parish.

The most recent hurricane to strike Grenada was Janet, which caused major destruction in 1955. The hurricane produced winds of up to 130 miles per hour and killed over 100 persons, devastated banana, nutmeg, and cocoa crops, severely damaged the forests and caused millions of dollars worth of wind and flood damage to property and infrastructure facilities. Storm waters caused flooding, landslides, severe erosion, the collapse of bridges and mini-dams, and the disruption of the water supply system. Storm surge destroyed coastal roads and jetties, caused the loss of fishing vessels and damaged St. George's harbor facilities and many beaches.

(2) **Inland Flooding.** The extent of environmental impacts associated with inland flooding in any particular area is dependent on the amount of rainfall, the slope of the land, the porosity of the soils, and the size and shape of the river basin through which the water will eventually flow. Grenada's combination of steep mountains and rolling hills with relatively low porosity soils (Lathwell, 1974) contribute to rapid run-off and downstream flooding. Of the six parishes in Grenada, only St. David's was listed by the Organization of American States (Bacarreza, 1988) as having a low probability of experiencing flooding.

(3) **Coastal Flooding.** Grenada has some nearshore coral reefs along Grand Anse Bay and other beaches on the west coast that act to protect beaches from high wave energy. On the east coast at Grenville, the beach is again protected by an offshore reef. However, many beaches and coastal areas are presently exhibiting considerable erosion that is *not* the result of natural hazards alone (see also Section 4.4 on coastal resources). Some attempts are being made to reduce these human-induced risks.

Generally speaking, the major sea defense structures in Grenada are sea walls, normally vertical, which serve to protect sections of the coastal highway (Cambers, 1985).

There are no major groyne fields, offshore breakwaters or port structures. Therefore, St. George's, other towns on the west coast, Sauteurs, and low-lying areas on the eastern side of the island are susceptible to flooding from the sea during storms, hurricanes and tsunamis ("tidal waves").

Most of Carriacou is protected by an outlying reef with substantial openings only on the west coast of the island. Despite offshore reefs, Carriacou is being eroded by the sea in several locations, including Tarleton, Kendeace, and Gun. During tsunamis, storms and hurricanes the coastal towns would be vulnerable to flooding from the sea as well as from land-based rainfall run-off.

(4) **Landslides.** In Grenada a secondary effect of flooding on steep slopes covered with clay-rich soils is the increased tendency for landslides to occur. Mabouya, in the Parish of St. John's, is listed as one of the worst land slip areas in Grenada (Bacarreza, 1988), but towns like Grenville, Victoria, and Sauteurs are also prone to land-based flooding and landslides. Roads would also be damaged by landslides during exceptionally heavy rainfall events.

TRENDS AFFECTING FUTURE RISKS FROM NATURAL HAZARDS

Urbanization of towns and villages, as well as the development of new communities in the southern section of Grenada, which require modifications to the natural landscape, could easily increase the risk of damage from flooding and landslides. Such modifications may include:

- construction of higher density, high-cost structures (like hotels and condominiums) closer to the shoreline or in flood plains;
- removal of mangrove trees along the shore which buffer sea wave and wind energy as well as help to maintain balanced nutrient levels in adjacent waters by absorbing nutrients in run-off;

- filling of salt ponds and swamps which absorb energy and sediments of out-flowing surface waters as well as buffering incoming storm surges and waves;

- offshore dredging to eliminate sandbars and shallows which normally absorb sea wave energy and prevent inland damage;

- deforestation of inland watersheds, including loss of ground cover such as decayed leaves or understory vegetation and the decomposition of subterranean root systems of former plants;

- road building and paving.

Population growth and increased emphasis on tourism will promote further development of the major towns of Grenada, which are all located in the coastal areas of the island. Problems associated with high population densities, insufficient community planning, and inadequate infrastructure support have been identified and linked to potential environmental impacts resulting from specific natural hazards (Bacarreza, 1988).

Enlarged populations in towns like St. George's, Grenville, or Gouyave place more people at risk from both inland and coastal flooding. Grenada also now faces the consequences resulting from earlier removal of over 80 percent of the trees along the seaward side of the western coastal road, now exposing the roadway to erosion by waves (Cambers, 1985a).

Steep slopes and river banks which have been denuded of trees promote rapid rain run-off, causing an increased risk of flooding and facilitating the occurrence of landslides. Additionally, deforestation to accommodate agriculture and development increases the silt load carried by surface run-off into rivers and streams and out to sea. The impact on agriculture of the loss of top soil, as well as its effect on river channels and marine life, is discussed elsewhere in this Profile.

Construction and waste disposal practices of human settlements along the

banks of the major rivers of Grenada have produced blockages of the river channels, increasing flood risk and damages in these areas. Blockages result from poorly situated roads and levees, undersized bridges, culverts and drains, and trash dumped in the river channel.

The removal of sand from the beaches of Grenada for construction purposes has reduced the island's sand buffers to storm waves and tides, thereby increasing their negative impacts on the shoreline. The problems with sand mining are localized, but severe enough to warrant serious attention. Beach sand mining and its negative environmental impacts (see Section 4.4 for details) are likely to continue, despite the 1979 Beach Protection Law, until alternative sources of fine aggregate are available in appropriate quantity and locations.

INSTITUTIONAL RESPONSIBILITIES

In 1983 the OAS, supported by the Office of Foreign Disaster Assistance (OFDA) of USAID, began a project for reducing natural hazard vulnerability in OAS member states. The project focuses on the incorporation of natural hazard assessment into the regional development planning process and provides technical assistance, training, and improved applied research capabilities for target countries. This effort increasingly focuses on urban-related natural hazard and natural resource management issues. The use of natural hazard assessment and mitigation information in investment project formulation is the topic of a manual prepared by GOG/OAS (1988a) for international development assistance agencies.

Grenada has a relatively new disaster preparedness and response system. The National Emergency Relief Organization is an independent office associated with the Office of the Prime Minister. It is responsible for the preparation of a National Disaster Plan and mobilization of the country's human and material resources in planning, training, and managing various aspects of a disaster or major emergency. A National Disaster Plan was prepared in 1985 but is now out of date. The

Plan has never been fully exercised nor tested for effectiveness or response time.

The Government of Grenada and the OAS prepared a manual for local disaster committees and government officials in 1988 based on the work of OAS consultant Vivian Bacarreza (1988) and a workshop held for government officials and parish representatives involved in emergency management. The document lays out the organizational structure to implement the National Disaster Plan. District Emergency Committees have been established to provide essential links between the National Emergency Organization and the Community Emergency Committees throughout Grenada, Carriacou, and Petit Martinique.

1.1.7 Global Environmental Change

There is growing international concern that warming of the atmosphere will have consequent climatic changes. Resulting changes in temperature and precipitation distribution could threaten natural ecosystems and agricultural production and could trigger a worldwide rise in sea level. Depletion of stratospheric ozone by one type of greenhouse gas, the chloroflourocarbons, may allow greater penetration of ultraviolet radiation to the surface of the earth, with serious impacts on biological systems, including a probable rise in human skin cancer.

The environmental, economic and social disruptions produced by such global changes would pose particularly severe challenges for developing island nations like Grenada. In the Caribbean region, critical ecosystems such as coral reefs and mangrove swamps may be seriously damaged if the sea level rises so fast that they cannot compensate. Global warming would increase sea-surface water temperatures and may cause changes in the strength, frequency and paths of hurricanes, and/or an extension of the hurricane season. Beaches vital to the tourism industry, such as Grenada's already eroding Grand Anse beach, are also at risk.

Some studies suggest that the sea level rise due only to climatic effects will be on

the order of 2-3 cm per decade in the Caribbean region (Maul, 1988), but others indicate that it may be larger and not necessarily linear. This may seem like a trivial change, but one rule of thumb states that a one centimeter sea level rise will generally result in a one meter shoreline retreat (Gable, 1987/1988). At a conservative rate of 2-3 centimeters rise per decade, within the next 40 years Grenada could therefore expect to lose some 8-12 meters (26-40 feet) of beach width in areas where sea level change is due solely to climate.

At this time many if not most experts believe that some global warming will occur, but there is a great deal of uncertainty about the rate and magnitude of warming and its effects on sea level. In the face of such uncertainty, the GOG should adopt a flexible, adaptive strategy. In the case of older infrastructure (which will have to be replaced in any event), provided there is an alternative location, the best and cheapest response may be to do nothing. In cases where existing economically vital infrastructure is threatened and no alternative location exists, such as certain sec-

tions of the coastal road and some parts of Grand Anse Beach, an immediate response is justified provided it is cost-effective and environmentally sound (see Section 4.4).

In other cases, especially where infrastructure can be modified or has not yet been built, measures to prevent or adapt to the warming should be taken only if such steps have good prospects of yielding benefits even without a climate change; if the climate changes do manifest, of course, then they will yield a much greater benefit. Grenada's recently adopted coastal set-back policy is a good example of this type of response because it also offers protection from storm surges and tsunamis, maintains the aesthetic qualities of the coastline, precludes monopolization of what should be a public resource by private interests, and mitigates impacts from artificial lighting on nesting sea turtles. Other opportunities for this type of multiple-benefit measure exist in the areas of energy conservation and alternative energy sources, water resource conservation, natural hazard disaster planning, and building code revision.

1.2 PEOPLE, HISTORY AND CULTURE*

HISTORICAL OVERVIEW OF THE NATION

In 1498, six years after his first round trip, trans-Atlantic cruise to the Caribbean, Christopher Columbus made a third return visit to the area, this time favoring a southerly approach to the mysterious, unnamed "continental" coastline known later as the Spanish Main. After a clockwise near circumnavigation of Trinidad, the Italian explorer sailed north out of Trinidad's inland sea known as the Gulf of Paria, passing through the island-studded Dragon's Mouth Channel separating Trinidad from the mainland.

Journals kept by Columbus have been lost, but contemporary records compiled from them say that the day after leaving Trinidad's mountains well astern, low on the southern horizon, he sighted Grenada from a distance and named it "Concepcion". He never set foot on the island and was unaware that it was then inhabited by an Amerindian people. These early inhabitants were primitive agriculturists who had migrated to Grenada from the South American mainland about the first century A.D. Archaeological analysis indicates that, some six centuries later, another wave of more developed Amerindians, the Arawaks, arrived in Grenada from the mainland.

About the time Columbus was opening up the New World to Europe, the warlike Caribs swept through the Lesser Antilles. They conquered the Arawaks, established several settlements on Grenada and, after Columbus passed by, remained undisturbed for over a century before European colonization encroached on their lives. Early explorers rendered the Amerindian name for the island as "Camerhogne."

Following two unsuccessful attempts at colonization, 200 Frenchmen from Mar-

* This section of the Profile is drawn largely from a paper entitled "Grenada Historical Overview," prepared by Mr. Alister Hughes, Grenadian journalist, for the Grenada Country Environmental Profile Project. For details on references used by Mr. Hughes, the paper is on file at the headquarters of Island Resources Foundation in St. Thomas.

tinique settled in Grenada in 1650. Within a year, the Carib inhabitants began to murder Frenchmen found hunting in the forest. This brought violent reaction from the French who successfully called for reinforcement from the colony of Martinique. The Caribs retreated to a precipitous hill in the north of the island where they sought refuge. After a long search, the French discovered their refuge and took them by surprise. Most of the Carib Indians committed suicide by leaping into the sea below. In several raids until 1654, the French all but completely exterminated the Caribs. A few elements of the Amerindian culture survive today. These include some words of Amerindian origin, pottery and other burial site remains, and petroglyphs in the Mount Rich area. Leapers Hill and the town of Sauteurs are named after the tragic events that brought an end to the Indian occupation.

This first successful European settlement of Grenada was a private development venture which was sold to the French West India Company in 1665. Nine years later, in 1674, the Company was dissolved and the island came under the French Crown. It remained a French colony until 1762, when it surrendered to a British squadron without firing a shot. The Treaty of Paris in the following year confirmed British possession, and the first British Colonial Government of Grenada was created by royal proclamation of George III.

In 1771 a fire completely destroyed St. George's, which was then a wooden town. Four years later, the greater part of the town was again destroyed by fire, as a result of which the Legislature enacted laws prohibiting construction of buildings which were not of brick or stone and covered with tiles. Those laws had a fundamental effect on the rebuilding of the town and are responsible for the unique architectural character of modern St. George's.

The 1775 War of American Independence involved Britain in a war with France in 1778, which had repercussions in Grenada. A French fleet sailed to the Caribbean after engaging British vessels along the American coasts. For several months, the fleet was blockaded at Martinique by the British Navy. Breaking out in 1779, the French sailed south to St. Vincent where the British capitulated.

The fleet then moved on to Grenada and captured the island from the British by a clever maneuver, after a brief but fierce fight.

Grenada changed hands again when it was returned to Britain in 1783 by the Treaty of Versailles. The Colony of Grenada was then defined as "... the island of Grenada and such of the islands commonly called the Grenadines to the southward of Carriacou, including that island, and lying between the same and Grenada", a delimitation still in force today.

During the French occupation, British settlers had been treated very badly, and this was not forgotten when the island was restored. Laws repressive to the French were enacted; Frenchmen were excluded from the Legislature and were persecuted because of their religion.

But the French in Grenada had their revenge. After the French Revolution of 1789, they rose up in rebellion against the British, instigated and armed by their countrymen in Martinique. Led by Julien Fedon, a colored Grenadian who owned the Belvedere Estate which was then the largest estate in Grenada, this bloody revolt began in March 1795 and was not crushed until 15 months later. Joined by slaves and "free colored", Fedon took possession of all of the island except St. George's. In 1796 a strong British force was sent out under the command of Sir Ralph Abercromby, who subdued the rebel forces by capturing their stronghold located on a flat-topped peak in the central mountain range (now called Fedon's Camp). Sir Ralph went on to capture Trinidad from the Spanish. Fedon himself was never captured.

In spite of this unrest, Grenada prospered. It had become a "free port" in 1767, a status conferred by Imperial Acts on several British islands in the Caribbean. Under this system, Britain allowed small vessels from neighboring foreign colonies into certain ports of the British West Indies with the privilege of importing and exporting specified types of goods. Grenada benefited from this trade for about 30 years. Nevertheless, during this time, the principal interest of the British was agriculture, as it had been with the French colonists.

The first French settlers in 1650 planted tobacco and by 1700 were producing indigo and livestock. In 1702 sugar cane was introduced from South America, and cane cultivation gradually took over from indigo in the early eighteenth century. Sugar cane cultivation necessitated the introduction of cheap labor into the country, and thus the slave trade was developed. Until the abolition of slavery in 1834, sugar cane was by far the most important crop cultivated on almost all low-lying land in the country. In 1714, cocoa, coffee and cotton were introduced and, after 1783, under British administration, exports of these crops were expanded. Fustic (dye wood), slaves, hides and wood were also added to the list of exports.

Trade in fustic declined drastically early in the nineteenth century, production of indigo had been abandoned by 1846 and exports of tobacco petered out in the late 1890's. Coffee lingered until the first quarter of the twentieth century, and cotton, its production eventually confined to the sister island of Carriacou, was exported for the last time in 1981 -- although there is some discussion of reviving the industry as part of a larger regional strategy.

Maltese, Portuguese and liberated slaves from Africa were imported in 1839 to solve labor problems created by emancipation of the slaves, but this experiment failed. Additionally, the price of sugar began to show a marked decrease because planters had to compete on the European market with the sugar still produced in Spanish colonies by slave labor. By 1856, many sugar estates in Grenada had been abandoned.

Immigration of East Indians to work on the estates began in 1857. While this permitted several sugar estates to be reclaimed, the gradual transference of agricultural interest from sugar to cocoa, which began with emancipation, continued. The emancipated slaves and indentured laborers took readily to this crop; a quantity of land could be easily had in the interior, and the cultivation of cocoa offered an independent existence and reasonable profits for a minimum of labor. This unfortunately led to the clearing of a large part of the remaining upland natural rain forest.

INFLUENCE OF HISTORICAL AND CULTURAL FACTORS

The relatively limited appreciation or recognition afforded by the majority of Grenadians for their historic and cultural background can be traced in large measure to their colonial past.

After the Treaty of Versailles in 1783, when Grenada passed finally into British hands, and until 1967, when the island became a State in Association with Britain, Grenada was a possession of the "Mother Country". The Colony was administered by standards approved by the Colonial Office, not necessarily in accordance with Grenadian standards. The Governor was not a Grenadian, but as representative of the British Monarch, he had the final word in all local matters. Additionally, until comparatively recently, all important posts in the Public Service such as Postmaster, Auditor, Treasurer and Chief of Police were held by Englishmen. To emphasize the dominance of the "Mother Country", the laws enacted by colonial legislatures -- the very basis of the government of the Colony -- did not come into effect until they had been approved by the Colonial Office. Annual budgets too needed approval in London.

In Grenadian schools, British history was standard curriculum, but the history of Grenada or of the Caribbean was excluded except as it involved the Caribbean exploits of British naval heroes. Students became familiar with William the Conqueror, the War of the Roses, and the Magna Carta but knew little of the Fedon revolution or the Carib massacre of 1654. British festivals, such as Guy Fawkes Day and the Queen's Birthday, were unflinchingly celebrated.

Against this background, it was typical for an adult Grenadian, having amassed sufficient funds to leave the Colony on vacation, to speak proudly (albeit in jest) of going "home" to London. Succeeding generations of Grenadians developed a veneration for British monuments such as Buckingham Palace and the Tower of London, while they carelessly disregarded their own historical landmarks.

In colonial times Grenadians found it socially advantageous to de-emphasize their cultural roots because those roots suggested connections with slavery. For the last two decades, the upsurge of the Black Power movement and other contemporary events have generated a search for those cultural roots. It is significant, however, that the members of these movements do not look for their roots in the land of their birth. For some Grenadians, as in colonial times, the "center of the universe" is still elsewhere. In this instance, it is in Africa.

Indicative also is the disfavor with which some educated Grenadians held (and still hold) the special Grenadian English spoken by natives of the island. This English, rich with words and phrases marking the varied international and historical origins of the Grenadian people, is spoken to a greater or lesser degree by all Grenadians. Yet, for the most part, Grenadian English is regarded in a patronizing manner, as the means of communication used by "the people", i.e., the uneducated poor. It carries the stigma of being "local", of being inferior, while the "good English" of the "Mother Country" is more generally advocated.

Until Grenadians are able to ferret out and remove such relics of colonial days, the country will continue to be saddled with "old hang-ups" which impede a true appreciation for things Grenadian.

Nutmegs (which earned Grenada the name "Isle of Spice") were introduced about 1843 as a curiosity by sugar planters returning from the Far East. Less than a decade later,

when disease seriously depleted the East Indies nutmeg plantations, Grenadian agriculturists started planting nutmegs seriously as an economic crop, but it was a slow process and there

were no exports of nutmegs until 1881. Today, together with bananas (which became an economic crop in the mid-1950's) and cocoa, nutmegs form the backbone of the island's agricultural economy.

Exploitation of Grenada's excellent potential as a tourist destination was first undertaken in 1938 when Government appointed a "Tourist Committee", but real development of this sector of the economy did not begin until the early 1950's after World War II. Since then, tourism has developed into an important segment of the island's economy.

Constitutionally, Grenada had an elected House of Assembly after the island was captured from the French in 1763. Except for a brief period from 1779 to 1783, that House continued to sit until 1876 when the House voted itself out of existence. From that date, until 1924, Grenada was a Crown Colony governed from London. It was the efforts of one of the island's national heroes, Theophilous Albert Marrayshow, which set the country again on the road of constitutional advancement. As a result of Marrayshow's agitation, elections for a Legislative Council were held in 1924 under a limited franchise.

In the years following, there was gradual constitutional improvement until, in 1951, adult franchise was introduced. This was also a time of great civil unrest. The liberalizing of the franchise coincided with the birth of trade union activity, and both political and economic issues created strife between the "plantocracy" and the working masses.

In 1967, Grenada became a State in Association with Britain. This arrangement for the first time gave Grenadians complete internal self-government, while Britain administered the portfolios of Defense and Foreign Affairs. But this constitutional advance heralded another period of civil unrest. The Duffus Commission of Inquiry sitting in 1973/74 found that the Government of that day had employed criminals who unleashed a "veritable reign of terror", inflicting "unspeakable atrocities" on opponents of the Government.

Against that background and in an atmosphere of continuing unrest, Grenada achieved independence on 7 February, 1974. During this period, the left-wing New Jewel Movement (NJM) was born, led by young intellectuals who contested and won seats in the 1976 General Elections. In March 1979, however, NJM abandoned democratic parliamentary procedure for revolution. In an almost bloodless coup, NJM seized and held the government for four and a half years. In October 1983 a power struggle within the party resulted in the assassination of the revolutionary Prime Minister with members of his Cabinet and in the deaths of a still unknown number of other Grenadians.

Days after these traumatic events, military intervention by United States and Caribbean forces recovered the island from the Revolutionary Military Council which had seized power, and, after a period of rule by an Interim Government, parliamentary democracy was restored when General Elections were held in December 1984.

The year 1990, marking the three hundred and fortieth year since the first colonization of the island, finds the country with a flourishing democracy (seven political parties), freedom of speech (six newspapers), a generally good record of human rights (attested to by Amnesty International in 1988) and an improving economy. There is some, although limited, evidence of an awakening realization by Government and the public of the need for environmental management and control. Provided that the lessons of their historical experience are heeded, that wise political and economic management prevail and that sustainable use of their nation's resources can be achieved, citizens of the "Isle of Spice" enjoy excellent prospects for continuing improvement in the quality of their lives.



Like a giant amphitheater, the hills of St. George's, Grenada, wrap around the deep harbor to shape one of the most geographically and architecturally remarkable port cities of the Caribbean region.

SECTION 2 DEMOGRAPHICS

2.1 OVERVIEW: POPULATION CHARACTERISTICS

The first national population census in Grenada was taken in 1844, ten years after the abolition of slavery. At that time 29,650 people lived in the country. Decennial censuses were held from 1851 to 1921; following 1946 and continuing to the present censuses have been held at irregular four- to five-year intervals. Except during the decade 1851 to 1861 (when there was a cholera epidemic), the population of Grenada grew consistently over the period 1844 to 1911, when it reached 66,750. From 1911 to 1946 growth slowed considerably, showing even a slight decrease in 1921, caused by high levels of emigration as well as a worldwide influenza epidemic (Figure 2.1(1) and Table 2.1(1)).

Fertility and mortality rates for the nineteenth and early twentieth century were probably around the norm for the era and region of 40-45 per 1,000 and 20-30 per 1,000, respectively (Bouvier, 1984). Fertility and mortality rates in 1945 were 31.1 births per 1,000 persons and 15.8 deaths per 1,000 persons, respectively. The excess of births over deaths resulted in a large natural increase (births minus deaths) of some 30,132 persons between 1921 and 1946. However, natural increase was counterbalanced by an increasing net emigration after 1920; during this interval the population size only increased by 6,085 persons to a total of 72,387. Bouvier (1984) suggests that substantial emigration of up to 25,000 people, or about 1,000 per year, must have taken place during that period. This level of net emigration accounts for more than half the total net emigration from the Windward Islands for that 25-year period. As a result, around the middle of this century Grenada's population grew at a rate of only 0.2 percent per year, the lowest of all the Windward Islands.

Demographic statistics for the period between 1946 and 1960 are based on information provided by Caribbean demographers George Roberts and Jack Harewood since no censuses were taken during this 14 year period (Bouvier, 1984). An increase of 17,573 per-

sons on Grenada between 1946 and 1960 indicated an average annual growth rate of 1.5 percent, a significantly higher rate than during the immediately preceding period from 1911 to 1946. Crude birth rates over this period went up from 32.7 per 1,000 population in 1946 through an historic high of 53.5 in 1957, to settle at a rate of 44.5 in 1960. At the same time that women were having an average of six to seven children, mortality fell from 17.0 per 1,000 persons in 1946 to 11.4 in 1960.

During the 14 year period from 1946 to 1960, the rate of natural increase rose from 1.6 to 3.3 percent with a high of 4 percent in 1957. Since the population increased by only 17,573 during that period, net emigration clearly was a limiting factor to annual growth. Demographers estimate that net emigration increased considerably after 1955, exceeding 2,000 per year from 1957 to 1960 (Bouvier, 1984). In this period, many Grenadians emigrated to Great Britain, Panama, Guyana and the nearby island of Trinidad.

Population growth over the next two decades was low or negative; at the same time both fertility and mortality dropped substantially. By 1970 the crude birth rate was down from 44.5 to 28.2 per 1,000 population, and the death rate had declined to 7.5 per 1,000 from 11.4 in 1960. Thus, with high levels of net emigration continuing at about 2,000 people per year, the average annual growth rate for the decade of the 1960's was a low 0.3 percent, a considerable drop from a rate of 1.5 percent in the 1950's. The rates and trends seen in the 1960's continued through the 1970's. The drop in fertility that began in the 1960's was particularly noteworthy in that it continued through the 1970's to a low of 22.8 births per 1,000 in 1982. N.B. The above population figures are taken from Bouvier (1984) and do not correspond to information found in the Grenada Annual Abstract of Statistics, 1987 (see Table 2.1(2)). For other population discrepancies, see box on page 38.

THE PLANNING DILEMMA: WHEN COUNTING COUNTS I

The literature regarding Grenada's national population size after 1970 is confusing and contradictory. Bouvier (1984) indicates that no census was taken in 1980 and that in 1984 the 1982 count was incomplete. However, a 1987 study prepared by D. Wirt for the Organization of American States refers to data from the 1980-1981 Population Census of the Commonwealth Caribbean, including Grenada. But the same OAS document gives the source of data as the Ministry of Health, Registrar General's Office. The 1987 Grenada Annual Abstract of Statistics (Ministry of Finance, 1987) gives a census figure of 89,088 for both 1980 and 1981.

Current population estimates range from 93,000 (Weaver, 1989) to 97,000 (EC News, Sept. 29, 1989) to 100,000 (Caribbean/Central American Action's Data Book, 1987) to 110,000 (Tobal, 1986 and The Caribbean Handbook, 1989 [edited by J. Taylor]) to 120,000 (estimated by Soler, 1988). Bouvier (1984) estimated the total fertility rate at 3.5 per 1,000. The fertility rate for Grenada is reported by Wirt (1987) as 4.2 per 1,000 for women with primary or no education and 3.3 per 1,000 for women with secondary and higher education. EC News (Sept. 29, 1989) reports that this rate is "almost 4".

Table 2.1(1). Grenada population data, 1844 - 1988.*

YEAR	POPULATION	YEAR	POPULATION
1844	29,650	1946	72,387
1851	32,671	1950	76,540
1861	31,900	1955	85,411
1871	37,684	1960	89,960
1881	42,403	1970	92,725
1891	53,209	1981	89,088
1901	63,438	1984	115,481
1911	66,750	1989	97,000
1921	66,302		

* 1844 to 1970 data from Bouvier, 1984. 1981 data from Grenada Annual Statistical Tables, 1987. 1984 data are estimates of Ministry of Health, Grenada (see Wirt, 1987, and Soler, 1988). 1989 data: Grenada National Population Policy.

Wirt (1987) gives the 1984 population estimate as 115,481, the birth rate as 25.09/1,000, the death rate as 6.48/1,000, and the natural increase as 18.61/1,000. The population of Petit Martinique (approximately 500) does not appear to have been included in any of these totals.

A recent (1989) Grenada National Population Policy document reports that the

population is 97,000 and is expected to grow by 40,000 to a total of 137,000 in the next 25 years -- a projection which has "serious implications" for the provision of health care, nutrition, housing and employment. The major factor in population growth is the relatively high fertility rate, fueled in part by an upward trend in teenage pregnancies. Based on current data, Grenadian women are likely to bear an average of almost four children, although

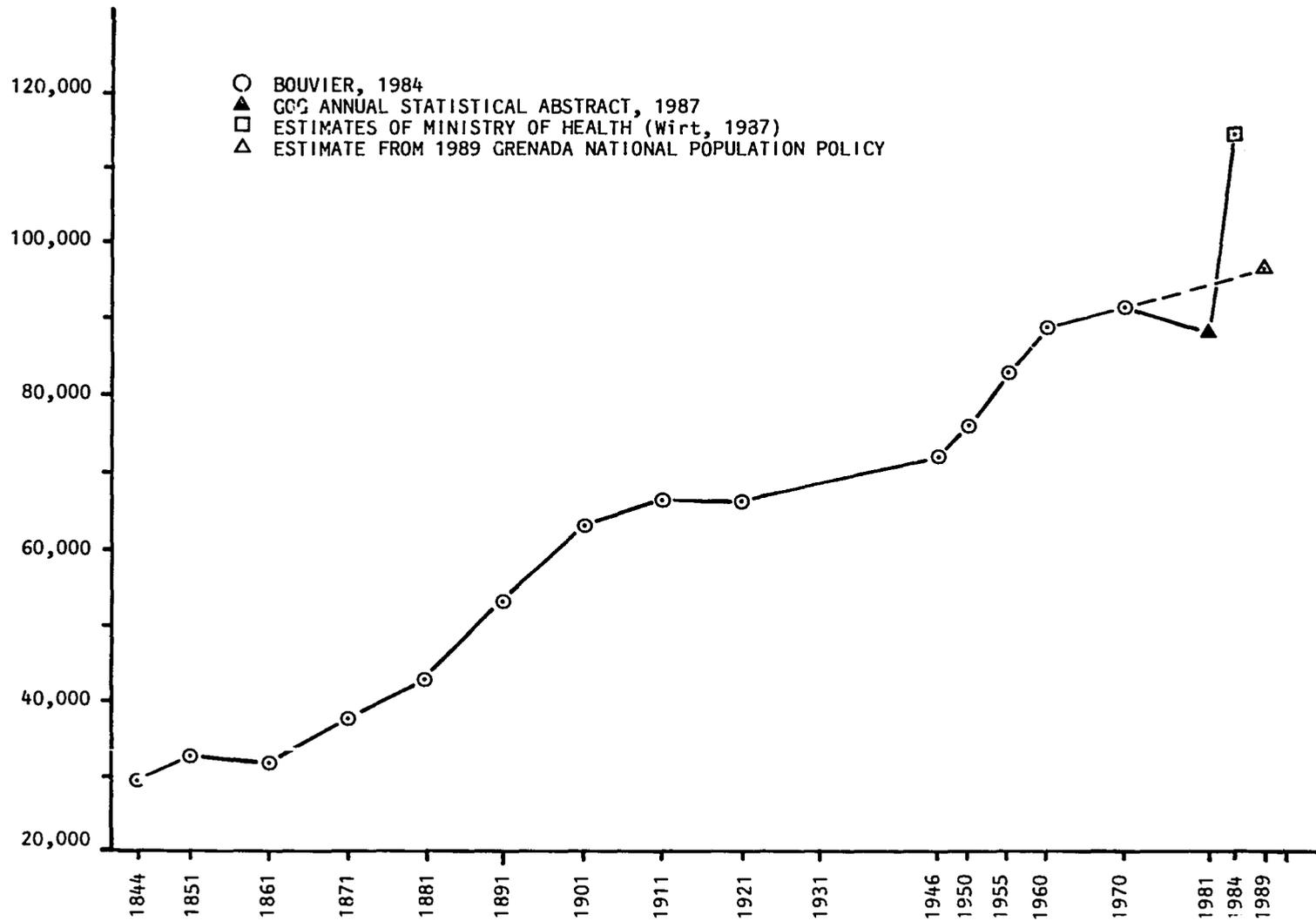


Figure 2.1(1). Grenada national population curve, 1844-1988 (source: Bouvier, 1984; Wirt, 1987; and Soler, 1988).

Table 2.1(2). Grenada population indicators, 1970 - 1987.

YEAR	INFANT MORTALITY RATE PER 1,000	BIRTH RATE PER 1000	DEATH RATE PER 1000	RATE OF NATURAL INCREASE PER 1000	NET MIGRATION (‘000)
1970	32.8	29.1	7.9	2.1	-2.0
1971	26.1	28.9	7.4	2.2	3.8
1972	16.0	28.3	6.4	2.2	2.4
1973	18.4	27.4	6.8	2.1	-3.1
1974	31.1	26.3	7.0	1.9	-2.2
1975	23.5	27.4	5.9	2.1	-0.5
1976	27.7	26.1	7.2	1.9	-1.1
1977	16.7	25.3	7.8	1.8	-0.7
1978	29.0	23.2	7.1	1.6	-1.1
1979	15.4	24.5	6.8	1.8	-3.7
1980	22.8	23.5	6.9	1.7	-2.5
1981	14.9	27.5	8.3	1.5	-3.5
1982	13.4	29.5	8.1	1.8	0.8
1983	21.2	31.5	8.7	1.9	-0.7
1984	19.6	31.0	7.7	1.8	1.6
1985	18.0	33.1	8.7	2.3	-2.3
1986	15.9	34.8	7.7	2.5	-5.3
1987	15.9	33.0	8.3	2.2	1.9

Source: Grenada Annual Abstract of Statistics, 1987.

the "desired average" (i.e., the replacement level in the absence of migration) is 2.1. The document confirms that emigration is currently about 2,000 per year. More than half those leaving permanently today are women, which is redressing the sex imbalance caused by the disproportionate number of men that left in the mid-1950's. The male to female ratio is now estimated to be 93:100. Life expectancy is 66 years for males and 72 years for females.

Grenada, like many of the islands in the Caribbean, has a very young population (Figure 2.1(2)). In 1981 39 percent of the population was under 15 years of age (Wirt, 1987). The sex ratios (males per 100 females) for all age groups were 85:100 in 1960, 89:100 in 1970, and 93:100 in 1981 (Wirt, 1987). Sex selective migration was thought to be the rea-

son for asymmetries in the sex ratio of groups older than 20 years of age.

Grenada has six major settlements located in the coastal area of the country. These settlements, from largest to smallest, are: St. George's Town, Gouyave, Grenville, Victoria, Sauteurs, and Hillsborough (Carriacou). Fifty percent of the settlements fall within the size range of 201 to 600 persons and 85 percent are within the 1 to 1,000 size range. According to 1984 population estimates, St. George's Township had a population of 6,463 (including St. George's proper: 4,712; River Road: 1,503; and Tempe: 248) (Wirt, 1987).

The island of Grenada is very rugged, with a land area of only 120 square miles (312 sq. km). Its average population density was 742 persons per square mile (286 per sq. km)

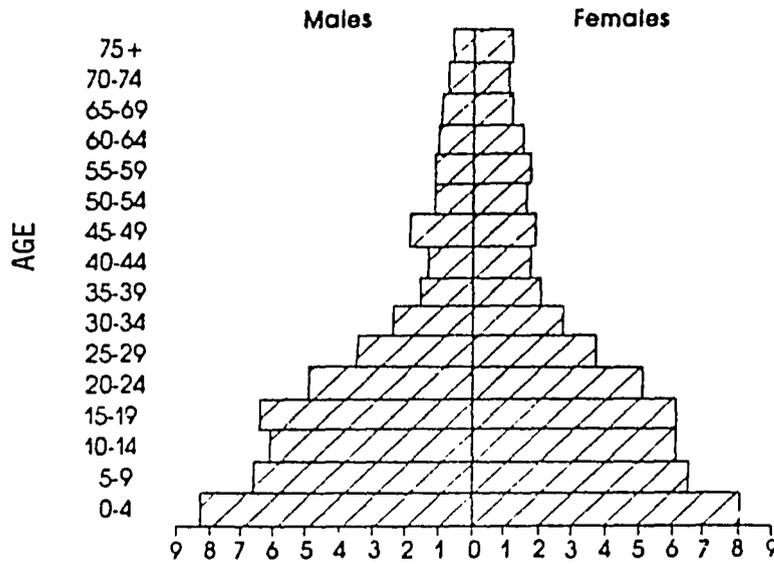


Figure 2.1(2). Age-sex structure of Grenada's national population, by percentage of population (source: Bouvier, 1984).

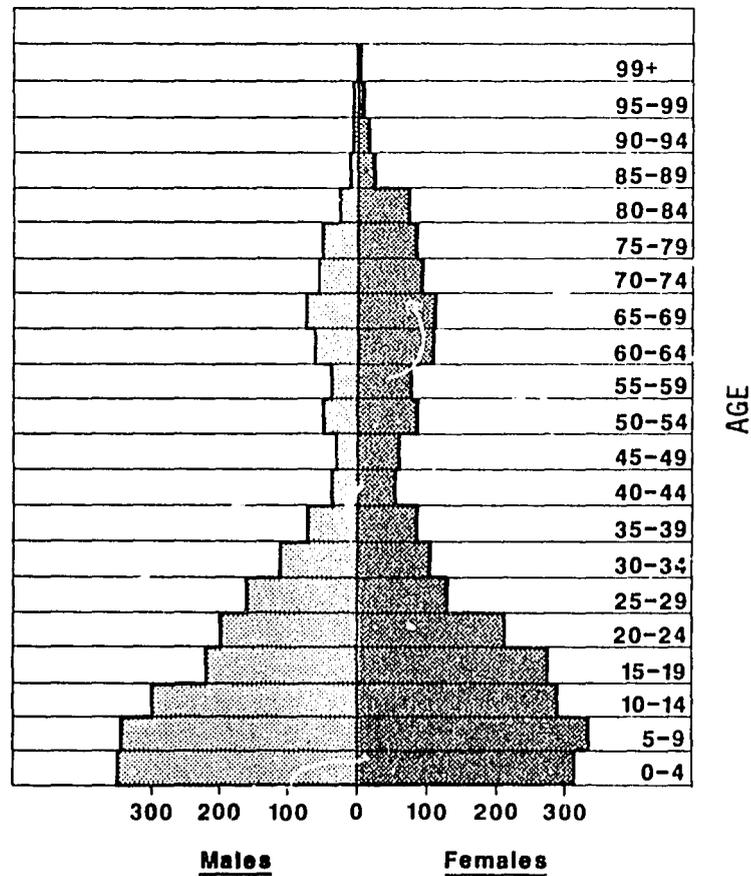


Figure 2.1(3). Age-sex structure of Carriacou's population, by number of individuals (source: GOG/OAS, 1988b).

in 1981, using that year's census figure of 89,088 persons. McElroy and de Alberquerque (1989), using a middle-of-the-road Grenada national population estimate of 103,000, computed a population density for the country of over 300 per sq. km, the highest of all the OECS countries on the basis of total land area.

St. George's, the second largest parish on the island of Grenada, has the highest density, and 33 percent of the population is concentrated within its boundaries (Wirt, 1987). Even as the density increased for the entire country, population densities for all the

other parishes except St. Mark's exhibited a decrease. St. George's is the predominant settlement with regard to diversification and aggregation of economic activities. Grenville is second to St. George's and serves as a major market center and point of transshipment for agricultural produce and fish to export markets. The major settlements in all parishes include persons who work in St. George's and Grenville because the majority of employment opportunities are concentrated in these settlements. The economies of the other major settlements are based almost entirely on agriculture and/or fishing.

POPULATION FUTURES

In order to estimate future growth trends for a nation, various assumptions must be made about future rates of fertility, mortality and net migration. The changes (or lack of changes) in these factors will determine future population size. The problem in Grenada is that hard data regarding the current values of these parameters (or even the current population size) are not available, making future predictions tenuous at best. For example, Figure 2.1(4) presents four hypothetical scenarios constructed by Bouvier (1984) which display different population growth possibilities for Grenada:

- Scenario A assumes a fertility rate of 3.5 and a net emigration of 1,800 per year (N.B. present emigration rate is 2,000 per year).
- Scenario B assumes a fertility rate of 3.5 and a decrease in the level of net emigration per year to around 900 persons, primarily due to an imposition of immigration quotas by popular destinations.
- Scenario C assumes that information, educational levels or economics could reduce the fertility rate to 2.8 and external factors would cut the net emigration to 900 persons per year.
- Scenario D assumes extreme conditions of no net migration and a decline in fertility rate to the replacement level of 2.1.

Projected expansion of the labor force (Bouvier, 1984) is presented decade by decade in Figure 2.1(5), under the same four alternative growth scenarios as above. This projection indicates that under all assumptions except Scenario A, the country will probably experience some growth in its labor force at least until the turn of the century, and that any decline in net emigration would pose major problems of unemployment.

These examples from Bouvier are used for illustrative purposes only. Given what little information is available today on current population size in Grenada, it would appear that none of these scenarios fits the pattern of growth which actually occurred. The planning data base deficiency, however, should receive some serious attention if resource allocation decisions and environmental planning for sustainable development in the future are to be conducted on a sound policy footing.

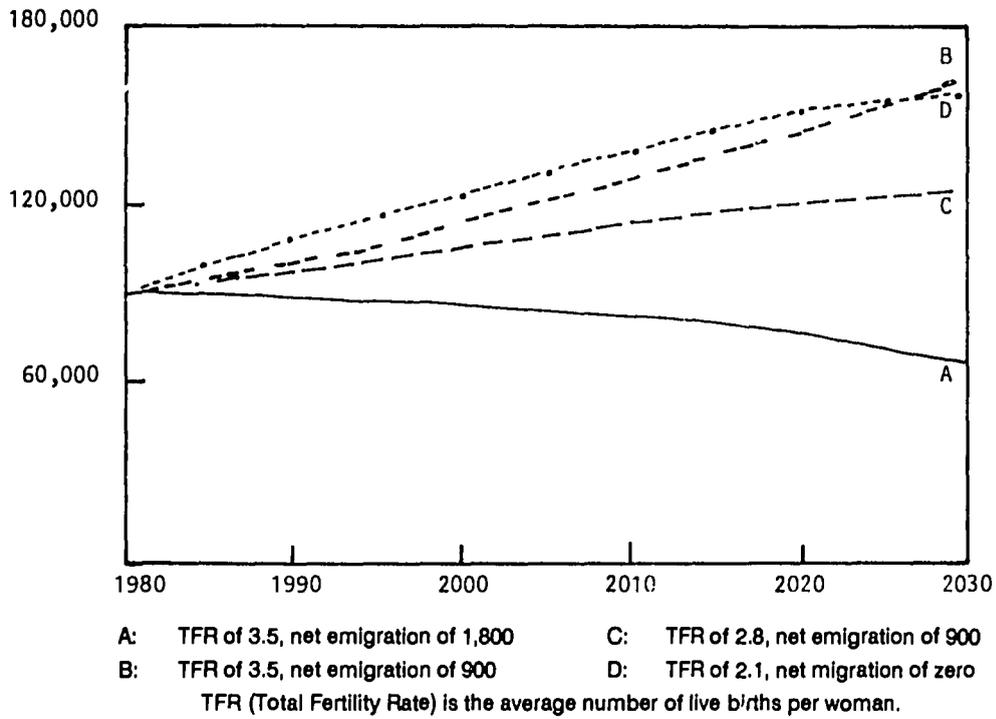


Figure 2.1(4). Grenada national population projections, 1980-2030 (source: Bouvier, 1984).

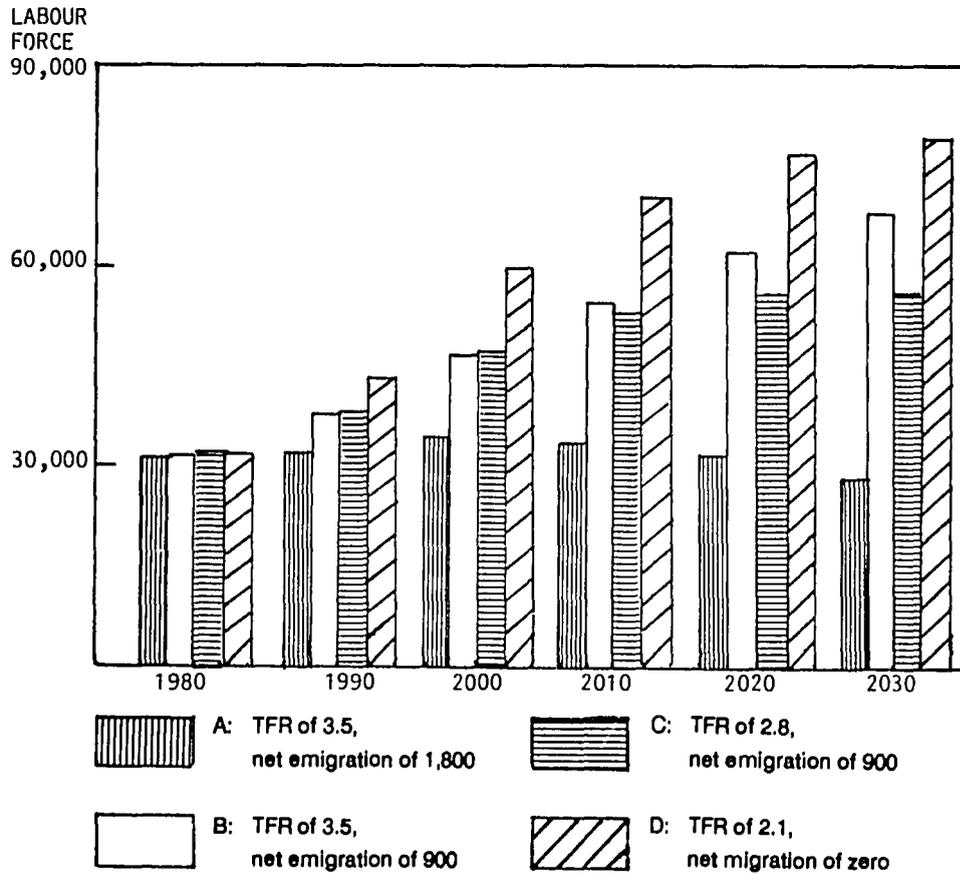


Figure 2.1(5). Grenada national labor force projections, 1980-2030 (source: Bouvier, 1984).

Population records in Carriacou date back to 1830, when 3,800 residents were counted (GOG/OAS, 1988a). Population increased to its maximum size of close to 7,000 persons in 1960, and since that time the island's population has shown an accelerating rate of decline. The 1970 census figure was 5,950; the 1981 census showed only 4,671 persons (GOG, 1987). The age-sex pyramid for Carriacou (Figure 2.1(3)) shows an overwhelmingly youthful population -- 40 percent of all residents are under 15 years of age. Also of interest is the fact that there is a high proportion of older people -- 14 percent are 65 years or older. The constricted middle section of the pyramid is probably due to high out-migration and fewer births during the depression years from 1930 to 1940.

There are eleven well-defined and generally coastal-situated villages in Carriacou, which has a total land area of 13 square miles (34 sq. km). In the 1950's and 1960's (GOG/OAS, 1988a), the average population density was close to 500 persons per square mile (192 per sq. km). Today, assuming a population in the neighborhood of 4,700, the average density is probably about 360 persons per square mile (138 per sq. km).

The size of the economically active population was reported (Wirt, 1987) as 31,363 persons for the entire country, including 19,289 males (62 percent) and 12,074 females (38 percent). This figure is 35 percent of the total population and 63 percent of all adults counted in the 1981 census. The four major areas of the economy providing the highest percentage of employment are agriculture, commerce, services and construction. The study concluded that the labor force has grown since 1970; that employment in the service sector has risen 42 percent since 1970; and that the number of unemployed has also increased since 1970. An overall unemployment rate of 17.4 percent was quoted for 1981. Of the total unemployed, almost half were under the age of 20.

In summary, large numbers of Grenadians and Carriacouans have left their home land every year since 1920. The proximity of larger islands which provide opportunities for employment, changes in immigration

laws of developed nations like Great Britain and the United States, and unstable political conditions in Grenada have all at various times served as reasons for the movement of people. In the years following the changes in the U.S. immigration laws (1965), the United States has become an increasingly attractive area for Grenadians migrating out of the Caribbean. As a result of this emigration "safety valve", Grenada has experienced a relatively low growth rate of its total population. Although population growth has not been consistent nor particularly rapid, Grenada's population size apparently continues to increase at the present time.

2.2 PROBLEMS AND ISSUES

Political and economic conditions will no doubt affect Grenada's overall growth rate in the future. Potentially the most volatile factor controlling the growth rate is net migration. With the present world population now well over five billion and projected to be 8.5 billion by the year 2025, there is an increasing likelihood that emigration opportunities for nationals of lesser-developed countries may soon be drastically reduced. A significant reduction in Grenada's current level of net emigration could occur at any time, and, other factors being equal, this would cause a corresponding rise in the local growth rate. A more rapidly increasing population due to a reduction in out-migration would bring additional stresses to bear on the natural resources of the country. Infrastructure problems (e.g., housing, schools, sanitation, water supply, roads), which are already serious and which are causing the Government to expend its limited funds in remedial efforts, would be further exacerbated.

Beyond some variable threshold, economic and social development is correlated with a decline in both death and birth rates; this is the so-called "demographic transition" phenomenon. However, for a lesser-developed nation such as Grenada with a predominantly resource-based economy and a large foreign debt (see Section 3), achieving a level of development that would bring about the demographic transition requires capital investment on a large scale. Unfortunately,

most developing nations can only acquire the necessary funds by entering a cycle of incurring even greater debt and permitting further depletion of their stocks of natural resources. In the long run, the only real hope to redress this situation is for the developed nations to forgive massive amounts of debt and to restructure their own economies so that they promote sustainable development on a worldwide basis (MacNeill, 1989). For the present, however, Grenada is more fortunate than many other lesser-developed nations in that out-migration has prevented its population from growing explosively, giving policymakers a chance to take action to reduce fertility levels, implement environmental conservation measures, and explore ways to find more productive *sustainable* uses for available natural resources.

The continuing loss of skilled personnel, mainly to the United States and Canada, is also a matter of serious concern for Grenada. However, any public policy attempt to reverse this situation must confront the dilemma that high net emigration in general has had a positive impact on the country.

The present youthful age structure of the population is another important demographic factor, since it means that about two-fifths of the population has not yet had its full impact on growth rates. Even if the fertility rate was reduced to a replacement level of 2.1, the current generation of young people is so large that without a substantial net emigration, the absolute number of births would remain large for at least two generations before leveling off. In other words, barring an increase in the death rate, it would be almost

impossible to put a rapid end to population growth in the absence of emigration.

2.3 POLICY RECOMMENDATIONS

* As a proactive measure, Grenada's policymakers could attempt to lower the country's fertility rate as rapidly as possible. To wait until natural constraints and external controls force a response is to ignore the opportunity for positive action now and to accept instead the probability of lowered living standards, accelerated unemployment, potential political instability, and ecological deterioration in the future.

* An optimal population strategy would combine accelerated economic and social development (emphasizing environmentally benign technology and environmental protection) with major efforts to educate the populace in the benefits of smaller family size and the acceptance and practice of birth control. It has been repeatedly demonstrated that easily available information about birth control and access to contraceptives have been major causes of declining fertility in all countries with strong family-planning programs (Keyfitz, 1989).

* If the country's ecological base is eroded by overpopulation and/or non-sustainable resource use, economic growth will inevitably be depressed. Good population policy must make expensive to citizens that which is expensive to the nation by transferring to individual parents the ecological (and other) costs of excessive childbearing.

SECTION 3 THE ECONOMIC CONTEXT

3.1 OVERVIEW

This chapter is based on the most current data available from established sources (e.g., the Government Statistical Office in the Ministry of Finance, the World Bank and the United Nations). In addition, to assure consideration of the most up-to-date data and government economic policies, summarized excerpts from the Prime Minister's address to the House of Representatives in April of 1989 have been included in the analysis. These data appear in the several sub-sections of this chapter headed "Recent Developments." Supporting data for trends mentioned in the Prime Minister's speech are not available in published form.

Economies like Grenada's are extraordinarily open and dependent on outside factors. Thus, conventional models of economic behavior and development do not work well for Grenada and her sister islands. Although from a technical perspective, the best current economic models for countries like Grenada are derived from urban and regional models in the developed world, in each country it is necessary to evaluate individually the external linkages and trade patterns which often derive from historic factors not related to economic conditions. In addition to the openness and dependency of island economies, other factors which analysts need to consider are the high energy costs inflicted on islands, because of required transport systems and small scale, and high transportation costs. Finally, as in many other developing economies, islands like Grenada in the Eastern Caribbean usually exhibit dual pricing structures for labor and locally produced goods and services -- a high price for modernizing sectors of the economy, and a lower cost structure for traditional markets.

3.1.1 General

As demonstrated by Figure 3.1(1), over the past decade there has been a steady increase in the level of economic activity in Grenada. It is a tribute to the industry of the people of Grenada that this progress was achieved during a period of unprecedented social and political upheaval.

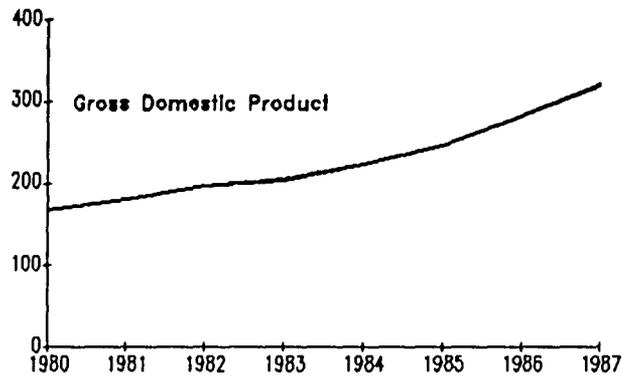


Figure 3.1(1). Gross domestic product 1980-1987 (EC\$ million current factor costs) (adapted from: GOG, 1987a).

Even after accounting for a high level of inflation, overall per capita income has been increasing (Figure 3.1(2)). A major contributor to the apparent increase in per capita GDP may result from numerical decreases in total estimated population during the 1980's (see Section 2).

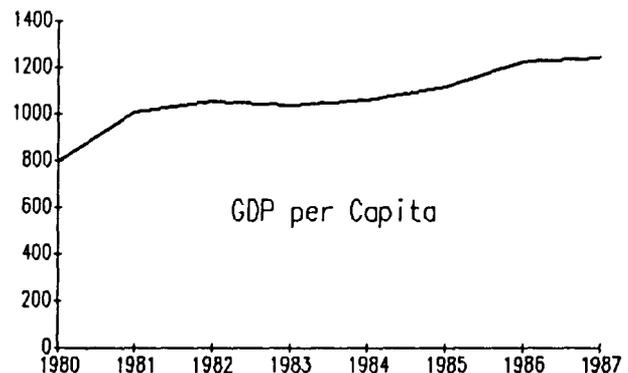


Figure 3.1(2). Per capita gross domestic product, 1982-1987 (1984 EC\$) (adapted from: GOG, 1987a).

The underlying strength of the economy is illustrated by the Figure 3.1(3), which shows the annual rates of GDP growth for Grenada over the eleven years between 1977 and 1988, as calculated by the World Bank. (These figures are not directly comparable with the Government's Statistical Abstract, but they represent a longer time se-

ries.) It should be noted that low or negative growth is associated with periods of major political unrest. Analysis of this data seems to confirm the popular belief that the major constraint keeping Grenada from better economic days is the danger of political or social disruptions. The underlying economy seems to be capable of providing real compound annual growth rates in excess of five or six percent. In the world community of nations, only the newly industrializing nations of Asia have consistently maintained a higher rate of growth.

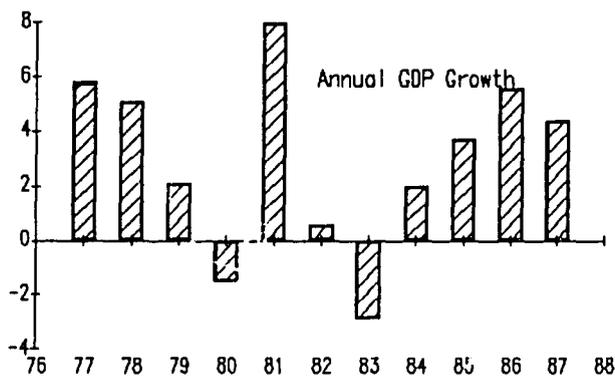


Figure 3.1(3). Annual growth: gross domestic product, 1977-1987 (adapted from: World Bank, 1988).

Since 1984, the economy of Grenada has maintained a real growth rate averaging 5.5 percent per year. This reflects strong tourism growth and an increase in commercial activity, construction and utilities (World Bank, 1988). Although traditional agricultural activities have not expanded as quickly as other sectors, the economy has become increasingly diversified. According to a special 1988 United Nations study, between 1970 and 1985, the Grenadian "concentration index" decreased from roughly .6 to .45 (1.0 would be a perfect monoculture economy) (United Nations, 1989).

3.1.2 Recent Developments

Based on preliminary estimates by the Statistical Department of the Ministry of Finance, the domestic economy in 1988 continued its steady performance which began in 1985 as a result of its transformation from a tightly controlled economy to a free enterprise system. Real Growth of 5.3

percent in Gross Domestic Product was achieved as a direct result of excellent performances within the construction, manufacturing and tourism sectors.

After two years of negligible inflation, 1988 experienced a rise in prices mainly as a result of the introduction of budgetary measures to strengthen the revenue base. According to the Consumer Price Index, the average increase in prices for the "basket of goods" covered in the Index was 6.5 percent.

Data on new registrations by the National Insurance Scheme, which can be used to provide an indication of new employment created, revealed that 3,435 new registrations were recorded for 1988 compared with 3,127 for 1987, an increase of about 10 percent.

Balance of Payments recorded a deficit on the Current Account of approximately \$80 million, mainly due to the high level of imports to meet the needs of local consumption, and the increased level of development. This was, however, largely financed by private and official capital flows which resulted in a positive overall balance of approximately \$11 million. (Blaize, 1989)

3.1.3 Sectoral Performance

Figure 3.1(4) illustrates the impact of the major economic sectors on growth in Grenada over the past several years.

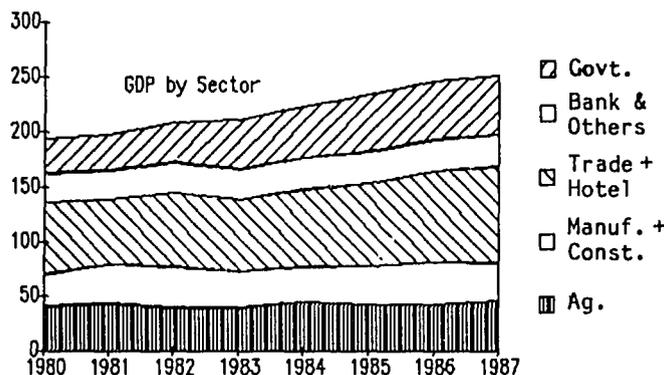


Figure 3.1(4). Gross domestic product by sector, 1984 (EC\$ million) (adapted from: GOG, 1987a).

The main points illustrated by this figure are:

- Growth has been distributed throughout all major economic sectors.
- The fastest growth is recorded in the trade and hotel sector, reflecting the major improvements in export earnings from tourism.
- Although not readily apparent in this figure, manufacturing production has not kept pace with other areas of the economy -- even including other industrial activities.
- Government activity has been increasing faster than overall growth.

AGRICULTURE

Although the agriculture sector recorded some upward trends in recent years (see Figure 3.1(5), for example, which shows an upward movement in export crop prices during a recent seven year period), 1989 indicators point to a sector which has lost some of its growth momentum (see also Section 5).

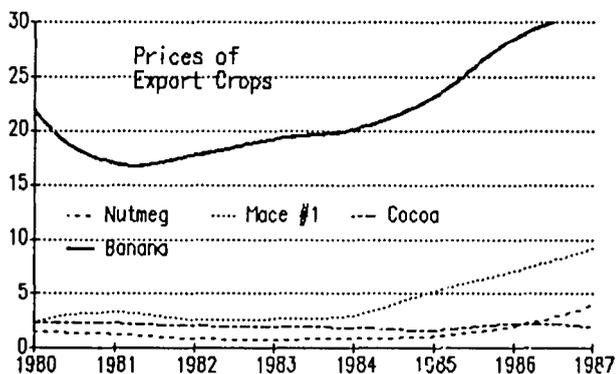


Figure 3.1(5). Prices for export crops received by growers (current EC cents per pound) (adapted from: GOG, 1987a).

Figure 3.1(5) summarizes information on prices for export crops during a recent seven year period. There are two cautionary notes to bear in mind with reference to these prices:

- 1) They are prices of world market commodities, which are notoriously volatile. Compounding the problem for Grenada, both prices are artificially supported by either producers' agreements (spices) or special import concessions (bananas).
- 2) Grenadian producers seem to have been slower than farmers in other countries to respond to improved prices. One indication is that from 1980 to 1987, the volume of Grenadian banana exports actually *decreased* 45 percent, while gross deliveries of nutmeg and mace increased only 17 percent.

The other side of the export agriculture picture is that of food production for the domestic market. According to estimates by the World Bank, per capita food production in Grenada has apparently decreased by a significant amount over the past eight years, as shown in Figure 3.1(6).

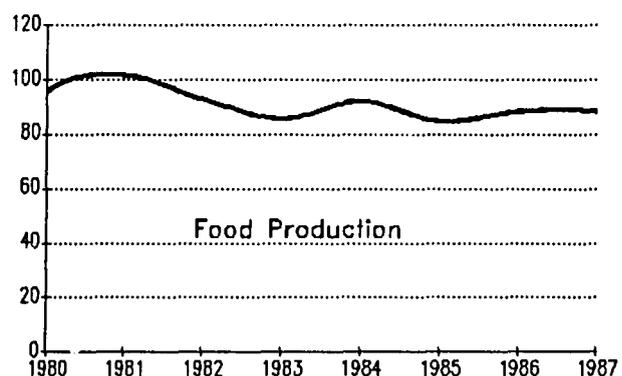


Figure 3.1(6). Index of per capita food production, 1980-1987 (1979-81 = 100) (adapted from: World Bank, 1989).

From a strictly economic point of view, this is not necessarily a negative trend since it can be argued inefficient food producers are better off producing expensive products such as spices for the export market and buying imported food produced more efficiently in other countries. In fact, it is unlikely that this substitution is taking place, given the sluggish response of banana and spice producers to the improved prices shown in Figure 3.1(5). It is more likely that increasing urbanization has reduced the amount of subsistence

and garden crops which people once fed their own families in the past. In addition, demonstration effects of tourism and modern media are encouraging increased import of food from continental sources, at considerable cost in foreign exchange.

A second factor affecting food production in Grenada has been the closing of the Trinidadian export market. Between 1985 and 1987, Grenadian exports to Trinidad-Tobago plummeted by 60 percent -- to \$EC7.5 million from 19.4 million (GOG, 1987). In the absence of any convenient new export markets, the loss of these basic produce markets will continue to depress local market prices for fruits and vegetables for several years.

The World Bank has identified the improvement of producer incentives in food production by eliminating price controls and the government import monopoly for selected imported foods (rice, sugar and powdered milk) as major priorities for government economic policies (World Bank, 1988). It also suggests that improved marketing arrangements and maintenance and rebuilding of the existing road network will improve both domestic and export agricultural production.

RECENT DEVELOPMENTS: AGRICULTURE

Climatic conditions prevailing at the start of 1988 were such that only a 1.5 percent growth in agricultural production was envisaged; however, actual achievement for the year was 2.1 percent. But this more optimistic trend did not continue. Since 1988, there has only been a more moderate increase in agricultural production of 1.5 percent; and all export prices, except for mace, have fallen while domestic exports for the first three quarters of 1989 dropped 17 percent below the level of the corresponding period in 1988. Nutmegs, mace, cocoa, and bananas all had lower than expected production levels in 1989, and all except mace earned less revenue than 1988. Total export earnings from these export crops dropped by about ten percent over the 1988 figure, despite a moderate increase (1.5 percent) in production (*EC News*, Dec. 29, 1989).

Nutmegs and Mace. The production of these crops in 1988 had surpassed targets which were set low because of a drought in 1987. Nut-

megs bettered by 2.9 percent the levels of production achieved in 1987, with a production of 6.3 million pounds for 1988. Mace had an increase of 5 percent to 0.73 million pounds in 1988 from 0.69 in 1987. However, in 1989, despite moderate increases in production, only mace earned more revenue than in 1988.

Bananas. 1987 had witnessed a reversal of a persistently long downward trend in production. 1988 showed further improvement with production reaching 20.6 million pounds, an increase of 12.8 percent from 1987 levels. Unfortunately, in 1989 there was another drop in production to approximately 18 million pounds.

Cocoa and Others. The cocoa industry has experienced several setbacks, including falling export prices and the consequent loss of interest among farmers. Efforts by the Interim Cocoa Board to reverse this trend have included Production Incentives Programs. Farm management competition, low interest credit for replanting, extended credit for fertilizer purchases, and the distribution of free shade plants were made to stimulate interest in the industry and hence increase production. The effect of these measures would affect the industry more in the long run than the short run.

For the period January to September 1988, production was slightly below the levels of the corresponding period of 1987. The last quarter of 1988 saw a slump in production to 0.20 million pounds, as compared with 0.95 million pounds for the same quarter of 1987. As a result, the production for 1988 of 3.1 million pounds was 21.8 percent below that of 1987 and a record low for the industry.

TOURISM

Tourism is a key development sector in terms of both the current economy and future growth. Because of its importance to the development prospects of the country and its multi-faceted impacts on natural resource management issues, tourism is dealt with in detail in Section 7 of the Profile.

Figure 3.1(7) illustrates the recent trend of tourism revenues, especially the rebound from the dislocations caused by the events of 1983.

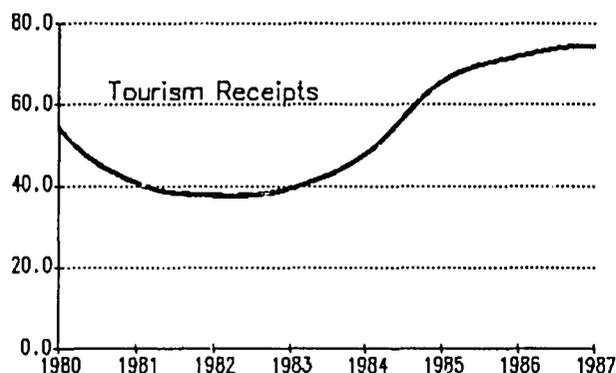


Figure 3.1(7). Tourism receipts, 1980-1987 (current EC\$ million) (adapted from: World Bank, 1988).

RECENT DEVELOPMENTS: TOURISM

Tourism's contribution to the Grenadian economy has been significant during 1988.

Tourist arrivals numbered 200,632 in 1988, an increase of 7 percent over 1987. Stay-over visitors increased 7.6 percent, to 61,795. Healthy increases were observed for visitors from the United States, Canada, United Kingdom and West Germany. In particular, the number of visitors from the U.K. has nearly doubled, mainly as a result of a weekly flight by British Airways. At the same time, the number of visitors from CARICOM countries has been steadily declining.

Hotel occupancy rates have also been increasing, with both bed-night and room-night rates recording increases of over 25 percent for 1988 compared with 1987.

Cruise ship visits declined to 234 from 260 in 1987, but there was a 6.9 percent increase in the number of passengers to 135,980 in 1988, as a result of visits by larger capacity cruise ships.

Tourist expenditures are estimated to have increased 7.6 percent, to EC\$76.3 million in 1988 (Blaize, 1989).

MANUFACTURING

Manufacturing is the weakest link in the current economy. From an environmental perspective, this is something of an advantage. It means that in designing future industrial promotion activities, Grenada is able to choose among those potential new investors with the least negative environmental impacts, rather than being forced to cope with (and pay for) the negative effects of established major enterprises.

The manufacturing sector is so small at present that analysis is impractical; apparent radical changes in the "manufacturing sector" are actually reflections of the opening and closing of individual plants. The Government of Grenada offers a package of incentives and subsidies to new manufacturing enterprises (customs exemptions, tax holidays, infrastructure support in industrial parks, etc.) which is comparable to similar programs offered by other OECS states. For a discussion of the key environmental issues associated with the industrial sector, see Section 6 of the Profile.

RECENT DEVELOPMENTS: MANUFACTURING

During 1988, the manufacturing sector did not live up to expectations but nevertheless achieved 10.3 percent real growth. Good performances were obtained from beer, rum, soft drinks, and paints and varnishes which increased by 17.5 percent, 29.6 percent, 15.5 percent and 48.0 percent, respectively. Flour projected a 28.9 percent increase for 1988 but just managed to achieve 5.9 percent due to competition on the export market. The other items had mixed performances, with cigarettes and oxygen and acetylene being among the items that showed increases. Stout and garments were among those showing decreases.

The construction sector, which on a whole increased in real terms by 15 percent, was largely driven by loans amounting to \$17 million by financing institutions in 1988 for the purchase of land and the construction of dwellings (Blaize, 1989).

ELECTRICITY AND WATER

Improvement of the country's capital infrastructure (roads, water and power) is given high priority by the Government of Grenada and most foreign development agencies. Restricted access to potable water and irregular electrical power are cited as restraints on both manufacturing and tourism development (World Bank, 1988).

RECENT DEVELOPMENTS: ELECTRICITY AND WATER

This sector grew in real terms by 11.9 percent. The amount of electricity generated continued on its upward trend, increasing by 13 percent from 40.1 million KWH in 1987 to 45.4 million KWH in 1988. At the same time consumption increased by 17.1 percent. Domestic consumption, which accounted for 45 percent of total consumption, increased by 16.5 percent, mainly as a result of the Government's successful rural electrification program; while commercial, and industrial consumption increased by 16.2 percent and 23.9 percent, respectively.

Water production, similarly, increased by 10.3 percent from 1.9 billion gallons in 1987 to 2.1 billion gallons in 1988 (Blaize, 1989).

COMMERCE, BANKING AND TRADE

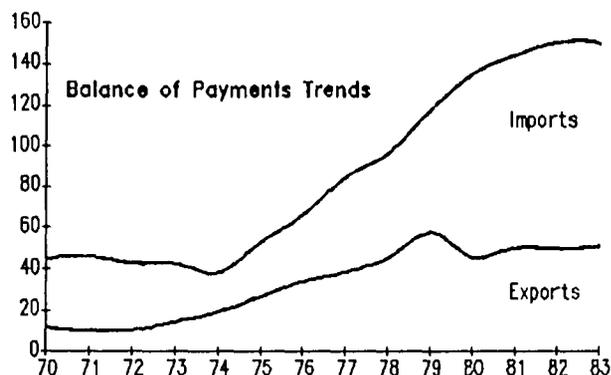


Figure 3.1(8). Imports and exports, 1970-1983 (current EC\$ million) (adapted from: United Nations, 1988).

As illustrated by Figure 3.1(8), in spite of great political and social uncertainty over the past several years, Grenada's exports of goods have gradually increased, while the value of imports, which had been rising steeply in the 1970's, began to level off in the early 1980's. Using data from the GOG Statistical Department's calculation of Grenada's balance of visible trade, Figure 3.1(9) demonstrates that the long term trend of a high current account foreign trade deficit persists.

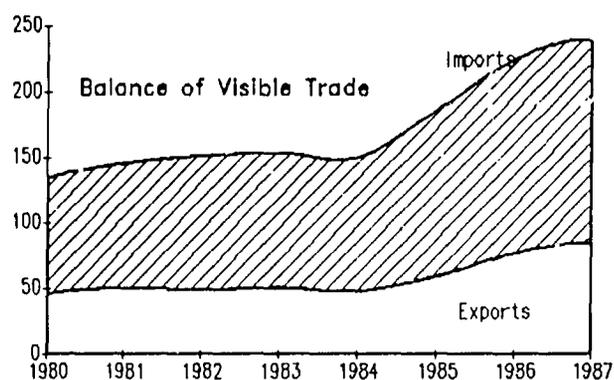


Figure 3.1(9). Balance of visible trade, 1980-1987 (adapted from: GOG, 1987a).

The need to reduce this deficit defines the objectives and constrains the economic options of the Government of Grenada for the foreseeable future. Compared to similar countries in the Caribbean, Grenada faces a much higher foreign trade deficit. For example, Table 3.1(1) shows the current account deficit of 15 Caribbean countries as a proportion of each country's 1986 Gross Domestic Product.

In managing its foreign trade deficit, Grenada has two advantages. The great bulk of its externally-held debt is held by public authorities, most of them being agencies of foreign governments. This is preferable to having foreign debt held by private banks. In addition, since 1983, Grenada has enjoyed a "special relationship" with the United States, which has eased the short-term problems of financing the foreign debt. This advantage will persist for a number of years but with less assurance. The size and growth rate of externally held debt -- which is approximately equal to two-thirds of the annual Gross Domestic Product -- cannot continue at current rates (see Figure 3.1(10)).

Table 3.1(1). Balance of payments current account, 1986.

COUNTRY	% GDP
Antigua	59.6
Bahamas	1.3
Barbados	0.3
Belize	2.9
Dominica	3.4
Dominican Republic	1.2
Grenada	26.5
Guyana	29.3
Haiti	4.3
Jamaica	8.8
St. Kitts	18.3
St. Lucia	2.9
St. Vincent	2.5
Suriname	3.2
Trinidad	12.1

Source: World Bank, 1989.

RECENT DEVELOPMENTS: COMMERCE, BANKING AND TRADE

The level of retail sales, which provides an indication of the general level of business activity, showed an increase of 22.1 percent during calendar year 1988 for four of the major distributive outlets in Grenada. Even when this increase is adjusted for the additional tax measures introduced in 1988, the situation for 1988 was quite good.

Deposits by Commercial Banks have been increasing at a rapid rate over the past five years, averaging nearly 20 percent per annum. Total deposits reached EC\$317.2 million at 31 December, 1988. Saving deposits, which comprise roughly half of total deposits, recorded the largest proportional increase (20.6 percent), followed by time deposits (17.0 percent) and demand deposits (14.6 percent).

Non-resident deposits reduced its share of total deposits from 16.3 percent at December, 1987 to 13.3 percent at 31 December, 1988. Resident deposits, on the other hand, increased by



Figure 3.1(10). External debt, 1982-1986 (adapted from: World Bank, 1989).

EC\$49.6 million or 22.0 percent from 1987 to 1988. Both business firms and individuals doubled their deposits within the past five years.

Loans by commercial banks have similarly kept pace with deposits. At 31 December, 1988, total loans outstanding reached EC\$246.9 million, an increase of 15.3 percent over the year before. Residents' share of the increase was 97.2 percent, with most of the loans going to the distributive trades -- tourism, manufacturing, transport -- and to individuals, mainly for the purchase of houses, land and durable consumer goods.

Non-commercial banks have also played an active role in channelling funds for investment. During 1988, the Grenada Development Bank and the Grenada Cooperative Bank provided loans totalling about EC\$15.5 million, an increase of EC\$2.7 million or 21.0 percent over the amount disbursed in 1987.

Insofar as foreign trade is concerned, total imports increased by 4 percent, to EC\$248.7 million in 1988. Food, machinery and equipment continued to be the dominant imports, accounting for nearly half of the total import bill. For the past five years, an average of 45.2 percent of total imports went to consumption goods, 32.1 percent to capital goods, including building materials, and 22.7 percent to intermediate goods. Significantly, while total imports had been continuing on an upward trend, the percentage share of CARICOM was steadily declining, from 32.8 percent in 1980 to

20.4 percent in 1987. This decline may reflect the country's need for a level of goods and services for business investment which cannot be readily secured from CARICOM sources.

On the other hand, in 1988, total exports increased by 1.9 percent, to EC\$87.7 million in 1988. Domestic exports decreased to EC\$75.3 million (some 6.4 percent) in 1988, mainly due to the performance of nutmegs and cocoa. Exports of nutmegs were EC\$31.3 million, EC\$8.1 million less than that of 1987, as a result of a 25.7 percent decrease in the quantity exported. At 4.0 million pounds, this was just 63.3 percent of production so there was a substantial build up of stocks. Because of extremely high prices, the value of mace exported was 1.1 percent above 1987, even though only 67.8 percent of production was exported as compared with 77.4 percent for 1987. Exports of cocoa decreased by EC\$2.0 million, due to reduced quantities exported and extremely depressed prices on the international market. All the other major items of exports increased, except fresh fruits and vegetables which showed an expected decrease of 38.4 percent, due to weather conditions early in 1988. Domestic exports were predominantly in the food group. CARICOM's share of exports has fallen from 35 percent during 1983 to 1985 to 17 percent in 1988, mainly due to substantial reductions in Trinidadian imports of Grenada's produce.

Of significance is the increased potential which now exists for direct air freight exports to Europe and North America. Via such flights, EC\$300,000 worth of produce was exported in 1988 (Blaize, 1989).

1989 GROWTH

Preliminary figures for 1989 (first three quarters) suggest a growth rate of 5.3 percent, with better performances in all sectors except agriculture, which experienced both reduced production and earnings (nutmeg, mace and cocoa). Unfortunately, domestic imports increased slightly, resulting in an expanded trade deficit, despite a significant growth of retail sales, bank deposits, commercial bank loans and tourist arrivals (*EC News*, Dec. 29, 1989).

3.2 ENVIRONMENTAL IMPLICATIONS

The preceding summary of major economic trends and priorities for Grenada highlighted the following strategic goals for the Grenadian economy over the next five years (World Bank, 1988):

- Reduction of the current account deficit
- Improvement of incentives for food producers
- Upgrading tourism, especially attractions and facilities for overnight visitors
- Increasing the number of manufacturing and other industries
- Reducing the number of public sector enterprises.

The public sector investment program (PSIP), which has been defined to achieve this agenda, includes substantial investments (70 percent of total programmed funds) in capital infrastructure, such as roads, telecommunications, electricity, water supply and sewerage (World Bank, 1985).

The elements of this program with the most direct implications for the environment are obviously the road maintenance and improvement program, the extension of the sewerage systems, improvements to the water supply, and solid waste management systems.

In general, sensitivity to or awareness of the environmental needs or consequences of public sector economic activities in Grenada is not well developed. Notions of "sustainable development" are not embedded in the investment strategies for public works or agriculture. Optimum rates of exploitation of natural resources tend to be equivalent to the maximum short-term yield to Grenadians.

It is now generally believed that the single public program with the greatest environmental impact is road building. The effects of a roads program are felt for generations and are generally irreversible. They include:

- Direct construction impacts, including increased run-off and risks of land slippages.
- The (often uncontrolled) movement of large numbers of people into previously untouched natural areas.
- Opening large tracts of land to capital-intensive cultivation. This usually means destruction of land cover, extensive physical disturbance of soils, and possible surface and groundwater pollution from fertilizers and pesticides.

After road building, stimulation of agriculture is likely to be the economic development program with greatest potential for affecting natural resources. In this regard, Grenada enjoys some significant environmental advantages in the area of spices which will remain its most lucrative crop. Spices are relatively high value and low in labor intensity. It is probable that many of the tree crops can be combined with cultivation of food crops in innovative and cost-effective agro-forestry projects.

Promotion of tourism is unquestionably dependent upon the promotion of sound resource management programs. Tourism development can have positive impacts too, including increased preservation of natural and historic areas, improved water quality, and construction of major sewerage systems in key resort areas such as

Grand Anse, to suggest a few. These issues are discussed in more detail in Section 7 of the Profile.

Promotion of manufacturing industries can have a negative impact on environmental parameters, but as a matter of public policy this is unlikely, given the high visibility of new industrial ventures and increasing public sensitivity to new polluting activities. There is a difference, however, between actions approved as a matter of policy and those effects which result from misrepresentation by the investor and inability of government to assess or monitor industrial conditions. Government requires a strategy for monitoring the environmental impacts of manufacturing activities and a cost-effective means for securing technical assistance on short notice, when needed.

Depending on the country's overall energy and water development plans, improvements to these key infrastructure systems can have major impact on the country's forest resources and fresh water reserves and carry the increased risk for polluting incidents.

Indirectly, reforms to the country's tax and banking systems are likely to have long term impact on natural resource management issues, including, in particular, the kind of cultivation practices supported for export agriculture and the location and infrastructure provided for new housing.



Levera Pond, Grenada. This unusual pond-wetland area should be one focal point of a national park system for the country -- some features protected for their natural and biological value, with other areas developed for their recreational and educational qualities.

SECTION 4 THE NATURAL RESOURCE BASE

4.1 FORESTS AND FORESTRY

4.1.1 Overview

Ever since the earliest days of colonial settlement, clearing by humans, coupled with occasional severe hurricane damage, have greatly reduced Grenada's natural forests. Today remnant natural forests exist mostly in areas with extremely steep terrain and poor accessibility. In 1982 Eschweiler (1982b) calculated that about 9,800 acres (13 percent) of the total land area of Grenada and 450 acres (5 percent) of Carriacou were under forest cover of one type or another. Another 7,360 acres (10 percent) of Grenada and 2,475 acres (25 percent) of Carriacou were covered by "woodland and scrub" not being used for grazing. According to Miller, *et al.* (1988), about 4,800 ha of nominally "forested" land belong to the Government, including 3,260 ha of Crown Lands and the 1,540 ha Grand Etang Forest Reserve.

Johnson (1985) has provided a capsule history of the development of forestry in Grenada. The earliest European colonists in Grenada cleared the forests over most of the lower elevations to plant sugar, along with some indigo and cotton. In the later development of the island, practically all land right up to the mountain tops was divided into estates (although some mountainous areas were reserved as Crown Lands), and plantations were cultivated with cash crops up to the highest practicable limits. A few landowners reserved belts of forest on the ridge tops as protective measures (Bearú, 1949), but most of the higher lands not planted in cash crops were farmed by shifting cultivation to produce food for the estate laborers.

E.D.M. Hooper, an officer of the Indian Forest Service, was apparently the first to make a formal report on the forests of Grenada and Carriacou (Hooper, 1887). He recommended that forests on ridges and watersheds be protected as reserves for water conservation purposes. A forest ordinance passed in 1906 set aside 1,000 ha (2,500 ac) in Grenada, including some Crown Lands and some acquired lands, as the Grand Etang

Forest Reserve. This was enlarged in 1963 to 1,547 ha (3,868 ac) (see Figure 4.1(1)). Some 136.4 ha (546 ac) of highlands in Carriacou were also designated as Forest Reserves (Figure 4.1(2)). In 1910 a Forestry Board was appointed.

A report by Marshall (1932), an officer of the Trinidad and Tobago Forest Department, recommended the creation of additional forest reserves, a reforestation project, and the exploitation of the Grand Etang Reserve. In 1935 the administration of the Forest Reserves was assigned to the Department of Agriculture. Beard (1944) listed nine silviculture projects which had been undertaken in Grenada since 1938, including the reforestation of the Les Avocats watershed which was started in 1943; he also recommended that a forest inventory and working plan for management of the Grand Etang Reserve should be prepared. Nothing came of any of these recommendations except for the reforestation project.

The story of forestry in Grenada from the late 1950's on is largely the history of Government's management of the Grand Etang Forest Reserve and various small government plantations of exotic timber species. Hurricane Janet struck Grenada in 1955 and severely damaged about 60 percent of the island's timber resources, including large parts of the forest in the Grand Etang Reserve. A Forestry Division was established under the Department of Agriculture in 1956; it became an autonomous entity in the 1960's but was then once more subsumed under the Department of Agriculture.

PLANTATION FORESTRY

There are generally a number of reasons given for the establishment of forest plantations, including:

- to reforest degraded lands;

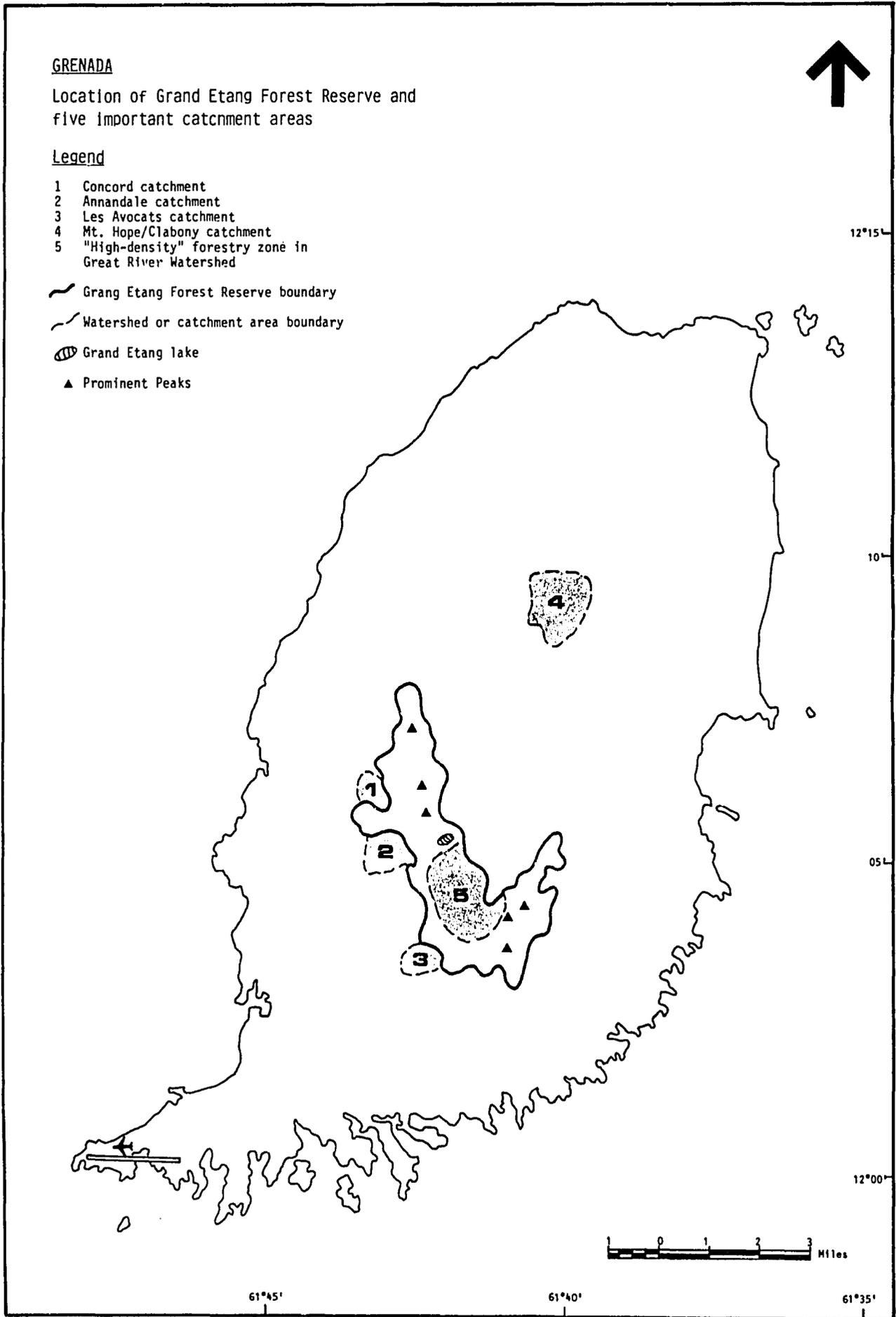


Figure 4.1(1). Location of Grand Etang Forest Reserve and selected catchment areas, Grenada (source: Weaver, 1989; GOG/OAS, 1988d).

CARRIACOU



KEY	PLACE NAME	AREA (HA)
1	HIGH NORTH	32.0
2	MT. PELEE	3.2
3	CEMETARY	3.2
4	TIDEAU WELL	0.4
5	GREAT HOUSE	2.4
6	BELAIR RIDGE	18.0
7	HOSPITAL	10.0
8	CRAIGSTON RIDGE	4.0
9	BELAIR PARK AND TEAK	8.0
10	ROCK QUARRY	10.8
11	BEAUSEJOUR WATERSHED	22.4
12	TOP HILL - BELAIR ROAD UNIT	0.8
13	HILLSBOROUGH WATERSHED UNIT	20.0
14	HILLSBOROUGH W. (SMALL UNIT)	0.4
15	CHAFEAU CARRE	0.4
CARRIACOU TOTAL		136.0
16	PITON (PETIT MARTINIQUE)	0.4
GRAND TOTAL		136.4

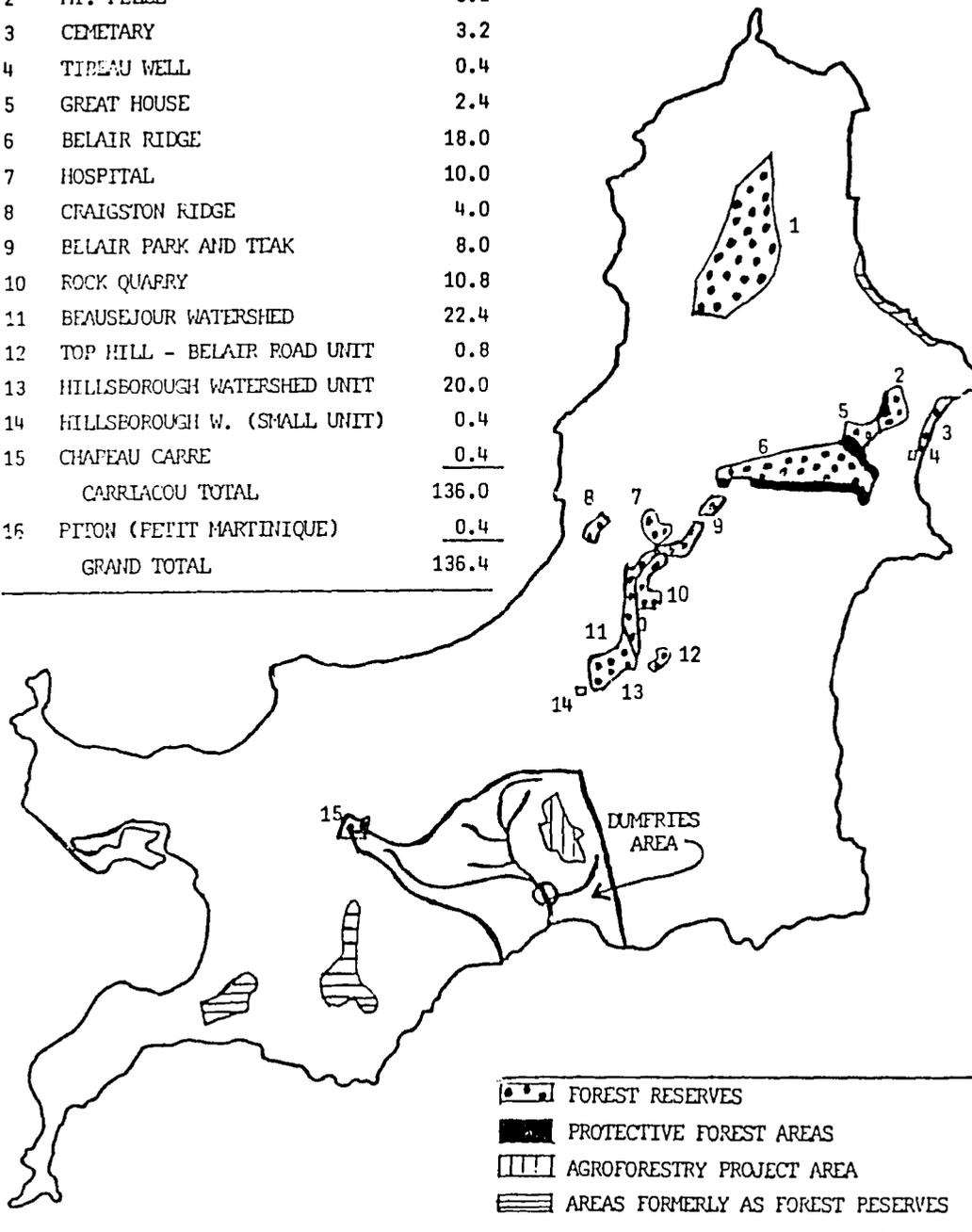


Figure 4.1(2). Location of forest reserve areas in Carriacou (source: Weaver, 1989).

- to control soil erosion and maintain watersheds;
- to reduce the pressure on natural forests;
- to generally improve the economy of the country by reducing imports of forest products;
- to increase production of specific forest products;
- to create employment opportunities especially in economically depressed rural areas.

In Grenada until recently the primary motivation for plantation forestry involved mainly the first two of these objectives, i.e., to stabilize eroding ridges, watersheds, roadsides, and streambanks. The forest damage resulting from Hurricane Janet in 1955 more than anything else spurred the development of forest plantations, since the threat of erosion was acute and disaster relief funds were made available to reforest damaged areas. The Forestry Department embarked on a large program of tree planting in 1957; to date about 165 ha have been established in Les Avocats, Panama, Grand Etang, Petit Etang, Vendome and St. Margaret (Figure 4.1(3)). More than 90 percent of the area was planted in Blue Mahoe, and about six percent in Caribbean Pine.

The Blue Mahoe (*Hibiscus elatus*), widely used for reforestation projects throughout the region, is originally from Jamaica but grows successfully in Grenada. The wood is used locally in the manufacture of furniture. It is fast growing and beneficial for soil and water conservation. Caribbean Pine (*Pinus caribaea*), a species originally found in Central America and the Greater Antilles, has shown good growth in other areas and is said to be comparable in timber quality to the U.S. Southern Pine. Rotation ages of 20-25 years for pine and 30-35 years for Blue Mahoe have been estimated (Stolz, 1986, in Miller, *et al.*, 1988). However, some authorities (e.g., Ford in Miller, *et al.*, 1988) have questioned the value of planting with pine since experience in Jamaica has shown that variations in wood density may preclude its use in structural applications.

In recent years, in line with GOG policy, the attention of the Forestry Department has turned to greater utilization of forest plantations for timber and fuelwood production, thereby reducing pressure on natural forests, reducing imports of wood products and creating employment. Two nurseries are presently operated by the Forestry Department at Vendome for the production of timber and Christmas tree seedlings. The GOG would like to expand local production of wood and wood products to reduce the importation of these products. Of the 1985 consumption of 20,000 cubic meters (roundwood equivalent) of commercial wood products, only 12.5 percent (a roundwood equivalent of about 2,500 cubic meters) was supplied by local production. Ninety-seven percent of the remaining 17,500 cubic meters that were imported was used in the construction industry and only three percent in the furniture industry (Kehr, 1986).

Most of the local production comes from private lands, forests and bushlands, with a small but increasing share from public plantations. There are four local sawmills, one of which is operated by the Forestry Department at Queen's Park. In 1986 none of the mills had secondary processing equipment, there was no drying kiln on the island, and there was only one saw capable of processing logs from old-growth forests or mature plantations (Miller, *et al.*, 1988).

The Forestry Department is interested in expanding the acreage in forest plantations by reforestation of logged natural forest, abandoned agricultural lands and "idle" lands with fast-growing exotic timber species. In addition, about 37 percent of the 670 ha of land currently involved in the Model Farms program (see Section 5) was designated as "marginal lands" inappropriate for agriculture, and Kehr (1986) recommended that these areas should be developed for plantation forests, including roads, with an average of 3.4 ha of forest per farm.

Some experimentation in the use of agroforestry for watershed protection has been carried out at the government-owned Annandale Estate. Another agroforestry project has been proposed for the Dumfries

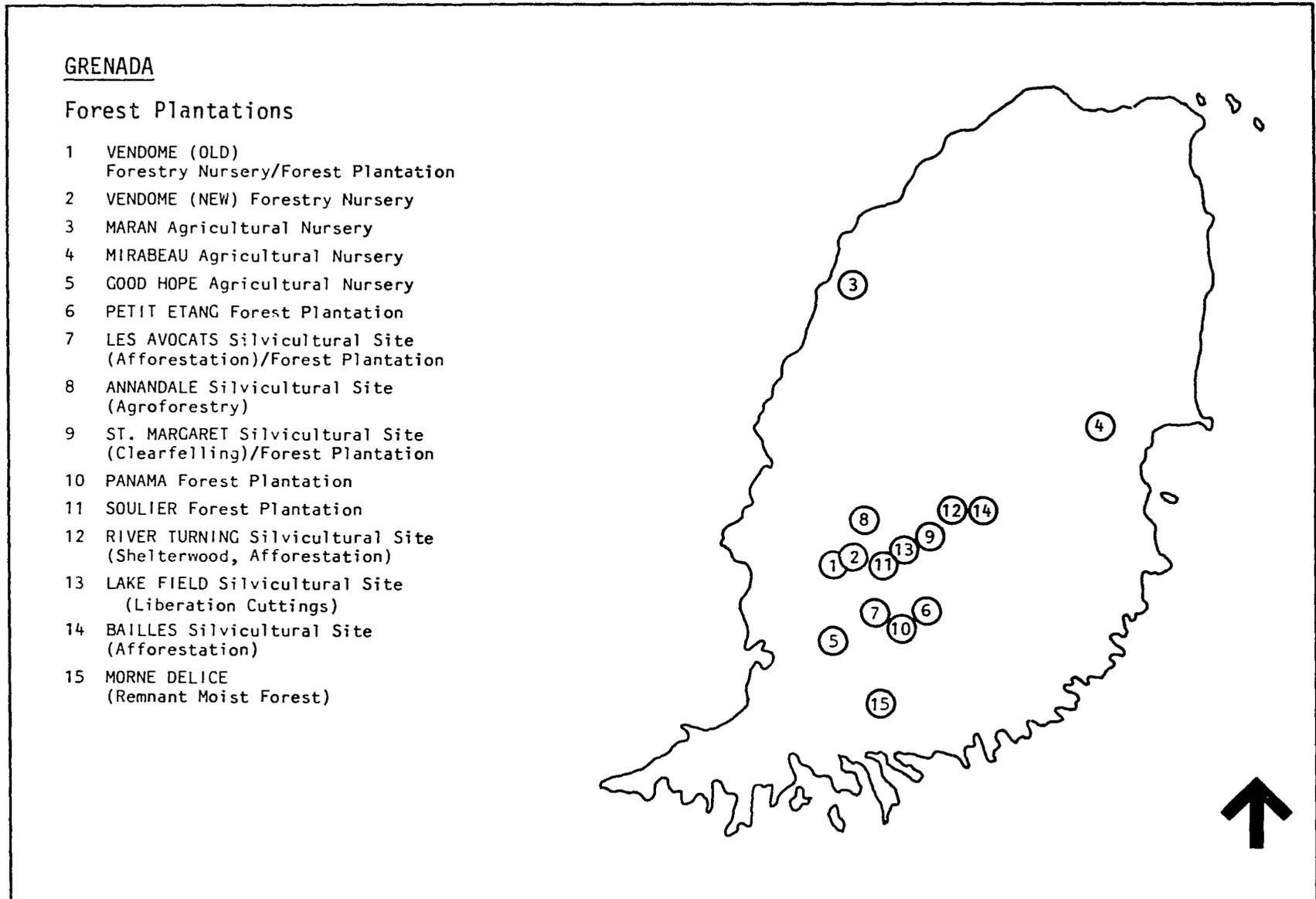


Figure 4.1(3). Location of nurseries, forest plantations, silvicultural experimental areas, and Morne Delice Moist Forest (source: Weaver, 1989).

area in Carriacou as part of the GOG/OAS integrated development concept for that island (see Section 4.2 for further discussion).

NATURAL FORESTS

In 1982, when the most recent land use map was prepared by the Department of Agriculture with the assistance of FAO, most of the 9,800 acres covered by "natural" forest in Grenada were concentrated in the Grand Etang Forest Reserve and in the Mount St. Catherine area. Of this area, only about 2,500 acres (1,000 ha, or three percent of Grenada) are estimated to be covered by natural forests which have been relatively undisturbed by man.

In 1978 and 1979 the first forest inventory of Government lands in Grenada was carried out by two Peace Corps Volunteers, but it did not include the forests in the Mount St. Catherine area. The inventory covered the whole of the natural forest area in the Grand Etang Reserve south of the St. George's to Grenville Road (Potter and Potter, 1979). The inventoried area comprised approximately 1,000 ha (2,500 ac), not only in the catchment of the Great River but southwards over the watershed into St. David's (Figure 4.1(4)). A 348 ha (860 ac) "high density" zone was identified in the Great River watershed and a "low density" zone of 647 ha (1,599 ac) mainly outside the Great River catchment. Timber volumes in the high density zone were estimated at 229 cubic meters/ha (3,269 cubic feet/ac) over 15 cm (6 in) diameter at breast height (dbh), giving a gross volume of 80,000 cubic meters (2,800,000 cubic feet). Volumes in the low density zone were estimated to be 64 cubic meters/ha (901 cubic feet/ac) over 15 cm dbh, with a gross volume of 41,000 cubic meters (1,456,000 cubic feet).

When the Grenadian Government was overthrown by revolution in 1979 (see Section 1.2), the People's Revolutionary Government (PRG) assigned the functions of the Forestry Division to a new statutory body called the Forestry Development Corporation. Under the PRG's mandate to utilize Grenada's forest resources to reduce reliance on foreign wood, earn foreign exchange and

provide employment, Potter and Lewis (1979) wrote a working plan for the Grand Etang Forest Reserve. This plan called for the entire area of 995 ha of natural forest to be clear felled in approximately 80 ha plots each year over a 15 year period. Clear-cut areas were to be replanted with plantations of exotic timber species. Access was to be via an extensive network of roads, and logs were to be hauled to a portable saw mill on rubber-tired skidders. Estimated annual production was two million board feet of sawn timber (equivalent to 7,920 cubic meters of solid wood in the round).

In 1980, in response to a PRG request for assistance with a proposed integrated forest industry complex based in Grand Etang Reserve, an FAO mission (FAO, 1981) selected from the previously inventoried area of 995 ha an "intensive forest management area" of 575 ha lying in the Great River basin (the "project area" in Figure 4.1(4)). It was estimated to contain 50,000 cubic meters of timber after subtracting a 38,000 cubic meter allowance for heart rot and felling damage. In 1982, a consultant's report (Hodam and Associates, 1982) positively assessed the economic and technical feasibility of using waste timber from the Grand Etang logging project to produce 25 percent of the country's charcoal needs and 850 kW of electricity. A land evaluation report was also prepared for the Great River watershed by an FAO consultant (Eschweiler, 1982d).

In 1983 a team of consultants working for the Caribbean Development Bank produced a report (Deutsche Forstinventur Service, 1983) expressing serious doubts about the feasibility of the proposed forest industry project in Grand Etang Reserve. They pointed out that Gommier is not a prime timber species and is not widely accepted in local markets. The costs of building roads is high, and the team felt it was doubtful the project could show a net positive economic benefit if road construction costs (especially roads built in an environmentally sound manner) were considered. The consultants recommended a feasibility study, and stressed the *environmental impacts of clear felling on steep erodible slopes in a major watershed*. It is noteworthy that this seems to have been the

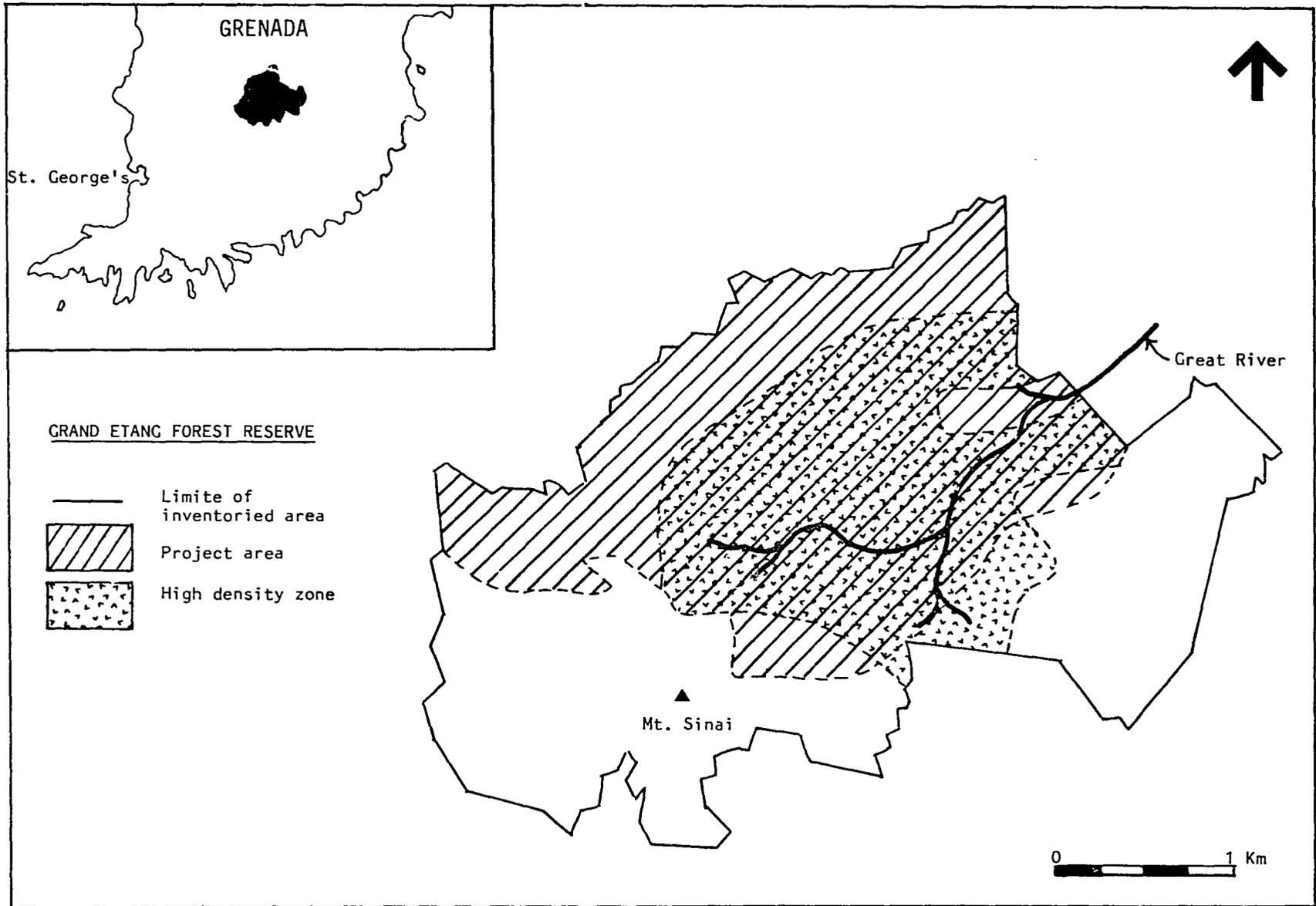


Figure 4.1(4). "High density" zone in Great River watershed (source: Hodam and Associates, 1982).

first time anyone had officially raised objections which took the environmental impacts of the project into consideration.

Following the October 1983 military intervention by the forces of the United States and six Caribbean nations, a Forestry Department was again set up under the Ministry of Agriculture. In 1984 the British Overseas Development Administration's Forestry Advisor, W. J. Howard, recommended that a new forest inventory of Grand Etang Reserve was needed. This was necessary because the original inventory report did not provide a breakdown by tree species and diameter class, and the field data from this survey were no longer available. At the request of GOG, the British Overseas Development Administration funded a forest inventory project which was carried out in 1985 by M.S. Johnson.

Johnson's (1985) study area covered 546 ha, all located within the watershed of the Great River (see Figure 4.1(1)). Using aerial photographs, he stratified the forest into types based on Beard's 1949 classification and found that rain forest (the only type with commercially exploitable volumes of timber) covered some 328 ha. Using steepness of slope as the sole criterion, he divided the project area into two zones: a 190 ha "exploitable zone" in areas with average slopes less than 30 degrees and a "non-exploitable zone" with slopes greater than 30 degrees.

Only 159 ha of rain forest fell within the exploitable zone, comprising about 84 percent of the exploitable zone and 29 percent of the total area. Gommier is the dominant species in exploitable forest, accounting for 62,800 cubic meters (or 81 percent) of a total gross timber volume of 77,200 cubic meters in the 190 ha exploitable area. Over 90 percent (56,520 cubic meters) of the Gommier was judged to be merchantable.

Johnson recommended that logging should be confined to the 190 ha exploitable zone plus a 90 ha "plantable area" in secondary scrub and Blue Mahoe plantations. No logging should be done where slopes locally exceed 30 degrees or closer than 20 m to the main course of the Great River. He

estimated that, of this total project area of 280 ha, about 250 ha would be suitable for conversion to plantations of exotic species (allowing 30 ha for locally unplantable areas). To minimize damage to the soil, he recommended that logging should be done by mobile tower yarder systems; skidders should only be used locally in areas of gentle slope.

FAO has continued its studies of the forestry sector under its Forest and Accessibility Development Technical Cooperation Project and has made recommendations in a series of recent reports (Gardiner, 1986; Kehr, 1986; and Stolz, 1986; summarized in Miller, *et al.*, 1988). Gardiner (1986) estimated that plantations and a somewhat larger area of exploitable rain forest (275 ha instead of 190 ha) in the Grand Etang Reserve can sustain an annual cut of about 2,180 cubic meters. Gardiner also recommends the use of a light skyline cable yarding system mounted on a truck, with logs cut up at the stump. With such a relatively low production system, logging could be restricted to the dry season, if a suitable log storage facility were built (Miller, *et al.*, 1988).

These more recent FAO forestry development recommendations still put considerable emphasis on industrial forestry while also stressing sustained yield management, strict erosion controls during road building and logging, protection of watersheds, and recreational and tourism development in ecologically fragile and scenic areas. However, forest cover loss -- whether due to illegal felling of trees for timber, land clearance for cultivation, or removal of wood for fuel -- continues to be of concern in Grenada. Reforestation figures since 1957 show that on average, only 5.7 ha per year have been planted (Weaver, 1989).

A Forest Management Plan for forest reserves and other lands in Grenada, Carriacou and Petit Martinique is currently being prepared by GOG with the technical assistance of an FAO consultant (Weaver, 1989), focusing on plans for utilization programs, reforestation, and nurseries.

4.1.2 Problems and Issues

(1) **Proposed logging scheme in the Great River watershed.** The last remaining large stand of "natural" forest is located in the upper watershed of the Great River (Stolz, 1986). Beard (1949) studied this area and singled it out for special mention as an interesting example of mature high forest which belonged physiognomically to the rain forest, lower montane rain forest, and montane thicket formations. However, perhaps due to profound modification by selective felling of valuable timber species in the nineteenth century, he found that this forest differed considerably from forests on most other West Indian islands in terms of floristic composition. Evidently protection afforded by the Forest Reserve had allowed the forest to recover to a mature structure by the 1940's, but floristic recovery had not yet attained a "climax" state.

This area has long been targeted by the Forestry Department as part of a scheme for timber exploitation in the Grand Etang Forest Reserve, the history of which has been summarized above. The terrain in this part of the Grand Etang Forest Reserve is very steep and highly dissected, is subjected to high rainfall and has large areas of unstable soils. According to Johnson (1985), in order to protect the densely developed communities downstream, it is vital that the logging project should not cause serious damage to the natural drainage system in this area. Johnson downplays the probable negative environmental impacts of the project in favor of providing a straightforward, descriptive forest inventory, but a close reading of his report reveals some rather important concerns.

For example, the Capital Clay Loam soils which predominate in the area are unstable and susceptible to erosion. Some places with very steep slopes are often subject to landslips, causing the loss of all shallow soil above the parent material. Vernon, *et al.* (1959) stated that these soils on land in the 20-30 degree slope category are marginal for cultivation due to extreme danger of erosion. In slope categories greater than 30 degrees, they recommend that the land should never be cleared of its natural vegetation because of the danger of excessive erosion and landslips.

Johnson notes that the slopes shown on the topographic maps used in his survey are too conservative, since they represent the shape of the tree canopy rather than the terrain beneath it. He found the terrain to be even more rugged than the map contours suggest, and he recommends that a ground survey be carried out to measure the actual slopes. Johnson admits that local areas with slopes steeper than 30 degrees will be found within the exploitable area; conversely, some areas with slopes less than 30 degrees will be found in the non-exploitable zone. He points out that, although the proposed logging road alignments generally follow ridge crests, it will be important that the loggers resist the temptation to reach isolated "exploitable" areas by driving roads through steep terrain where erosion and severe disruption to drainage is likely to result. However, he offers no comment on the likelihood of such restraint actually being exercised.

Johnson further states that even under undisturbed forest the present rates of natural erosion in the watershed are sufficient for the Great River to be discolored with sediment during heavy rainfall, and flash floods occur at such times. In the study area, streams run in steep-sided V-shaped valleys or even ravines, ridge crests are frequently less than 10 m broad, and slopes generally are in excess of 20 degrees. In this type of terrain, it is likely that the erosion impacts mentioned by Vernon, *et al.* will occur when the natural forest is *clear-cut* and roads are built on 20-30 degree slopes. It is also likely that whatever erosion does occur will not be filtered out by leaving a thin strip of forest on the *main course* of the Great River itself (to say nothing of its tributaries).

In order to avoid the undesirable consequences of clear-cutting large areas in the Great River watershed, selective logging, tropical shelterwood, and clear-cutting in small blocks followed by reforestation with fast-growing species have been suggested by other consultants. For example, Stolz (1986) recommends that the main and central parts of the area should be managed by a "permanent tropical shelter wood system" (i.e.,

a system that maintains a certain amount of tree cover), aiming at:

- promotion of natural regeneration and permanent soil cover;
- maintenance of natural vegetation on exposed ridges;
- enrichment planting in palm brake areas;
- restriction of logging to slopes less than 30 degrees;
- clear-cutting and conservation plantations only in the heavily hurricane damaged, relatively flat areas along the St. George's to Grenville Road;
- sustained yield management;
- strict erosion controls for roads and logging activities;
- establishment of permanent monitoring plots in managed forests.

However, Gardiner (1986) contradicts Stolz and states that in this kind of tropical rain forest under the existing conditions, shelterwood management is impractical because of difficulties in extracting the timber without damaging the remaining trees. He recommends instead that clear-cutting in small blocks using a mobile tower yarder and skyline cable system is the only practical solution.

Aside from the apparently unresolved question of which logging method would be the least damaging, all the FAO consultants have emphasized the extreme importance of proper design, construction and maintenance of logging roads. It seems clear that this logging project, if it can be done in an ecologically acceptable manner at all, can only avoid heavy soil loss by the use of advanced and expensive means of erosion control. In this type of terrain, such measures are rarely successful even in affluent countries with relatively strict environmental control regulations and enforcement. In a developing nation like Grenada, which lacks the funds and expertise to maintain even the main thoroughfares of the nation in good repair, it would seem to be very unlikely that the proper controls would be implemented and maintained throughout the life of the project.

Kehr (1986), a consultant with FAO, points out that logging on such steep terrain and vulnerable soils with only a few small exploitable patches available within the total area, requires building a relatively high density of logging roads at very high costs (US\$60 - 75,000 per km in 1986). Moreover, previous economic feasibility studies of the Great River basin logging project charged only the yearly road *maintenance* costs to the final costs of the extracted logs. Kehr states that unless the road *construction* costs can be charged to "other economic activities than forestry such as tourism, environmental protection and water conservation," the proposed forestry development seems to be economically unfeasible and should be dropped. The justification for charging the road costs to other sectors (when no impact or costs would exist without a forestry project) is not explained and would appear to be simply an example of "creative bookkeeping" to avoid internalizing full environmental costs.

In summary, severe damage to the watershed of the Great River remains a distinct possibility if this logging project is carried out. Stolz (1986) rightly cautions that destructive exploitation of the forest resource in this watershed would incur very large environmental and socio-economic costs, which would probably far outweigh any short-term economic benefits derived from the harvest of its timber. Grenada would inevitably have to bear the costs of heavy soil erosion in the watershed, flash flooding, siltation of water treatment plant intakes and hydroelectric facilities, sediment deposition in the Great River, significant flood damage to the lower-lying, densely populated towns and cultivated areas, and sediment damage to nearshore marine ecosystems. In return for this heavy environmental cost, the estimated long-term annual harvesting volume from the area would amount to 2,180 cubic meters (Gardiner, 1986) or about 10 percent of the 1986 annual demand for wood products.

Given its species composition (mainly Gommier, *Dacryodes excelsa*, with a relatively low commercial value), average trunk diameter and age distribution, the short-term revenues from timber exploitation of this forest may fall far short of possible future profits de-

rived from other economic uses such as nature tourism and watershed protection. Today the forest is also of considerable scientific interest for studies of rain forest recovery in island ecosystems, since it has been under protection for more than eighty years and is one of the few wet forest areas studied by Beard in the 1940's which has remained essentially undisturbed by man. Much the same is true of the moist forest remnant which still survives at Morne Delice.

(2) **Additional areas for watershed protection.** The north central parts of Grenada, e.g., the massif of Mount St. Catherine, are also areas with high rainfall, extremely steep slopes and erodible soils. There is an urgent need to designate additional areas in this part of the island for watershed protection, either as forest reserves, national parks or multiple-use areas (Stolz, 1986). A plan for a nationwide system of national parks and protected areas which addresses this need by proposing several "multiple-use areas" has been prepared (GOG/OAS, 1988d) but so far has not been officially accepted by Government.

Multiple-use designation implies an intent to manage areas so as to optimize the level of various activities allowed in them, e.g., protection of water supply, production of forest products and forage, provision of wildlife habitat, hunting and recreation. Three sub-watersheds recommended as multiple-use areas in the 1988 GOG/OAS study -- the Annandale catchment, the Mount Hope/Clabony catchment and the Concord catchment -- are especially important. The proposed parks and protected areas plan points out that in addition to the Forestry Department, the Central Water Commission and the electrical utility company should also have an interest in the integrated management of watersheds. However, no formal institutional arrangements exist between these bodies and the Forestry Department (see further discussion in Section 12).

(3) **The Moist Forest at Morne Delice.** Perhaps 10 ha - 25 ha of the moist forest remnant at Morne Delice (see Section 1.1.5 and Figure 4.1(3)) still exist. This late secondary forest is currently under threat

from piecemeal housing development, charcoaling, and conversion to plantation forest. Apparently much if not all of the land is Government-owned, but it seems that no boundary map is available. There is a need to survey the boundaries and gazette them and to take action to protect the remaining forest from further damage.

(4) **Fuelwood Production.** Charcoal has traditionally been the primary cooking fuel in Grenada. The continued demand of poor and marginalized rural populations, in particular, for charcoal and firewood contributes to the overall exploitation of forest resources. Since the early 1980's, concern about the contributory role played by fuelwood cutting or charcoal production in deforestation has increased, but there are no reliable data on utilization of these fuels in Grenada or rates of deforestation related to their use. Therefore, the current status of fuelwood harvesting and its impact on forests is difficult to state with any degree of confidence or reliability.

A 1980 UNDP survey found that charcoal was used in 75 percent and fuelwood in 51 percent of Grenadian households for cooking. The quantity of these products produced locally was estimated by UNDP at a roundwood equivalent of 14,923 to 19,500 cubic meters per year, and the total demand was estimated by a FAO consultant to be a roundwood equivalent of 40,000 cubic meters per year (Kehr, 1986; Smith, 1986). Smith believes these figures to be very suspect since he feels that such quantities would quickly diminish the existing forest resources. Nevertheless, it seems that fuelwood cutting may represent a significant impact on the environment in Grenada, one which requires further research aimed at accurate quantification.

Fuelwood plantations do not appear to have been tried on any large scale in Grenada. Limited experience has been gained with experimental plantations for charcoal production by the St. Lucia Department of Forest and Lands, as part of a regional OAS-funded study on *Leucaena* (*Leucaena leucocephala*) yields. Proponents of the fast-growing *Leucaena* species had anticipated average annual growth rates of approximately 50

cubic metres per hectare per year, or about /50 cubic feet/acre, when the original experiments were established. However, assessments of early plantings under a community forestry project indicate actual *Leucaena* yields are considerably less than expected -- ranging from 16 cubic metres/hectare/year to a high of 38 cubic metres/hectare/year (CCA/IRF, 1988). These yields may reflect lower than optimal inputs and the early experimental stage of community management strategies.

4.1.3 Policy Recommendations

For the most up-to-date, detailed recommendations on forests and forestry, see Weaver's (1989) recently completed technical report for FAO, *Forestry Development: Grenada*.

FOREST MANAGEMENT

* The highest and best use of the few remaining mature or nearly mature forest stands may well derive from conserving a major portion of them for their potential as a genetic reserve, for wildlife habitat, for watershed protection, for education, for scientific research and for nature tourism development (Stolz, 1986). Secondary forests and plantation forests are more suited for the production of forest products.

RESEARCH

* The rationale for the current emphasis on exotic species in Grenadian plantation forestry needs to be examined. In St. Lucia, CIDA has proposed that a review of Beard's 1949 classification of the indigenous forest be carried out and that one or more indigenous and/or exotic species, adapted to each ecological condition, be identified, followed by establishment of small experimental plantations of species within each ecological type. Research efforts would be initiated which focus on the most highly valued indigenous species, with a view toward establishing silviculture prescriptions for these. A

similar program in Grenada would be deserving of consideration.

* Research to select the most appropriate silviculture system needs to be conducted with indigenous species in each of the major forest types. The major silviculture alternatives for tropical forest management are plantations, shelterwood cuttings, secondary forest management following natural disturbance or logging, enrichment plantings, and agroforestry with timber species. All of these management systems have already been tried in Grenada (Weaver, 1989), but in most cases the experiments were abandoned after a few years and results were inconclusive. A long-term program to compare the merits of the various alternatives is needed.

* Throughout the Caribbean region, dry forests have been disturbed more than any other type, and Grenada is no exception. At the Virgin Islands Biosphere Reserve in St. John, U.S. Virgin Islands, techniques are being developed for the restoration of degraded dry forests. Similar research should be applied to the dry forests in the area of the proposed Levera National Park, perhaps through a cooperative agreement with the Virgin Islands Biosphere Reserve. Such a project would be of considerable value to neighboring islands and to the region. The moist forest at Morne Delice could also benefit from a similar approach.

FOREST CONSERVATION AND DEVELOPMENT

* To reduce and eventually halt forest cover loss, GOG conservation and resource development policies need to be re-examined to focus on the need:

(1) To prevent agricultural encroachment and the harvesting of trees in specifically designated "completely protected" forest areas;

(2) To provide for carefully supervised harvesting on the basis of ecologically sound, sustained yield management in other parts of forest reserves, including natural forest areas and plantations, which should be

zoned according to their most appropriate use, e.g., "wildlife conservation/sustained yield production" and "exploitation/conversion to plantation forest";

(3) To develop new plantations in areas where they are appropriate, such as on marginal farm lands, and on some degraded forest lands;

(4) To rigorously defend water catchment areas against encroachment and to permit no land use other than controlled forestry in such areas.

* Specific recommendations to assist in carrying out these general policy goals include:

(1) Experimentation with agroforestry techniques. Given the high costs of plantation maintenance and the continued infringement on protected natural forests by illegal farming, additional pilot projects in agroforestry such as the Annandale project (see Section 4.2) should be implemented to test their feasibility for future plantation maintenance. In such projects, farmers interplant agricultural crops with forest trees on selected sites which are monitored and evaluated.

(2) Support for an integrated wood products industry. The premise that a viable wood products industry in Grenada is not only desirable but possible still needs further investigation and testing. To achieve this goal, a plan to rationally link processing facilities to both supply (quality and quantity of available timber) and to demand (existing markets) is needed. Attention should be focused not on the remnant areas of natural forest, but on plantations of native and exotic species.

Appropriate technology for logging, transporting and processing of timber needs to be adapted to Grenada. Existing roads should be upgraded and maintained; road design for any additional forest access roads should follow stringent soil and water conservation requirements.

(3) Support should be provided for upgrading existing small saw mills to process

trees harvested under the forest management program and to provide lumber for the local, small-scale woodworking industry (Miller, *et al.*, 1988; Stolz, 1986).

A great deal of information already exists on the structural and mechanical qualities of native Caribbean woods. Support systems for incorporating native woods into the local construction and furniture industries need to be developed, including drying kilns, treatment, and engineering specifications.

(4) Expansion of protected water catchment areas. It has been proposed that forest reserves established primarily for water catchment purposes should be increased in size, and that a long-term program of afforestation should be undertaken (Stolz, 1986). Increasing the size of watersheds falling under protected management strategies (by incorporation as part of the national parks and protected areas system) is an option which must be seriously examined by appropriate government agencies. Before this can happen, Crown Lands which offer potential for forestry must be surveyed, gazetted, and demarcated.

(5) Incentives for the practice of private forestry management -- e.g., technical assistance, tax credits -- need to be studied, and legislation that will strengthen the ability of Government to protect and manage critical land areas, including private watersheds, is needed. In St. Lucia, for example, the institution of a levy on domestic water bills to raise funds for the purchase and maintenance of key private forested watersheds has been recommended. This is an innovative proposal and could serve as a model for the Eastern Caribbean region.

* A similar source of funds will need to be identified in Grenada to finance protective measures such as the following:

(1) purchase of conservation easements (where the owner agrees not to do certain things, e.g., build a road, cut trees, harvest fuelwood);

PRECEPTS ON SOCIAL FORESTRY *

The term *social forestry* has been used to distinguish a new approach to the management of trees, which is different from the technically and commercially directed development that previously prevailed in the field. Commercial forestry deals with trees on a large scale, in monocrop operations, and without involvement of the people who live in and around the forests. Conventional approaches often appear to regard people as enemies rather than as partners in forest management and include no more local institutional development than assigning a few technicians and many forest guards.

Social forestry recognizes the need for associating local people closely with any forest management effort. In social forestry, trees are managed in association with other plants and animals, often in small or fragmented areas. Multiple uses not necessarily for market sales are emphasized, and management is done largely by the people living nearby and primarily for their benefit.

Users of forest resources are an ambiguous group even when the resources themselves are readily identifiable and delimitable. Not only do persons in the immediate area utilize the resources, but outsiders may use them as well. Therefore, voluntary user groups cannot be relied upon as a management institution. More authoritative institutions, such as local governments, are usually required to regulate outside as well as local resource use and to mobilize people's time and funds for improving the resource base.

Successful forestry management depends on the cooperation of the poorer strata in rural areas as well as the richer ones. Although local governments are often dominated by the more substantial elements of the community, they are more likely than central government agencies to produce a consensus on a resource management regime that is broadly perceived as fair and binding.

With appropriate technical guidance, locally elected bodies at the village level can provide effective institutional support for small social forestry schemes. However, simply assigning certain responsibilities to local government within administratively conceived and implemented social forestry programs is not the answer. Since the benefits from planting and protecting trees are relatively long-term, before local people will commit their time and effort to forest management, they will usually require unambiguous control over use rights and benefits.

The local government should therefore be given clear responsibility for the resources, and all or most of the immediate benefits from improved management should accrue to the community. If by doing this forests are preserved, soil erosion reduced, and the water cycle protected, there are obvious gains at the national level as well.

* Source: Uphoff, 1986.

(2) payment of a premium for improved landscape/forest management, e.g., terracing of damaged areas or reforestation;

(3) purchase of development rights;

(4) payment for a long-term lease of watershed land needing protection;

(5) compensation for landowners for down-zoning (reclassifying) land as a restricted or no development, protected area

(which might allow certain uses but not others, by definition).

FUELWOOD

* A more systematic evaluation of fuelwood extraction rates is required in order to identify specific areas in Grenada where continued harvesting for this purpose poses a serious environmental problem. Although conclusive documentation is not presently available, it would appear that fuelwood production may represent a high-risk threat to forest resources at this time. Obvious areas of concern are the forest reserves as well as primary watersheds where removal of ground

cover for any reason endangers key water supplies.

* Key management strategies should focus on enforcement (a trespassing and policing issue) and monitoring (for example, repeated monitoring of the charcoal market to pinpoint production increases from areas of critical concern). Finally, the planning, monitoring and quantifying of fuelwood harvesting and new community-based fuelwood plantation production may be sufficiently important to warrant the eventual creation of a fuelwood forester post and/or a community/social forester post (see box, page 70) within the Forestry Department.

4.2 FRESHWATER RESOURCES AND WATERSHED MANAGEMENT

4.2.1 Overview

Annual rainfall in Grenada varies from approximately 1,270 mm (50 in) in dry coastal locations to 4,060 mm (160 in) in the wet central mountains (Evans, 1973, cited in Francis, 1986); see Figure 4.2(1) and Table 4.2(1). The length of the dry and wet seasons varies greatly depending on location, but there tends to be a dry season from about January to May and a wet season from about June to December. About 75 percent of annual average rainfall occurs during the wet season. In Carriacou and Petit Martinique annual rainfall is variously estimated at between 762 mm (30 in) to 1,360 mm (54 in), although there are no long-term meteorological records readily available (Mente, 1985).

According to Kennedy and Donkin (1983), consulting engineers to the Grenada electrical utility, rainfall data have been collected in Grenada since 1926, but all the data collected before 1976 have reportedly been lost in a fire. Data on daily rainfall were collected from about 12 mostly coastal gauges between January 1980 to 1984. Since then, more gauges were set up, including some in the interior highlands. Figure 4.2(2) displays the location of rain gauges in Grenada at present.

No data are available for evapotranspiration, but rough estimates from Grenada and neighboring islands range from 1,000 mm/year to 1,500 mm/year (Kennedy and Donkin, 1983). A figure of about 1,000 mm/year was adopted by Kennedy and Donkin for their area of interest, i.e., the proposed hydroelectric water catchment areas in Grenada's central mountains.

Figure 4.2(3) shows the country's river drainage network. Grenada has 71 distinct watersheds according to a map used by the Department of Agriculture's Land Use Division (see Figure 4.2(4) and Table 4.2(2)). Surface water (streams, rivers and ponds) is the major source of fresh water for human consumption and agriculture in Grenada. The locations of the 23 surface water supply facilities in Grenada are shown in Figure 4.2(5),

and information on source, dry season supply and storage is provided for each one in Table 4.2(3). (N.B. The Central Water Commission uses a different watershed map and numbering scheme which assigns watershed numbers as high as 92; the CWC's system is the one shown in Figure 4.2(1)).

Very little data on streamflow exist for Grenada, except for some dry weather measurements and estimates for potential water supply projects. Kennedy and Donkin (1983) summarized the available data from Grenada and nearby islands, including extrapolated average flows, flood flows and a flow duration curve. However, three water level recorders have been installed on the Marquis River, the St. Marks River and the Great River; their locations are shown on Figure 4.2(2).

MAJOR WATERSHEDS AND KEY CATCHMENT AREAS

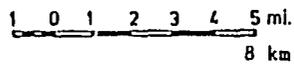
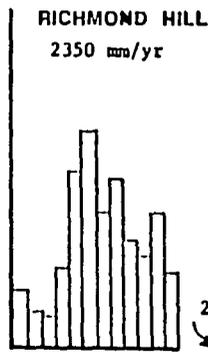
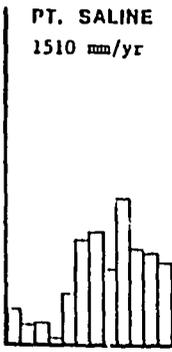
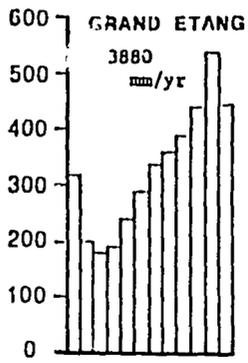
Watersheds provide a convenient and valuable framework for studies of erosion, biogeochemical balances, and ecological systems in addition to assessment of hydrological budgets. For these reasons, FAO guidelines (FAO, 1976) recognize the watershed as the fundamental unit for land use planning and land suitability classification.

There are eight major watersheds on Carriacou, shown in Figure 4.2(6). Carriacou and Petit Martinique have no important permanent streams or springs. Household water supplies in these islands depend upon catching rainwater and storing it in cisterns, while water for agriculture and livestock comes mainly from withdrawal of groundwater and surface water (run-off) stored in ponds.

The 12 largest watersheds in Grenada according to Waal (1987), a consultant working for the Central Water Commission and the United Nations Department of Technical Cooperation for Development, are

GRENADA

Rainfall



MAIN DRAINAGE AREAS

RIVER	AREA (ha)	No.
Great River	4719	43
Beausejour	1568	90
St. Patrick's	1240	55
St. John's	1229	1
Baillies Bacolet	1077	14
St. Mark's	1022	73
Antoine	981	48
Simon	936	44
Chemin	805	9
Duquesne	794	64
Charlotte	789	79
Gouyave	721	80

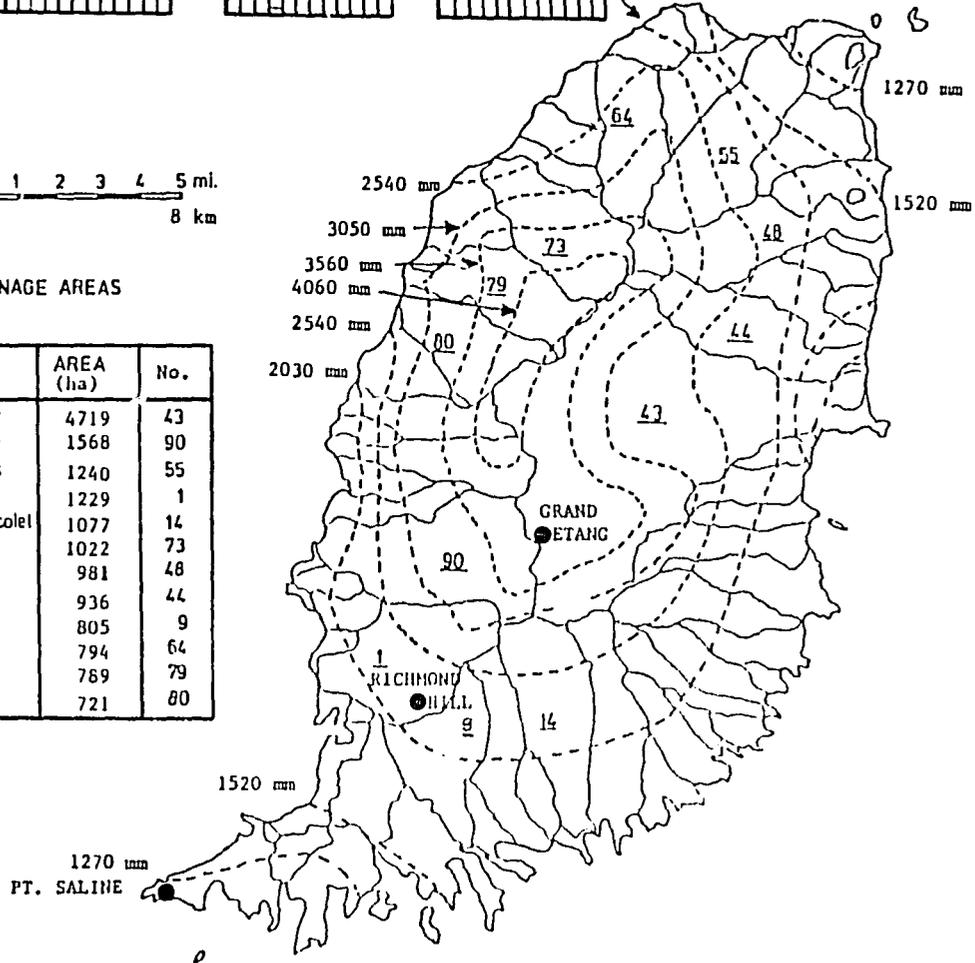


Figure 4.2(1). Rainfall isohyetal map, Grenada (source: Weaver, 1989).

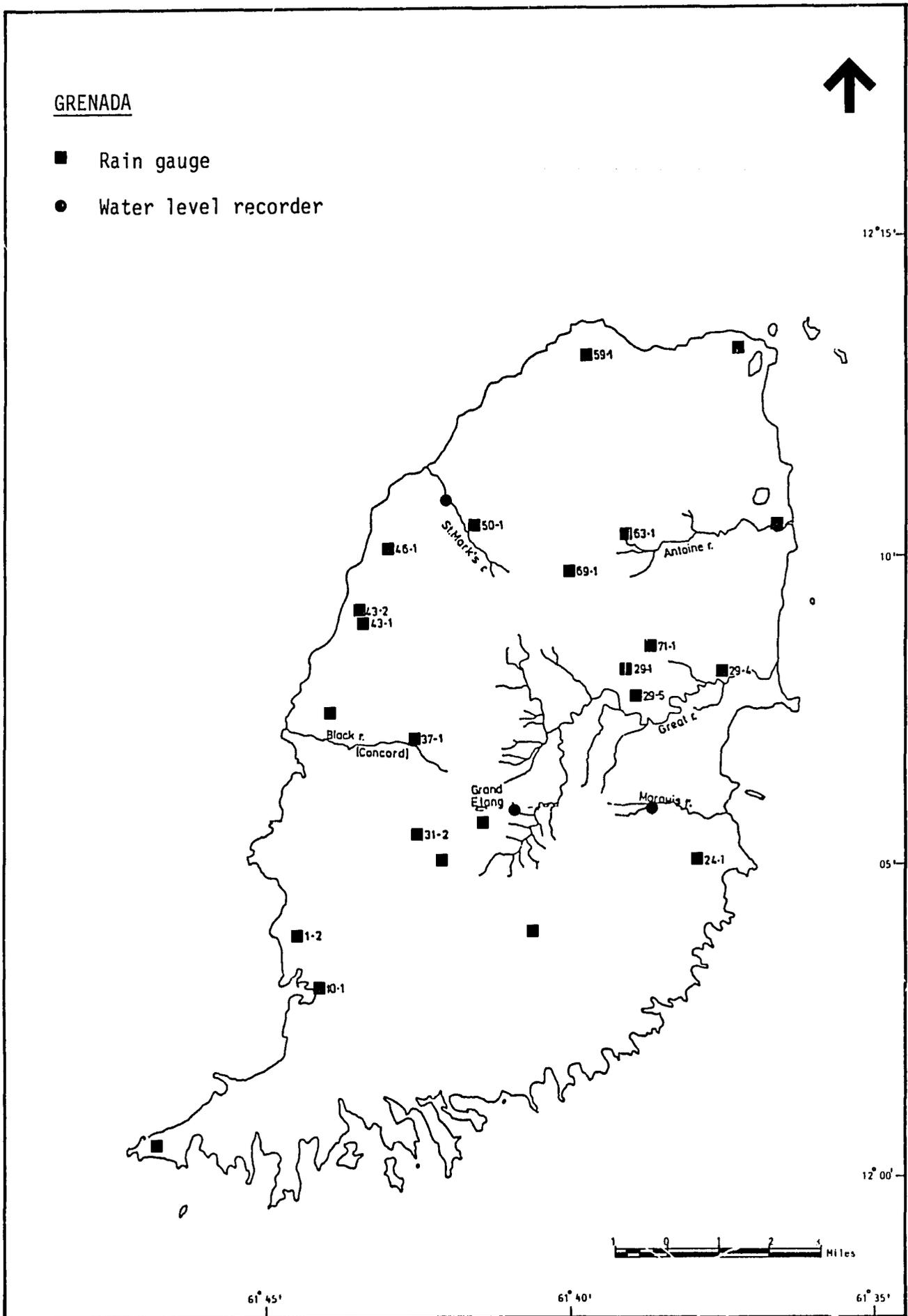


Figure 4.2(2). Rain gauges and water level recorder in Grenada (source: Weaver, 1989).

Table 4.2(1). Grenada rainfall at selected stations and for selected years (in mm).

SELECTED STATIONS	1981	1983	1985	1987
St. George's Botanical Garden	1,823.0	1,914.4	2,639.2	3,032.0
Grand Roy, St. John	1,672.6	ID	1,683.5	1,841.0
Dougladston Est., St. John	2,645.2	ID	NA	ID
Maran Cocoa Station, St. John	2,472.2	2,589.8	2,416.8	1,878.6
Boulogne Cocoa St., St. Andrew	1,825.8	1,624.6	1,575.6	ID
Mt. Horne Cocoa St., St. Andrew	1,951.7	2,120.9	2,097.0	2,041.9
Mirabeau Estate, St., Andrew	2,445.5	2,235.2	2,302.8	1,783.3
Ashendon Cocoa St., St. David	2,200.2	2,257.0	2,103.6	ID
Mirabeau Ag. Station, St. Andrew	NA	1,909.5	1,729.5	NA
St. Rose Estate, St. Patrick	NA	4,253.5	3,169.9	NA
Mardigras, St. George	2,174.0	NA	NA	ID

Notes: ID = Incomplete data; NA = Not available. Parish references follow name of site location.

Source: GOG, 1987a.

listed in Table 4.2(4). Taken together, these watersheds comprise 159 square km, or about one-half the area of Grenada. In some cases the numbering system, names, shapes, and acreages of the watersheds used in the Waal report differ from the system used by the Department of Agriculture's Land Use Division. Table 4.2.1(4) compares the numerical designations and areas for these 12 watersheds as given by the two systems.

The catchment areas (i.e., sub-watersheds) surrounding all of the reservoirs and water intakes shown in Figure 4.2(5) should be managed to prevent sedimentation and pollution of the water supply. However, because of their critical importance, three catchments were singled out for special management as "multiple-use areas" in the 1988 GOG/OAS National Parks and Protected Areas study: Annandale, Concord and Mount Hope/Clabony. Multiple-use designation means that an area will be managed so as to optimize the level of the various activities allowed in it. (A fourth catchment originally

proposed as a multiple-use area, Les Avocats, was later dropped but still appears on the cover map of the GOG/OAS report.)

The *Annandale multiple-use area*, 202 ha in the central mountains at Annandale Estate northeast of St. George's, comprises the upper portion of the Beausejour watershed. It acts as the catchment area for the Annandale water treatment facility. This area has been designated as a critically important sub-watershed by the Ministry of Agriculture and the Central Water Commission because it supplies about 40 percent of the water for the most populous region of the country, the town of St. George's and the Grand Anse hotel area.

The *Concord multiple-use area* is located in the Concord Valley east of the Concord Falls and includes 96 ha in the upper watershed of the Black Bay River. The headwaters of that river have been tapped to supply piped water to about 3,000 people in the villages of Concord, Marigot and Cotton

GRENADA

River Drainage Network

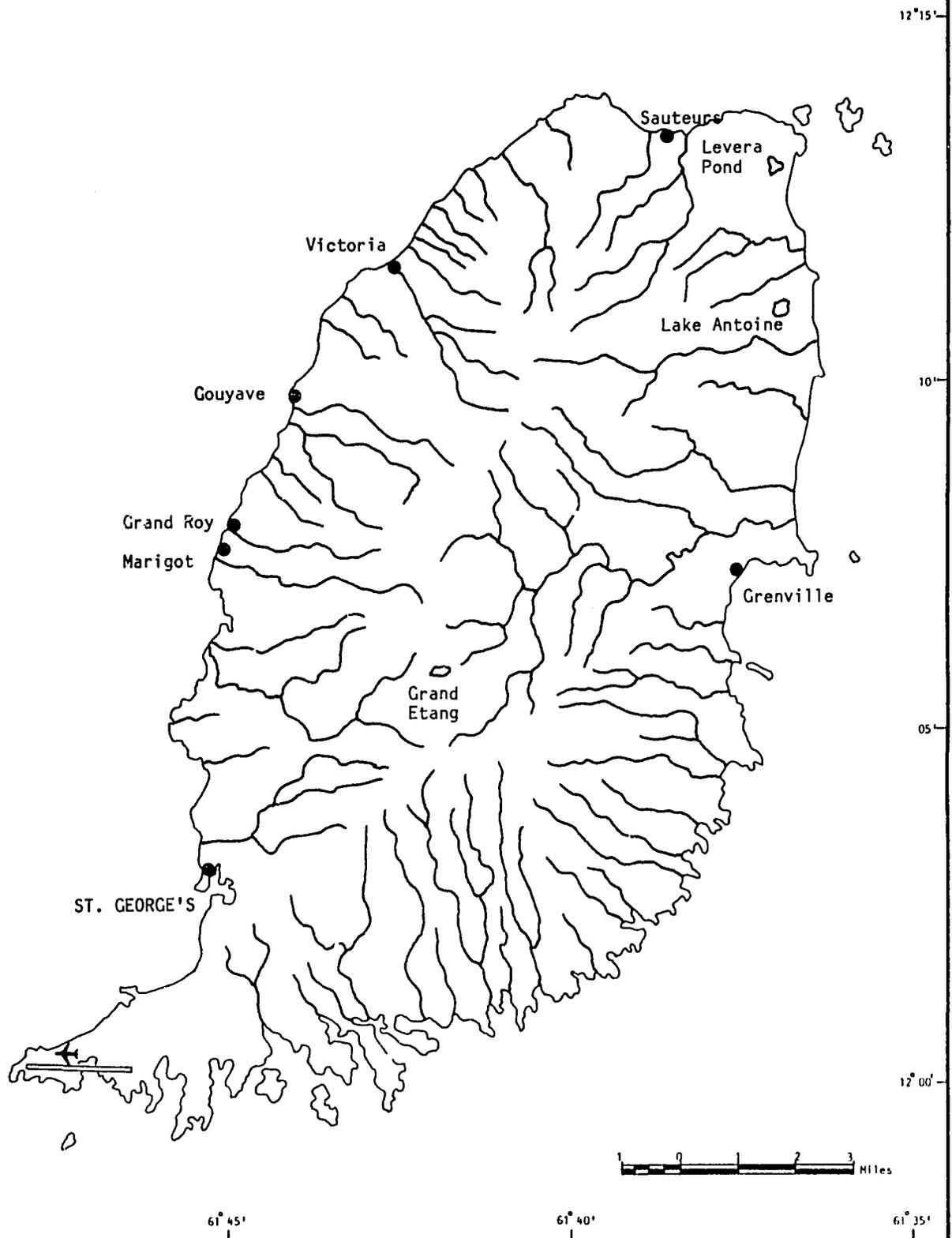


Figure 4.2(3). River drainage network in Grenada (source: Francis, 1986).

Bailey in St. John's Parish. The area of the valley between Concord Falls and Fountainebleu Falls is privately owned and cultivated. The Central Water Commission has identified this as a key catchment area because it is one of the only reliable water sources that remains for development by the Parish of St. George's.

The *Mount Hope/Clabony catchment* consists of about 260 ha of privately owned land, mostly forested but with some cultivation on the lower slopes. Located in the uplands west of the abandoned Pearls Airport in St. Andrew's Parish, the area encloses the headwaters of the Simon River and the Grand Bras River (the latter is a major tributary of the Great River). The Mirabeau and the Mount Horne water treatment plants which are situated on these rivers are the main sources of domestic water supply for Grenville, Grenada's second largest town.

Kennedy and Donkin identified other important catchment areas for proposed hydroelectric installations on the St. Francis, Marquis, St. Marks and Great Rivers.

PRODUCTION, CONSUMPTION AND DEMAND

Approximately 52 percent of the population have private water service, 23 percent use public standpipes, and 22 percent use rain water catchments, private springs, streams or ponds (Waal, 1987). There are presently 29 water supply facilities on Grenada (23 surface water and six ground water). These facilities provide a total supply capacity of about seven million gallons per day (gpd) in the rainy season. In the dry season this capacity may diminish to about 4.8 million gpd. Maximum demand occurs in the dry season, estimated in 1985 to be on the order of 6.5 million gpd. Therefore, wet season production is adequate to meet demand, but there is a deficit of 25 percent in the dry season. At present, a conservative estimate for wastage of water is thought to be about 40 percent of the total water supplied (Waal, 1987).

Tourism demand is expected to grow as the number of visitors increases; the distri-

bution of demand by parish is projected to be 70 percent in St. George's, 20 percent in St. David's, and 10 percent in Carriacou (Weaver, 1989).

Tentative estimates of the current agricultural water demand are in the neighborhood of 15 percent of total demand (Weaver, 1989). While cocoa, bananas, nutmeg and sugar cane do not require irrigation during the dry season, under GOG's agricultural diversification effort, the production of new vegetable crops which do require dry season irrigation is increasing; and there is potential for further expansion of vegetable production in flatlands in the east and south of Grenada.

Surveys have shown that there is good groundwater potential in the Beausejour, Tempe-St. John's, Woodlands, Chemin, Bailles Bacolet and La Sagesse river valleys in Grenada. There are plans to increase groundwater production by the construction of several new bore-holes in these areas in the near future (Waal, 1987). Some groundwater is already produced from wells in the Tempe-St. John's Valley, Chemin Valley and Woodlands Valley.

If wastage is not reduced below present levels, overall water demand for Grenada will be about 8.3 million gpd in 1997. Under the assumption that a long-term waste prevention program will reduce wastage to 25 percent by the year 2000, overall water demand is projected to be only about seven million gallons at that time; the slow growth in projected demand is due to the combination of reduced wastage and low projected population growth. If currently proposed production facilities are implemented, island-wide wet season supply will be about 8.7 million gpd in 1997. Dry season capacity in 1997 will reach about eight million gpd, somewhat short of demand if wastage continues at a constant 40 percent of supply but more than adequate to meet projected island-wide demand if an effective waste reduction program is realized. Of this, an estimated 1.7 million gpd (21 percent) will be produced from groundwater, and the rest from surface water sources (Waal, 1987).

GRENADA

Major Watersheds

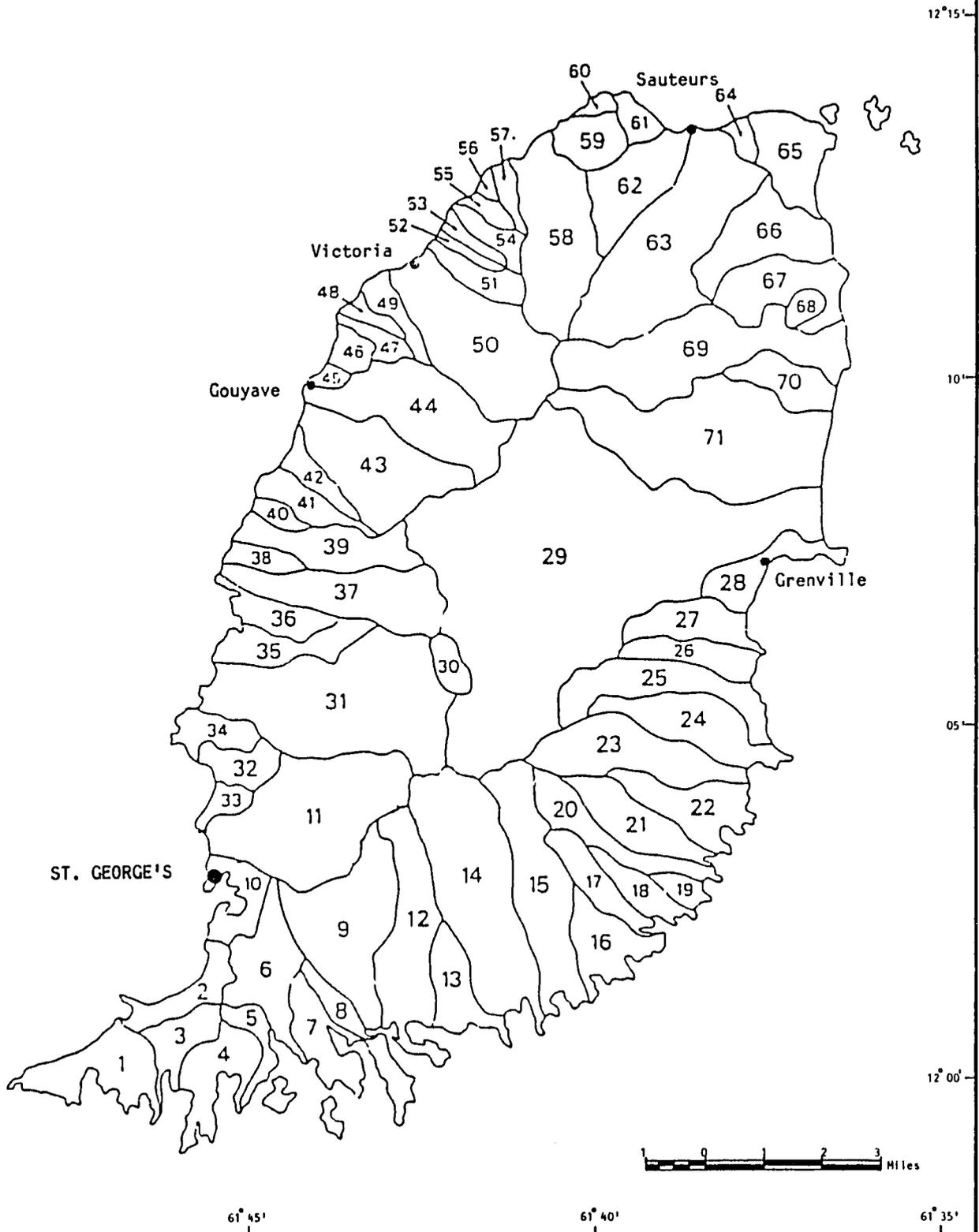


Figure 4.2(4). Major watersheds in Grenada, according to the Land Use Division (source: Francis, 1986).

Table 4.2(2). Watershed numbers and areas in Grenada according to Dept. of Agriculture.

NO.	TITLE	AREA (AC.)	NO.	TITLE	AREA (AC.)
1.	True Blue	1045	37.	Black Bay	1525
2.	Grand Anse	487	38.	Marigot	263
3.	Grand Anse Valley	452	39.	Trand Roy	1065
4.	Mt. Hartman	1191	40.	Dothan	191
5.	Clark's Court Bay	258	41.	Palmiste	401
6.	Richmond Hill	1157	42.	Mt. Nesbit	306
7.	Woburn	1094	43.	Dougladston	1830
8.	Confer	162	44.	Gouyave	2019
9.	Chemin	1953	45.	Millet Bay	134
10.	St. George's	502	46.	Maran	205
11.	St. John's	3022	47.	Gros Point	406
12.	St. Louis	1607	48.	North Gros Point	143
13.	Petit Baccave	802	49.	Nettle Point	234
14.	La Chaussee	2861	50.	Victoria	2528
15.	La Sagesse	1689	51.	Waltham	459
16.	Petit Trou	788	52.	Silver	105
17.	Requin	473	53.	Great Ravine	177
18.	Belle Vue	421	54.	Great Crayfish	339
19.	Bishop	186	55.	Little Crayfish	162
20.	La Tante	812	56.	Crayfish	67
21.	Crochu	827	57.	Duquense Point	162
22.	Mama Cannes	1122	58.	Union	2182
23.	Grand Bacolet	1433	59.	La Sausos	478
24.	Munich	931	60.	David Point	110
25.	Marquis	1362	61.	Mt. Rodney	277
26.	Deblanc	717	62.	Sauteurs	1133
27.	La Digue	654	63.	St. Patrick's	2933
28.	Harford	728	64.	Levera	119
29.	Great River	11167	65.	Levera Pond	849
30.	Grand Etang	282	66.	River Sallee	1352
31.	Beausejour	3793	67.	Mt. Ross	893
32.	Grand Mal	396	68.	Lake Antoine	115
33.	Fontenoy	167	69.	Tivoli	2699
34.	Mt. Moritz	411	70.	Conference	645
35.	Perseverance	745	71.	Pearls	3066
36.	Woodford	454			

Source: Land Use Division, Government of Grenada..

GRENADA - Existing Surface Water Supply Facilities

- 1 PETIT ETANG
- 2 MAMMA CANNES
- 3 POMME ROSE
- 4 MUNICH
- 5 PLAISANCE
- 6 BELLEVUE
- 7 BRANDON HALL
- 8 MIRABEAU
- 10 MT. HORNE
- 11 PEGGY'S WHIM
- 12 UNION
- 13 TUFTON HALL
- 14 DUGLADSTON
- 15 GLOZIER
- 16 GRAND ROY
- 17 CONCORD
- 18 ANNANDALE
- 19 VENDOME
- 20 BON ACCORD
- 21 MARDIGRAS
- 22 RADIX SPRING
- 23 LES AVOCATS

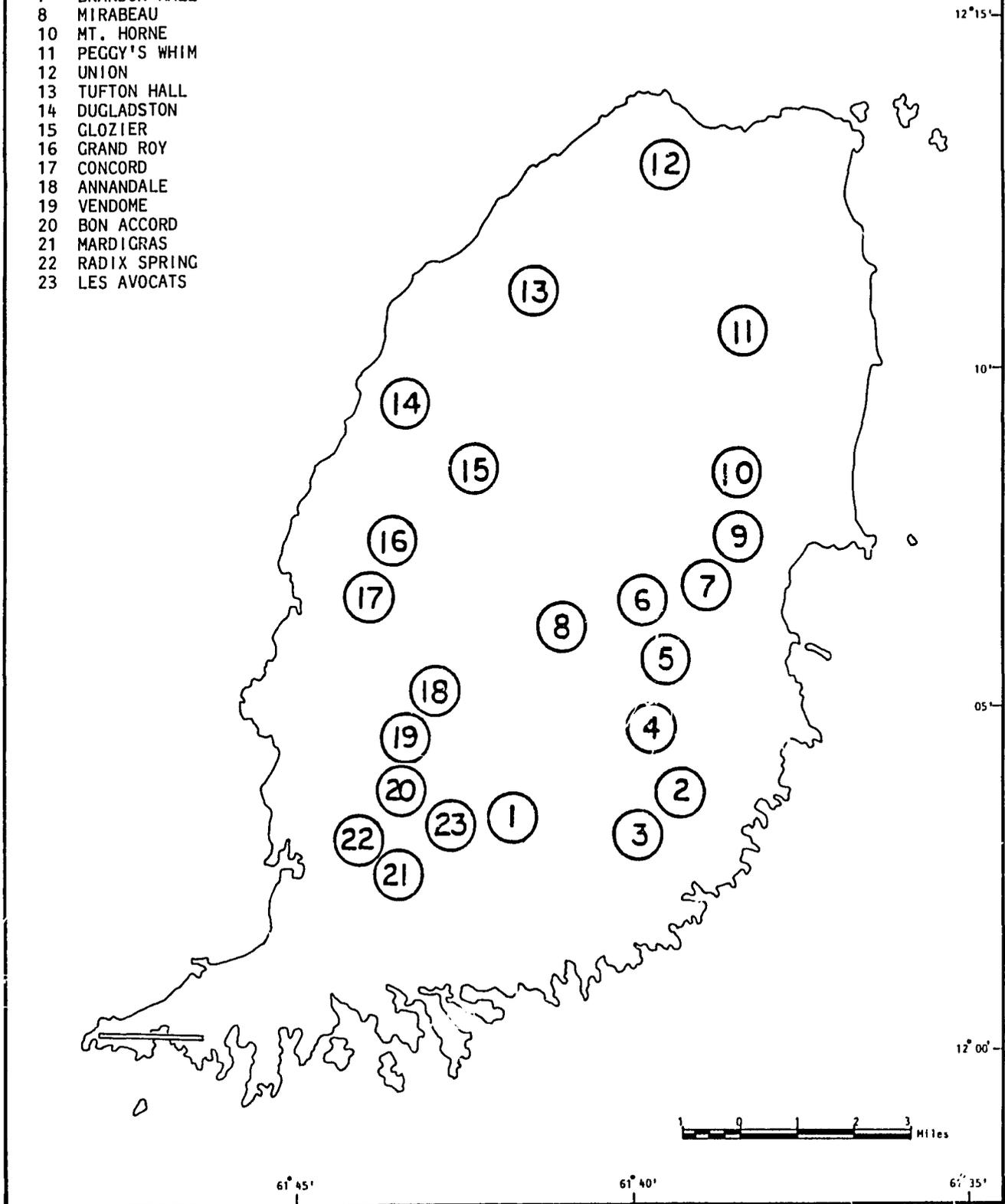


Figure 4.2(5). Existing water supply facilities (reservoirs and water intakes) in Grenada (source: Weaver, 1999).

Table 4.2(3). Information regarding water treatment plants in Grenada.

KEY	PLANT NAME	ELEVATION ¹ (m)	SOURCE		RIVERS	DRY SEASON SUPPLY (gpd)	STORAGE (g)
			Dams	Springs			
1	Petit Etang	352	3	-	Little Marquis/Bacolet	210,000	81,000
2	Mamma Cannes	293	1	-	Francis	250,000	250,000
3	Pomme Rose	262	-	-	Francis	100,000	175,000
4	Munich	259	1	-	Great Bacolet	60,000	1,100
5	Plaisance	250	1	-	Marquis	40,000	-
6	Bellevue ²	358	1	-	Great River	12,000 ²	14,000
7	Brandon Hall	195	1	-	Balthazar	100,000	72,000
8	Spring Garden	341	1	-	Great River	250,000	-
9	Mirabeau	244	1	-	Grand Bras	180,000	145,000
10	Mt. Horne	152	1	-	Simone	160,000	56,250
11	Peggy's Whim	244	2	-	Antoine Tributaries	400,000	33,000
12	Union	152	-	2	-	25,000	10,125
13	Tufton Hall	107	-	1	-	250,000	3,300
14	Dougladston	68	2	-	Gouyave/Great Ann	250,000	32,800
15	Clozier	366	-	2	-	35,000	1,000
16	Grand Roy	198	1	1	Small Streams	30,000	1,500
17	Concord	305	1	1	Black	50,000	1,500
18	Annandale	234	1	-	Beausejour	1,000,000	200,000
19	Vendome	288	2	-	Beausejour	300,000	225,300
20	Bon Accord	244	1	-	Bon Accord	30,000	30,000
21	Mardigras	358	1	-	St. Louis	150,000	250,000
22	Radix Spring	213	-	1	-	30,000	1,500
23	Les Avocats	333	1	-	Baillies Bacolet	300,000	71,630

¹ Estimated elevation of clear wells. ² Plant abandoned, no output.

Source: Weaver, 1989.

In the dry climate of Carriacou and Petit Martinique, an adequate water supply is highly dependent on the timely arrival of the rainy season. Estimates of the water resource availability in Carriacou were made for a 100 Day Critical Period (100 DCP), corresponding to roughly the last three months of the dry season (Mente, 1985). Except in very dry years, the cisterns fed by rainwater catchments are still full (or close to full) at the beginning of this critical period, but are then drawn down during these months. Estimates based on the 100 DCP are thus "low side" volumes

related to drought rather than "normal" conditions during the wet season. Wet season estimates would be about 25 percent higher, the increase being accounted for by larger volumes of surface water stored in ponds at that time.

Mente's study indicates that the total sum of water available in Carriacou during the 100 DCP (summing up rainwater, surface water and groundwater) is about 9.5 million gallons. Of this total, about six million gallons (62 percent) is groundwater, three million

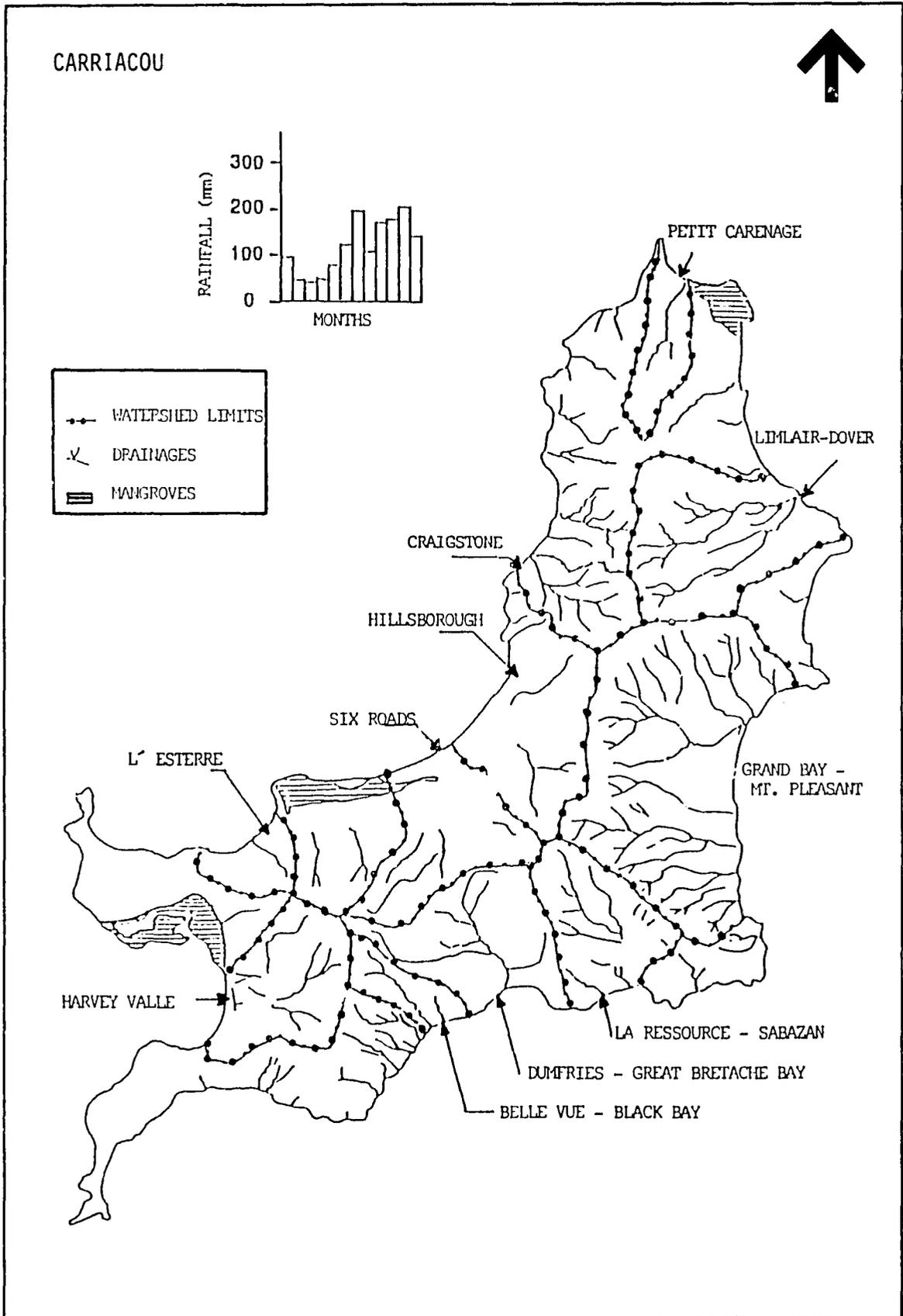


Figure 4.2(6). Major watersheds in Carriacou (source: Weaver, 1989).

Table 4.2(4). Grenada's twelve largest watersheds.

RIVER	BASIN NO. (de Waal)	ACRES	BASIN NO. (Land Use Div.)	ACRES
Great River	43	11,657	29	11,167
Beausejou.	90	3,872	31	3,793
St. Patrick's	55	3,062	63	2,944
St. John's	1	3,035	11	3,022
Bailles Bacolet	14	2,660	14	2,861
St. Mark's	73	2,524	50	2,528
Antoine	48	2,424	69	2,699
Simon	44	2,311	71	3,066
Chemin	9	1,989	9	1,953
Duquesne	64	1,960	58	2,182
Charlotte	79	1,950	44	2,019
Gouyave	80	1,781	43	1,830

Source: Waal, 1987; Land Use Division, Government of Grenada.

gallons (32 percent) is water in cisterns, and a little more than half a million gallons (6 percent) is stored surface water. Rain water catchments are the most widely distributed type of water supply system, followed by dug wells. Most dug wells are sited along the coast; there are also three drilled wells (now in disrepair) and three perennial ponds. Aquifer capacities are low and only suitable for small withdrawals, public rainwater catchments are badly in need of repair and maintenance, and private rainwater catchments are adequate in only 40 percent of houses. The three large perennial ponds are in good condition, and there are a dozen small ponds which contain water only in the wet season.

Existing water demand in Carriacou is about 60,000 gpd; 30,000 is used for human consumption and the other half is needed for livestock watering. The present rate of water consumption is estimated at about 10 gallons per person per day. Available water storage capacity in the rain water catchments can just about meet the 100-day minimum requirement for dry-season demand from the present

human population, but the water available from ponds and dug wells can meet only 80 percent (80 days) of demand from the livestock.

Carriacou's potential water demand has been estimated at about 1.85 million gpd for the next five to ten years; 95 percent of this potential demand will be needed for irrigation in the rural areas. The assumptions used in predicting potential water demand were that:

(a) the present population size of about 4,600 will remain constant for the next five to ten years;

(b) in the rural areas, significant improvement and expansion of agricultural programs requiring irrigation will take place;

(c) in urban areas, a small-scale piped distribution system (i.e., a main and several public taps) will have been restored, hotel accommodations will increase to at least 200 beds, one small industry will be established, and the

size of the average "floating" population will be about 1,000 persons; and

(d) the rate of water usage will increase to an average of 30 gallons per person per day.

CURRENT WATER MANAGEMENT PRACTICES

Water supply on Carriacou and Petit Martinique is the responsibility of the Public Works Department under the Ministry of Communications and Works. Since the demand for potable water is met almost entirely through private catchments and cisterns, the Department has focused on the need to increase the availability of water for irrigation and small industries by repair and improvements in infrastructure. The restoration of twelve public cisterns by the OECS Natural Resources Management Project, with cooperation and funding by OAS and GTZ, has been completed as the initial water development component of an Integrated Development Program for Carriacou (St. Helene, 1986; GOG/OAS, 1988b).

Under the Water Supply Act of 1969 the CWC has powers to construct and operate surface water production, treatment and distribution facilities, levy water rates, acquire property under the Land Acquisition Act, and control all groundwater abstraction in Grenada through the issuance of licenses and permits. The CWC implements its program almost exclusively on revenues from water rates, with only a minor monthly contribution from Government. The present emphasis of the CWC's program is on extending the distribution system and bringing new sources of groundwater into production.

The only dams of any size are Annandale Dam and Mardigras Dam, each of which impounds approximately two million gallons. Grenada's only natural water supply storage reservoir for surface water is Grand Etang Lake. A number of years ago it was proposed to raise the dam at the outlet to the lake, which drains into the Annandale watershed, in order to raise the level of the lake and thereby supplement the water available to the

Annandale and Vendome treatment plants during the dry season. These plans have been dropped; presently the Forestry Department plans to use the lake as a tourist attraction and has restricted the outflow from the lake to that which would occur naturally (Waal, 1987).

INTEGRATED WATERSHED MANAGEMENT AND AGROFORESTRY

There is an emerging interest within GOG regarding the integrated management of watersheds for purposes which are broader than water production per se. For example, two pilot projects in agroforestry, one at Annandale Estate in Grenada and the other at Dumfries in Carriacou, are beginning to address these concerns.

The Annandale project is of special interest because of the area's documented history of abuse through poor land use practices, followed by an attempt by GOG to institute proper watershed management. Early settlers cleared most of the natural vegetation (rain forest and lower montane rain forest) and replaced it with cocoa and nutmeg plantations. Much of the tree cover was damaged in 1955 by Hurricane Janet, after which extensive areas were planted with Blue Mahoe. Sometime later the spice plantations were abandoned and a period of neglect followed. The present cover is a mix of vegetation types, including natural forest species, areas of maturing Blue Mahoe, derelict cocoa and nutmeg plantations, and open scrub/grassland. The latter vegetation type makes up about 10 percent of the basin area and is used for cattle grazing (Ternan and Williams, 1986).

Prior to 1964, when the GOG took over the area from private ownership and declared it to be a protected watershed, there were already water pollution problems resulting from heavy use of herbicides and fertilizers. Until fairly recently, the activities of illegal charcoal cutters denuded some parts of the basin of its tree cover, resulting in accelerated erosion and siltation of dams (Thomas, 1984). In spite of the now generally good vegetation cover, there are continuing problems of erosion and siltation of water intakes. Dry

weather water yields at the Annandale treatment plant have declined from about eight million litres/day in the early 1970's to around 4.1 million in 1985 (Ternan and Williams, 1986).

The Ministry of Agriculture and the Department of Forestry now have an ongoing agroforestry project in the Annandale basin, funded by USAID/CDB and begun in the early 1980's. The project is aimed at providing economically productive crops while protecting the value of the area for water supply. This scheme is based on mixed plantings of spice and fruit trees, with surviving nutmeg trees being brought back into production. Nearly 17,000 seedlings of mahoe, mahogany, galba, *Luecaena*, Christmas trees, citrus, cloves and mango were planted on 13 ha of the watershed between 1985-1987 (Weaver, 1989). Areas of abandoned cocoa plantations are being cleared, forest access roads are being installed, and Blue Mahoe seedlings are being thinned. However, there are no good data as yet on the hydrological or erosional impact of these management activities.

The Dumfries watershed in Carriacou (Figure 4.1(6)) is the site of a proposed demonstration project in agroforestry aimed at redressing some of that island's chronic land management problems. These problems include a shortage of water during the dry season, free-roaming goats and sheep which ruin crops and diminish regeneration of brushlands and forests, general overgrazing with consequent widespread erosion, a shortage of timber for the boat-building industry, and a shortage of fuelwood.

The Dumfries project site includes about 20 ha of land which is presently covered by grasses and brush in the lower areas and by secondary forest in the steep uplands. The agroforestry project plans (Weaver, 1989) call for maintaining the steep slopes and ridges in natural forest, for enrichment plantings of fruit or forest trees on the intermediate slopes, and for intensive cultivation of irrigated crops on the lowlands. Rainwater will be collected on the rooftops of existing buildings and stored in renovated cisterns for use in irrigation of crops.

OTHER WATERSHED RESEARCH EFFORTS

An ambitious program of land evaluation surveys was undertaken by the Ministry of Agriculture's Land Use Division in 1981. Land evaluation is the process of assessing the suitability of land for different uses and determining the effects of changes in land use. The intent of the program was to avoid detrimental effects on the watersheds which might be caused by changes in agricultural land use. Any farmer wishing to obtain government funding for agriculture was required to review his proposed project within the context of "land evaluation units"; recommendations for appropriate crops and land use practices would then be made by the Land Use Officer.

A series of large-scale land use maps of the entire country were compiled from aerial photographs (Eschweiler, 1982b); maps are currently available from the Land Use Office. A methodology for land evaluation, combining physical attributes of the land, a climatic inventory and an agro-climatic suitability classification, was adopted, following FAO guidelines (Eschweiler, 1982 a, c and d).

Land units, defined on the basis of slope, land form, and soils, were mapped together with other characteristics such as climate, geology, vegetation, fauna, and man-made structures. Each mapped unit was evaluated to produce a land suitability table and a report was compiled for that area. A project to produce such ecologically-oriented land evaluation reports for each watershed in Grenada was begun, but to date reports for only twelve watersheds have been completed. Further surveys are not being actively pursued at the present time.

Under a project funded by the Commonwealth Foundation, two other surveys relating to watershed management have been conducted: a small-scale detailed study of soil hydrological properties in the Annandale watershed and a large-scale reconnaissance survey of water chemistry in the majority of Grenada's watersheds. The hydrological study, carried out in 1986 (Ternan, *et al.*, 1987; Ternan, *et al.*, 1989) was designed to investigate the impacts of different forestry and

agroforestry practices on total stream flow, storm flow, and low season flow. Attention was focused on the soil hydrological properties of selected sites within areas of typical land use, i.e., in order to study the flow processes within the soil, permeability was used as an indication of soil water pathways.

The results of this study showed that surface soil permeabilities at Annandale varied widely, being highest beneath a Blue Mahoe canopy and lowest at a cleared and over-grazed site. Indications were that under trees the upper soil horizons are well structured, and soil permeabilities were sufficient to absorb even the most intense rainfall. In sites where overgrazing of cattle had taken place, there was damage by compaction of the soil structure, which caused decreased percolation and increased overland flow, tending to increase soil erosion. However, at all sites a discontinuity in the soil profile at a depth of about 20 inches severely limits percolation to the deeper horizons. During prolonged rainfall, the upper horizons at all sites may become saturated, causing surface run-off and a high risk of erosion if a good protective cover is not maintained.

A reconnaissance survey of water chemistry (Ternan, *et al.*, 1989) was done during the dry season in April, 1986. This project was intended to clarify some of the major influences on water chemistry and establish a baseline against which to measure the effects of future changes in land use. The parameters measured were: specific electrical conductance (S.E.C.), silica, chloride, sulfate, calcium, magnesium, sodium and potassium. Unfortunately, with the exception of a single flood event on the Great River, suspended sediment concentrations were not reported. In Figure 7 of their 1989 paper, Ternan, Williams and Francis show which watersheds were surveyed and give the results of the measurements. Stream water chemistry was found to be largely a reflection of natural processes relating to very active chemical weathering of volcanic rocks, rather than pollution. Such processes produce high silica concentrations in the rivers. Some watersheds in the area of most recent volcanic activity have extreme silica values, which are considered to result from volcanic water inputs.

4.2.2 Problems and Issues

DRINKING WATER POLLUTION

Agricultural Contamination. Pollution levels measured in a reconnaissance survey of stream water quality in Grenada's lower watersheds were generally low even towards the end of the dry season. Although data are sparse at present, the results of this single survey indicate that *fertilizer* pollution of Grenadian rivers by agricultural activities may be minor. The maximum nitrate concentration recorded (1.6 mg/litre) was in the Great River. Potassium concentrations were also found to be low (Ternan, Williams and Francis, 1989).

Nevertheless, CWC personnel report having chronic problems with agricultural fertilizers getting into the upper watershed water treatment plant intakes and causing algal growth in the slow sand filters. Pre-chlorination is being used in an attempt to deal with this problem. CWC has no information on whether biocides in drinking water are causing a problem at this time.

EROSION AND SEDIMENTATION

Lugo, *et al.* (1981) point out that erosion due to deforestation is a widespread problem in the region. The recommended maximum annual rate of soil loss is 1-3 tons/ha, but measured annual rates in some Caribbean countries are as high as 35 tons/ha.

In Grenada, various sources are in apparent conflict about the extent of soil erosion. For example, Ternan and Williams (1986) state that in spite of the protective tree canopy, measurements of sediment levels in some Grenadian rivers have demonstrated that erosion rates are already excessive, e.g., an estimated 700 tonnes/year of soil loss from the Annandale watershed upstream of the water intakes. Siltation of the water intakes is already a recurrent problem at Annandale. They point out that such erosion rates are comparable to other tropical areas subject to accelerated erosion and pose major implications for water storage and treatment facilities.

ties, hydro-electric development, and downstream coastal ecosystems such as coral reefs.

Nevertheless, in their 1989 paper, Ternan, *et al.* (1989) state that "... severe soil erosion is not at present a widespread problem in Grenada because agriculture is mainly based on tree crops." In the same paragraph, however, they report that high suspended sediment concentrations in excess of 1,000 mg/litre have been recorded in the Beausejour River (which drains the Annandale watershed) during floods. Flow was estimated to be greater than 2.5 cubic meters/second, which meant that more than 150 kg of soil was leaving the watershed every minute.

Persons interviewed by the CEP project team -- public officials in the National Parks, Land Use, and Forestry units of Government, with the National Science and Technology Council, and with individuals in the water sports industries (e.g., divers) -- tended to view soil erosion as a serious issue in areas outside of the forest reserves. These individuals mentioned the following as priority issues on private lands.

(a) *Erosion of river banks, likely due to removal of vegetation (e.g., bamboo) and by farming too close to the banks.* No legislation exists at present to deal with this problem; therefore, no GOG agency has authority to take action. The problem has been discussed in the context of proposed revisions to forestry and water resources legislation, but there has been no observable action.

(b) *Soil erosion caused by farming on slopes that are too steep.* Many farmers who have crops on steep slopes in mountainous areas traditionally make their furrows down the slope instead of across it in order to shed water in the rainy season. This greatly accelerates erosion.

(c) *Watershed management.* The Forestry Department is hoping to set up an extension service to implement integrated watershed management. However, they are restricted to dealing

with Forest Reserve areas and Government-owned lands such as Annandale Estate. The watersheds on privately owned lands are not being managed properly, if at all. Huber, *et al.* (1987) reported on the status of the St. John's River watershed and made recommendations for its management. There is no specific soil or water conservation legislation for agriculture, private lands or non-forest state lands.

Adams (1986) notes that, with reference to the state-owned farm lands, erosion is not a serious problem at present. Exceptions do occur, such as at St. Omer where cultivation of *pure* stands of bananas on steep slopes have resulted in clear signs of excessive soil loss. He stresses that prevention of erosion requires appropriate management of the land. In Grenada, according to Adams, this means emphasizing *biological* measures (i.e., the maintenance of good vegetative cover to protect the soil surface from rain splash), rather than the use of *physical* measures of erosion control, such as terraces and benches.

ENGINEERING MATTERS

(1) *Distribution Network.* There are no good maps of the water distribution network in Grenada; in fact until recently there were none at all. At present the only maps available are small-scale, rough location plans of existing/proposed well sites and draft-form maps of intakes, treatment plants and major water distribution mains for some areas.

About 40 percent of the water produced appears to be lost in the distribution system (Waal, 1987), indicating a need to trace leaks and possible illegal taps. De Waal's projections for future water supply needs have been made on the basis that these losses will be traced and that conservation measures will be implemented. If this is not done, then there is a real possibility of serious shortfalls in water supplies.

(2) *Alternative Supply.* CWC is now completing preliminary geological mapping and borehole drilling to assess ground water

productivity and recharge in Grenada and Carriacou.

(3) *Production and treatment.* All treatment plants are operated as more or less autonomous units; plant operators are generally left to run the plants as they think best, with minimal communication with the head office. Most operators have little training, and the equipment with which they work is inadequate. Operation and maintenance of the water treatment plants is generally poor, and repairs are often delayed, resulting in periods of sub-standard treatment (Waal, 1987).

POLICY MATTERS

(1) *Protection of Water Production Facilities.* The silting up of dams and consequent loss of water quality at water production facilities due to soil erosion in the catchment areas has been identified as a major environmental concern.

The Central Water Commission, which has responsibility for water production and for the operation of water production facilities in Grenada, was legally set up as a statutory body in 1969 under the Water Supply Act. However, CWC did not become a functional entity until 1979. The agency previously in charge of water supply was a GOG department under the Ministry of Works. While the CWC has substantial holdings of land in theory (some 40 plus properties), it has clear title to only a few. Some lands were appropriated by GOG, and others were acquired by verbal or other informal agreements, resulting in many cases of contested ownership. CWC is currently re-surveying its holdings as a prerequisite to at least confirming titles to treatment plant sites, wells, storage facilities and dam sites.

(2) *Institutional Relationships.* There are major weaknesses in the existing legislation pertaining to the mission of the Central Water Commission and other GOG departments with overlapping responsibilities for watershed management, such as Forestry. Formal working relationships among these agencies are not clearly defined, nor are areas of specific responsibilities effectively desig-

nated. Several consultant reports have addressed these issues (e.g., Clark, 1988a; Lausche, 1986). Draft legislation is now under review for revision of the Water Supply Act, which will include watershed protection measures (Clark, 1988b). Passage of this legislation may occur in the near future.

At present, the responsibility for management and conservation of catchment areas rests with the Forestry Department; yet the Water Supply Act makes the CWC responsible for the prevention of pollution or contamination of the rivers, springs, wells, catchment areas, or other water source or supply. In spite of this overlap, there are no mandatory reporting requirements, little coordination, and no formal procedures for shared management responsibilities between the CWC and the Forestry Department. Moreover, there are no regulations to implement the CWC's legislative authority (see also Section 12).

The CWC also shares administrative authority in the area of water quality monitoring with the Ministry of Agriculture's Land Use and Water Resources Unit and with the Environmental Health Department of the Ministry of Health. It is not clear which agency is actually responsible for monitoring and enforcement of water quality standards, especially in rivers and marine waters. Responsibility for monitoring water quality in the distribution network and at the consumer lies with the Ministry of Health. Because this Ministry does not have laboratory facilities, the CWC takes its own daily samples for chemical and bacteriological testing and sends results to the Ministry of Health. That Ministry can advise people in areas of contaminated water to exercise precautions, but apparently this is rarely done. Samples are tested for total coliforms; facilities for fecal coliform testing are available, but this is not done on a routine basis. Samples from boreholes are analyzed for chemical content once a month (Waal, 1987).

4.2.3 Policy Recommendations

FRESHWATER RESOURCES

* It is crucial that the wastage of water in the public distribution system in Grenada, currently estimated at 40 percent, be reduced to at least 25 percent by the year 2000 in order to avoid a shortfall in supply. It should be noted that this recommendation is based on the assumption that current trends in population growth will continue and that therefore growth will be slow over the next 35 years. This trend is a result of the present high rates of emigration, which could decrease at any time, exacerbating the water supply situation (see Section 2).

* Immediate maintenance of the twelve rainwater catchments which have recently been restored in Carriacou is important to ensure a small reserve beyond the minimum 100-day supply of water for the human population on that island. Several of these catchments are already in need of repairs (Martinez-Soto, 1989).

* Other priority recommendations for freshwater resources in Carriacou include (Mente, 1985; GOG/OAS, 1988b):

(1) The existing perennial freshwater ponds, drilled wells and dug wells should be repaired, cleaned and maintained in the near future to increase the water supply for livestock to at least the 100-day minimum.

(2) To meet potential water demands, new sources of supply will have to be developed, including:

- construction of new rainwater catchments or the improvement of existing ones at the private level, with soft-payment loans financed by a donor agency (a mid-term project);

- drilling of two new public wells at Hillsborough and one at Harvey Vale (a mid-term project);

- implementation of a water conservation pilot project in one selected

small watershed, to include the construction of a small earth dam and two ponds (a mid-term project).

- implementation of a water management project, designed by the Forestry Department, which calls for the damming of one of the larger seasonal streams to irrigate 250 acres of mixed crops and vegetables (a long-term project).

WATERSHED MANAGEMENT

* If watershed boundaries can be clearly defined and the inputs, throughputs and outputs of matter can be measured, then the function of the whole ecosystem can be studied. Measurements of solute inputs and outputs can be used to characterize the ecosystem and to study its internal cycling mechanisms, and measurements of sediment loads in streams can be used to calculate rates of erosion. This would enable the "health" of these watersheds to be assessed. A research program aimed at obtaining such measurements for several representative watersheds in Grenada and the Grenada Grenadines is needed (Ternan, *et al.*, 1989).

In order to gauge and monitor the effects of future land use changes, a baseline should be established now for the various parameters which can be used to judge the condition of watersheds. Data obtained from baseline research programs in typical upland watersheds would be transferable to other watersheds in Grenada as well as to other volcanic islands in the Eastern Caribbean.

* Initial land evaluation efforts and reconnaissance work in watershed chemistry and soil hydraulic properties have laid the groundwork for an understanding of Grenadian watersheds at the whole-system level, but further research and field work remains to be done. Ternan and Williams (1986) recommend that the following studies be carried out for at least some of the more important or threatened watersheds.

(1) Establish a hydro-meteorological network to obtain data on rainfall

characteristics (rainfall totals, intensities, altitudinal effects, etc.), river discharge, soil water storage component, and evapotranspiration. These are the essential data for watershed hydrology and erosion investigations.

(2) Conduct plot studies using existing planted areas to obtain data on run-off, soil erosion, and soil water conditions under the principal crops and vegetation types (including natural high forest, mature and recently planted Blue Mahoe, economic tree crops, derelict cocoa, and grassland).

(3) Collect suspended sediment samples, on a regular basis and during floods, from rivers and principal tributaries in the watersheds to identify sediment source areas and take remedial action.

* Successional forests should be managed for growth and yield, mature or "climax" forests for environmental protection, and plantations for certain wood products which cannot be produced as quickly or as effectively in natural forests. Achieving this goal calls for a combination of enlightened forestry research, aggressive implementation programs, and strict enforcement of protective legislation (Lugo, *et al.*, 1981).

* If the watershed management objective is to optimize for some mix of water

yield, timber or crop production, and soil conservation, plot studies are essential to evaluate the effectiveness of natural forest, exotic timber species, and tree crops for erosion protection and minimal water loss by evapotranspiration. Various planting combinations and densities, harvesting methods and feeder road construction plans must be evaluated as well.

* Any tree cover, whether tree crops, plantation forests or natural forests, leads to significant evapotranspirational losses of water but confers superior percolation and protection of the soil surface from raindrop erosion. Hardpans may be penetrated by planting deeply-rooting trees which facilitate the percolation of water to deeper horizons, thereby somewhat increasing water yield over shallow-rooted tree crops. Conversion of forests to crops or grassland will generally increase the total yield of the watershed in terms of stream flow but, on the other hand, will significantly increase sediment yield. Cattle grazing causes additional damage by compaction of the soil structure, further decreasing percolation and increasing overland flow. The recommended land management for watersheds with steep slopes such as Annandale is therefore a scheme based on forest and/or tree crops, with the elimination of grazing (Ternan *et al.*, 1987; Ternan *et al.*, 1989).

SLOPE STANDARDS FOR EROSION CONTROL

Steeper slopes are generally at greater risk from erosion than gentler ones when the vegetation cover is disturbed, but it is well known that a number of factors influence erosion rates in addition to the degree of slope. For example, whether steep slopes can be farmed in a sustainable manner depends on the skills of the farmer, the methods and rate of clearing, the types of crops employed and how they are planted, variations in the length and complexity of slopes, the physical and biological methods of erosion control used and the intrinsic stability of the soil (Adams, 1986). However, not all farmers will necessarily have highly developed skills, and the optimum combinations of other factors will not always be present. One way to deal with this problem is to set standards for the maximum slopes on which various types of farming and other development activities will be allowed.

For example, in St. Lucia, Stark, *et al.* (1966) recommended that only land with slopes less than 10 degrees should be farmed intensively. Land with a slope of 20-30 degrees should only be used for tree crops, which should generally be deep-rooted to hold the soil and have a dense canopy of leaves to break the force of the raindrops. Land of greater than 30 degrees slope should be kept under permanent forest and not used for agriculture at all. Similar standards were also suggested by Vernon, *et al.* (1959), but they have never been adopted in Grenada (see also Section 9).

4.3 BIODIVERSITY AND WILDLIFE RESOURCES

4.3.1 Overview

J. Groome (1970), in a small booklet entitled *A Natural History of the Island of Grenada, West Indies*, compiled much of the information available at that time on the animals and plants of Grenada and their origin. According to Groome, most of Grenada's small flightless animal species colonized the island from the vicinity of the Orinoco River delta in South America, arriving by over-water "rafting" on mats of vegetation. The majority of birds and flying insects, however, appeared to be of tropical North American origin. Within the past few thousand years the natural biogeographic patterns have been altered by man through hunting, habitat destruction, and introduction of exotic (non-native) species -- e.g., food plants, domestic animals, "weeds" and animal "pests".

Some mammals introduced by man have become naturalized in Grenada and now thrive in the wild (Groome, 1970). Two species of rats (the Brown or Norway Rat, *Rattus norvegicus*, and the Black Rat, *Rattus rattus*) and the House Mouse (*Mus musculus*) were introduced accidentally, probably from ships. The Large Opossum or Manicou (*Didelphis marsupialis*) is thought to have been introduced from South America by Amerindians. The Mona Monkey (*Cercopithecus mona*) was introduced from West Africa during the slave trade. Europeans brought the Mongoose (*Herpestes auropunctatus*) to Jamaica from Indo-Asia, and in the 1870's it was introduced in Grenada in an attempt to control cane rats. The mongoose and the monkey are now considered serious pests and predators of other valuable wildlife species. The large opossum, the armadillo and the monkey are hunted as game animals.

Several species have become extinct in Grenada since the arrival of Europeans, including the Manatee (*Trichechus manatus*), the Grenada Parrot (*Amazona* sp.), the Agouti (*Dasyprocta albida*), Neuweid's Moon Snake (*Pseudoboa neuweidi*), Shaw's Racer (*Liophis melanotus*) and the Morocoy Tortoise

(*Geochelone carbonaria*). Groome (1970) suggested that the introduction of the monkey led to the extinction of the parrot and that the manatee and morocoy tortoise were hunted to extinction for food (the latter has been reintroduced through escapes from captive populations). Groome (1970) has also reported that Hurricane Janet severely reduced agouti and other wildlife populations in 1955, and he blames this event together with over-hunting by humans and predation by mongoose for the probable extinction of the agouti in the wild. Hurricane Janet also may have played a large role in reducing populations of Shaw's Racer and Neuweid's Moon Snake according to Ludeke, *et al.* (1989).

A recent report by Ludeke, *et al.* (1989) examines the status of wildlife in Grenada today and reviews historical evidence and contemporary research on introductions, extinctions, endemic species, endangered species and game species. Bindernagel (n.d.) conducted a reconnaissance survey of wildlife during September/October 1986 and made recommendations regarding the management of wildlife species and their habitats. The approximate areas where some selected game species and endangered or threatened wildlife are known to occur in Grenada and Carriacou are shown in Figure 4.3(1a and 1b).

Howard (1974-1989) has provided the most recent treatment of the flora of the Lesser Antilles, but as of early 1989 only four volumes had been published (covering Ochiaceae, Pteridophyta, Monocotyledoneae, and part of the Dicotyledoneae). The recent publication of volumes five and six have completed the series, representing the first comprehensive flora of the lesser Antilles. Until the recent publication of Howard's work, no complete flora of Grenada was available.

GRENADA

Game Species

 Green monkey

 Tatoo

 Ramier

Endangered/Threatened wildlife

 Grenada Dove & Hook-billed Kite

 Wading bird nesting & feeding area

 Seabird nesting site

 Turtle nesting area

● Hawksbill

○ Leatherback

◁ Green

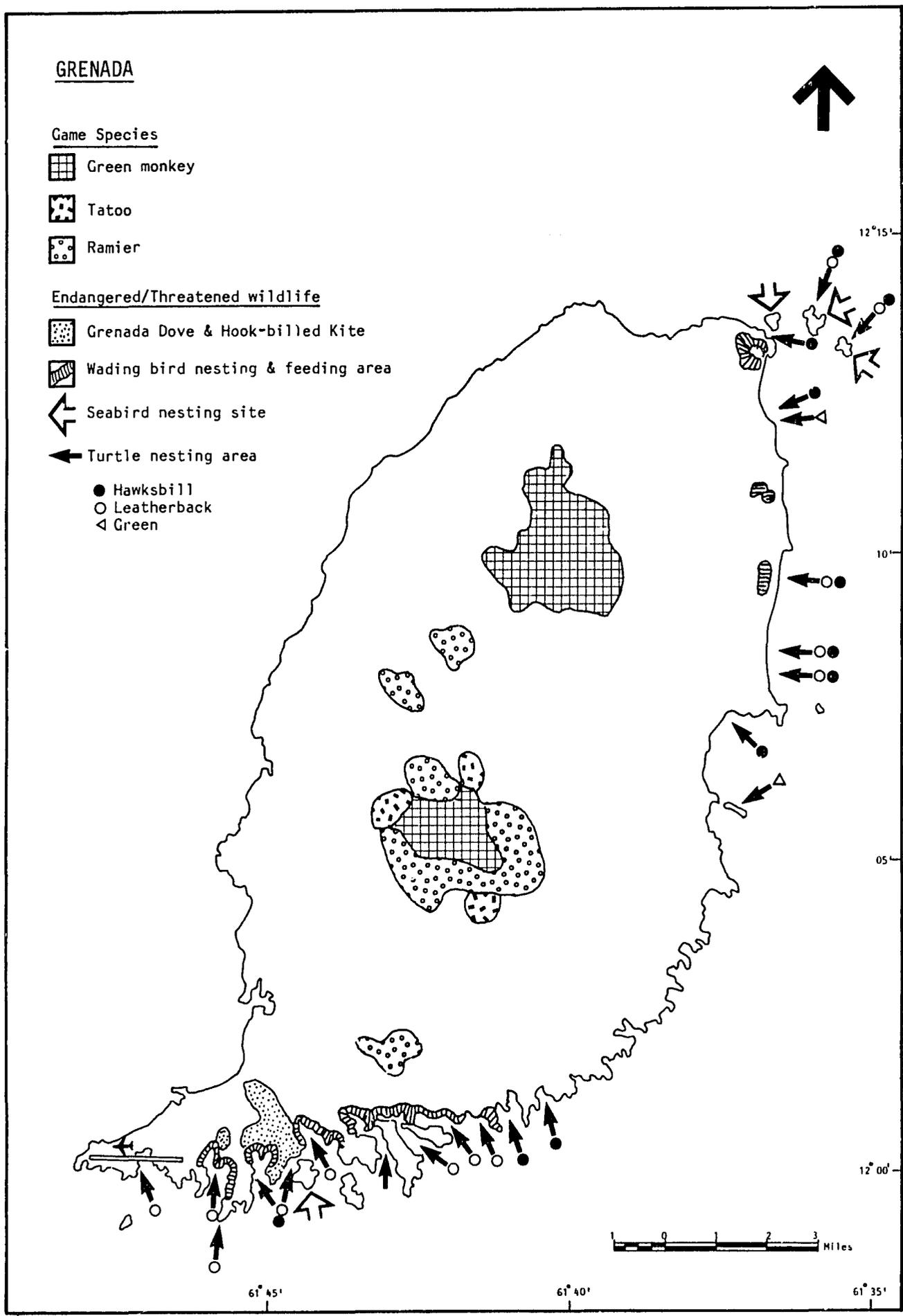


Figure 4.3(1a). Areas in which selected game species or endangered/threatened wildlife are known to occur (source: ECNAMP, 1980a; Bindernagel, n.d.; Blockstein, 1988).

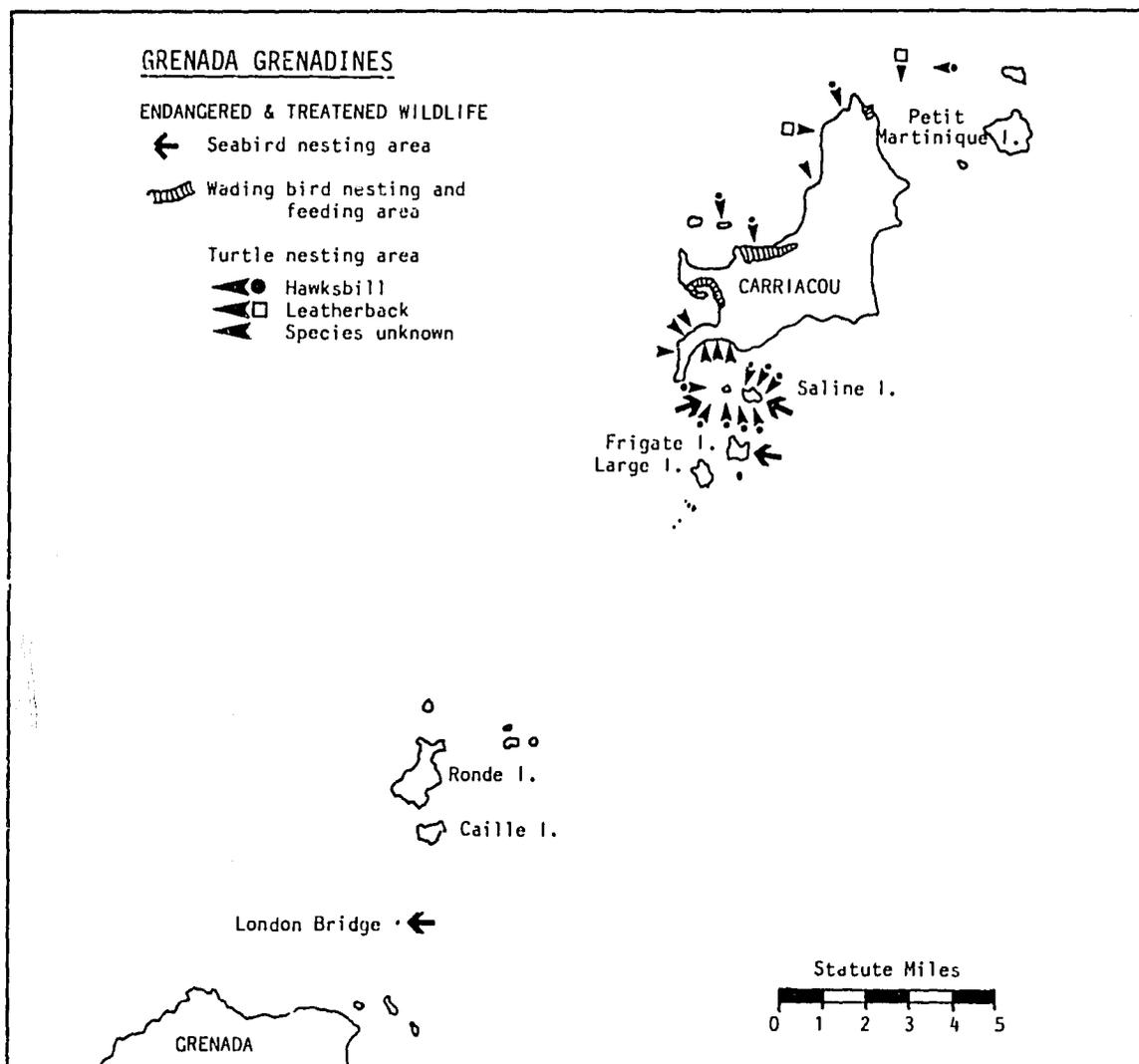


Figure 4.3(1b). Areas in which endangered/threatened species are known to occur (source: Carr, *et al.*, 1982; GOG/OAS, 1988d; Johnson, 1988).

BIODIVERSITY AND ENDEMIC, THREATENED OR ENDANGERED SPECIES

(1) **Plants.** Beard (1949) estimated that about 2,000 species of flowering plants occurred in the Lesser Antillean region; he compiled a regional list of 243 native and naturalized tree species of which 68 were regionally endemic (i.e., found only in this area). According to Beard, Grenada at that time had 120 known tree species or 49 percent of the regional total, with 15 of these being Lesser Antillean endemics (Table 4.3(1)).

Beard (1949) lists only one Grenadian rain forest tree, *Maytenus*

grenadensis, which he considered to be a single-island endemic (i.e., found only in Grenada). Two plants -- the fern *Danaea sp.* (found in the Grand Etang region) and the Palmiste or Cabbage Palm *Oreodoxa oleracea* -- were reported as endemic to Grenada by GOG/OAS (1988d, citing Groome, 1970). (It is probable that the latter species is the same as *Roystonea oleracea*, listed by Beard (1949) as occurring "throughout the islands"; hence, not endemic to Grenada at all.) Johnson (1988) could find no references in the literature on threatened or endangered species pertaining to Grenadian plants, and no Grenadian endangered plant species are listed in IUCN's Red Data Book (Lucas and Syngé, 1978) or in Davis, *et al.* (1986).

Table 4.3(1). Distribution among Lesser Antillean islands of 243 tree species (68 regionally endemic).

ISLAND	TOTAL NO. TREE SPECIES	PERCENT REGIONAL FLORA	NO. REGIONAL ENDEMICS	NO. ISLAND ENDEMICS
St. Kitts-Nevis	121	50	13	1
Montserrat	132	54	17	-
Guadeloupe	193	78	43	3
Dominica	167	68	42	2
Martinique	181	74	47	5
St. Lucia	151	62	35	3
St. Vincent	151	62	29	-
Grenada	120	49	15	1

Source: Beard, 1949.

(2) **Invertebrates.** The decapod crustacean fauna of Grenada includes several species of freshwater shrimp and freshwater or terrestrial crabs, but there seems to be little information concerning these animals in the literature. Chace and Hobbs (1969), in their review of West Indian terrestrial crustacea, list only *Macrobrachium crenulaum*, *M. heterochirus*, and *M. faustinium* as collected in Grenada, but there are certainly other species which occur there. Groome (1970) reports that several "types" of freshwater shrimp (genera *Atya* and *Macrobrachium*) are present in rivers; that Blue (probably *Cardisoma guanhumi*) and Red (*Gecarcinus sp. or spp.*) Land Crabs are common and are used as food; that the "Manicou Crab" (family Potamonidae) is present in freshwater; and that a terrestrial Hermit Crab (almost certainly *Coenobita clypeatus*) is present. Shore-living species such as ghost crabs, rock crabs and mangrove crabs (family Grapsidae), considered semiterrestrial by Chace and Smith, are no doubt also present. Most of these animals are widely distributed in the Caribbean.

Some of the most remarkable West Indian biological phenomena are the seasonal mass migrations of several land-crab species from inland areas to form dense aggregations at the shore, where they release their larvae into the sea. The larvae generally require some salinity (varying from estuarine conditions to full-strength seawater) to complete their development. For these species, recruitment of larvae from other islands (and therefore genetic exchange) is likely, so that Grenadian populations are unlikely to be genetically distinct.

No endemic invertebrates have been described in Grenada, with the possible exception of the weevil, *Diaprepes sp.* (Groome, 1970). Johnson (1988) was unable to find any sources of information on regional endemism among invertebrates, or any information on the ecology and status of invertebrate groups except swallowtail butterflies, none of which appear to be threatened.

(3) **Fishes.** The freshwater fish fauna of the Lesser Antilles is derived from only a few families -- Poeciliidae, Anguillidae,

Gobiidae, Eleotridae, Mugilidae, Gerridae, Centropomidae, and Carangidae -- and apparently includes no species which occur exclusively in freshwater. Freshwater fish, particularly the mountain mullet (*Agonostomus monticola*), are a traditional West Indian food resource.

Grenada's fresh-water fish fauna, consisting of about twelve species of gobies, mountain mullets, clingfish, etc., is not well studied; CCA (unpublished; cited in Miller, *et al.*, 1988) considered it to be threatened by sedimentation and pollution in rivers. All the known species can move between fresh and salt water and some spawn at sea.

Two fresh-water fish species, the Tete-chien and the "Go-bird" Fish (a corruption of Gobiid?) are believed to be rare in Grenada. The Go-bird Fish is a goby (*Sicydium plumieri*) which migrates up the rivers from the sea in the post-larval stage and matures in fresh-water habitats, returning to the sea to spawn. The Tete-chien is a very odd fresh-water fish (*Synbranchus marmoratus*), resembling a snake and belonging to the Swamp Eel Family, Synbranchidae. It wanders about on land during the rainy season and estivates in the dry, can grow to three feet in length, and has a scaleless skin, gill openings confluent in a single ventral slit, vestigial teeth and no paired fins (Groome, 1970).

Marine fishes and invertebrates found in Grenadian coastal waters are those typical of the Lesser Antillean Region. Estuarine fishes such as Mullet (*Mugil*), Mudfish (*Centropomus*), and Shad (*Alosa*) have become scarcer or have been extirpated in recent times (Groome, 1970).

(4) **Amphibians.** Grenada has four amphibian species: the Giant Toad (*Bufo marinus*), which was introduced from South America; the Highland Piping Frog (*Eleutherodactylus urichi euphronides*), which is confined to the wet forests around Grand Etang; the Piping Frog (*E. johnstonei*); and Garman's Woodland Frog (*Leptodactylus wagneri*), which is also characteristic of the Grand Etang forests. The Giant Edible Frog (*Leptodactylus fallax*) reportedly was introduced but did not survive (Groome,

1970). No single-island or regionally endemic amphibian species occur (Schwartz and Thomas, 1975), although Crombie (pers. comm., in Johnson, 1988) feels that the endemic subspecies *Eleutherodactylus urichi euphronides* is probably a valid species. Information is lacking about the status of amphibian populations in Grenada.

(5) **Reptiles.** There are eight species of lizards reported from Grenada -- these are the Common Anole or Wall lizard (*Anolis richardi*), the Crested Anole or Tree Lizard (*A. aneus*), the Mabouya gecko (*Hemidactylus mabouia*), introduced from Africa, the Wood Slave gecko (*Thecadactylus rapicauda*), Garman's Ground Lizard (*Ameiva ameiva tobagana*), Allen's ground lizard (*Bachia heteropus alleni*), the Slipperyback Skink (*Mabuya mabouya*), and the Green Iguana (*Iguana iguana*) (Maclean, *et al.*, 1977; GOG/OAS, 1988d). The iguana is reportedly becoming increasingly rare due to hunting and is considered threatened by CCA (unpublished; cited in Miller, *et al.*, 1988; Ludeke, *et al.*, 1989; GOG/OAS, 1988). The status of the other lizards is unknown, but some species may be in danger of extinction because of mongoose predation (Miller, *et al.*, 1988).

There are five species of snakes known to occur on Grenada today: the burrowing species *Typhlops tasymicris* which was described from a single specimen collected in St. David's Parish (Schwartz and Thomas, 1975), the White-headed Worm Snake (*Leptotyphlops margaritae*), the Tree Boa (*Corallus enydris* in Schwartz and Henderson, 1985; = "*Boa* near *enydris*", formerly *Boa grenadensis*, in Groome, 1970), Boddaert's Tree Snake (*Mastigodryas bruesi* in Schwartz and Henderson, 1985; = *Drymobius* near *boddaerti* in Groome, 1970) and the constrictor or Cribo (*Clelia clelia groomei*). Most snakes are either rare or their status is uncertain (CCA, unpublished; cited in Miller, *et al.*, 1988). Two snakes formerly found on Grenada are now thought to be extinct (Neuweid's Moon Snake, *Pseudoboa neuweidi*, and Shaw's Racer, *Liophis melanotus*; = *Dromicus melanotus* in Mclean, *et al.*, 1977). There are no venomous snakes dangerous to humans.

The snake *Typhlops tasymicris* is presently the only known single-island endemic reptile in Grenada according to Johnson, 1988. However, at least one worker (Crombie, pers. comm., in Johnson, 1988) thinks that the endemic snake subspecies *Clelia clelia groomei* may be a valid species. Groome (1970) thought it likely that the Tree Boa was a valid endemic species (*Boa grenadensis*), but Schwartz and Thomas (1975) and Schwartz and Henderson (1985) do not differentiate it from the mainland form *Corallus enydris*, which is also found in St. Vincent and the Grenadines. Three Grenadian reptiles are regional endemics: *Anolis aeneus*, *A. richardi* and *Mastigodryas bruesi* (Johnson, 1988).

There is a single record of an Orinoco Crocodile (*Crocodylus intermedius*) being washed ashore in Grenada in 1910 (Groome, 1970).

The Morocoy Tortoise (*Geochelone carbonaria*) has been reintroduced to the wild in Grenada through escapes from captive populations (Groome, 1970). Bindernagel (n.d.) reports that Frigate Island is known locally for its populations of Morocoy and Iguana. The distribution on Grenada and its satellite islands of living terrestrial amphibian and reptile species is given in Table 4.3(2).

All marine turtles are listed as endangered by IUCN, with the Hawksbill being the most critically endangered species. Natural factors such as storm damage to nesting beaches, disease and natural predators have always taken their toll, but the actions of man have had the greatest impact on sea turtle populations. The eggs of all species are eaten; juvenile and adult turtles are killed for their meat, as well as for an oil rendered from their fat which is reputed to have medicinal properties, and for sale to tourists as stuffed curries; Hawksbills are killed for their colored shell which is valued for jewelry.

Besides direct slaughter, other threats to the survival of turtles are destruction of nesting beaches by sand mining and development; bright lighting along the shoreline which disturbs nesting females and causes disorientation of the young at hatching; predation

on hatchlings by domestic animals such as dogs and pigs; floating tar balls and plastic bags that cause injury or death when ingested; and floating monofilament fishing line in which the turtles become entangled. In the case of the Hawksbill, the increasing damage to coral reefs from siltation, pollution and dredging affects the survival of populations, since this species feeds on the invertebrates associated with coral reefs and also depends on reefs for shelter at all stages of its life cycle.

Four sea turtle species -- Leatherbacks (*Dermochelys coriacea*), Hawksbills (*Eretmochelys imbricata*), Loggerheads (*Caretta caretta*) and Greens (*Chelonia mydas*) -- have been reported to nest on beaches in Grenada and the Grenadines (Bacon, et al., 1984; Goodwin, Goodwin and Putnam, 1982; Groombridge, 1982). Figure 4.3(1) shows turtle nesting beaches, and Table 4.3(3) summarizes data on sea turtle populations as compiled by Bacon (1981).

Although ECNAMF (1980a) reported Leatherback nesting along the south coast of Grenada (see Figure 4.3(1a)), this information could not be confirmed more recently by WIDECAS, which reports Leatherback nesting taking place between March and July in five areas: Sauteurs, Levera, Grenada Bay (Bathway), the beach north of Artiste Point (Antoine River beach), and the beaches of Conference and Great River Bays. According to WIDECAS, these beaches are, for the most part, under considerable threat from sand mining and, at least in the case of Sauteurs, from residential and fishing development on the beach (K. Eckert, WIDECAS, pers. comm., 1990).

Carr, et al. (1982) conducted interviews on Carriacou and Grenada; they reported that favorable nesting habitat for marine turtles is extensive in the Grenadines. Hawksbills are the prevalent nesters there, coming ashore from April through October. A few Leatherbacks nest each year on Carriacou, but no Loggerheads or Green turtles were reported to nest in the Grenadines. Hawksbills and Leatherbacks are the predominant nesters on Grenada, emerging in small numbers during the summer months;

Table 4.3(2). Distribution on Grenada and its satellites of terrestrial amphibian and reptile species.

GRENADA	LARGE ISLAND
<i>Bufo marinus</i>	?
<i>Eleutherodactylus johnstonei</i>	
<i>Eleutherodactylus urichi</i>	FRIGATE ISLAND
<i>Leptodactylus wagneri</i>	<i>Geochelone carbonaria</i>
<i>Geochelone carbonaria</i>	<i>Ameiva ameiva tobagana</i>
<i>Ameiva ameiva tobagana</i>	<i>Iguana iguana</i>
<i>Anolis aeneus</i>	
<i>Anolis richardi</i>	SALINE ISLAND
<i>Zachia heteropus alleni</i>	?
<i>Hemidactylus mabouia</i>	
<i>Iguana iguana</i>	CARRIACOU
<i>Mabuya m. mabouya</i>	<i>Anolis richardi</i>
<i>Thecadactylus rapicauda</i>	<i>Hemidactylus mabouia</i>
<i>Clelia clelia groomei</i>	<i>Iguana iguana</i>
<i>Corallus enydris cooki</i>	<i>Mabuya m. mabouya</i>
<i>Dromicus melanotus (extinct?)</i>	<i>Corallus enydris cooki</i>
<i>Mastigodryas bruesi</i>	<i>Mastigodryas bruesi</i>
<i>Pseudoboa neuwiedi (extinct?)</i>	
<i>Typhlops tasymicris</i>	MABUYA ISLAND
<i>Leptotyphlops margaritae</i>	<i>Anolis richardi</i>
<i>Crocodylus intermedius (accidental)</i>	<i>Iguana iguana</i>
BIRD ISLAND	PETIT TOBAGO
?	<i>Anolis aeneus</i>
SANDY ISLAND	PETIT MARTINIQUE
<i>Anolis aeneus</i>	<i>Anolis aeneus</i>
<i>Ameiva ameiva tobagana</i>	<i>Hemidactylus mabouia</i>
GREEN ISLAND	ILE A CAILLE
<i>Anolis aeneus</i>	<i>Ameiva ameiva tobagana</i>
<i>Ameiva ameiva tobagana</i>	<i>Anolis aeneus</i>
<i>Thecadactylus rapicauda</i>	<i>Iguana iguana</i>
	<i>Mastigodryas bruesi</i>
LEVERA ISLAND (SUGARLOAF)	DIAMOND ISLAND (KICK 'EM JENNY)
<i>Anolis aeneus</i>	<i>Anolis aeneus</i>
<i>Anolis richardi</i>	<i>Iguana iguana</i>
LONDON BRIDGE	GLOVER ISLAND
?	<i>Anolis aeneus</i>
	<i>Mabuya m. mabouya</i>
ISLE RONDE	
<i>Anolis aeneus</i>	
<i>Ameiva ameiva tobagana</i>	
LES TANTES	
<i>Anolis aeneus</i>	

Source: Groome, 1970; Maclean, *et al.*, 1977; Bindernagel, n.d.

Table 4.3(3). Summary of data on sea turtle populations in Grenada.

Species Present: (Key: Ei = Hawksbill; Dc = Leatherback; Cm = Green; Cc = Loggerhead)

STATUS	NESTING	FORAGING	
		ADULTS	JUVENILES
Abundant			
Common			
Frequent		Ei Cm	Ei Cm
Occasional	Ei Dc	Dc	Cc
Rare	Cm Cc		

Nesting Areas: Hog Island, Little Bacolet Bay, La Sagesse Bay, Soubise, Pearls, Levera, Sandy Island, Green Island, Caille Island (Ei Dc). From Telescope Point to La Poterie, Hartman's Lagoon, L'Anse Epine, Caliviny, Wasterhall, Baccaye (Dc); Marquis Island (Cm).

Foraging Areas: Woburn, La Sagesse, Crouchu, Soubisse, La Poterie (Ei Cm); Black Bay (Cm).

Population Estimates: None.

Sanctuaries: None.

Legislation: Closed Season, 1 May to 30 September, Birds and Other Wildlife (Protection of) Ordinance, 1957.

THE GRENADA GRENADINES:

Nesting: Carriacou - Petit Carenage, Anse la Roche (Ei Dc); Tarlton Bay, Bogles, Hillsborough Beach, Grand Bay (Ei); Sandy Island, White Island, Mopion, Punaise, Petit St. Vincent, Petit Martinique (Ei).

Foraging: All around islands (Ei Cm Cc).

Source: Bacon, 1981.

Greens and Loggerheads have been reported to nest only rarely.

As in the other Eastern Caribbean islands, sea turtle stocks in Grenada are considered by many experts to be depleted, but quantitative information is scarce. The extensive shallow waters and reefs around the Grenadines are excellent foraging habitat for Hawksbills and Greens; the most commonly seen turtles there are the Greens, with the Hawksbills second in abundance, followed by Loggerheads. Green turtles are also the most

abundant species around Grenada. The Olive Ridley (*Lepidochelys olivacea*) is present peripherally in the Wider Caribbean region, but is considered to occur only accidentally in the Lesser Antilles. Kemp's Ridley (*L. kempi*) has not been recorded from the Caribbean (Carr, *et al.*, 1982; Meylan, 1983).

(N.B. Grenadian wildlife literature (e.g., Ludeke, *et al.*, 1989; GOG/OAS, 1988d) frequently cites Kemp's Ridley as an endangered sea turtle species occurring in Grenada. This appears to be an error deriving from the

fact that this species is listed in Groome's (1970) booklet on Grenadian natural history. However, Groome rightly points out that the infrequent records of *L. kempi* from the Caribbean -- he does not say Grenada -- probably are mistaken identifications of *L. olivacea*).

(6) **Birds.** About 150 species of birds have been recorded in Grenada and the Grenadines (Groome, 1970), and Grenada has 35 resident species of land birds (Blockstein, 1988). Information on seabirds is considered poor by Halewyn and Norton (1984), who reported three species of breed-

ing seabirds from Grenada and twelve from the Grenada and St. Vincent Grenadines combined (see Table 4.3(4) and Figure 4.3(1)). Habitat destruction and disturbance and the exploitation of adults, eggs and/or young are listed as the known threats to seabirds.

Halewyn and Norton (1984) assigned to each area a rough subjective rating of its regional importance for breeding seabirds; on this basis Grenada is classified as "relatively unimportant" and the Grenadines as "extremely important". With regard to regional conservation priorities for the twelve

Table 4.3(4). Seabird species reported to breed in Grenada and the Grenadines.

GRENADA		
COMMON NAME	SCIENTIFIC NAME	REG. CONSERVATION PRIORITY
Audubon Shearwater(?)*	<i>Puffinus lherminieri</i>	Special Concern
Laughing Gull	<i>Larus atricilla</i>	No Immediate Concern
Roseate Tern	<i>Sterna dougallii</i>	Special Concern
GRENADA GRENADINES/ST. VINCENT GRENADINES		
COMMON NAME	SCIENTIFIC NAME	REG. CONSERVATION PRIORITY
Audubon Shearwater (?)	<i>Puffinus lherminieri</i>	Special Concern
Red-billed Tropicbird	<i>Phaeton aethereus</i>	To Be Monitored
Magnificent Frigatebird (?)	<i>Fregata magnificens</i>	Special Concern
Masked Booby	<i>Sula dactylatra</i>	Special Concern
Red-footed Booby	<i>Sula sula</i>	To Be Monitored
Brown Booby	<i>Sula leucogaster</i>	To Be Monitored
Laughing Gull	<i>Larus atricilla</i>	No Immediate Concern
Gull-billed Tern (?)	<i>Gelochelidon nilotica</i>	---
Roseate Tern	<i>Sterna dougallii</i>	Special Concern
Bridled Tern	<i>Sterna anaethetus</i>	No Immediate Concern
Sooty Tern	<i>Sterna fuscata</i>	To Be Monitored
Brown Noddy	<i>Anous stolidus</i>	No Immediate Concern

* (?) means breeding is unconfirmed.

Source: Halewyn and Norton, 1984.

species of seabirds listed for Grenada and the Grenadines, these authors listed four species as being "of special concern", the status of five are "to be monitored", and three are "of no immediate concern" (Table 4.3(4)).

Bindernagel (n.d.) states that some species of seabirds, including the Brown Booby, Laughing Gull, Noddy Tern and possibly Red-Billed Tropic Bird, are reported to nest on Saline, White and Frigate Islands during April/May. Grazing by goats is causing habitat deterioration on these islands, and it has been reported that "people from Martinique" visit them to shoot birds and dynamite fish.

The Grenada Flycatcher (*Myriarchus nugator*), Scaly-breasted Thrasher (*Margarops fuscus*), Lesser Antillean Bullfinch (*Loxigilla noctis*) and Lesser Antillean Tanager (*Tangara cucullata*) occur in Grenada and are endemic to the Lesser Antillean region. None of these except for the Thrasher, which may

possibly be extinct there, is believed to be under any threat in Grenada (Johnson, 1988).

Two birds are endemic to the island of Grenada only: a subspecies of the Hook-billed Kite (*Chondrohierax uncinatus mirus*) and the Grenada Dove. The Grenada Dove was first described in 1884 as a distinct species (*Leptotila wellsii*) but was reclassified in 1983 as a subspecies of the Gray-fronted Dove (*L. rufaxilla*), to which it is morphologically similar. Blockstein and Hardy (1989) recently argued that the Grenada Dove should be restored to the status of a full species on the grounds that there are significant differences between it and *L. rufaxilla* in the details of songs and plumage. Both the Grenada Dove and the Hook-billed Kite are now found mainly in the dry southwest portion of Grenada and are listed as endangered by the International Council for Bird Preservation (King, 1978-1979) and the U.S. Fish and Wildlife Service (1987).

Table 4.3(5). Grenadian birds listed as endangered by the Caribbean Conservation Association.

Blue-hooded Euphonia, *Euphonia musica*
 Blue-tailed Emerald Hummingbird, *Chlorostilbon mellisugus*
 Broad-winged Hawk, *Buteo platyterus*
 Common Snipe, *Gallinago gallinago*
 Everglade Kite, *Rostrhamus sociabilis*
 Fulvous Tree-duck, *Dendrocygna bicolor*
 Great Egret, *Casmerodius albus*
 Grenada Dove, *Leptotila wellsii*
 Grenada Hook-billed Kite, *Chondrohierax uncinatus mirus*
 Large-billed Seed Finch, *Oryzoborus crassirostris*
 Lesser Elaenia, *Elaenia chiriquiensis*
 Lesser Seed Finch, *Oryzoborus angolensis*
 Limpkin, *Aramus guarana*
 Masked Duck, *Oxyura dominical*
 Scarlet Ibis, *Eudocimus ruber*
 Swallow-tailed Kite, *Elanoides forficatus*

Source: Ludeke, et al., 1989.

In addition to the Grenada Dove and the Hook-billed Kite, another fourteen Grenadian bird species are listed as endangered by the CCA (Table 4.3(5)), and thirty-four other species of birds are presently listed as "vulnerable" in Grenada (CCA, unpublished; cited in Ludeke, *et al.*, 1989). The Grenada Hook-billed Kite, the Grenada Dove, and the Tundra Peregrine Falcon (*Falco peregrinus tundrius*) are listed in the IUCN Red Data Book on Endangered Birds (King, 1978-1979) as regionally endangered. The Grenada Parrot (*Amazona sp.*) became extinct shortly after the arrival of Europeans.

(7) Mammals. Four native species of terrestrial mammals occur in Grenada: Nine-banded Armadillo or Tatou (*Dasyopus novemcinctus*); Lesser Chapman's Murine Opossum (*Marmosa fuscata carri*); Greater Chapman's Murine Opossum (*Marmosa robinsoni chapmani*); and Agouti (*Dasyprocta albida*)

There are no single-island or regionally endemic species of mammals in Grenada or the Grenada Grenadines (Johnson, 1988), and none of the mammals is listed as threatened in the IUCN Red Data Book (Thornback and Jenkins, 1982). Nevertheless, GOG/OAS (1988d) consider some native mammals to be locally threatened. The Nine-banded Armadillo or "Tatou", which lives in forested areas and is heavily hunted for food, is listed as endangered. The Lesser Chapman's Murine Opossum is listed as vulnerable, and the Greater Chapman's Murine Opossum is thought to be rare.

There are eleven native species of bats recorded from Grenada (Groome, 1970):

- Sac-winged Bat (*Pteropteryx macrotis*)
- Fish-eating Bat (*Noctilio leporinus*)
- Bare-back Bat (*Pteronotus davyi*)
Micronycteris megalotis (no common name)
- Long-tongued Bat (*Glossophaga longirostris*)
- Leaf-nosed Bat (*Carollia perspicillata*)
- Fruit-eating Bat (*Artibeus jamaicensis*)
- Large Fruit-eating Bat (*Artibeus lituratus*)

- Pygmy Fruit-eating Bat (*Artibeus cinereus*)
- Little Black Bat (*Myotis nigricans*)
- Small Free-tailed Bat (*Molossus obscurus*)

None of the bat species is known to be threatened (Johnson, 1988), but very little information on the status of bats is available.

The Manatee (*Trichechus manatus*) was extirpated soon after the arrival of Europeans in Grenada, and the Agouti (*Dasyprocta albida*) is thought to have been hunted to extinction only recently (Groome, 1970).

There is a stock of Humpback Whales (*Megaptera novaeangliae*) which migrates between Greenland and the Eastern Caribbean. A small group of Humpbacks still winters in the waters between St. Vincent and Grenada. Their calving grounds are located in the Grenadines and also between Anguilla and Antigua. Humpback Whales had been hunted from a station on Glover Island off Grenada since at least 1857 but were virtually exterminated in this area by American whalers by 1927 (Groome, 1970). Other species of cetaceans formerly taken by whalers operating out of Glover Island and Barrouallie Village in St. Vincent (Mitchell and Gold, 1982) included Pilot Whale or Blackfish (*Globicephala macrorhynchus*), Killer Whale (*Orcinus orca*), Beaked Whale (*Zizyphus sp.*), Bottlenose Dolphin (*Tursiops truncatus*), and two species of Ocean Dolphin (*Stenella spp.*).

Artisanal whalers from Bequia are still permitted by the International Whaling Commission to take a maximum of three whales per year from this severely depleted population (Greenpeace, 1988), but this fishery is virtually defunct. Although the Bequia whalers are the only ones officially still operating in the Caribbean, it appears that a whale fishery for Humpback, Sperm and Pilot Whales may still be carried out from Barrouallie Village in St. Vincent (deGeorges, 1989).

Table 4.3(6). Principal Grenadian game species and their hunting seasons in Grenada.

Hunting season opens 1 September, closes 1 March:

Ramier or Pigeon (*Columba squamosa*)
Tatou or Armadillo (*Dasypus novemcinctus*)
Mona Monkey (*Cercopithecus mona denti*)
Manicou or Opossum (*Didelphis marsupialis insularis*)
Birds

Mallard duck (*Anas platyrhynchos*)
Blue-winged teal (*Anas discus*)
Green-winged teal (*Anas crecca carolinensis*)
American widgeon or baldpate (*Anas americana*)
Shoveller duck or sucet (*Spatula clypeata*)
Lesser scaup duck (*Athya affinis*)
Florida gallinule or waterhen (*Gallinula chlorous cerceris*)
Caribbean coot or waterfowl (*Fulica caribae*)
Hudsonian curlew or whimbrel (*Numenius phaeopus hudsonicus*)
Greater yellow legs (*Tringa melanoleuca*)
Willet or tell-bill-willy (*Catoptrophorus semipalmatus*)
Wilson's snipe or common snipe (*Capella gallinage delicata*)
Violet-eared dove or Trinidad ground dove (*Zenaida auriculata stenurs*)
Zenaida dove or mourning dove (*Zenaida aurita*)
Broad-winged hawk or chicken hawk or gree-gree (*Buteo platypterus antillarum*)
Peregrine falcon or duck hawk (*Falco peregrinus anatum*)
Glossy cowbird (*Molothrus bonairiensis minimus*)
Lesser Antillean Grackle or Blackbird (*Quiscalus lugubris luminosus*)

Hunting season opens 30 September, closes 1 May:

Sea Turtles

Green (*Chelonia mydas*)
Hawksbill (*Eretmochelys imbricata*)
Loggerhead (*Caretta caretta*)
Leatherback (*Dermochelys coriacea*)

Source: Ludeke, *et al.*, 1989.

WILDLIFE LEGISLATION

Protection was given to birds and certain other species of wildlife in the Grand Etang Forest Reserve by the Wild Animals and Birds (Sanctuary) Ordinance (Cap. 314) of 1928. This law gave absolute protection within any forest reserve to a species of armadillo and certain snakes specified in a schedule and to agouti throughout the island for a period of six years. Since then, the

agouti and armadillo have been over-hunted throughout the country (Ludeke, *et al.*, 1989; Lausche, 1986).

The Birds and Other Wildlife (Protection of) Ordinance (Cap. 36) of 1957 designated game species in Grenada and established hunting seasons for each, as shown in Table 4.3(6). This law was extended until the end of 1972 by Ordinance No. 26 of 1964,

Birds and Other Wildlife (Protection of) (Amendment).

Ordinance 26 of 1964 included 18 other birds (mostly ducks and waterbirds, also listed in Table 4.3(6)) under the coverage of the September 1 to March 1 hunting season. The Broad-winged Hawk and Peregrine Falcons were included in the hunting season because they are thought to prey on domesticated fowl, and the glossy cowbird and the Lesser Antillean Grackle because they were considered garden pests. All other wild birds and their eggs were provided absolute protection. Turtle, lobster, and oysters were also protected during closed seasons (Ludeke, *et al.*, 1989).

However, according to Bindernagel (n.d.), Ordinance 26 of 1964 has never been extended beyond its original expiration date of 1972. Therefore, it appears that none of the species covered under this ordinance or the Birds and Other Wildlife Ordinance of 1957 are currently protected.

RESERVES, NATIONAL PARKS AND OTHER PROTECTED AREAS

The 1906 Grand Etang Reserve Ordinance (Cap. 135) designated the area around the Grand Etang Lake as a forest reserve, as well as two areas in Carriacou. The Forest, Soil and Water Conservation (Amendment) Ordinance of 1984 (Ordinance No. 34 of 1984) established as forest policy the protection of "such areas as may be required to provide natural and undisturbed habitat for the flora and fauna of Grenada."

At the present time, there are no officially designated national parks in existence in Grenada or the Grenada Grenadines, but a proposed National Parks and Protected Areas Plan has been prepared (GOG/OAS, 1988d). Although the plan itself has not yet been accepted by GOG, some of its recommendations have already been implemented by the National Parks Unit. The objectives of this plan which are most directly related to wildlife are the following:

- to preserve genetic materials as elements of natural communities;
- to maintain biological diversity by minimizing the loss of any plant or animal species; and
- to preserve and manage fish and wildlife resources in view of their important role in environmental regulation, sport, and recreation activities and as producers of protein and other products.

The Minister may declare any fishery waters (and, as appropriate, any adjacent or surrounding land) to be a marine reserve. The Grenada Fisheries Act of 1986 gives the Fisheries Department the authority to prevent the disturbance, alteration or destruction of the natural environment in any marine reserve or conservation area -- this includes the control of fishing, dredging, extraction of sand and gravel, and discharge or deposit of waste or any other polluting matter. Unfortunately, these broad powers are inconsequential at the present time since no such marine reserves or conservation areas have been set up. It is not entirely clear whether such authority would include jurisdiction over marine parks if and when such areas are designated under the proposed National Parks and Protected Areas Plan.

4.3.2 Problems and Issues

(1) **The Grenada Dove and Grenada Hook-billed Kite.** A population survey carried out in 1987 by Blockstein (1988) estimated that there were only about 100 Grenada Doves and 15-30 Hook-billed Kites on Grenada. Aside from two recent records from dry secondary woodlands on the central west coast, almost the entire Grenada Dove population now appears to be located in an area of about 500 ha in the southwest peninsula (Figure 4.3(2)). Most of the Doves are found in the Government-owned Mount Hartman Estate, an abandoned sugar cane plantation. The estate has extensive agricultural clearing and cultivation in the lowlands,

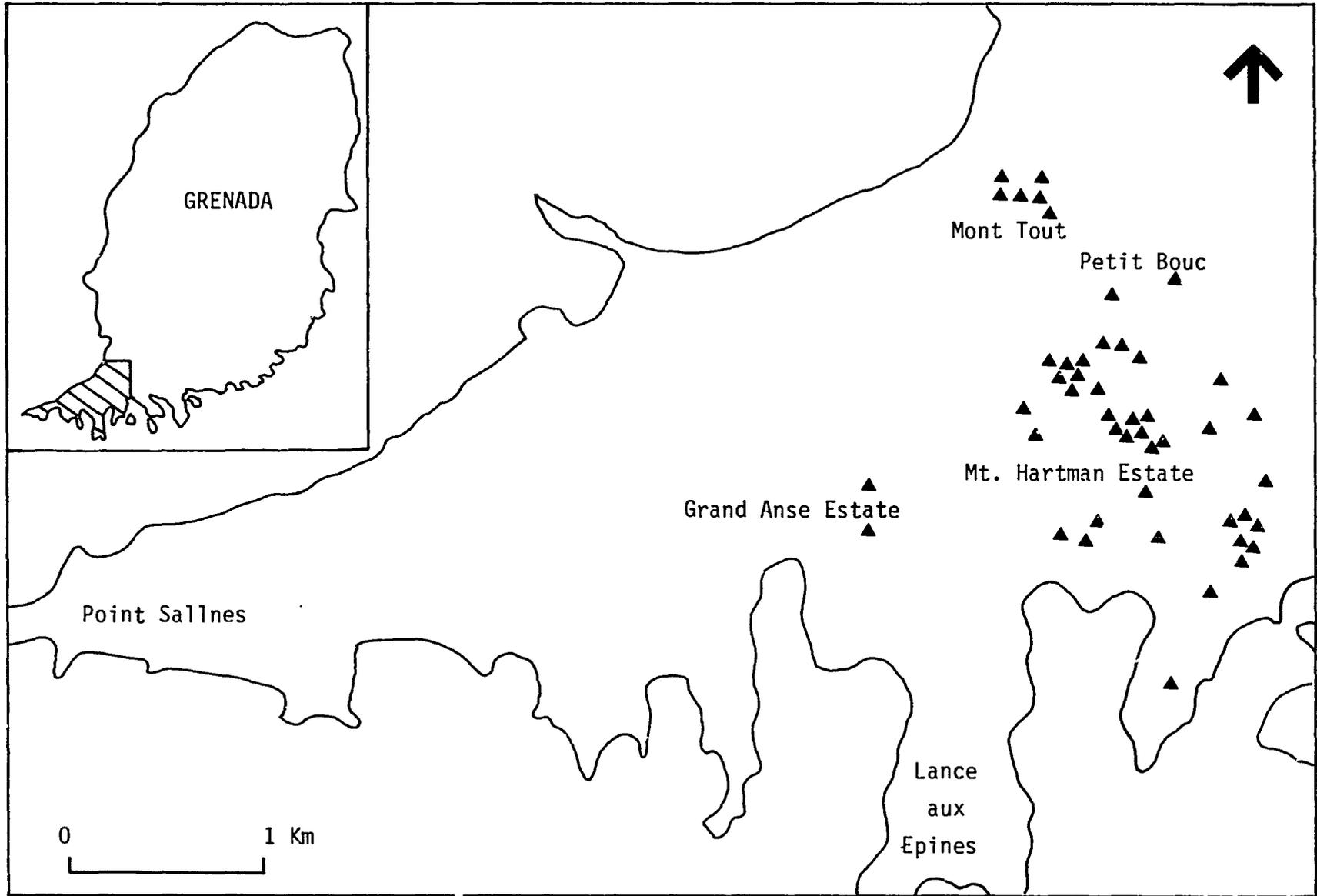


Figure 4.3(2). Distribution of Grenada Doves, July 1987 (source: Blockstein, 1988).

but some thickets of deciduous thorn scrub still remain on the hillsides.

Blockstein believes that the range of the Grenada Dove has contracted in recent decades. The species has probably always had a small population, with the main center of distribution being the dry scrub woodlands of the southwest peninsula. However, at one time, they also existed in the Levera Pond area and on Green Island, but they were not found in either of these places or on the islets off the southwest peninsula during Blockstein's survey.

The Hook-billed Kite has always been regarded as rare in Grenada. Except for occasional sightings in the area of Mount Fedon and near Levera, all observations of this species have been in the southern part of the island (Figure 4.3(3)). Since the Kite feeds exclusively on a few species of snails which are most abundant in the xeric parts of the island, the number of snails available may be the limiting factor on the population size. It is not likely that the population can be increased significantly above the present level (Blockstein, 1988).

Destruction of dry woodlands and scrub for agriculture and development is having a negative impact on the Grenada Kite, especially luxury home construction in the ridge-top forests which are used as roosting, foraging and nesting sites. Building on ridge tops is reportedly illegal in Grenada, but this law is not enforced at present (J. Pitt, pers. comm., in Blockstein, 1988).

The major threat to both the Grenada Dove and the Hook-billed Kite is the continuing loss of their habitat, although the Kites seem to be somewhat more tolerant of disturbance and altered habitats. The survival of these species now depends largely on the preservation of the hillside scrub habitat in Mount Hartman Estate. However, land use in the southwest peninsula has become more intensive since the 1970's. Tourist hotel and luxury home development, quarrying, residential subdivisions, and the construction of the international airport at Point Salines in the early 1980's have permanently converted many of the wooded areas to other uses. The

airport construction project alone destroyed about ten percent of the scrub habitat on the peninsula (Wunderle, 1982). Agro-industrial land uses are also proliferating in the area (e.g., expansion of sugar cane plantations, a proposed large pig farm and meat processing industry).

Much of the present clearing of scrub woodlands in Mount Hartman Estate is due to various development projects supported by Government, e.g., its Agricultural Rehabilitation/Crop Diversification Program, funded by the International Development Association of the World Bank/Caribbean Development Bank. Andrews (1988) investigated and rejected the area as an alternative sanitary landfill site and also recommended that the present quarrying operations be discontinued in favor of tourism development. The latter, if done sensitively, may in fact be the land use which is most compatible with the continued existence of these endangered birds.

It is almost inevitable that the world's only population of the Grenada Dove will be extirpated if present trends continue. Blockstein (1988) reported that in 1987 the lower part of the estate was being bulldozed for new sugar cane fields. Observations by the CEP Project Team in June 1989 show that this habitat destruction is still continuing and has now spread to many of the hillsides.

(2) **Effect of mongoose and monkey predation on wildlife.** The possible impact of predation by monkeys and mongooses on the Grenada Dove and other wildlife in Grenada has not been investigated quantitatively. However, the mongoose (*Herpestes auropunctatus*) is known to be destructive to poultry, lizards, turtle eggs and hatchlings and ground nesting birds. Hummelinck and van der Stein (1983) estimated a high mongoose population density of 10.4 individuals per hectare in a small gridded area on the southwest peninsula, and 3.2 per hectare on the Mount Harman Estate. It is probable that eggs and nestlings of the Grenada Dove are preyed upon to some extent by mongooses.

The Mona Monkey is common in the upper montane forests of Grand Etang and Mount St. Catherine and is hunted for food.

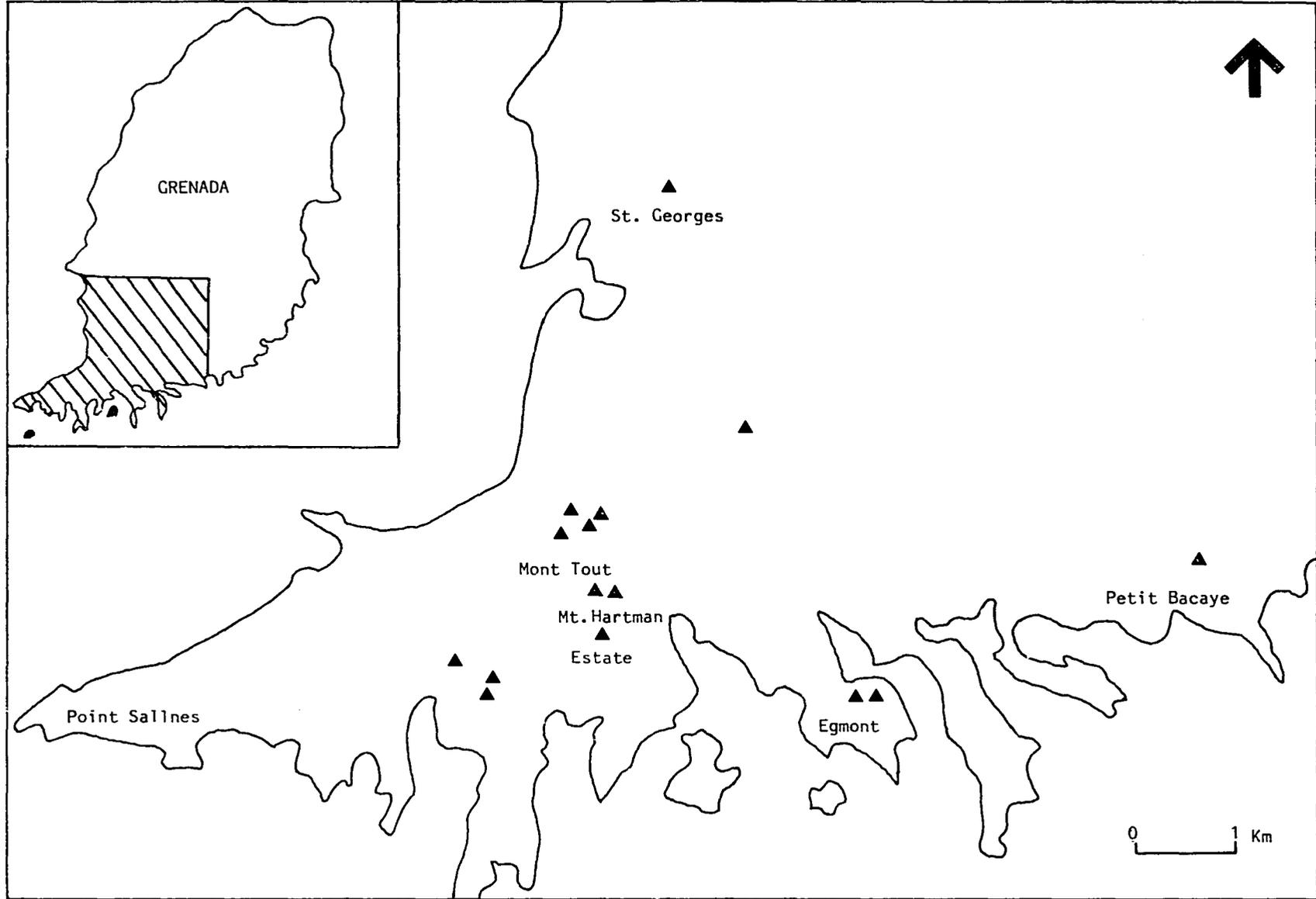


Figure 4.3(3). Distribution map of Hook-billed Kites, July 1987 (source: Blockstein, 1988).

These monkeys are reputed to be very dangerous and destructive to the local fauna (GOG/OAS, 1988d). While their numbers were reportedly reduced in numbers by Hurricane Janet in 1955, recent restrictions on the use of firearms has apparently allowed an expansion of the population.

(3) Need for amended wildlife legislation. The laws pertaining to wildlife in Grenada are both outdated and not effectively enforced (Ludeke, *et al.*, 1989). The major pieces of legislation protecting wildlife and setting hunting seasons have lapsed and therefore have no legal force at present, as discussed above in relation to birds. Moreover, these laws do not conform to internationally recognized standards, especially in regard to endangered species. Some species (e.g., marine turtles) are listed both as endangered species and as game species.

(4) Hunting. There are two hunter's associations, which are the only non-governmental organizations allowed to bear arms in Grenada. The members of the Grenada Wild Game and Conservation Association, founded in 1970, are allowed a limited number of shotguns, and the recently founded Grenada Hunting and Fishing Group is also allowed a number of shotguns. Both groups favor the protection of game species populations by strict observation of the hunting season, and both want the Government to approve more shotguns for their members. A third objective of these groups is the introduction or reintroduction of wildlife (e.g., agouti) for hunting purposes.

Currently there is concern that the present five year ban on hunting in Trinidad may severely stress Grenada's remaining wildlife by increasing illegal hunting to fill the demand for "wild meat" in Trinidad. It is felt by some that more knowledge of the population dynamics of game species is needed before additional gun permits are issued by GOG. Ludeke, *et al.* (1989) emphasize that extensive research on the effects of exotic game species on the native flora and fauna are essential before such species are introduced.

(5) Protection for coastal wetland habitats. Many mangroves and freshwater

wetlands, critical habitats for birds and other wildlife, are at risk from development. Mangroves total only 470 acres in Grenada and 98 acres in Carriacou, and freshwater wetlands total a mere 70 acres in Grenada (Eschweiler, 1982b). Some of these areas have already suffered damage (e.g., Levera Pond, Halifax Harbor wetlands, mangroves in Mount Hartman and Woburn Bays, Lake Antoine).

Forests, wetlands and coastal habitats in the Lesser Antilles provide critical feeding and nesting habitat for many species of birds migrating along the West Indian Flyway between North and South America (Johnson, *et al.*, 1988). The loss of these habitats, especially coastal systems such as mangroves, salt ponds, and other wetlands, could threaten the long-term survival of a number of migratory shorebird and songbird species. Over 100 migrant species are regularly recorded in the Lesser Antilles; most of these species nest in North America and over-winter in the Caribbean or South America.

Levera Pond in Grenada is the northernmost range extension of the Scarlet Ibis, an occasional visitor to Grenada. This pond is also an important breeding and feeding area for waterfowl and other migrant birds, but is under pressure from charcoal cutters. Funding is presently being sought from EEC to establish a wildlife sanctuary in the Levera area (Vincent, 1989).

La Sagesse and many of the mangrove-lined bays on the southern coast of Grenada, as well as Point Salines Ponds, are important for migratory shorebirds. Calivigny Mangrove Swamp supports a seabird colony, and numerous seabirds are reported to nest on Glover Island (P. Hall, pers. comm., in Blockstein, 1988).

In Carriacou, the "Carriacou Mangroves" and Petit Carenage mangroves have many resident waterbirds and rare migrants, and London Bridge has seabird colonies (Johnson, 1988). Not any of these areas are legally protected at present, although some are proposed for inclusion in the national park system.

(6) **Effects of biocides on biodiversity and wildlife.** Large amounts of pesticides and herbicides (collectively referred to as biocides) are applied to agricultural crops in Grenada (see Chapter 8), but the effects of these chemicals on wildlife and the terrestrial and marine ecosystems of Grenada remain unstudied. Even if standard toxicological data were available for Grenada, there is growing recognition that such data are frequently not sufficient to predict the path and consequences of toxic synthetic compounds in an ecosystem. Furthermore, the consequences for wildlife populations of exposure to sublethal levels of one or more pesticides in combination with multiple environmental stresses (e.g., habitat reduction, an unusually severe dry season) cannot yet be predicted even at the single-species level.

With these sweeping caveats in mind, it can be noted that birds are generally more sensitive to pesticides than mammals, perhaps in part because mammals have better detoxification systems. Fish are frequently, but not consistently, more sensitive than warm-blooded vertebrates. There is also a general developmental hierarchy of sensitivity within each species. Vertebrate embryos, eggs and larvae are often more sensitive to toxicants than adults because they are less protected from the surrounding environment, have limited means for detoxifying absorbed substances, and are less able to move away from noxious substances.

Evaluating the possible effect of biocides requires information on the distribution of wildlife across habitats, daily and seasonal movements, and diet -- a fairly detailed ecological picture which is rarely available for tropical vertebrates and which is exceedingly labor intensive to acquire. Because such detailed field data are not available for Grenada, the following brief discussions of biocide effects on terrestrial wildlife are based on a study by Rainey, *et al.* (1987) in Dominica, which was concerned only with the biocides used in the banana industry.

(a) Direct observation at night of tiny streams coursing through banana plots in Dominica revealed significant numbers of at least two genera of

shrimp (*Atya* and several species of *Macrobrachium*), including adults, even though one of the streams served periodically for spray tank washing. In these upland banana growing areas, a shrimp population of varied age structure persists under current pesticide application practices. Freshwater shrimp on Dominica feed on macroscopic organic debris, suspended or deposited organic particles. Their continued presence indicates that lethal levels of biologically available pesticides are not constantly present in the streams either in solution or adsorbed on plant debris or soil which they ingest.

However, it should be noted that periodic fish-kills in the lower reaches of Dominican rivers offer a strong indication that there is indeed an aquatic pollution problem. These areas combine the cumulative pollution load of biocides and other toxic materials with higher temperatures and slower flow.

If catastrophic destruction of freshwater fish, shrimp or crab populations on Grenada did occur due to biocide contamination, those species with abundant marine larvae would likely recover most rapidly. For species whose link to the sea is weaker or broken -- larval development is completed in fresh or low-salinity water -- local adaptation is possible but recovery from extirpation would be slower.

(b) Frogs occur widely in Grenada in wetter natural and man-made habitats likely to be exposed to pesticide contamination from banana and tree crop farming, but their apparent abundance in similar areas of Dominica suggests there is no reason for concern about species survival. Reptiles are most diverse and abundant in the warmer, drier coastal areas of both Dominica and Grenada; in Grenada they are likely to be affected either by habitat destruction or by agrochemicals from the sugar cane,

vegetable and fruit growing industry in these drier areas.

While no quantitative data have been identified, it is commonly observed that spraying programs for mosquitoes kill lizards around human habitations. Where adjacent, unsprayed habitat provides a refuge, populations of small lizards probably recover fairly quickly, and there is no serious threat to species survival. But if the bulk of any lizard's habitat comes under cultivation, it should be kept in mind that use of insecticide may well reduce reptile populations.

Iguanas are arboreal leaf eaters, typically seen feeding or basking in the crowns of trees along streams and beaches. There is some possibility that they will consume biocide-sprayed foliage in aerially sprayed areas, but the major threat to survival as a species and a resource is likely to be hunting and habitat destruction. This and introduced predators are the primary pressures elsewhere -- if pigs or mongooses are present where iguanas nest, they are remarkably effective at finding concealed eggs.

(c) Birds which forage (or reside) in banana cultivations are likely to be directly exposed to fungicides from aerial or ground spraying. They also may be contaminated as they perch and forage on sprayed plants. If they forage on or near the ground they may contact or ingest the substantially more toxic nematicides used. In Dominica there were reports of disorientation and mortality of small birds foraging in areas recently planted in bananas. Either some nematicide intended for the planting holes remained on the surface, or they consumed poisoned soil invertebrates which had emerged on the surface.

Despite the likelihood of fungicide exposure and indications of some mortality from nematicides, it was found in Dominica that mixed plantings

of citrus and banana supported the highest bird diversity among the several types of cultivated habitats examined. Some birds, such as the bananaquit or sucrier (*Coereba flaveola*) and bullfinch (*Loxigilla noctis*), were particularly abundant in these and other cultivated habitats. Many of the bird species common in the banana plots have relatively short generation times and have coexisted with current pesticide use patterns for several years, indicating that the fungicides do not cause substantial mortality or lead to population declines by disturbing reproduction or other mechanisms. Because of evidence for at least some mortality, there should be an evaluation of nematicide and insecticide effects on populations of longer-lived ground foraging birds.

(d) As with birds, in Dominica the diversity of native mammals (all bats) is highest in rain forest areas. There is generally a broad overlap between the habitat of both native and introduced mammals and agricultural areas in Caribbean islands; many species forage in crop plots. Among the agricultural areas, bat diversity and abundance was highest in mixed plantings of citrus and banana. Since bats conceal themselves in the daytime, only those which seek shelter in forest foliage adjacent to cultivated plots are likely to be directly exposed to drifting biocide spray. The diversity and abundance of bats in established banana plots in Dominica suggests that current pesticide use patterns in that island's banana industry have no marked impact on their populations.

(7) Loss of native forest habitat.
The primary negative impact of development on wildlife is habitat reduction via the conversion of forested wildlands to other habitat types and land uses. Home range requirements and minimum viable population sizes for most species are as yet poorly known. The proposed system of parks and protected areas, *if maintained largely as native forest and other native vegetation types*, may perhaps include

sufficient area to prevent the extinction of the smaller species of wildlife.

Among natural vegetation types on Dominica, rain forest supported the highest bird diversity and biomass (but this is not necessarily the case on Grenada). In the Dominica studies, the pattern as well as the extent of forest clearing was found to be significant because the forest birds differ considerably in home range size. The pattern of clearing was also significant to the substantial number of birds which foraged in cultivated areas but required forest for roosting and nesting. Cultivated plots with native forest adjacent had higher bird diversity than extensive crop monocultures.

The importance of *native* forest for wildlife perhaps needs to be underscored. Unfortunately, even-age plantations of exotic timber trees are typically almost free of native wildlife; even mixed tree-crops are better habitat. The suggestions offered elsewhere in the Profile that, for the smaller species, existing forest reserves and proposed parks may be adequate to assure species survival depend on retaining substantial tracts of native forest. To the extent that native forest within the reserves is replaced by exotic trees, those suggestions grow more tenuous. The question of how much forested land is necessary to have a reasonable probability of maintaining a given species or community is difficult, but not impossible, to answer by means of research.

(8) International trade in threatened and endangered wildlife. International trade is a major threat to the survival of many species in the Caribbean (TRAFFIC [U.S.A.], 1988). Many Caribbean countries permit commercial export of wildlife, including species listed as endangered by IUCN. The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) attempts to regulate wildlife trade through a worldwide system of import and export controls. However -- in the Caribbean -- the Bahamas, Dominican Republic, St. Lucia, St. Vincent and the Grenadines, and Trinidad and Tobago are the only independent nations which have joined CITES. Grenada is not at present a member of this convention.

In some instances, Japanese dealers, in particular, have sought the cooperation of non-CITES countries to disguise the true origin of sea turtle products imported in defiance of CITES regulations. An increased membership in CITES by those Caribbean countries having sea turtle populations may help to ensure the survival of the species by further limiting the availability of turtles for such markets -- providing turtles are not exempted as many countries have done.

Non-commercial trade, specifically exotic tourist souvenirs or live wildlife, is probably the area of most concern to those monitoring wildlife trade in the Caribbean since it is largely unreported (TRAFFIC [U.S.A.], 1988). The Hawksbill and other marine turtles, corals, black coral, some seashells, marine aquarium fish, reptiles and birds are examples of wildlife species in which there is a substantial Caribbean trade. It has been reported (Carr, *et al.*, 1982) that the trade between fishermen and yachts in stuffed souvenir turtles and turtle shells was lively in the Grenada Grenadines in the early 1980's; this trade probably still exists to some extent.

It should be noted that a nation's membership in CITES does not limit domestic use of CITES-listed species. For species which play a significant role in *local* subsistence and commercial markets, a CITES member country is obligated only to ensure that products from such species do not enter *international* trade. Although it offers imperfect protection to endangered species, the treaty does contribute to the goal of bringing wildlife exploitation down to levels that wild populations may be able to sustain.

4.3.3 Policy Recommendations

LAND USE

* A detailed land use plan should be completed for Grenada which includes consideration of biodiversity issues. Restrictions should be placed on clearing native forest from agriculturally marginal lands in certain areas and for specific habitat types. Since

wildlife values are typically given little weight in planning efforts, one item needed is an ecologically sound, quantitative analysis of current land use practices and trends and their effects on wildlife.

BIOCIDES

* An "institutional memory" (i.e., long-term record keeping by an appropriate GOG office) should be developed for pollutant impacts on wildlife by means of a simple database. Descriptive information, even if unconfirmed by site visits, would provide a perspective on the frequency and distribution of events. It would also be desirable to do selective sampling of soil and groundwater levels for the more toxic biocides used in the agricultural industry. Such a survey could constructively include a limited assessment of chlorinated hydrocarbon residues in wildlife as well.

* There is a need to establish a small scale pesticide disposal system and to review how to avoid or minimize dispersal of pesticides from agricultural industry warehouses in hurricanes.

RESEARCH

* To maintain biodiversity in the face of increasing demands for agricultural land requires at least semi-quantitative knowledge of what is required to maintain species or communities (in terms of land area or other resources). One way external aid agencies, whose funds fuel the engines of development, can aid in the maintenance of biodiversity is to support ecological and demographic assessments of species which are either obviously threatened (e.g., the Grenada Dove) or are less well-known but closely linked to the habitat being modified.

* A Wildlife Unit needs to be established within the Forestry Department, employing a trained wildlife biologist and one or two assistants. Responsibilities of the Unit should emphasize applied research in wildlife management for selected species (e.g., establishing ranges and ecological requirements,

assessing degree of threat, estimating minimum population and habitat sizes) as well as long-term monitoring of wildlife populations and habitats. Those species which are most significant and/or most critically endangered should be given priority attention by the Unit.

* Blockstein (1988) recommends that the threats to the Grenada Dove and the Hook-billed Kite (e.g., habitat destruction and fragmentation, mongoose predation, hunting) should be assessed quantitatively and that the populations should continue to be monitored. He does not recommend captive breeding at this time, but this will sooner or later become the only option for saving these species if habitat destruction continues.

* Seabird breeding sites should be surveyed and populations should be monitored, particularly on the offshore islets and in the Grenada Grenadines. Some management of exotic species (e.g., goats) and habitat restoration may be required. Seabird population dynamics appear to be controlled largely by unpredictable climatic events such as the El Nino-Southern Oscillation phenomenon (Schreiber and Schreiber, 1989). Therefore long-term monitoring is the only method of gaining insight into the true status of seabird species in the local area.

* A data base on the status of Grenadian wildlife populations *and their habitats*, probably in computerized form, should be established and maintained by the recommended Wildlife Unit.

* A public education and awareness program for wildlife (along the lines of the innovative programs recently implemented by RARE, Inc. and the St. Vincent Government or the excellent, longer-standing environment education programs of the Forestry Department in St. Lucia) should be established to work hand-in-hand with the proposed GOG Wildlife Unit. In addition to working closely with the Grenada National Trust, the Unit might also encourage the formation of nature-study groups, non-governmental wildlife conservation organizations, diving clubs, and similar groups with conservation objectives. The role of such citizen groups in environmental

monitoring is invaluable and does not require the expenditure of scarce government funds.

* The Forestry Department should seek start-up funding from appropriate donor agencies for staff training, technical support, and equipment for the proposed Wildlife Unit and related public education program.

PROTECTED AREAS

* The proposed system of National Parks and Protected Areas, or some subset of it which includes the most critical areas for the preservation of Grenada's biodiversity, should be implemented as soon as possible.

* The areas of dry scrub in the Government-owned Mount Hartman Estate and the adjacent wooded hillsides should be designated as a national landmark or multiple-use area within the proposed national park and protected areas system (GOG/OAS, 1988d). Blockstein (1988) states that the most critical factor in the continued existence of the endangered Grenada Dove and the Hook-billed Kite is the preservation and management of these scrublands. Management should be along the lines of the international UNESCO/MAB Biosphere Reserve concept, with patches of scrub and woodland reserved for scientific and conservation purposes, habitat restoration, and other compatible land uses in the surrounding area. The selection and appointment of a wildlife officer would also be most timely.

LEGISLATION

* The proposed National Park plan highlights the fact that existing legislation in Grenada does not adequately provide for wildlife conservation. Indeed, it appears that the strongest pieces of legislation relating to

wildlife protection have been allowed to lapse. Urgent action is needed to re-enact legislation protecting all wildlife, but especially endangered species and endemics (e.g., sea turtles, the Grenada Dove and the Hook-billed Kite). New or revised laws are needed which will promote the management of non-endangered game species for sustainable harvest, while also protecting endangered species and non-game wildlife. New legislation should be based on a strong scientific foundation and should include enforceable restrictions on the capture and/or killing of endangered and threatened species. The introduction of exotic game and other species should also be controlled by legislation (Ludeke, *et al.*, 1989).

* The existing laws prohibiting building on ridge tops, mining of beach sand, and construction within the coastal set-back zone should be strictly enforced. Habitat loss and disturbance due to human activities constitute a grave threat to many species of wildlife in Grenada. Sandy beaches which are nesting habitat for sea turtles are being developed for tourism and mined for construction sand. Bright lighting installed adjacent to such beaches is a known impact on hatchling turtles, causing them to become disoriented when leaving the nest. Blockstein (1988) states that forested habitat on ridge tops in the southwest peninsula is critical to the survival of the endangered Hook-billed Kite.

INTERNATIONAL CONVENTIONS

* The actual extent of wildlife trade in Grenada, which appears to be largely unknown at present, should be assessed by GOG. Grenada should become a member of CITES, since membership offers access to a wealth of materials, training and expertise on species conservation and wildlife trade regulation.

4.4 COASTAL AND MARINE RESOURCES

4.4.1 Overview

PHYSICAL FEATURES, CRITICAL HABITATS, SYSTEM INTEGRITY AND PRODUCTIVITY

Grenada has a relatively large insular shelf area of 3,100 sq. km. The shelf is quite narrow on the west coast, extending out an average of 0.5 mile to the 100 fathom line (Figure 4.4(1)). From the southeast to the northeast the shelf varies in width between 2.5 miles and 7.5 miles, and it extends to the west-southwest in a 12-mile wide tongue for about 20 miles. Depths on the shelf vary from 20-40 fathoms with average depths of 15-20 fathoms; in the Grenadines the shelf is from 10-30 fathoms deep over the greater part of its area (Goodwin, *et al.*, 1985).

The dominant ocean currents in the vicinity of Grenada flow from the east-south-east. Some upwelling of deeper ocean waters is thought to exist along the eastern part of the insular shelf. During the South American rainy season, enormous quantities of fresh water are discharged from the Orinoco and Amazon rivers; the water then drifts toward and across the southern islands of the Eastern Caribbean chain. As this low-salinity water mass (called "Orinoc" by the Grenadian fishermen) moves across the area, distinct interfaces between the turbid green (Orinoco) and clear blue (oceanic) water are recognizable. Neither oceanic pelagic nor bottom fishes are easily catchable by fishermen when such water masses are present in the area.

Three habitats -- mangroves, coral reefs, and seagrass beds -- are of critical importance in nearshore tropical marine ecosystems; there is a direct link between the extent and health of these habitats and the productivity of inshore fisheries. The majority of bottom-dwelling fish species in shallow nearshore waters of the Eastern Caribbean are associated with coral reefs as adults (more than 300 species), and many of these reef fishes are associated with mangroves and/or seagrass beds as juveniles. Mangroves and seagrass beds also provide significant energy

inputs to the reefs and filter out sediments from land-based run-off before they reach the reefs.

Figures 4.4(2a and 2b) display the generalized distribution of these major marine habitat types in Grenada and the Grenada Grenadines, but there is a lack of detailed mapped information on marine bottom communities. Marine benthic surveys and mapping have been carried out in only a few locations, such as Grand Anse Beach, off the Point Salines Airport and in Levera Bay.

(1) **Mangroves.** According to Eschweiler (1982b), there were a total of 470 acres of mangroves in Grenada in 1982 (six-tenths of one percent of the total land area). Several significant areas of mangrove wetlands still exist on Grenada, including: Levera Pond ("best mangroves on Grenada" according to GOG/OAS, 1988d), Conference Bay, La Sagesse ("best salt pond in Grenada"), and the bays and islands from Woburn Bay to West-hall Bay. However, little or no detailed information is available on the status of the nation's mangrove systems. Charcoal cutters and other users have caused significant damage to mangroves at Levera and Calivigny Bays (Johnson, 1988). Important wetlands in Grenada, including mangroves, are described by Scott and Carbonell (1976).

In Carriacou, there are important mangrove systems at Petit Carenage Bay ("best in entire country" according to GOG/OAS, 1988d), Saline Island, Tyrrel Bay, and Lauriston Point near the airport. Eschweiler (1982b) estimated that there were 98 acres of mangroves in Carriacou in 1982 or a little less than one percent of the land area of the island.

(2) **Coral reefs.** Reefs occur mainly on the north, east, and south coasts of Grenada. GOG/OAS (1988d) reported that Levera Bay and the adjacent islands have large areas of coral reefs. However, an earlier marine survey by Goodwin, Goodwin and

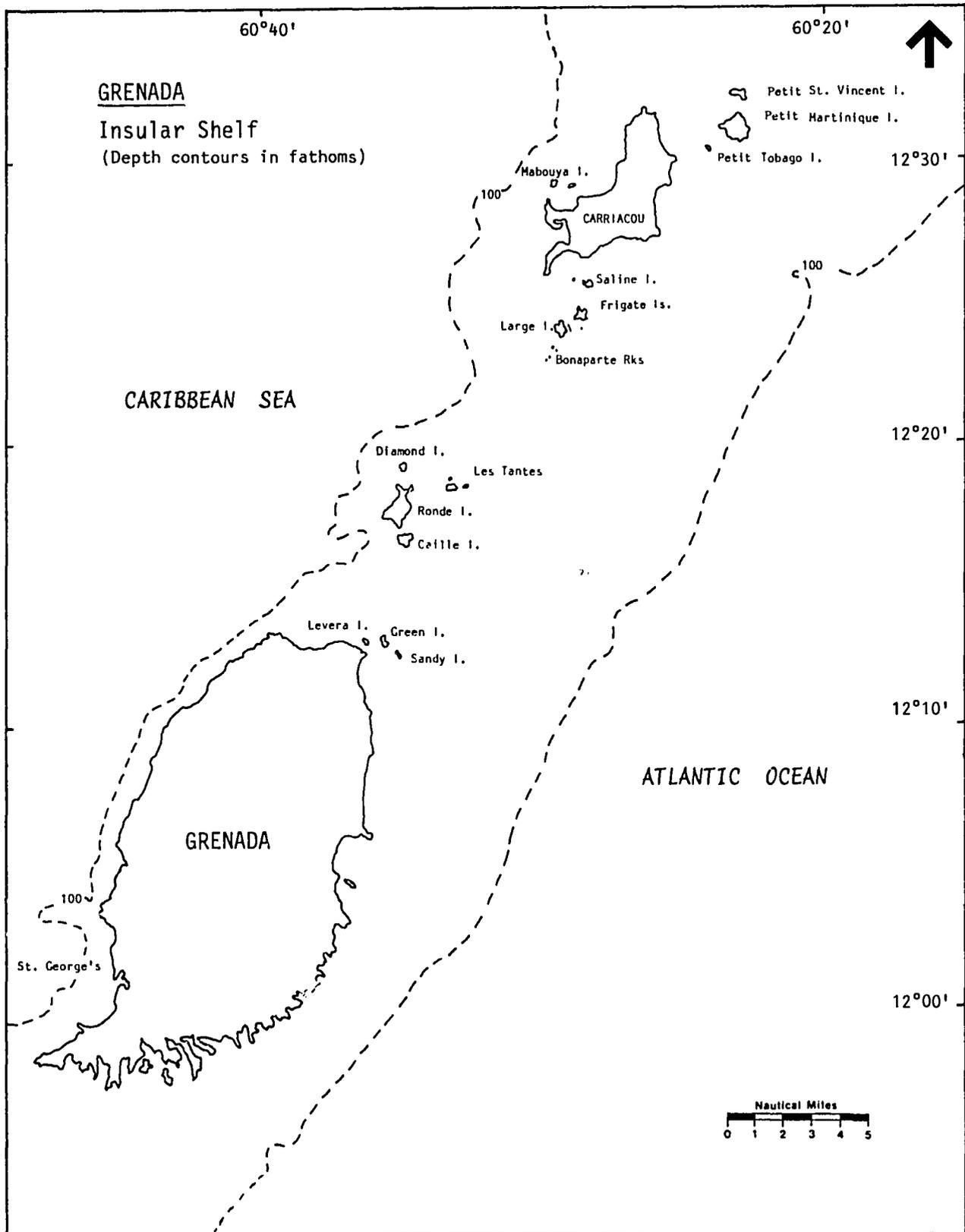


Figure 4.4(1). Grenada Insular shelf, 100 ftn contour (source: ECNAMP, 1980a).

GRENADA

Coastal and Marine Habitats

-  Seagrass bed
-  Living reef
-  Saltpond
-  Wetlands (mangroves)
-  Beach

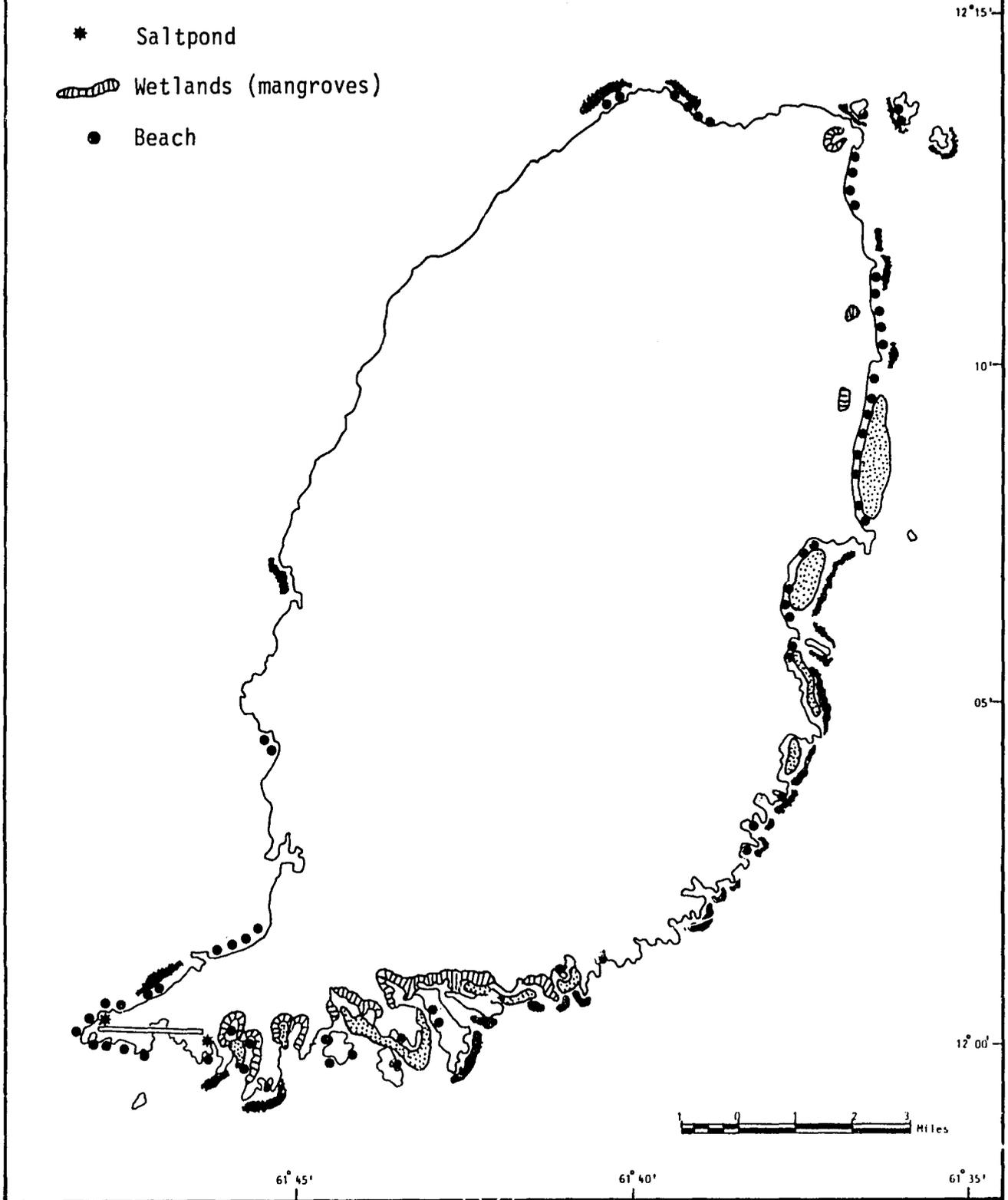


Figure 4.4(2a). Distribution of major coastal and marine habitats, Grenada (source: ECNAMP, 1980a).

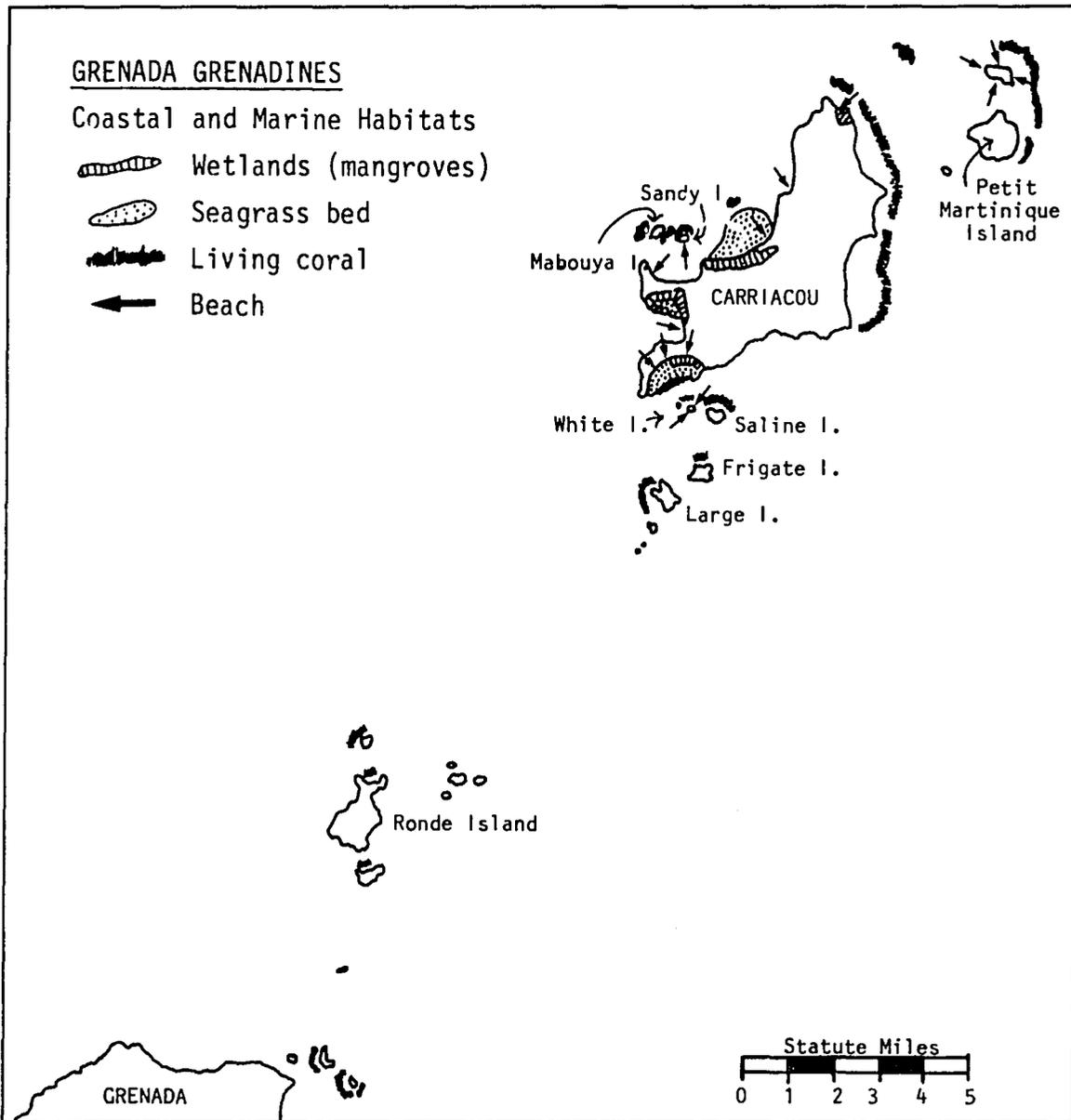


Figure 4.4(2b). Distribution of major coastal and marine habitats, Grenada Grenadines (source: ECNAMP, 1980b).

Putnam (1982), while identifying some patches of corals and gorgonians in this area, found there are no well-developed reefs due to turbulence and the scouring action of strong currents.

The Grenada Preliminary Data Atlas (ECNAMP, 1980a) shows several areas of "living reef" along the east coast of Grenada but does not comment on their species composition or status. Reefs at a depth of 10-20 m on the southeast coast from Marquis Point to Telescope Point were described by Adey and Burke (1976) as the bank-barrier

reef type. These authors also described small fringing reefs (mainly of elkhorn coral, *Acropora palmata*) in several bays along the south coast from Point Salines to Westerhall Bay. No algal ridges have been found in Grenada.

Large bank-barrier reefs occur on the east coasts of Carriacou and Petit Martinique and around some of the smaller islets in the Grenadines. Many of these reefs are strongly dominated by elkhorn coral in the shallow areas, with well-developed boulder coral zones on the deeper forereefs (Wells, 1987).

Two small algal ridges occur on the south side of Carriacou. Saline and White Islands are said to have "the best reefs in the country" (GOG/OAS, 1988d). Mabouya Island and Sandy Island are also said to have good reefs (these two islands are apparently also called Sandy Island and Jack-A-Dan Island, respectively).

Bank-barrier reefs are also found off Watering Bay, Grand Bay, Petit Carenage Bay, and Manchineel Bay in Carriacou (Wells, 1987; ECNAMP, 1989b), but there is no information about their status. The northern tip of Ronde Island reportedly has an excellent reef. While there is not any documentation on the status of reefs around Petit Martinique, the ECNAMP data maps (1980b) do identify an area of "living reef" off its east coast.

Grenada's "best reef" is reputed to be the Molinere Reef on the west coast north of Grand Mal Bay, which is proposed for an underwater park and marine reserve (GOG/OAS, 1988d). However, Molinere Reef seems to be under a significant degree of sediment stress, presumably from upland erosion; Grand Anse and other west coast beaches such as Grand Mal and Morne Rouge also appear to be under stress from high sedimentation rates (DuBois, 1984).

In Grenada and the Grenadines run-off, dredging, pesticides, coral harvesting, anchor damage from boats and fishing by explosives have reportedly caused reef damage in the past (Goodwin and Bannerot, forthcoming); other threats include sewage pollution, sand mining, and coastal developments (Johnson, 1988). Local divers have reported a general increase in coral death and algal overgrowth on Grenada's reefs in recent years, but no long-term quantitative data are available. Local boatmen have stated that the Grand Anse reefs appeared healthy and were good fishing grounds through the 1960's, but deterioration of both the reefs and fish catches began around 1970 (Archer, 1984a; Cambers, 1984).

No detailed information on the distribution or effects of various "natural" stressors is available for Grenadian reefs. A die-off of the long-spined black sea urchin

(*Diadema antillarum*) occurred in Grenadian coastal waters during an apparently Caribbean-wide event in 1983-84. Reef damage from white-band disease and storm damage have been reported in Grenada and the Grenadines (Wells, 1987). The only major hurricane to hit Grenada since European colonization was Janet in 1955 (see Section 1.1.6), but its effects on Grenada's reefs and other marine systems were not documented.

Goodwin, *et al.* (1976) studied species density and coral associations at Saline Island and Jack-A-Dan Island off Carriacou. These reefs and those in Grand Anse Bay are probably the best-studied reef areas in Grenada in terms of community composition and species diversity. Marine biological surveys of the reefs and other benthic habitats in Grand Anse Bay and adjacent areas were carried out by DuBois (a preliminary, mostly qualitative survey in 1984) and Hunte (a quantitative baseline survey in 1987).

Based on his experience with the better-studied reefs in Barbados, Hunte (1987a) believes that the community structure of all living nearshore reefs within Grand Anse Bay is characteristic of reefs subjected to stress from high nutrient levels. Species diversity of corals is low compared to unstressed reefs, and the community is dominated by finger coral (*Porites porites*). Sea urchins are common, and algae are beginning to overgrow the corals. The species numbers and abundance of sponges are reduced (see Figure 4.4(3)).

Hunte found that nearshore reefs outside the Bay and north of the deep basin, as well as the most northerly offshore reef, had community structures characteristic of reefs exposed to sediment stress. Algal and coral coverage is low, but the species richness and abundance of sponges is high. He suggests that these reefs are subjected to severe sediment stress by water probably coming from the region of the St. George's harbor mouth during periods of heavy run-off.

Most reefs offshore from Grand Anse on the Three Fathom and Six Fathom Banks were found by Hunte to be in a healthy condition at present, despite the elevated nu-

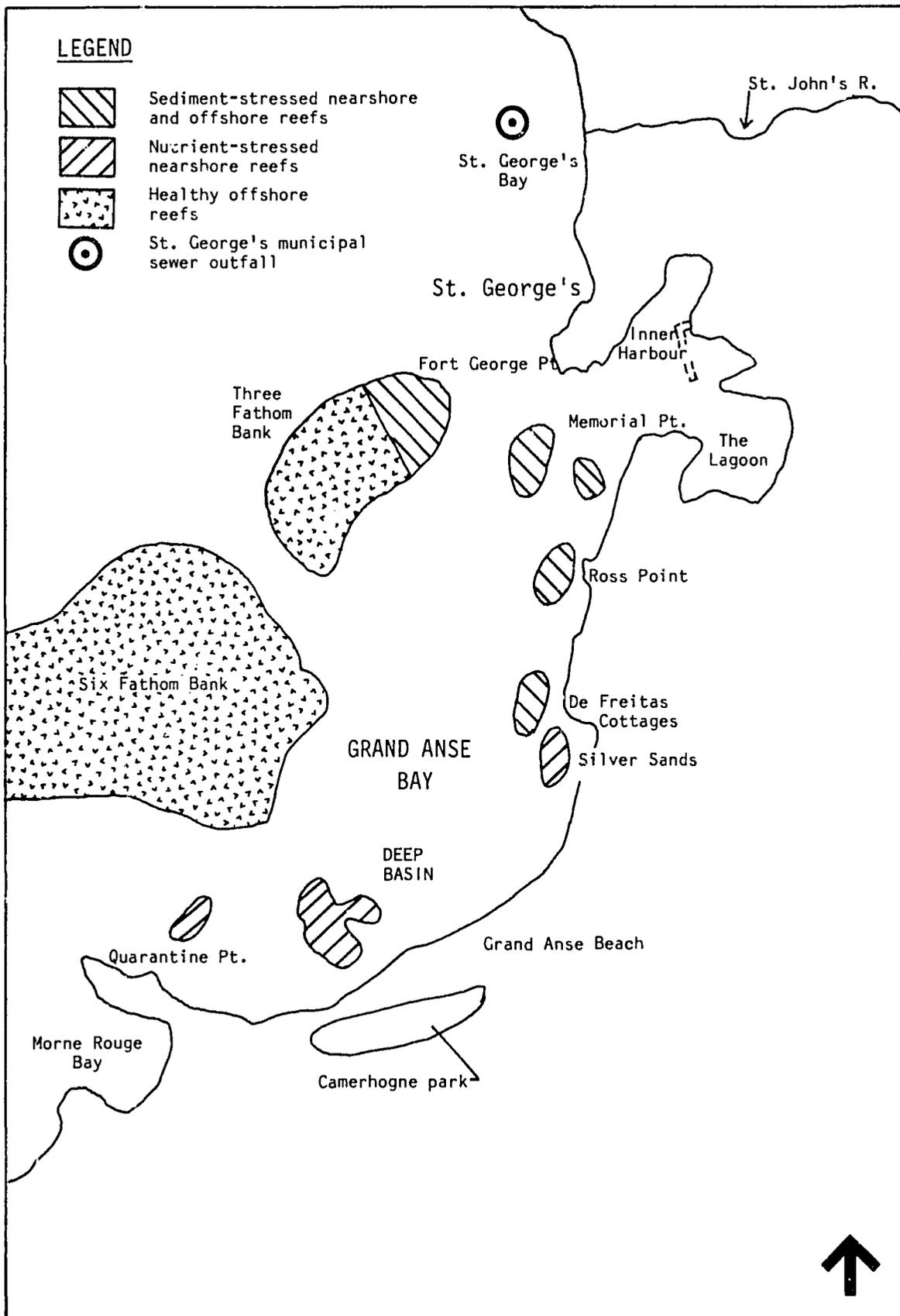


Figure 4.4(3). Condition of Grand Anse Bay reef communities in 1987 (source: Hunte, 1987a).

trient levels measured in the water. It is likely that these reefs may also begin to show measurable signs of stress if nutrient levels are not reduced.

(3) **Seagrass beds.** Little accurate information exists on the distribution of seagrass beds in Grenada or the Grenada Grenadines. The rough maps by ECNAMP (1980a; 1980b) show some areas of seagrass along the east-central and south parts of Grenada's coast and on the west coast of Carriacou. Smith (1987) shows seagrass beds in Grenville Bay, Great Bacolet Bay, the southern bays from Mount Harmon to West-erhall, and Windward Bay in Carriacou.

(N.B. Some resource management documents by outside researchers mention the occurrence of "Eel Grass" beds in Grenada, but this is highly unlikely since Eel Grass is the common name of a temperate seagrass, *Zostera*. The species referred to is probably Turtle Grass, *Thalassia testudinum*, which is common in the region.)

FISHERIES RESOURCES

The regional framework for Grenada's fisheries is best described by Mahon (1988), who has summarized the current state of knowledge regarding resource problems and suggested management options for large offshore pelagic fishes, flyingfish, reef fishes, deep demersal fishes, coastal pelagic fishes, lobster, conch, turtles and sea urchins in the Windward Island area.

Grenada has the second largest shelf area in the OECS countries as well as substantial fishery resources in comparison to many other Caribbean islands. The major fishing centers on the island of Grenada are at St. George's, Grand Mal, Gouyave, Victoria, Duquesne Bay, Sauteurs, and Grenville; with the exception of Grenville, all are on the west coast. Fishing is also an important activity on the Grenadine islands of Carriacou and Petit Martinique. At the present time the fishery is mainly artisanal; in 1988 there were 1,749 full-time and 266 part-time fishermen and 580 boats (Finlay, *et al.*, 1988). There are two fishing seasons during the year, the "low sea-

son" from July to December and a "high season" from November to June when offshore pelagic species become more abundant. The type, distribution and seasonality of the nearshore fisheries is shown in Figure 4.4(4).

The major types of more-or-less "traditional" fishing gear and methods used in Grenada and other countries of the Eastern Caribbean include (Goodwin, *et al.*, 1985; Mitchell and Gold, 1982):

- bottom hand lines (in depths from 20 m to 200 m, with monofilament lines and several baited hooks)
- trolling lines (with artificial feather lures or baited hooks, deployed at 100 m or more while the boat is drifting or at the surface with outriggers when underway)
- fish traps or "pots" (usually Z-shaped with one or two funnels, made from chicken wire or sometimes wicker reinforced with wooden stakes and weighted with stones)
- beach seines (set from a rowboat to enclose schooling fish and then hauled to shore)
- gill nets (primarily used for catching pelagic flying-fish and occasionally used for both demersal and other pelagic species)
- trammel nets (consisting of three panels of netting -- an inner panel hanging between two larger-meshed outer panels -- attached to common float and lead lines; typically set in shallow reef areas where lobster, conch, and a wide variety of fish may be captured)
- diving (often with SCUBA equipment; live lobsters are caught by fishermen using snares, conch are taken by hand, and spearguns are used for fishes).

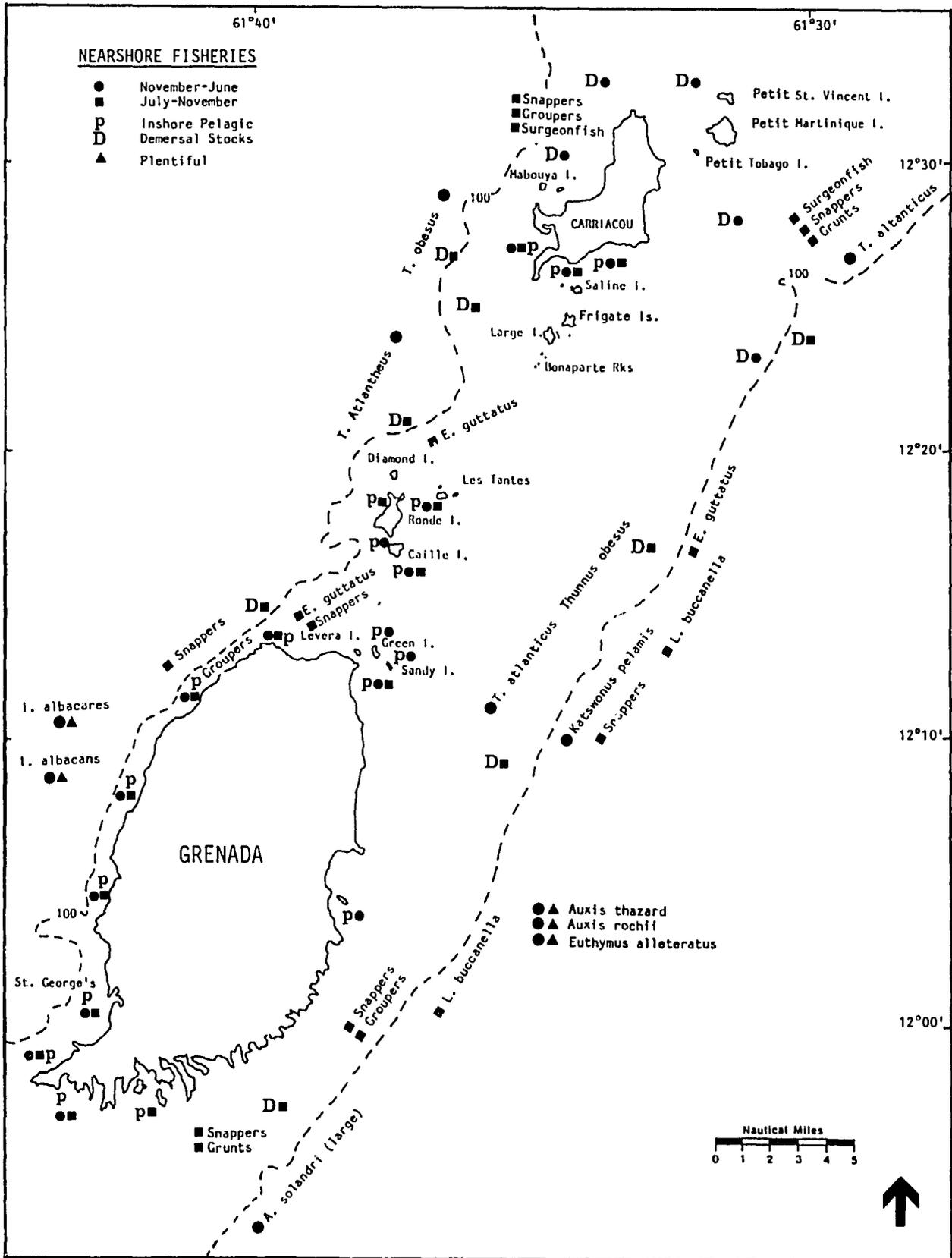


Figure 4.4(4). Type, distribution and seasonality of nearshore fisheries (source: Mitchell and Gold, 1982; supplemented by data from J. Finlay, Grenada Fisheries Division, 1989).

Four categories of fishing are recognized (unpubl. data, Fisheries Division, 1989). The major category concentrates on the oceanic pelagics such as tuna, billfishes, flying fish and dorado during the traditional "ocean season" from November/December to June/July. This fishery accounts for approximately 50 percent of national landings and is carried out principally by fishermen from the area around Gouyave, using 18-28 foot wooden-hulled canoes and pirogues powered by gasoline outboard motors. These artisanal fishermen are now using longlines 1.5 to 3.5 miles long to exploit this resource.

The second type is the fishery for bottom-dwelling ("demersal") species on the deeper shelf and ocean drop-off, where groupers, snappers and other tropical rockfish are caught from June to November. The same vessels which target the oceanic pelagics during the ocean season are used in this fishery. Additionally, on the north shelf of the island, i.e., Carriacou and Petit Martinique, 25-40 foot sailing sloops are used to catch demersal fish. This demersal fishery accounts for 15-20 percent of total landings.

The third type is the nearshore beach seine fishery which uses encircling nets to harvest small schools of fishes such as scad (*Decapturnus spp.*) or sardines. Nets vary in length from 500 to 750 feet with the deepest section being 30-36 feet. This fishery accounts for perhaps 30 percent of national landings.

The fourth type comprises the shell fish, sport fish, and dive fisheries for species such as white sea eggs, turtles, lobsters and conch together with some fin fishes. This fishery may account for five percent of national landings, of which less than one percent at present is landed by sports fishing tourists.

Organized in 1987, the Fisheries Division has data on annual landings of fin fishes between 1978 and 1988, which is shown for the entire nation in Figure 4.4(5); also shown is a breakdown for the islands of Grenada and Carriacou between 1984 and 1988 (see also Table 4.4(1)). These data represent estimated total landings, based on the landings recorded at the fish markets multiplied by a factor to correct for unreported landings.

There are six established public fish markets in Grenada, but the majority of the catch has not traditionally been sold through these outlets. In the past, most of the fish catch was marketed directly at the landing site without processing or was transported without refrigeration to individual buyers. This situation is changing. There has been an increase in the availability of ice and cold storage facilities, and a greater proportion of the catch is now sold to buyers who export it to other countries.

In Carriacou and Petit Martinique, most of the catch (about 90 percent) is now sold to fish buyers who export it to Martinique, and the local retail market is negligible (Martinez-Soto and Gabriel, 1989). Because the export fish buyers offer a higher price than local buyers will pay, only a few fishermen sell locally. About 12-15 locally-made sailing sloops from Carriacou and Petit Martinique go out daily to fish for shellfish and demersal species such as snappers, parrot fish, groupers, grunts and other reef fishes; but they only fish whenever there are boats with ice available to buy their catch. There are about 13 of these buyer boats, powered by both engines and sails. Each has a capacity of 10,000 lbs. of ice and 6-12,000 lbs. of fish. There are roughly five boats on stand-by in the Grenadines in any given month. Each buyer from Carriacou and Petit Martinique must have an agent in Martinique who is licensed by the Government there.

Despite the seasonal availability of the same offshore pelagic species that are caught in Grenada, Grenadine fishermen do not exploit this resource because they have not developed a market for it. During November to July fishermen in the French island of Martinique can catch enough pelagic species to supply that island's demand (the importation of pelagics to Martinique is strictly prohibited at this time and the trader boats will buy only demersal fishes). After July, boats from Carriacou and Petit Martinique are allowed to take both demersal and pelagic species to Martinique, but the availability of the latter is then low. Therefore Grenadine fishermen concentrate on demersal species year-round (Martinez-Soto and Gabriel, 1989).

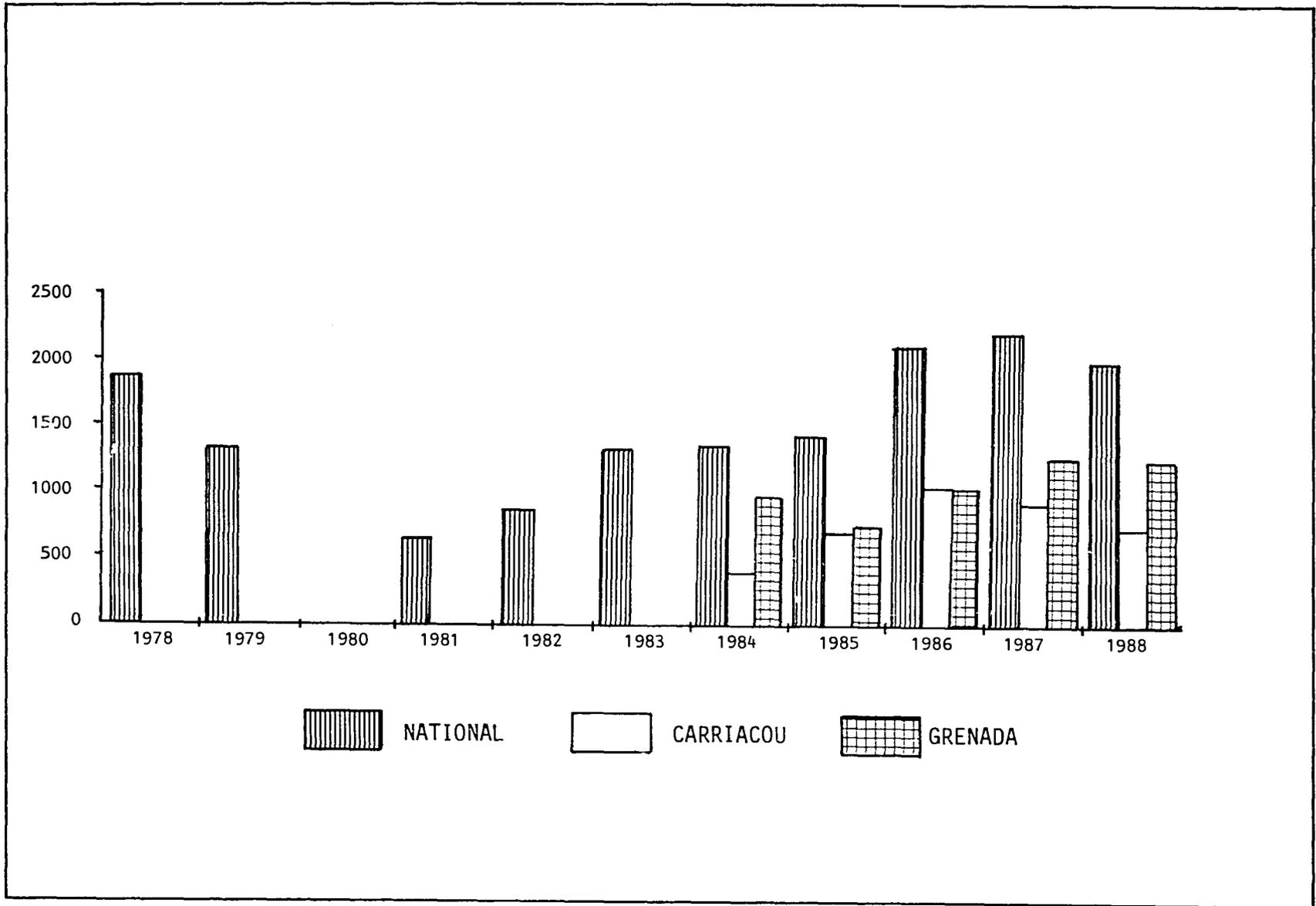


Figure 4.4(5). 1978-1988 annual fish landings in metric tons (source: J. Finlay, Grenada Fisheries Division, 1989).

Table 4.4(1). Fish landings in Grenada, 1978 to 1988, in metric tons.

YEAR	NATIONAL TOTAL	CARRIACOU LANDINGS	GRENADA LANDINGS
1978	1,872	data missing	data missing
1979	1,328	data missing	data missing
1980	data missing	data missing	data missing
1981	651	data missing	data missing
1982	871	data missing	data missing
1983	1,337	data missing	data missing
1984	1,368	403	953
1985	1,437	682	744
1986	2,112	1,060	1,036
1987	2,215	925	1,272
1988	2,001	730	1,254

Source: Data from GOG Fisheries Division, 1989.

A GOG Ice Plant/Fish Storage Facility at Windward in Carriacou provides small volumes of ice at low cost to fishermen, as well as fishing equipment (GOG/OAS, 1988b). The plant was built in 1986 with funds from the International Fund for Agricultural Development (IFAD), but no electrical power was available until September 1988 when the power lines were extended to the facility. It is presently operated with community development funds through the Ministry of Works (EC \$11,850/yr). Due to chronic equipment problems, the ice plant is only operating at about 50 percent of its capacity. The fish storage facility is not being used, for reasons having to do with the current marketing structure (i.e., the major market is the Martinique buyer boats, and other markets which might require the storage of fish for export have not been developed).

The OAS Integrated Development Project for Grenada recently stationed a consultant in Carriacou to provide assistance with several fisheries development projects, e.g., renovation of the fish market in Hillsborough, a seamoss mariculture project, development

of the mangrove oyster bed in Tyrrel Bay, improvement of the fish marketing and distribution system, development of pelagic fisheries and marketing for pelagics in Grenada (Martinez-Soto and Gabriel, 1989; GOG/OAS, 1988b).

In recent years increased emphasis has been placed by GOG on artisanal fisheries development. An artisanal fisheries project, funded by IFAD, was begun by GOG in 1979 to give assistance to fishermen. The project originally emphasized the development of physical infrastructure, a fishermen's loan scheme, training, sale of equipment, and the establishment of cooperatives. Today the artisanal fisheries project operates under the Ministry of Education, Culture, Youth Affairs, Sports, and Social Security (which includes Fisheries) as a semi-autonomous agency dealing with the commercial aspects of the fisheries sector. With the recent opening of its new fish processing facility in St. George's, funded by the Venezuelan Investment Fund, the emphasis of this project is now on buying surplus catch from fishermen at the Government markets, processing it, freezing it and

reselling it to retailers and exporters. Grenada is also a participant in the FAO-sponsored Caribbean Technical Cooperation Network in Artisanal Fisheries and Aquaculture.

A prototype of a 36-foot catamaran fishing boat, designed to be capable of a variety of fishing activities and to be easily fabricated in fiberglass by fishermen themselves, has recently been launched by the Grenada Fisheries Division. The boat was designed to be very stable and virtually unsinkable and was built with funding from FAO as a demonstration project in appropriate technology for fisheries. Training in construction and operation of this type of vessel is being provided to fishermen. One fish aggregating device (FAD) has been installed about 10-15 miles offshore in about 1500 m depth as a part of this project.

Grenada and other OECS countries are presently initiating joint licensing arrangements to facilitate the development of the swordfish and tuna fishery in the region, according to a report by a Grenadian representative at the 1988 Gulf and Caribbean Fisheries Institute meetings. Three larger longline vessels are licensed and are now being operated as joint ventures between Grenadian and U.S. companies, and much of their catch is exported to Puerto Rico and Miami. These boats pay annual fees based on the size of their catch. Three of the five-person crews on each of the boats must be Grenadians, and the majority of stock in such joint venture companies must be held by Grenadians.

MARICULTURE

Seamoss (*Gracilaria spp.*, a red alga) is harvested from nature and used as an ingredient in a popular drink in many Caribbean islands. It seems to grow best on windward coasts which are not too exposed but where agitation of the water by wave action is sufficient to keep the plants free of epiphytes. In volcanic islands such as Grenada, available nitrates appear to be the main limiting factor for the growth of seamoss.

In 1981, Canada's International Development Research Centre began a project with the Fisheries Management Unit in St. Lucia to develop simple and profitable methods for the cultivation of seamoss (Smith and Renard, 1988). In 1985 ECNAMP began a successful 18-month project to transfer seamoss technology from pilot stage to commercial production in St. Lucia and to produce instructional material to assist transfer in other countries. In early 1987 the OECS Fisheries Unit and GOG, with support from ICOD, engaged ECNAMP to execute a project for the extension of seamoss cultivation to Grenada.

The Grenada seamoss project aims at the establishment of small commercial farms in a five-phase strategy: training of the staff biologist at the Artisanal Fisheries Development Project in seamoss cultivation; site identification; set-up of a pilot project; workshop for potential farmers; and establishment of commercial farms. Smith and Jean (1987) have surveyed the coastlines of Carriacou and Grenada to locate bays which are well suited to seamoss cultivation. A test raft for growing seamoss was installed in Grenville Bay on Grenada by Smith, and the species of *Gracilaria* harvested by the local people were identified. There is also a private seamoss aquaculture venture in Carriacou.

USAID/HIAMP is considering a Mangrove Oyster Mariculture pilot project to start raft culture for *Crassostrea rhizophorae* in Carriacou. Several rafts have already been constructed in the lagoon at Tyrrel Bay (GOG/OAS, 1988b).

CURRENT COASTAL DEVELOPMENT TRENDS

The major marine industries, i.e., fisheries, tourism and sea transport, have played an important role in Grenada's development. In 1978, the contribution of these marine industries to the GDP was estimated to be about 30-35 percent; by far the largest contribution was from tourism, followed by fisheries. From 1970 to 1979 the total number of visitors to Grenada increased from 72,000 to 171,000, due primarily to the number of

cruise ship visitors which increased from 41,000 to 139,000, an average increase of 13.9 percent per year. Yacht visits to Grenada increased from 830 in 1973 to 1,415 in 1978 (Mitchell and Gold, 1982). These figures began to fall after the 1979 revolution but have been gradually returning to the levels achieved before the political unrest of the early 1980's.

Policy guidelines developed by a joint GOG/OAS task force (Moore, *et al.*, 1986) point to the ongoing expansion of the tourism sector, which continues to be highly dependent on marine resources and on the development of recreational pursuits which are water-related. The guidelines recommended that tourism accommodation establishments should be increased to a total of about 1,500 rooms by mid-1989 and that cruise ship arrival figures should be increased to reach 1980 levels (i.e., 145,594 visitors via 236 cruise ship calls). At the same time the Grenada Ports Authority published a concept plan calling for the creation of a new cruise ship port which would involve the dredging and filling of a large area of seabed along the Esplanade in St. George's (Grenada Ports Authority, 1986).

The GOG/OAS report also recommended that a steady growth in yacht arrivals (beyond the 1986 total of 1,689 arrivals) could be achieved by the provision of an additional 300 yacht berths and expansion of yacht repair and marina facilities. Room for the expansion of yacht facilities was to be provided by dredging the seaward and filling the landward sides of the lagoon in St. George's.

The Government's guidelines have been generally met in the case of tourist accommodations and cruise ship arrival figures: there were 136,443 visitors in 1988 via 242 cruise ship calls (Grenada Ports Authority), and there are currently about 1,050 hotel rooms with another 400 rooms scheduled to be under construction by the end of 1989.

No expansion of the existing marina services in the Lagoon has yet been undertaken, and no recent dredging and filling has been done in that area. However, there is another marina facility at Prickly Bay (Spice Is-

land Marina), and in 1988 combined yacht arrivals for the two marinas totaled 2,140 vessels (no data on yacht arrivals in Carriacou or Petit Martinique are collected by the Ports Authority). A bareboat charter operation and marina is under construction by The Moorings, Inc. at the Secret Harbor Hotel in Mt. Hartman Bay. At present the proposed new cruise ship port is in the discussion stage only; there are no plans drawn, and no funding source has been identified by the Ports Authority.

All these existing and proposed tourism and port projects clearly have implications for the marine and coastal environment and the potential for negative environmental impacts in the absence of adequate controls and standards. Expanding numbers of yachts and cruise ships will increase the existing level of pollution in harbors and bays from routine discharges of oil and sewage, particularly since yachts and other vessels entering Grenadian waters are not required to have holding tanks for wastes. Greater traffic of large cruise ships, tankers and cargo vessels will increase the likelihood of major oil spills in the marine environment, a potentially serious situation in view of the fact that the Government of Grenada has no oil spill contingency plan, spill control equipment, or personnel trained in cleanup methods. Table 4.4(3) shows annual ship arrivals in Grenada by class and net tonnage.

Greater numbers of tourists, in the absence of adequate treatment facilities, will increase sewage discharges into nearshore waters, which may result in further degradation of coral reefs. Clearing of beach vegetation for coastal resorts may result in increased erosion of beaches if proper setbacks are not observed. Dredge and fill projects for ports and marinas will result in larger inputs of sediments into marine waters. More tourist demand for fresh seafood will put greater pressures on the country's conch and finfish fisheries. Garbage from more hotels, yachts and cruise ships will compound the problems of the already overloaded land fill site at Halifax Harbor.

Table 4.4(2). Ship arrivals in Grenada, 1978 - 1987.

NUMBER OF SHIPS						
YEAR	SCHOONERS	SHIPS UNDER 100 TONS	SHIPS OVER 100 TONS	TANKERS	PASSENGER SHIPS	TOTAL
1978	166	436	256	47	188	1093
1979	137	270	263	60	209	939
1980	102	212	272	49	239	874
1981	143	155	252	54	144	748
1982	125	144	299	48	106	722
1983	127	95	327	49	83	681
1984	153	57	402	59	70	741
1985	124	124	451	60	171	930
1986	146	162	497	68	217	1090
1987	140	134	533	63	274	1144

NET REGISTERED TONNAGE						
YEAR	SCHOONERS	SHIPS UNDER 100 TONS	SHIPS OVER 100 TONS	TANKERS	PASSENGER SHIPS	TOTAL
1978	7,497	9,747	358,859	53,725	1,788,201	2,218,011
1979	5,782	8,751	375,383	42,942	1,829,371	2,262,234
1980	3,187	11,551	NA	42,741	NA	NA
1981	4,753	17,183	470,815	47,840	1,095,449	1,636,040
1982	4,900	6,201	465,272	50,882	1,077,115	1,604,370
1983	6,991	3,755	643,668	53,367	NA	NA
1984	7,671	1,943	748,381	67,183	508,733	1,333,911
1985	7,034	4,013	685,542	58,630	1,208,684	1,963,903
1986*	14,668	3,799	1,139,755	107,923	2,993,324	4,259,469
1987*	16,074	3,933	1,343,377	80,659	3,526,386	4,970,429

* Gross Tonnage

Source: Grenada Annual Abstract of Statistics, 1987.

These potential impacts on the coastal environment from increased sea transport and tourism development argue for the need to integrate economic development with greater efforts in the area of environmental protection.

RESOURCE MANAGEMENT PRACTICES AND CONTROLS

The Fisheries Division manages fisheries resources through an extension program; currently there is a chief fisheries officer, a biologist, an aquaculturist and several other support staff engaged in working directly with

fishermen. The Fisheries Management Plan for 1989 addresses the promulgation of safety regulations for fishermen, additional regulations for threatened species, size limits, the phasing out of destructive fishing gear such as trammel nets, and regulations for the use of SCUBA gear as a fishing method.

The Fisheries staff collects basic fisheries statistics such as gear, species, sizes and quantities caught, area fished, effort and price. The fishery data collection system in current use consists of forms filled out by the managers of the markets at each major fish landing site, which contain information from each boat. All fishing boats except those involved in the beach seine fishery are required to obtain an annual license, and there has been a recent inventory of fishing boats by landing site. It is proposed to expand the present data collection system to include additional sampling tools (Finlay *et al.*, 1988).

Some fisheries controls have been implemented. The minimum size for lobsters is 9 inches total length or a tail weight of 225 g. There is a closed season for lobster which ran from May 1 to August 31 in 1988 but which will be extended to September 30 in 1989 to coincide with the closed season in St. Vincent. The closed season for turtles runs from May 1 to September 1. The taking of sea turtle eggs is prohibited by law but is probably not effectively enforced. There is a minimum weight limit of 25 lbs. for any species of sea turtle (Leatherback, Green, Hawksbill, and Loggerhead). There is no closed season for conch, but in response to the perception of fisheries authorities that it is a commercially threatened species, a minimum weight law has been enacted (SRO No. 9 of 1987), and individuals are required to have a shell with a flared lip.

All fisheries officers together with the customs, coast guard, and district police officers, are authorized to enforce the fisheries regulations, including closed seasons and size limits.

Andrews (1988), an engineering consultant from Geotech working with the Ministry of Health, briefly discussed the concept of turning discarded automobiles and tires

into an asset by using them as materials for construction of nearshore artificial reefs. He recommended that consideration be given to bottom topography, depth, wave action, boat traffic, seabed bearing capacity, siltation and mobility of bottom sediments. Conspicuously absent is any discussion of the biological and ecological aspects of siting and construction of artificial reefs, without which such a project becomes merely an excuse to dump such materials at sea. Care must be taken in building artificial structures so that the "reef" provides the necessary shelter space, is close to a source of recruitment for juvenile fishes and food for adults, and toxic substances (e.g., oil) are carefully eliminated. Many reefs built without these considerations in mind are simply junk piles. To be fair, Andrews points out that the necessary studies should be carried out before any decisions are made, a requirement which is reiterated here.

A large literature exists on this topic in other tropical and temperate areas, some of them within the wider Caribbean (e.g., Goodwin and Goodwin, 1981; Goodwin and Chambers, 1983; Fourth International Conference on Artificial Habitats for Fisheries, 1989).

4.4.2 Problems and Issues

OVERFISHING

The paucity of information on landings, fishing effort, and exploited stock and the multi-species nature of reef fisheries makes it difficult to estimate sustainable yields for Caribbean nearshore fisheries in general. Fishery development proposals for Caribbean nations often base their recommendations on guesswork by experts (e.g., Guidicelli, 1978) or else rely on abundance or yield estimates determined by extrapolating results of experimental fishing or visual censuses of known smaller areas to larger oceanic areas. These procedures may provide a useful starting point, but there are many uncertainties and difficulties of interpretation inherent in such methods. Nevertheless there has been a tendency among fisheries biologists and planners in the region to use a single figure (often the

most optimistic one) for potential yield when writing development plans.

The wide range in published estimates of maximum sustainable yields for nearshore fisheries of Grenada and other Eastern Caribbean nations illustrates the inadequacy of the available information (Goodwin, *et al.*, 1985). In an effort to address this problem, CIDA has recently funded a projected seven-year-long stock assessment survey on a CARICOM regional level, to include assessments for each country in the OECS.

Shallow-water pot fisheries for reef fishes around northern Grenada and Carriacou are heavily exploited and may be approaching the limits of sustainable yield, if indeed they are not already overfished as many persons believe. Overfishing of the nearshore stocks has not been scientifically documented, but has been reported by fishermen and biologists in all of the Eastern Caribbean islands, including Grenada, on the basis of extensive circumstantial evidence.

Harvesting of small inshore pelagics (jacks, sprat, herrings, anchovies, round robin and small tunas, etc.) is traditionally done by beach seine and represents a significant aspect of the fisheries economy. There are about 50 beach seines and crews currently active on the small beaches around Grenada, Carriacou and Petit Martinique. Details of this fishery are given in Finlay (1984). In Grenada the stocks of small coastal pelagic fishes and deepwater demersal fishes (snappers and groupers) are not believed to be overfished at present, but there are no good data. The potential yield of these fishes is not known. Many of the deepwater demersal stocks are thought to be "under-fished" because of the difficulty inherent in traditional methods of hauling deepwater fishing gear by hand (Goodwin, *et al.*, 1985).

There has been concern with over-harvesting of conch and lobster for more than a decade, but again conclusive data are lacking. There is little doubt that they are seriously over-exploited at least in the Grenadines -- fishermen now have to dive much deeper areas with SCUBA in order to find them in

any quantity. Mangrove oysters were once harvested commercially at Tyrrel Bay on Carriacou, but these oyster beds have been depleted.

Sea turtle stocks in Grenada are probably depleted due to over-exploitation as is common throughout the region, but almost no quantitative data exist on the local population. Leatherbacks (*Dermochelys coriacea*), Loggerheads (*Caretta caretta*), Hawksbills (*Eretmochelys imbricata*), and Green Turtles (*Chelonia mydas*) are the sea turtle species which are taken in Grenada (see Section 4.3).

Grenada's inshore fisheries have also suffered as a result of the pollution and destruction of highly productive "nursery" areas such as seagrass beds, mangroves, and shallow coral reefs. Other contributing factors to the depletion of stocks of fishes, lobsters, conch, and sea turtles are exploitation of reproducing females and eggs, illegal poaching and poor enforcement of size limits and closed seasons.

Offshore pelagic fishes (swordfish, kingfish, wahoo, dolphinfish, big-eye tuna, yellowfin tuna, mako shark, etc.) account for the majority of fish landings in Grenada and most other Eastern Caribbean islands. The use of longlines by the artisanal fishermen for offshore pelagics has raised some problems relating to the territorial boundaries of neighboring states. Grenada and other OECS countries have also initiated joint longlining ventures with industrial fishing companies from the United States and other nations, and much of the offshore catch is exported to them.

Although large-scale expansion of the pelagic fishery is sometimes advocated, estimates of abundance and sustainable yield are not available for most Caribbean stocks (with the exception of some tunas, dolphin, and flying fish -- e.g., Hunte, 1987b; Oxenford, 1985; Oxenford and Hunte, 1984). Many important species are migratory and possibly consist of several stocks, which implies that any management of such stocks must be carried out on a regional basis. Regional management is not presently feasible, but it is an OECS Fisheries Unit agenda item pending collection of the required data.

It is possible that the pelagic fishery resources of the region are not large enough to sustain further large increases in fishing pressure, and uncontrolled expansion of industrial longline fishing could severely deplete these fisheries. Population estimates of some commercially exploited pelagic fishes in the southeastern Caribbean are much lower now than they were thought to be in the 1970's, and the potential for large-scale fishery development of these stocks does not seem to be promising. For example, sharks have been promoted by many persons as an "under-fished" resource which holds promise for industrial fishery development in the Caribbean, but it is now recognized by the U.S. National Marine Fisheries Service that shark stocks are heavily overfished, at least in U.S. waters in the Gulf of Mexico and the Caribbean.

Since the mid-1980's, the United States fishing fleet has greatly increased its exploitation of the billfish resource in the Eastern Caribbean. Japan, Taiwan and South Korea have also rapidly expanded their longlining activities in the Caribbean in the last few years. The Asian boats sometimes work in conjunction with a mother ship and are able to bypass monitoring by delivering their catch to ports outside the region (Greenpeace International, 1988).

Recent (1989) findings by the U.S. South Atlantic Fishery Management Council provide a sobering preview of the possible fate of pelagic industrial fisheries in the Caribbean islands. The Council concluded after a lengthy study that the swordfish spawning biomass off the southeastern U.S. has declined steadily since 1979; the current biomass is estimated to be only 40 percent of the 1978 level (Leech, 1989). The average weight of swordfish has continually declined due to high fishing mortality rates. This stock assessment was based on the 1987 data, the most recent available, but presumably the swordfish stock has continued to decline in 1988 and 1989. An emergency management plan has been drawn up in an attempt to save the fishery; it recommends a quota system which is a reduction of 78 percent from the 1987 commercial harvest.

COASTAL EROSION, SAND MINING AND DREDGING

(1) **Coastal Erosion.** Under the auspices of BDD, a baseline study of beach geomorphology and offshore geology was carried out during 1970-73 around the coastline of Grenada for the purpose of erosion control (Deane, *et al.*, 1973). These authors found that the beaches were fairly stable. However, a Physical Tourism Development Plan prepared for GOG/OAS by Jackson, *et al.* (1983) identified beach erosion as a critical problem at Grand Anse Beach, Grenada's most important tourist resort area. Erosion rates for the period 1970-1982 were as high as 2 m per year in some places. These findings prompted further study of the problem, and a team of consultants funded by OAS carried out investigations at Grand Anse during 1984. These studies were divided into three components: beach dynamics (Cammers, 1984), water quality (Archer, 1984a) and coral reefs (DuBois, 1984).

Grand Anse is a 2.5 km long white sand beach on the southwestern coast of Grenada (Figure 4.4(6)). It is divided into a major section trending east-west, behind which much of Grenada's tourism infrastructure is located, and a north-south trending section behind which the land is less developed. The east-west section is subtly subdivided into two bays which separate at the approximate location of the Africa Club. The form of the beach is influenced by various structures such as storm drains ("seaheads") and jetties. The beach typically has a moderately steep intertidal zone and a narrow berm, but vegetation clearing in front of some of the hotels and accretion of sand near the seahead drains have resulted in a wider beach in these places.

Wave energy is low during most of the year on the west coast, but higher wave energy may occur during winter swell events and hurricanes. Wave direction in the vicinity of Grand Anse is predominantly from the north; however, refraction results in wave fronts that are nearly parallel to the shoreline. The beach is composed of fine sand (0.125-0.25 mm), with the sand size becoming coarser towards the southwest. There is a slow

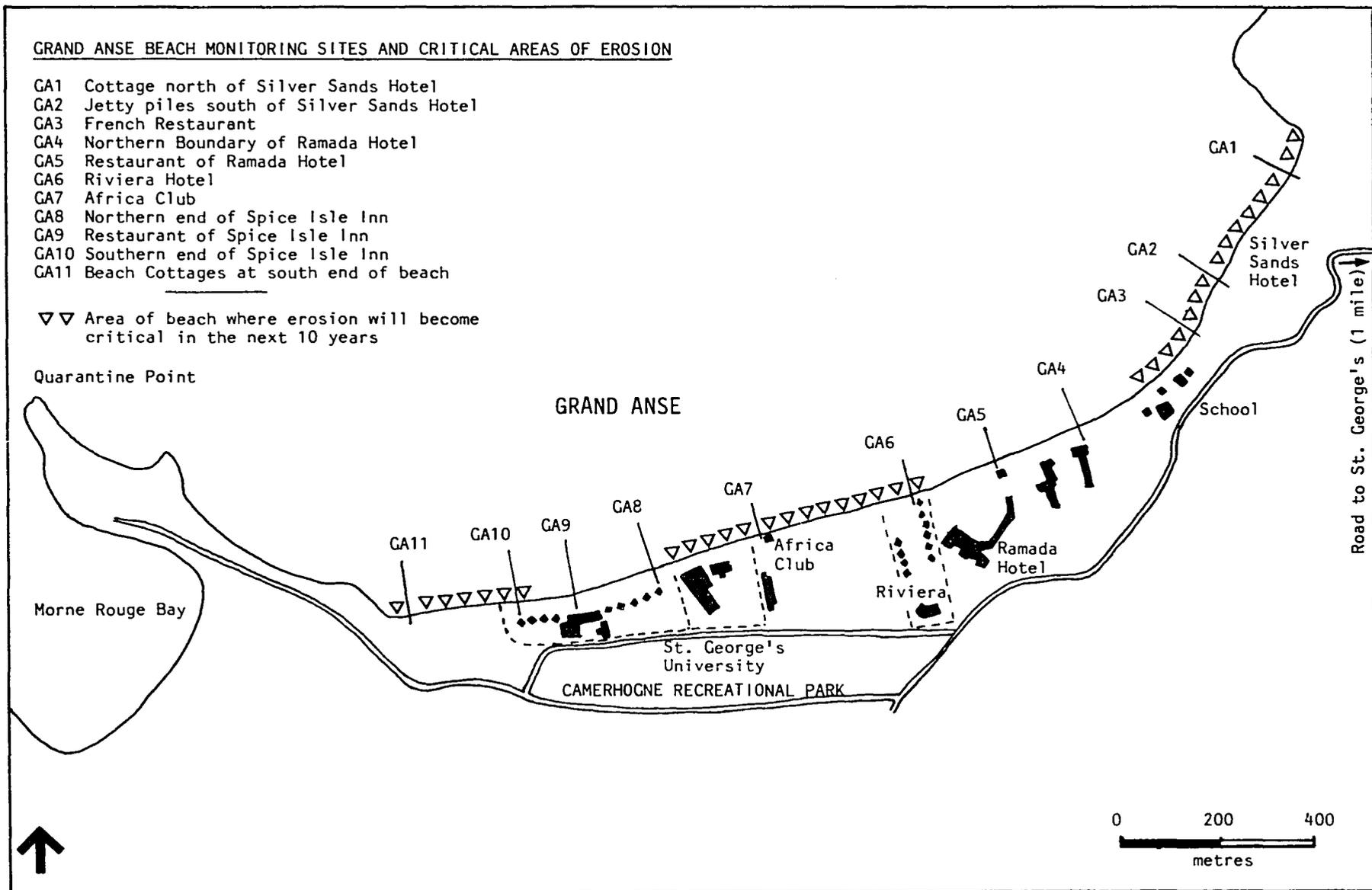


Figure 4.4(6). Grand Anse beach monitoring sites and critical areas of erosion (source: Cambers, 1986b).

movement of sand ("longshore drift") along the beach face from northeast to southwest, and an equally important seasonal onshore-offshore movement.

Average erosion rates at Grande Anse were about 0.4 m per year between 1951 and 1970, but this was partly related to extensive sand mining for construction which has been stopped in recent years. By comparison, average erosion rates were found by Cambers (1984) to be 0.7 m per year, with considerable spatial variation along the length of the beach.

Other areas of concern. Comparative measurements of other beaches in Grenada (Figure 4.4(7); Cambers, 1984) showed that during the period 1951-1970 there was generally little change; beaches were stable except for some localized accretion and erosion (the worst erosion was related to sand mining at Grand Mal Beach). At Levera Bay a tombolo (sand spit) on the coast in the shelter of Levera Island showed no change between 1951-1971; a coastal road ran along the beach and a bridge crossed the outlet to Levera Pond.

Between 1970-1984 there was a general increase in erosion rates, particularly on the west and north coasts. Beausejour Bay showed a very high erosion rate of 2.9 m per year, but this was at least partly related to ongoing sand mining activities. The erosion rate at Sauteurs Bay was measured at 1.8 m per year, and in 1984 several houses were in danger of being washed away. At Levera Bay the erosion rate of 3.6 m per year was the highest measured in the country; the tombolo had virtually disappeared and the coastal road and bridge had been washed out. On the east and south coasts there were also some signs of erosion.

The generally increased beach erosion around Grenada during this period parallels a similar trend of increased coastline erosion noted in other Eastern Caribbean islands, e.g., Barbados, St. Vincent, Montserrat, St. Kitts and Nevis, possibly the result of sea level rise (Cambers, 1984). The erosion at Levera, however, may be a long-term phenomenon possibly related to local subsidence of the land; apparently there was a previous

road seaward of the present one that was also washed out.

In mid-1985 a coastal monitoring program was set up in Grenada to collect and analyze data on beach profile changes, waves, surface currents and tides at Grand Anse and other beaches. This program has been carried out more or less continuously to the present, at least for some coastal areas (Cambers, 1985b-c, 1986a-f, 1987b, 1988). The data collected so far generally confirm the conclusions of the 1984 studies and show that Grand Anse is still experiencing serious long-term erosion. Where the beach is already narrow, the situation will become critical within the next ten years (Cambers, 1986b). In the short term the two areas in greatest danger are those near the Silver Sands Hotel and the area from the northeastern end of the Spice Island Hotel to the public area northeast of the Africa Club (Figure 4.4(6)). Morne Rouge, a nearby beach to the south of Grand Anse, also seems to be experiencing similar erosion problems (Cambers, Prelim. Draft, n.d.).

The major conclusion of Cambers' beach erosion studies was that the present trend of increased erosion at Grand Anse is due mainly to natural causes, such as sea level rise and/or land subsidence, and possibly increased wave energy from winter swells and hurricane swells. Man-made causes such as removal of vegetation cover, localized pollution which kills coral reefs, and the residual effects of previous sand mining are of lesser importance but most likely also contribute to the problem. The data base is insufficient to rank the importance of these factors.

Healthy nearshore reefs shelter beaches from wave erosion and act as a sand source, but Cambers (1984) feels that by itself coral reef degradation and die-off cannot adequately explain the high beach erosion rates recorded at Grande Anse. High erosion rates have been measured in the area northward from the Silver Sands Hotel where the nearshore reefs have apparently been degraded for a considerable time. Man-made pollution was probably a major factor in the death of these northern reefs, which have been exposed to the highest concentrations of pollutants originating from St. George's and

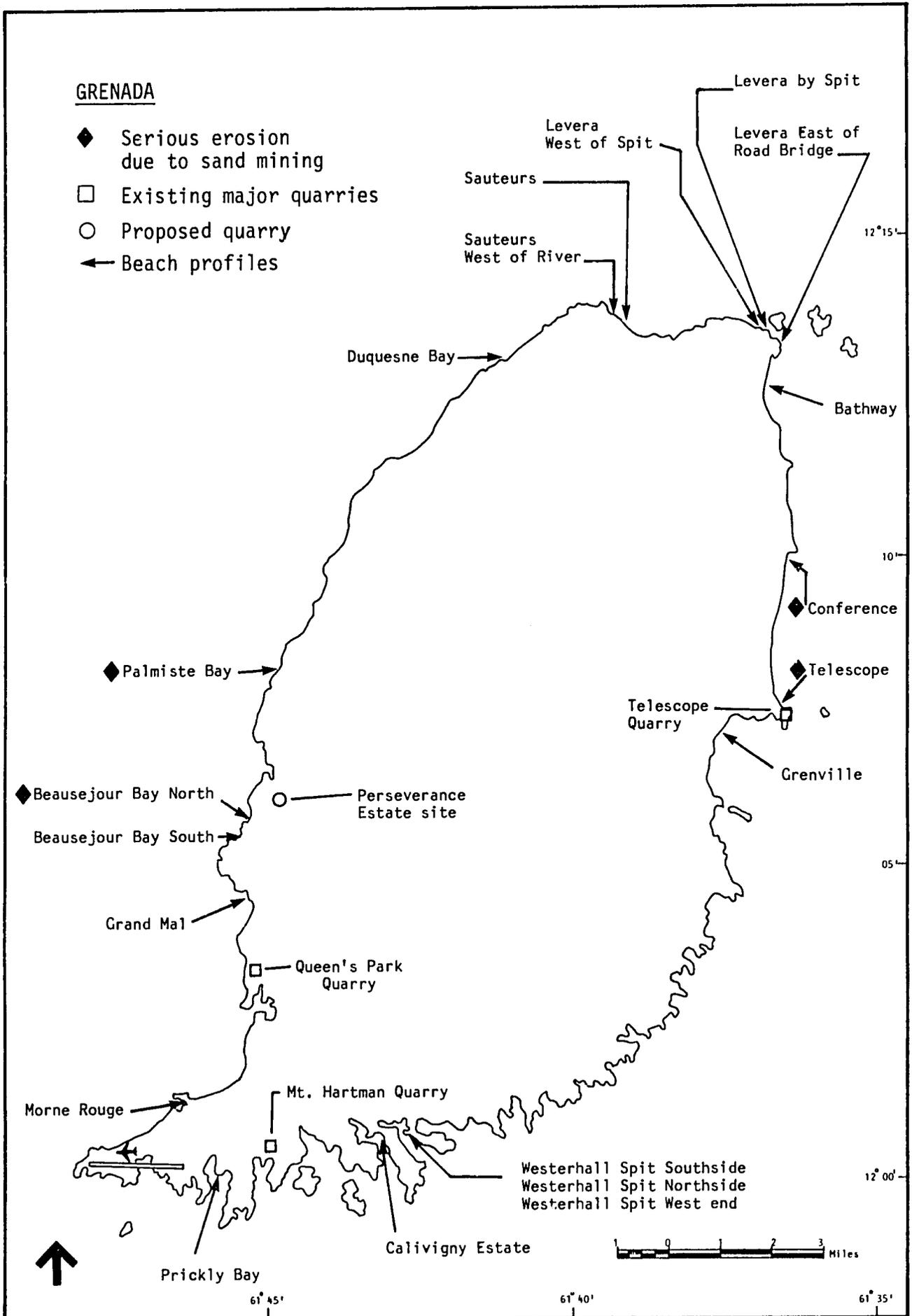


Figure 4.4(7). Location of sand mining, quarries and beach profiles in Grenada outside Grand Anse (source: Cambers, 1987; Andrews, 1988).

from the St. John's River. Nevertheless, Cambers notes that living nearshore reefs still occur along most of the rest of Grand Anse Beach, and yet in these areas the erosion rates were also high.

Not everyone agrees with Cambers regarding the causes of erosion at Grand Anse. For example, Taylor (1986, 1987), an engineering consultant with OAS, is critical of Cambers' conclusions. He believes that a combination of several causes, linked mainly to development rather than natural factors, is responsible for the increased beach erosion. He argues that the areas where estimated erosion rates are highest (the Silver Sands Hotel and the Africa Club) are areas where wave energy is focused during storms. These two areas were also the sites of wooden jetties which were destroyed about 1966 and which had previously provided the beach with protection from storm waves. Additionally, substantial mining of beach sand was done between the Riviera Hotel and the Africa Club, which removed vegetation and contributed to erosion. Finally, Taylor says that uncontrolled surface run-off is also causing loss of sand from the beach at these areas.

Some progress has been made in addressing the problems of drainage, run-off, sewage pollution and beach erosion at Grand Anse (Cambers, Prelim. Draft, n.d.). A tree revegetation program has been carried out at Grand Anse, sponsored by the OAS, and coastal setback guidelines (50 m) have been recommended for the country. In 1987 a retention pond was built at the southern end of Grand Anse to improve the quality of the run-off. A drainage improvement scheme which includes a similar pond has been proposed for the northern end of the area, but it has not yet been implemented. Many studies have been conducted on sewage treatment for the southwestern section of Grenada which includes the Grand Anse area (see Section 8). A recent study funded by USAID recommended an aeration treatment system with a long ocean outfall at Grand Bay just to the south of Point Salines Airport. Environmental studies for the project have just been completed, and construction will probably also be funded by USAID.

(2) **Sand Mining.** During the period in which coastal monitoring has been done, small-scale sand mining has been observed at most beach profile sites. Extensive sand mining which has caused serious erosion was observed at Beausejour, Palmiste, Conference and Telescope Bays (Figure 4.4(7); Cambers, 1986b, 1986c). Grand Anse Beach was extensively mined in the past, and other south coast beaches were reportedly mined for construction of the Point Salines Airport. Jew Bay is the major sand mining area on Carriacou.

Much of the erosion experienced along the west coast beaches could at least in part be related to beach sand mining. Often sea defense structures have to be built to protect the coastal highway following a concentrated period of beach sand mining, e.g., at Beausejour, where the beach has been almost totally depleted (Cambers, Prelim. Draft, n.d.). The principal uses of beach sand are in the construction industry for production of concrete, for manufacture of concrete blocks and for plastering. Almost all of Grenada's sand comes from the beaches; no appreciable amount of sand is produced from the crushing of rock at the quarries. No solutions will be found to the problem of beach sand mining until alternative sources are identified. GOG has recently asked the OAS to investigate offshore and inland sources of rock and gravel that could be crushed to provide sand.

Mining for aggregate and rock. Grenada's total maximum demand for aggregates is estimated at about 150,000 tons/year, with the greatest demand in the southern section of the island (Andrews, 1988). There are three quarries on Grenada, located at Mt. Hartman, Queen's Park and Telescope (Figure 4.4(7)). The Mt. Hartman and Telescope quarries produce high quality basalt rock and gravel, but the Telescope operation takes sand directly from the beach as well (Cambers, Prelim. Draft, n.d.). The Queen's Park quarry produces coarse sands and medium gravels (red and black volcanic scoria) used in road work and concrete making, not for first-grade construction materials.

The Grenada Rock, Asphalt and Concrete Products, Ltd. (GRAC) runs the

main rock quarries at Mt. Hartman and Telescope and is considering the establishment of a third quarry at Perseverance. Another company, the Grenada Gravel and Concrete Corporation (GCC), has jurisdiction over all gravel and sand sources with the exception of Telescope and Mt. Hartman; these include Queen's Park, Marybou, Levera, Grenville and Pilot Hill. Andrews (1988) recommended in a consultant report to GOG/OAS that the Mt. Hartman quarry be closed, based on its potential impact on the tourism industry in that part of the island, e.g., the impacts from heavy truck traffic on the newly rebuilt road in the area and the fact that the existing equipment is very old and needs replacement. He states that the Perseverance site should be developed as the major rock quarry serving St. George's and the southwest peninsula, as well as the northwestern coast, and that the Telescope quarry should be retained to meet the needs of the eastern section of the island.

Andrews (1988) carried out a preliminary analysis for identifying alternative sources to beach sand for construction material. The gravels and sands produced by the Queen's Park quarry are not fine enough to be used for plastering sand, either in their natural state or after screening. Suitably fine sand can only be obtained by crushing the material to improve the grading. A combination of crushing and screening could produce sand fine enough for plastering, and Andrews suggests that this is one approach that should be considered. Although there are other quarriable lava flows and domes among the main mountain ridges, Andrews does not believe that they represent a practical alternative for sand production.

Riverine sand sources have not been traditionally exploited in Grenada, although it might be feasible to mine sand in the estuarine reaches of the Great River and the Antoine River, both located on the northeastern coast. The potential impact of such activities on the erosion of river banks and the sand budget of nearby beaches would need to be carefully investigated beforehand. Because these sites are far from the major areas of development and would call for specialized mining equipment, Andrews does not recom-

mend exploitation of these sand sources at this time.

Offshore sand deposits in bays and on insular shelves have been mined in various Caribbean islands and elsewhere in the world. This is an undertaking fraught with environmental risks, and the materials obtained are often substandard or even unusable for construction purposes. It is therefore an option that should be approached with extreme caution; fortunately, an extensive literature exists on the subject (see, for example, DuBois and Towle, 1985). The only area considered by Andrews (1988) as a source of offshore sand is St. George's Harbor, which the Ports Authority is interested in dredging. Samples of harbor-bottom sand from a previous abortive dredging attempt were analyzed for suitability as construction sand. The material is coarser than required for plastering sand but, with screening, could be made of acceptable grain size. The presence of shells and sea salts are other constraints. Preliminary indications are that the shell content of the dredged material is unacceptable for use in concrete or mortar; the salts can be leached out by rain if the sand is stored on land for an appropriate time.

(3) Dredging and Filling. Archer (1984) mentions but does not discuss the environmental impacts of the following dredge and/or fill projects carried out in the St. George's area: construction of the deep water harbor at the port during 1958 to 1960; dredging of a channel into the Lagoon in 1958; reclamation of a swamp on the boundary of the Lagoon in the early 1960's; and dredging of the area southeast of the port breakwater known as The Spout to provide berthing facilities for small craft. Hardy Bay to the east of Point Salines was partially filled in to build the International Airport runway, and the swamp behind Grand Anse Bay was filled in during the 1940's (Taylor, 1987).

4.4.3 Policy Recommendations

FISHERIES MANAGEMENT AND DEVELOPMENT

* The most important fisheries management and development challenges for Grenada are: to implement long-term monitoring of catch and fishing effort for each major fishery; to regulate fishing effort so as to maintain levels that will not over-exploit the resources; and to introduce appropriate technology that allows economically efficient fishing operations and therefore provides good returns to the fishermen.

* Fishing effort must be utilized efficiently. It is crucial to avoid premature introduction of large (greater than about 65 feet, Mitchell, 1988²), costly and sophisticated vessels into the national fleet. The recently initiated strategy of licensing foreign vessels which pay fees and royalties and employ Grenadians as part of the crew is a sensible alternative.

* Where appropriate, levels of fishing effort must be regulated by measures such as gear restrictions, closed areas, closed seasons and economic measures such as fees and royalties; provision for such measures has been made in the harmonized fisheries legislation of all the OECS countries but requires better implementation.

* Artisanal fishermen should cater primarily to meeting domestic demands for fish, and the industrial fleet should concentrate on meeting export demands or any short-fall in the domestic market. This would ensure that the industrial sector would not adversely affect the artisanal sector, which is the major source of employment in fisheries, by depressing fish prices (Mitchell, 1988).

* Given the scarcity of economic resources and the poor performance in the tropics of traditional stock assessment procedures, Grenada should instead opt for a strategy of *adaptive management* of fisheries; i.e., implementation of common sense, trial and error management measures while simultaneously emphasizing monitoring of the fishery to evaluate the impact of those measures. Sum-

maries of appropriate management approaches for fisheries regulation are given in Hunte (1986) and Mahon (1988).

* The working principle for fishery managers should be that most fisheries, even those that are artisanal and relatively low-technology, tend towards over-exploitation and excessive fishing effort if not regulated. Fishery management plans should be oriented towards conserving the resource and attempting to optimize its long-term returns, rather than towards the classical objective of maximizing long-term catches (Mahon, 1988).

* Fishery managers, in concert with other GOG planners, must decide on the relative importance of the fisheries sector to employment, total food production, local food availability, return on investment, and export commodities. They must then evaluate the feasibility of attaining the desired mix of objectives, both in terms of the estimated capacity of the fishery resource and in terms of the practicality of implementing necessary regulations.

* For large pelagic fish species with ranges extending outside of the region and which are fished by industrial fleets from other nations, management measures implemented by Grenada are not likely to have any significant impact on the status of the resource. An appropriate strategy for Grenada would be to improve the harvesting efficiency of existing vessels so as to catch as many of these species as are available. Major industrial fleet expansion based on expectations of increasing catches for these species should not be undertaken.

* For those species which are likely to be regional in distribution, Grenada should participate in discussions on cooperative regional management. Because of the many unknowns regarding migration patterns and stock structure, it would be futile to consider management based on estimates of stock size for these species. A priority is the establishment of regional data collection systems for catch and effort. Following a period of 5-10 years of monitoring, a picture of migration, distribution and the response of the resource to increasing fishing pressure may emerge.

Similar considerations also apply for flying-fish.

* Effective management of reef fishes could probably be implemented, at least for trap fisheries, without knowledge of potential yield. If it is clear that the resource is over-exploited, it may be desirable to simply reduce the fishing effort by an appropriate amount and observe the results over a period of several years.

* Management objectives for reef fish populations should probably be oriented towards conserving the artisanal nature of the fishery and rebuilding the stocks. The immediate objective should be to reduce fishing mortality, particularly on juvenile fishes. Mesh size regulations for traps coupled with limits on the number of traps per fisherman may be the most appropriate strategy.

* Too little is currently known about the status of deep demersal fishes to propose management measures. However, there are reports of local depletion in the Lesser Antilles, particularly of known spawning aggregations. Monitoring of catch and effort, as well as mapping the distribution of these resources, would be priorities for management.

* Lobsters are protected by the harmonized fisheries regulations which are already in place in Grenada, but these regulations are poorly enforced. Monitoring of catch and effort for several years will be essential to determine whether the new regulations are effective. Some means of limiting effort will probably be required in the long run. The shortage of suitable juvenile nursery habitats -- mangrove lagoons and seagrass beds -- may limit the abundance of harvestable lobsters and these habitats should be protected.

* The situation for conch is very similar to that for lobster, and the same recommendations apply.

* A total moratorium on the exploitation of all species of sea turtles has already been approved by OECS countries (Mahon, 1988). Assuming that in the near future this moratorium can successfully be

implemented and enforced, there will be no catch to monitor, but the recovery of populations should be monitored by collecting data on nesting frequency. Increased public education and the utilization of natural history enthusiasts, members of the National Trust, and local schools for monitoring efforts may be one appropriate method to support the monitoring of nesting turtles at low cost; it should be pursued by Government.

* Management of white sea urchins in Grenada should aim at conserving the resource and monitoring the stocks. Many coral reefs in Grenada show excessive algal overgrowth, perhaps related to increased levels of nutrients, a regional die-off of long-spined black sea urchins in 1984, overfishing of herbivorous fishes, or other causes. Since sea urchins eat algae from coral reefs, encouraging expansion of the fishery for these animals is probably unwise.

* A priority item for Grenadian fisheries management is to expand the existing data collection system as soon as possible by implementing sampling routines for minor landing sites; purchase slips for middlemen, hotels and restaurants; enforcement of export licenses; logbooks for large offshore boats to include catch and effort data; and monitoring strategies for foreign fishing (Finlay, *et al.*, 1988).

COASTAL ZONE MANAGEMENT

* The current program of coastal monitoring should be continued with the aim of acquiring a continuous and reliable data set. Long-term monitoring is essential to the documentation of trends in sea level changes and the formulation of a rational GOG response to changes in the resource base.

* The 50 m coastal setback should be implemented and rigorously enforced, and beach vegetation should be protected. Revegetation of beaches cleared in the past should be accelerated in order to stabilize the beaches.

* GOG resource managers need to assess available sand deposits and make

judgments as to where continued sand removal will have the least detrimental impacts on natural systems and is more compatible with current site utilization. Until a substitute for sand has not only been identified but also has demonstrated technical and monetary capability for widespread use, sand will continue to be removed from the beaches. To better manage and control an almost inevitable exploitation of this resource in the near-term, GOG must make hard decisions to earmark priority areas where sand removal will be absolutely protected and areas of lesser concern and stress where regulated sand removal will continue at some determined level. At the same time, every effort must be made to identify and develop alternative sources of construction aggregate.

* An oil and hazardous materials spill contingency plan should be developed, and a spill response capability should be created by the training of a response team and

the acquisition of basic spill control equipment (see also Section 8).

* Control of upland erosion and sediment discharges and appropriate treatment of sewage and other discharges with high nutrient loads is vital to protect coastal water quality, public health and the integrity of coral reefs. This is especially critical in the area of St. George's Harbor and Grand Anse Bay on Grenada (see also Section 8).

* An environmental impact assessment process should be required for all large coastal development projects such as the proposed new cruise ship port or any new marina expansion. The *cumulative* effects of such projects must be assessed rather than analyzing each project in isolation. The Physical Planning Unit should be designated as the GOG lead agency responsible for impact assessments in the country (see also Section 9).

SECTION 5 AGRICULTURE

5.1 OVERVIEW OF THE AGRICULTURAL SECTOR

Agriculture has long been and continues to be the single most important sector of Grenada's economy. It accounts for 25 percent of gross domestic product (GDP), 40 percent of export earnings, and about 50 percent of employment (USAID, 1988), in all cases higher than for any other single sector. In 1984, 75 percent of the sector's overall value came from the four export commodities of cocoa, bananas, nutmeg, and mace (World Bank, 1985), but other fruits and vegetables were and still are gaining in importance.

The island's earliest inhabitants, the Arawaks and their successors the Caribs, obtained much of their food through farming Grenada's fertile soil. These Amerindian peoples maintained a highly nutritious diet based largely on the cultivation of root crops, beans, maize, squashes, papaya, guavas, and a wide variety of other fruits and vegetables.

Cotton and tobacco were also grown. In fact, it was the potential for profitable tobacco production that drew European settlers to Grenada in the mid-1600's when a group of French colonists pushed aside the Carib inhabitants, gained a foothold on the island and harvested the first tobacco crop in 1651 (*The Courier*, 1986).

Tobacco and cotton cultivation became the island's most important economic activities. Production of cotton, as well as cocoa and coffee, expanded considerably in the first half of the eighteenth century, a process which carried with it a substantial increase in the island's population, from about 800 in 1700 to 13,000 by 1750 (*The Courier*, 1986). The latter figure included the thousands of African slaves imported to work the plantations by the French, and later, the British, colonists.

Over the course of the 1700's sugar cane became the dominant crop on Grenada, grown for production of both sugar and rum. The industry led to extensive deforestation of the island, first to expand the area under cultivation and subsequently to fuel the sugar factory boiling houses and rum distilleries. By the

end of the eighteenth century, the mostly monocrop plantations had almost completely displaced the relatively undisturbed multi-species ecosystem which had prevailed during the pre-Columbian period.

In Carriacou the first European settlement was also established by the French. Sugar cane and cotton were introduced, as were African slaves to work the plantations. During the eighteenth and nineteenth centuries the expansion of areas under cultivation brought about the displacement of Carriacou's native vegetation. The impact on the landscape has been severe and pervasive, a fact which is evident from an examination of present conditions. Soils with well developed profiles are virtually non-existent on the island, having been eroded long ago. Both local informants and the available literature attribute this degradation to the abusive agricultural practices that have prevailed since European settlement.

As discussed below, such practices continue today, particularly in the form of overgrazing. The naturally scrubby vegetation is now sparse and impoverished, and in many locations the land base is too degraded to allow for a spontaneous process of re-vegetation. This deteriorated state of the natural resource base has been identified as one of the most important obstacles to development in Carriacou (GOG/OAS, 1988b).

In contrast to some selected improvement in performance within the agricultural sector during specific years of the 1980's (as discussed in Section 3), over the long-term period of the last twenty years, there has been a more general decline in agricultural production in Grenada. This has been due in large part to fluctuating world prices for the major export commodities of nutmeg, mace, and bananas, to foreign exchange constraints, and to price increases leading to reductions in the use of imported fertilizers and pesticides (USAID, 1984b; Babb, *et al.*, 1984). Marketing problems for nutmeg and mace have led to donor assistance for agricultural diversification projects

which focus on crops such as bananas, sugar cane, coconuts, cocoa rehabilitation (CIDA, USAID, PADF), and on other tree and food crops (World Bank, OAS, IICA).

Other problems facing the sector have included increasing labor costs, inefficiency in the management of grower associations, serious crop disease and pest problems (particularly for banana and cocoa), low levels of farm investment, rampant praedial larceny, poor transportation infrastructure, and weak government research and extension services.

A critical factor contributing to a general decline in agricultural production has been the dislocation associated with the demise and break-up of the estate system, particularly during the 1970's, and the failure to develop a productive alternative. Government programs for the acquisition and control of several large estates have been fraught with poor management. Some of these estates have been retained under public-sector control, while others have been divided into small plots for redistribution to small farmers.

Many of the difficulties facing the agricultural sector in modern Grenada have their roots in the legacy of the colonial past and in particular its plantation-based economic structure. Under colonial rule throughout the Caribbean, investment in agricultural production, infrastructure, technology, and marketing, focussed almost exclusively on the traditional export crops of sugar, cocoa, bananas, coconuts, nutmeg, and citrus. Research programs sponsored by colonial regimes administered by Great Britain were primarily designed to serve the vested interests of those involved in plantation-based export crop agriculture. Small farming, on the other hand, functioned as a secondary activity (at least in the eyes of the authorities) on marginal lands at the fringes of commercial plantations. The small farming system lacked a support structure to assist farmers in significantly increasing productivity.

With the recent decline in the estate system following World War Two, it has become increasingly evident that the now dominant small farm sector (and thus the broader national economy) has suffered and will con-

tinue to suffer from this history of neglect. Poor cultivation practices, low productivity, and a considerable level of resource base degradation remain as entrenched features of the existing system.

At the same time, in a pattern common throughout the Caribbean, the historical development of the agrarian sector in Grenada also fostered a continuing, widespread avoidance if not disdain for plantation agriculture and, in general, a view of farming as a low-status occupation. Perhaps more importantly, the colonial structure served to severely hinder the development of managerial competence and entrepreneurial skill among the general population; the metropole provided the market and dominated its supply through a system in which few local people were meaningfully involved.

On a more positive note, the small farming and other rural resource systems which have emerged in the last 40 years have been characterized by a considerable degree of crop diversity, occupational multiplicity, and self-reliance. These features remain largely intact to the present and will contribute to efforts to develop a productive and thriving rural sector.

With the growing importance of the small farm sector since independence, the challenge ahead is to improve the institutional structures, managerial performances, and technical expertise necessary to promote and support the productivity expansions necessary to ensure an improved quality of life for Grenadian people. Concurrently, it is important that the country reverse existing patterns of resource degradation and thereby allow for sustained improvements in productivity and in the overall quality of life.

5.1.1 Land Capability

Grenada's soils are mostly well-drained and reasonably fertile. Together with high temperature and rainfall in most areas, the country's land base has considerable potential for productive crop growth. However, as a mountainous country, there is also a high erosion potential, a factor which places sub-

stantial constraints on the way the vast majority of the country's land base can be sustainably utilized. This point will be discussed in more detail below.

The most recent work in evaluating land capability in Grenada was conducted by the Ministry of Agriculture (Eschweiler, 1982a). The methodology used was based on a "land unit" approach in which a series of units were defined (primarily according to land form, slope, and soil characteristics) and subsequently mapped.

The units were evaluated for various possible types of land use through a process of matching the land unit characteristics with the requirements of numerous crops. Accompanying land unit reports contain tables which indicate the units with the "highest acceptability classes" for each crop (Ternan, *et al.*, 1989).

To date, 12 surveys of land units have been completed on the basis of this system. Unfortunately, the program has lapsed, and no surveys have been conducted since the original pilot study (C. Francis, Land Use Officer, pers. comm., 1989).

An earlier land capability study (Vernon, *et al.*, 1959) identified seven broad capability classes based on overall suitability, taking into consideration, among other factors, "the risk of soil erosion or other damage and the difficulties of management." Table 5.1(1) lists these classes along with the hectareage that falls within each on both Grenada and Carriacou. It also describes the most intensive suitable use to which land in each class should be put. Table 5.1(2) describes the slope categories upon which the capability class designations have been largely based.

Within each class, four possible limiting factors were identified, creating a number of subdivisions within all classes except Class 1 which has no limitations. These limiting factors are: slope and erosion risk; seasonal or permanent excess water (poor natural drainage); edaphic factors (e.g., shallow or droughty soil); and climatic factors (usually low rainfall and a long dry season).

As shown in Table 5.1(1), only about 25 percent and 28 percent of all land in Grenada and Carriacou, respectively, is considered suitable for cultivation (tillage) -- a total of 7,490 ha (18,500 ac) in Grenada and 931 ha (2,300 ac) in Carriacou. However, the vast majority of these "cultivable lands" (e.g., 81 percent in Grenada) are actually in Class 3 and thus have "strong limitations" to their use. Given that terrain in Class 3 has "mainly D slope[s]" of 10-20 percent (see Table 5.1(2)), it can be assumed that erosion risk is the most common limitation.

This picture of land capability vs. land use is of considerable importance to conservation practices in Grenada. The country's land resources must be utilized and managed in ways that are appropriate given the serious risk of erosion. If they are not, then quite simply, the country's land resource base, arguably the most important foundation of its economy, is being degraded. In the following section, existing land use and farming systems are examined with this precept in mind.

5.1.2 Land Use Patterns and Farming Systems

LAND USE AND FARMING SYSTEMS ON THE ISLAND OF GRENADA

The agricultural system in Grenada is one of mixed cultivation, particularly on small farms. At present, some 90 percent of the farms are under 5 ha (12.3 ac) in size (Ternan, *et al.*, 1989). Such small farms support a system that has changed little over time and remains largely subsistence-based. The system serves as a buffer or insurance mechanism against external forces such as natural disasters and fluctuations in export crop prices. It also acts as a cushion against financial hardship when production of traditional export crops is low, since fruit crops are available to be sold.

Pure stands of export crops occur primarily in some of the few remaining large estates. The hurricane of 1955, before which there were relatively vast acreages of pure stands, highlighted the vulnerability and risks of a monocrop system. For example, about 80

Table 5.1(1). Land capability classes and suitable uses.

CLASSES AND FEATURES	GRENADA		CARRIACOU		MOST INTENSIVE SUITABLE USE
	ha	%	ha	%	
I. A and B slopes, good soils	749	2.5	81	2.5	Cultivation (tillage) with almost no limitations
II. Mainly C slopes, good soils	668	2.2	486	14.8	Cultivation (tillage) with moderate limitations
III. Mainly D slopes, some gentler slopes with less favorable soils	6,073	20.4	364	11.1	Cultivation (tillage) with strong limitations
IV. Mainly E slopes, some D slopes	7,692	25.9	739	22.5	Tree crops, grasses and very limited cultivation
V. Mainly E and F slopes	7,287	24.5	1,478	44.9	Not suitable for cultivation; suitable for forest, tree crops or improved grass
VI. Mainly steep rocky land or dry climate	7,287	24.5	142	4.3	Not suitable for cultivation; suitable for poor forest
	<u>29,756</u>	<u>100%</u>	<u>3,290</u>	<u>100%</u>	

Source: Vernon, *et al.*, 1959.

percent of all pure stand nutmegs were destroyed or severely damaged by the hurricane (Eschweiler, 1982b).

Table 5.1(3) provides a quantitative breakdown of the main types of agricultural land use in Grenada as of 1982. It is clear that tree crops were (and still are) the dominant agricultural product, occupying 13,700 ha (33,839 ac) or roughly 70 percent of the total cultivated area. This high proportion of tree cropping manifests a relatively good adaptation to the island's steep topography and climate.

Nutmeg and cocoa were the first most important tree crops, followed later by coconuts, limes, and other spices such as cloves

and cinnamon. Only after the 1955 hurricane did bananas become an important crop (Eschweiler, 1982b). As noted earlier, Grenada's main export crops currently are cocoa, nutmeg, and banana.

Table 5.1(4) displays the land use changes that have occurred in recent decades. The figures presented are based on the Agricultural Censuses of 1961 and 1975 and on air photo interpretation conducted in 1982 by Eschweiler (1982b). The most substantial land use changes occurred in the 1970's with an average annual decline of 500 ha (1235 ac) in the total area under agriculture between 1967 and 1975 (Ternan, *et al.*, 1989). Grassland declined most, but primarily during the 1960's,

Table 5.1(2). Slope categories and their extent.

SLOPE CATEGORY	GRENADA		CARRIACOU	
	ha	%	ha	%
A - 0 to 2 degrees	476	1.6	81	2.5
B - 2 to 5 degrees	1,012	3.4	466	14.2
C - 5 to 10 degrees	1,457	4.9	253	7.7
D - 10 to 20 degrees	5,709	19.2	931	28.2
E - 20 to 30 degrees	14,170	47.6	1,457	44.3
F - over 30 degrees	6,923	23.3	101	3.1
	<hr/>	<hr/>	<hr/>	<hr/>
	29,747	100.0	3,289	100.0

Source: Vernon, *et al.*, 1959.

with 1,250 ha (3,087 ac) coming out of production between 1961 and 1967. This pattern has continued to the present, coinciding with a decrease in the livestock population. The area under bananas has increased recently, while cocoa and nutmeg cultivation has remained static or have decreased (Ternan, *et al.*, 1989). The increase in banana cultivation, 12.8 percent between 1987 and 1988 (Blaize, 1989), has seemingly occurred in response to the high prices the crop has been receiving in the late 1980's.

Most of the land use changes have taken place in the estate sector, consistent with the pattern that has prevailed throughout the Caribbean.

Land use maps for the State of Grenada are based on aerial photographs taken in 1982. Two map sheets exist for the island of Grenada, while an additional sheet depicts land use patterns on both Carriacou and Petite Martinique. Among the agricultural land uses in Grenada proper, ten units or clas-

sifications based on cropping patterns have been identified. In Carriacou and Petite Martinique, seven such units are relevant to agriculture. The following is a brief description of each of these land use units on the main island of Grenada, derived from Eschweiler (1982b). The units identified for Carriacou and Petite Martinique are outlined in the following subsection.

AGRICULTURAL LAND USE UNITS IN GRENADA

Unit 1 - Food Crops and Vegetables.

The vegetables and other foodcrops cultivated in Grenada include peas, corn, sweet potatoes, yams, beans, dasheen, tannia, eddoe, cassava, peppers, cucumbers, tomatoes, carrots, and cabbage. They are grown throughout the island but especially around urban and suburban settlements in the southern half of the island. A total of 591 ha (1,460 ac) falls within this unit, most of which (405 ha/1,000 ac) are found in the south.

Table 5.1(3). Main types of agricultural land use and their area in Grenada.

CATEGORY	TOTAL AREA (in ha) 1982
Food crops (maize and vegetables)	4,160
Sugar cane	530
Tree crops	
Cocoa	4,460
Banana	3,560
Nutmeg and spices	3,780
Coconuts	940
Fruit trees	930
Grassland (pasture)	170
Grassland and scrub	290
Total Area in Agricultural Use	18,820

Source: Eschweiler, 1982b.

Table 5.1(4). The change in cropping pattern through time (data derived from agricultural censuses of 1961 and 1975, and air photographs).

CATEGORY	YEAR OF CENSUS		
	1961 (ha)	1975 (ha)	1982 (ha)
Total area in agricultural use	19,810	14,090	18,820
Foodcrops and sugar cane	5,163	4,018	4,690
Tree crops including cocoa and nutmeg	11,109	9,170	13,670
Grassland, cultivated and uncultivated	2,480	590	460
Forest/woodland	3,830	2,880	3,970

Source: Eschweiler, 1982b.

Unit 2 - Food Crops and Vegetables Mixed With Fruit Trees. Fruit trees are commonly grown on the edges of the food crop/vegetable plots, serving as a windbreak. Some 425 ha (1,050 ac) fall within this unit in the south, and an additional 259 ha (640 ac) occur in the north (684 ha/1,690 ac total). An

estimated 25 percent of the area in this unit is under fruit trees; thus, there are roughly 170 hectare-equivalents (420 ac) of the latter.

Unit 3 - Mixed Cultivation. This unit is an association of units 2, 5, 6, 7, 8, and 10. At 15,304 ha (37,800 ac), it is the most

Table 5.1(5). Approximate extent of unit 3 land uses.

Category	Est. %	Ha (ac)
Foodcrops/vegetables	20	3,061 (7,560)
Fruit trees	5	765 (1,890)
Treecrops:		
cocoa	20	3,061 (7,560)
nutmeg	15	2,296 (5,670)
banana	15	2,296 (5,670)
Other (including idle land)	25	3,826 (9,450)
TOTAL	100	15,305 (37,800)

Source: Eschweiler, 1982b.

widespread of all units, a reflection of the great extent to which intercropping is practiced. Table 5.1(5) lists the approximate acreage-equivalents for each crop.

Unit 4 - Sugar cane. Most of Grenada's sugar cane is grown in the south, near a factory at Woodlands where the crop is processed to sugar. Only 12 ha (30 ac) is under cultivation in the north, in the vicinity of two rum distilleries (other estimates place this figure at about 45 acres; E. Peters, CEP Tech. Com., pers. comm., 1990). Total current hectareage is 534 (1,320 ac).

Unit 5 - Banana. This unit includes relatively pure stands (at least 70 percent) of banana. Normally the crop is interplanted with cocoa, acting as a nursery shade crop for the latter. The banana, however, is generally not later removed (following the period when its use as a shadier has ended), as would be expected. Some mixtures with nutmegs/spices and with fruit trees also occur. Total area in Unit 5 is 344 ha (850 ac), with most (267 ha/660 ac) in the wetter, northern part of the island.

Unit 6 - Banana Mixed With Cocoa and/or Spices. This unit includes lands which contain 50 percent bananas, 30 percent cocoa, and 20 percent nutmeg/spices. Total acreage, occurring mostly in the south, amounts to 899 ha (2,220 ac), consisting of 449 ha (1,110 ac) of

bananas, 271 ha (670 ac) of cocoa, and 178 ha (440 ac) of nutmegs/spices.

The total area under bananas in Grenada, most of which lies within the mixed cultivation unit (Unit 3), is 3,563 ha (8,800 ac), as shown in Table 5.1(3).

Unit 7 - Cocoa. In a pattern consistent with that described above, cocoa is usually mixed with bananas and/or spices (mostly nutmeg). This unit includes lands which support at least 70 percent cocoa, a total of 328 ha (810 ac) (227 ha/560 ac in the north and 101 ha/250 ac in the south).

Unit 8 - Cocoa Mixed With Bananas and/or Spices. Unit 8 consists of areas with about 50 percent cocoa, 30 percent banana, and 20 percent spices (mainly nutmeg), a total of 1,579 ha (3,900 ac) located primarily in the northern part of the island.

The total area under cocoa in all units amounts to 4,460 hectare-equivalents (10,990 ac), as shown on Table 5.1(3).

Unit 9 - Coconuts. This tree crop is grown throughout the island, primarily along the coast. The total extent of Unit 9 is 943 ha (2,330 ac), a figure that does not account for the scattered trees throughout the island. According to Eschweiler (1984b), "Many of the

coconut plantations are in a deplorable state at the moment."

Unit 10 - Nutmeg. Nutmeg trees are grown almost exclusively in the northern half of the island. The unit describes areas with an estimated minimum of 70 percent nutmeg -- a total of 996 ha (2,460 ac). In the south, the crop is heavily mixed with other crops and even with forest. Lands supporting less than 50 percent nutmeg have been classified under Unit 3, in which are found an estimated 3,061 ha equivalents (7,560 ac) of nutmeg and other spices.

A simple comparison of the land capability and the land use figures for the island of Grenada seems to suggest that, in general, the land base is being used in a suitable manner. For example, Capability Classes I and II together account for 1,417 ha on the island. Similarly, some 1,488 ha have slopes below five degrees. These figures generally reflect the maximum amount of land that can be utilized for intensive cultivation without taking special measures to guard against land degradation due to erosion or otherwise. The three most intensive land use units -- food crops and vegetables (Unit 1), sugarcane (Unit 4), and pure stand bananas (Unit 5) -- have a combined total area of 1,469 ha, roughly equivalent to the figures indicated for high capability and moderately sloped lands. All the other agricultural land use units on the island feature mixed cropping with tree crops, a pattern that generally would render them appropriate for the remaining steeper and otherwise harsher lands.

However, these island-wide, 1982 figures only reveal that the amount of land that can be used intensively in a sustainable manner (without special protection measures) corresponds to the total amount of land that is in fact being used very intensively. The figures do not indicate whether the land uses associated with each unit described are actually occurring in the high capability, gentle slope areas. It is clear that at present, at least some of Grenada's pure stand banana crop is actually being raised on much steeper slopes. During the late 1980's bananas have commanded a high price, and thus they have been planted more extensively, including in areas that are

excessively steep or otherwise are unsuited to their cultivation.

AGRICULTURAL LAND USE UNITS IN CARRIACOU AND PETITE MARTINIQUE

Carriacou has a long history of agriculture, based first on sugar cane and subsequently on cotton, peanuts, and eventually the current system of livestock and the production of "animal foodcrops" such as maize and peas. Livestock grazing is presently carried out on about half the island, mostly in the south. Mixed crop farming is practiced on both Carriacou and Petite Martinique but little is produced due to unreliable rainfall and an extremely long dry season.

Eschweiler (1982b) describes a total of 11 different land use units. Those which are relevant to agriculture are summarized below.

Unit 1 - Food Crops. A total of 197 ha (486 ac) in Carriacou and 7 ha (17 ac) in Petite Martinique are planted with food crops. These include maize and pigeon peas grown mainly on a subsistence basis and groundnuts which are shipped to Grenada.

Unit 2 - Fruit Trees. Fruit trees generally are found on a scattered basis around dwellings or in suburban settlements. Some have been planted on the edges of small food crop plots. The main fruit trees are citrus (limes), mangoes, guava, tamarind, golden apple, and soursop.

Unit 3 - Coconuts. This tree crop also occurs on a scattered basis both in Carriacou and in Petite Martinique. Several small pure stands, with a total estimated area of 15 ha (36 ac), can be found near Hillsborough.

Unit 4 - Citrus. Isolated patches of pure stands of citrus (mostly limes) exist throughout Carriacou. Total acreage amounts to 10 ha (25 ac). Scattered trees also occur in settled areas of the island.

Unit 5 - Pastures and Grazing Land. Most of Carriacou's land base is considered pasture, but much of it is extremely weedy and contains very poor quality grasses. In fact,

"many pastures are little more than ruiate" (Eschweiler, 1982b). Nevertheless, livestock is the primary source of income, derived mostly through sales of goats and sheep. Overall totals of 800 ha (1,976 ac) and 26 ha (63 ac) are used for grazing in Carriacou and Petite Martinique, respectively. These acreages include the grazing lands that comprise 70 percent of the total area within Unit 11 (see below).

Unit 10 - Open Scrub Cactus Vegetation With Scattered Trees Used for Grazing. This type of land use is the most widespread in both Carriacou (1,219 ha/3,010 ac) and Petite Martinique (143 ha/353 ac). The vegetation is reportedly "nothing else but ruiate and bush where people turn loose their goats, sheep, and some cows" (Eschweiler, 1982b). Soil erosion directly resulting from overgrazing is a significant problem on Carriacou.

Unit 11 - Mainly Pastures and Grazing Lands But Mixed With Food Crops. This unit is found in the vicinity of rural and urban settlements, extending over 550 ha (1,358 ac) in Carriacou and 15 ha (38 ac) in Petite Martinique. About 70 percent consists of pasture and grazing land; 30 percent is under food crops. The acreages that stem from these percentages have also been included in the total figures provided for Units 1 and 5.

The statistics for Carriacou show that a vast area is being used for grazing and that much of this land is already degraded. The extent to which the degradation process is continuing, and how severely, depends primarily on the density of animals being permitted to graze the land relative to the latter's carrying capacity.

5.1.3 Land Tenure

In 1988 there reportedly were 5,959 farms in Grenada, more than in any other country in the OECS. Some 49 percent of these farms were under 0.4 ha (1 ac) in size, 47 percent were between 0.4 and 4 ha (1 and 10 ac), 3.4 percent were 4 to 20 ha (10 ac to 50 ac) in size, and only 0.9 percent were larger than 20 ha (50 ac) (Chemonics, 1988).

Very many of the small farms actually consist of several parcels. In fact, only 50 percent of all farms under 2 ha (5 ac) in size consist of a single parcel. Some 18 percent are comprised of 2 parcels, while 32 percent consist of 3 parcels (Chemonics, 1988).

The various parcels that together make up a given farm are commonly located at some distance from each other, a factor which likely complicates certain aspects of the farming operation (e.g., mechanization) and increases commuting time. Concurrently, however, the focus of effort on different micro-environments serves to reduce production risks for the individual farmer.

Table 5.1(6) presents data on tenure in terms of the percentage of farmers that own, rent, sharecrop, etc. It is noted by Chemonics (1988) that despite the high percentage of rentals, leases, and occupancies without ownership (i.e., squatting), "these arrangements usually are reasonably secure, even when on a year-to-year basis." However, the degree to which such casual tenure arrangements serve to stimulate long-term investments, for instance, in soil conservation practices, crop diversification, and the like remains questionable.

Farms in the broader Eastern Caribbean region frequently are characterized by precarious tenure due to unregistered titles and/or a "family land" situation in which multiple family members are vested with ownership. As displayed in Table 5.1(6), almost 20 percent of the farms in Grenada are classified as "family land". In theory all family members are entitled to a share of produce from the land in question and must agree to a property sale before the land can be transferred. Such a situation also tends to limit the commitment to long-term soil conservation practices and other such improvements.

During the 1960's the Government began a program of expropriation of agricultural land by eminent domain, creating almost 3,375 ac (1,350 ha) of publicly owned state farms. In 1980 the People's Revolutionary Government (PRG) formed a statutory body called the Grenada Farms Corporation (GFC) to manage the state-controlled farms (see page

Table 5.1(6). Percentage of farmers by land tenure and district.

TENURE	EAST	NORTH	WEST	SOUTH	C/COU	GRENADA
Owner	54.9	48.7	35.8	46.9	39.5	46.7
Owner-Rent	8.9	7.4	10.7	5.1	3.4	7.9
Renter	9.8	12.8	16.4	11.7	9.4	12.2
Mcnager	8.2	11.6	6.0	2.9	1.8	7.0
Family owned	13.8	12.9	22.9	24.1	40.3	19.4
Share cropped	0.9	0.4	1.7	4.5	3.9	1.9
Land-less	3.3	6.0	6.7	4.7	1.7	4.8
No. of farmers	2,476	1,801	1,790	1,542	593	8,202

Source: Grenada Annual Abstract of Statistics, 1987.

149). By 1983, after three years of accelerated expropriation by the PRG, the GFC controlled 35 farms totaling 7,800 ac (3,120 ha), or about 20 percent of the farm land then in use (Babb, *et al.*, 1984). The GFC has since been superseded by the Grenada Model Farms Corporation (GMFC) which, among other things, is engaged in returning much of this government-controlled farm land to private ownership (Tobal, 1986).

5.2 PROBLEMS AND ISSUES

EROSION RELATING TO CULTIVATION

According to Ternan, *et al.* (1989), "severe soil erosion is not at present a widespread problem [in Grenada] because much of the agriculture is based on tree crops." Tree cropping generally manifests a more appropriate form of land use in areas of high erosion hazard, simply because it protects the ground from the direct erosive force of heavy raindrops and because many tree crop species have a rooting system that effectively consolidates the soil in which it is anchored.

The prevalent pattern of mixed cropping in Grenada also helps protect against

accelerated soil erosion, by ensuring the maintenance of a continuous vegetative cover.

There nevertheless seems to be a problem with accelerated erosion in certain areas of the island. In some rivers sediment concentrations of greater than 1,000 mg per liter were recorded during floods. With an estimated flow of more than 2.5 m³/s, over 150 kg of soil was estimated to be eroding from the watershed every minute. And at least 12 hours had passed since the storm in question had begun (Ternan, *et al.*, 1989).

Although a suspended sediment concentration of 1,000 mg per liter "may not be an absolute indicator of accelerated erosion," reportedly the situation is of "most concern" to the Ministry of Agriculture (Ternan, *et al.*, 1989). Watersheds of the central mountain zone provide the main water supply for St. George's and for tourist developments in the southwest part of the island. Siltation of the water intake pipes is a recurring problem (see also Section 4.2). Reportedly the high sediment discharges and their effect on water quality are degrading reefs south of St. George's (Ternan, *et al.*, 1989). (See also Section 4.4 of the Profile.)

GRENADA MODEL FARMS

The Grenada Farms Corporation (GFC), created in 1980 by the PRG, at one time controlled 22 percent of the agricultural land but produced only six percent of the island's export crops. After the intervention of 1983, GOG decided to divest itself of this unproductive operation and return the farms to the private sector. In 1984 ten large farms totalling 1,440 ha (3,557 ac) were returned to their previous owners.

The GFC was then dissolved in 1986 when the Grenada Model Farms Corporation (GMFC) Act was passed. At that time GFC operated 24 estates ranging from 15 to 142 ha (37 to 351 ac) in size, comprising a total area of about 1,300 ha (3,211 ac). Under the new law, the GMFC subsumed the assets and liabilities of the GFC, even though about half of the estates were the subject of legal claims by former owners who had not yet been compensated by GOG (Adams, 1986). Some of these claims are still under review by the courts.

Table 5.1(7) provides data on each government-owned estate. As indicated, about 45 percent of the total area originally involved in the Model Farms program was considered inappropriate for agriculture; in fact, Adams (1986) felt that some estates (Levera, Perseverance, and St. Omer) should be entirely excluded from the Model Farms program in light of "derelict" conditions or a high erosion risk. He also concluded that "much of the natural vegetation [in the program area] should be retained as it covers slopes which are too steep, dry, or stony to be cleared for cultivation."

The total land area to be subdivided under the program has since been reduced to 670 ha (1,655 ac). However, about 37 percent of this hectareage still is considered marginal for agriculture (Weaver, 1989).

In order to prevent unauthorized squatting, Adams (1986) recommended that all program land (both cultivable and uncultivable) not set aside for housing be included in the agricultural subdivisions. Depending on land capability, together with considerations of yield, input/output prices, and environmental concerns, the consultant felt that gross farm sizes should not be smaller than about 4 ha (10 ac) of cultivable land in hill areas or 1.6 ha (4 ac) in fertile alluvial flats. He warned that if holdings are too small to provide returns sufficient to cover inputs, forested slopes inevitably will be cleared for charcoal production and to extend the planted area. Farm sizes should thus be large enough to minimize land hunger while allowing for gradual replacement of the natural forest cover on a given farm with economic species of timber trees (Adams, 1986).

With funding from EEC and IDB, GOG is currently divesting itself of the land by breaking up the estates into farms averaging 7 ac each or garden lots of 1 ac (*V.I. Daily News*, Nov. 27, 1989). More specifically, farms established in valley bottom areas have ranged from 4 to 5 ac; those in more marginal areas generally have ranged from 5 to 10 ac in size. Forested areas have been excised from the program and put under the management of the Forestry Department (C. Francis, Land Use Officer, pers. comm., 1990). To date, seven of the estates have been divested and the lands transferred to 76 farmers. The latter lease the farms with an option to buy after 15 years. Paradise Estate was the most recent property involved in the land reform program.

In light of the fact that much of the land involved is marginal, a development program for each farm reportedly is being prepared jointly by the recipient farmer and the Ministry of Agriculture. Each plan covers land use, cropping patterns, etc., and thus is designed to help ensure sufficient protection of the land from degradation.

Table 5.1(7). Information on Grenada's Model Farms. See also Figure 5.1(1).

KEY	NAME	ELEVATION (m)	SIZE (ha.)		MARGINAL LAND (%)
			GROSS	NET	
1	Black Bay**	0-15	52.6	10.1	81
2	Perserverance***	0-305	131.6	64.8	51
3	Belle Vue, SG	150-215	23.1	13.8	40
4	Bon Accord***	230-425	56.7	20.2	64
5	Laura	120-180	39.7	31.2	22
6	La Sagasse	0-10	47.8	21.9	54
7	Requin**	0-15	41.3	15.8	62
8	Marlmont	40-90	48.6	24.7	49
9	Percher	395-460	26.7	12.6	53
10	La Force	105-230	60.7	27.9	54
11	Belle Vue, SA	215-460	89.1	53.4	40
12	Grand Bras	10-75	74.5	55.1	26
13	Paralise	0-10	80.2	34.4	57
14	Mt. Home	120-150	12.6	9.7	23
15	Springs**	150-305	84.2	56.7	33
16	Carriere	90-180	28.7	22.7	21
17	Poyntzfield	10-15	17.4	16.2	7
18	Montrevil	150-300	64.4	51.4	20
19	Levera***	0-5	48.2	4.0	92
20	Samaritan***	45-150	15.0	12.1	19
21	Diamond	45-200	55.1	43.7	21
22	Bocage**	20-290	141.7	83.0	42
23	Loretto***	60-150	19.8	19.8	0
24	St. Omer**	305-410	36.4	8.9	76
<hr/>					
	Range/Totals	0-460	1,296.1	714.1	45
	Reduced Range/Totals****	0-460	668.4	418.6	37

** Estates to be returned to previous owners.

*** Estates that will be sold by the Model Farm Corporation.

**** Reduced totals after removal of estates returned to previous owners or sold.

Source: Organization of American States.

In 1959, Vernon, *et al.* identified a connection between soil erosion and the level of tenure security on Grenada's small farm holdings. With no security of tenure, for instance on land which is rented for short periods of time, there is a tendency to over-exploit the land, to avoid planting long-term (tree)

crops and otherwise implement necessary soil conservation measures.

As noted earlier, there has been an increase in the extent of banana cultivation on the island in recent years. This trend has implications for soil erosion. As a fast growing

GRENADA

Model Farms Project



- 1 Black Bay
- 2 Perseverence
- 3 Belle Vue
- 4 Bon Accord
- 5 Laura
- 6 La Sagesse
- 7 Requin
- 8 Marlmount
- 9 Pecher
- 10 La Force
- 11 Belle Vue
- 12 Grand Bras
- 13 Paradise
- 14 Mount Horne
- 15 Springs
- 16 Carriere
- 17 Poyntzfield
- 18 Montreuil
- 19 Levera
- 20 Samaritan
- 21 Diamond
- 22 Bocage
- 23 Loretto
- 24 St. Omer

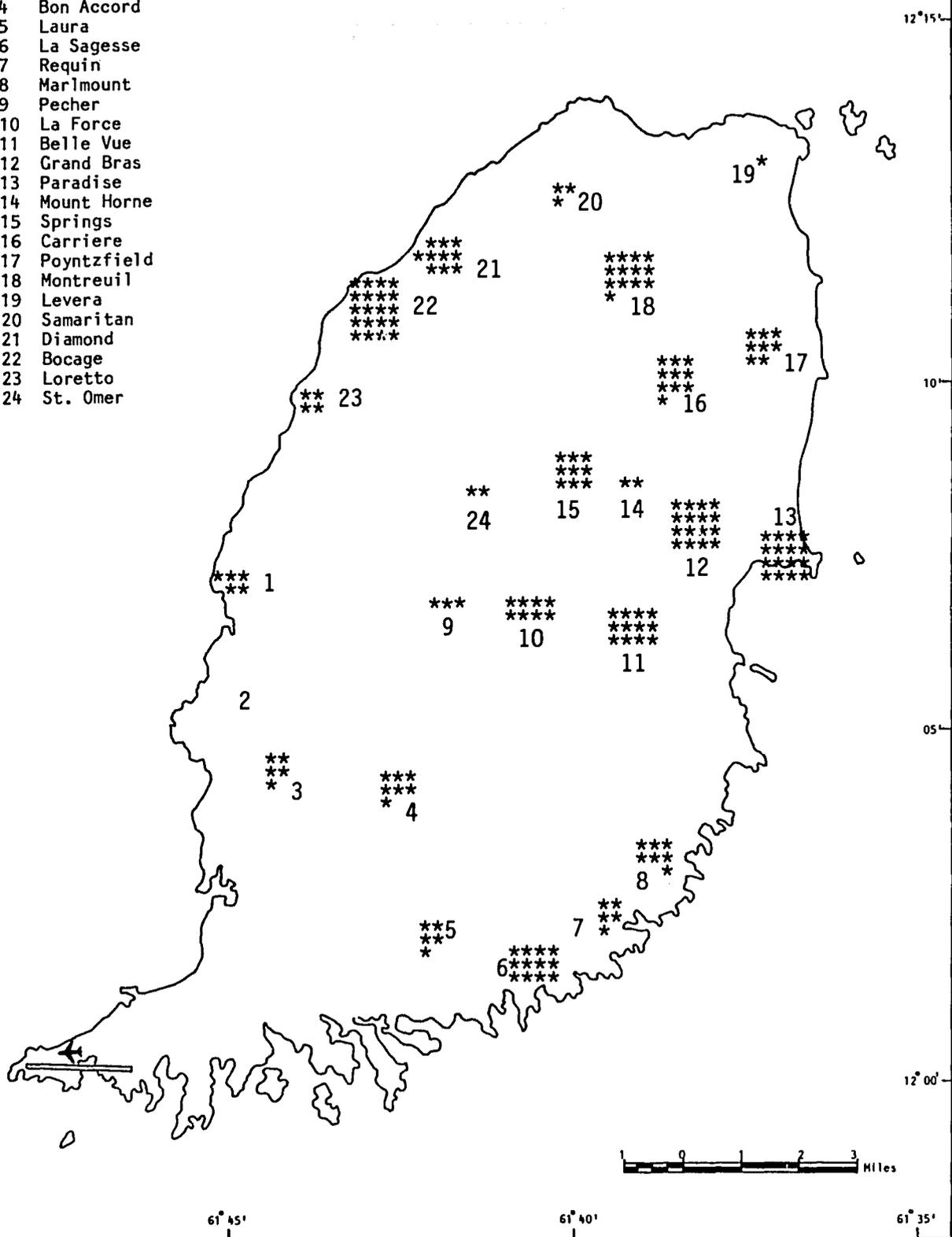


Figure 5.1(1). Location of model farms in Grenada.

crop (roughly nine months to "throw a bunch" after planting), it is often the choice crop of squatters (or others with insecure tenure) seeking a quick return, even on very steep slopes within forest reserve areas. The banana is an herbaceous perennial plant, rather than an actual tree crop. It has a very shallow rooting system and no tap root. Thus, while its large leaves afford some protection to the soil from the erosive force of raindrops, it does very little to consolidate the soil and thereby prevent it from being weathered and transported downslope. The only sites on Grenada's state-owned farms where soil erosion is a serious problem are those where pure stands of bananas are being cultivated on steep slopes (Adams, 1986).

EROSION RELATING TO OVERGRAZING

Soil erosion and general land degradation resulting from overgrazing have become significant problems in Carriacou. Almost every family on the island has many (in some cases, a dozen or more) animals, and the herds are expanding. The principal reason for this situation is the existence of a relatively high priced livestock market in Trinidad which reinforces the view that animals are a ready and reliable form of cash. Trinidad's healthy market for livestock is rooted in that country's large East Indian population which maintains the tradition that meat must be blessed before it is slaughtered.

The herd size on Carriacou expanded significantly following a 1983 ban on exporting breeding female livestock, effected through the withholding of necessary quarantine documentation. (Crane and Rojas, 1985). The Government was seeking to force livestock owners to sell within the national market rather than to the much higher priced external markets, primarily Trinidad.

The herd's size is considered to be in excess of Carriacou's present carrying capacity. It is estimated that there are over 10,000 animals on the island, equivalent to about 1.3 animals per acre on average. This figure seems reasonably accurate given that in 1982 almost 6,000 sheep and goats alone were exported (i.e., not including cattle, burros, pigs).

Effective livestock management on Carriacou is made particularly difficult by a long-standing tradition known as the "let go" season. When gardens are being cultivated, from June to December, animals remain fenced or tethered. But after the harvest, when vegetation on the island generally begins to dry, animals are permitted to roam and browse throughout the island at their own free will.

An excessive number of animals also results from the fact that much land is unsuited for agriculture and/or is owned by absentee landlords who leave their properties unmanaged. An island resident can thus possess many more animals than could be supported on the actual amount of land (if any) which he or she owns, particularly during the dry season. The effect "is a classic case of overuse of what essentially becomes a communal resource -- the land" (Crane and Rojas, 1985).

USE OF AGRICULTURAL CHEMICALS

USAID (1984b) reported that yields per acre of cocoa and bananas in Grenada were low in comparison to other areas in Latin America and Africa where these crops are grown. This was believed to be partially due to the high cost of agricultural chemicals, leading to "insufficient levels of fertilizer and disease control inputs". The solution recommended by USAID was to set up an incentive program to increase significantly the amounts of agrochemicals used by Grenadian farmers. USAID grant funds were also earmarked to support, train and equip a Pest Management Unit within the Ministry of Agriculture. A CIDA-funded cocoa rehabilitation program also includes incentives to farmers to increase the use of agrochemicals (see additional discussion in Sections 8.1 and 8.2). It is important that such efforts also include attendant training on appropriate application and management techniques. However, recent interviews conducted by DeGeorges (1989) with key persons involved with pesticide management, including Grenada's Pesticide Control Board (PCB), indicate that Grenada does not yet have proper management controls in place.

There currently are no pesticide inspectors in the PCB, and the country generally

lacks both trained personnel and equipment to monitor systematically pesticide residue in humans and in food products. Farm workers, for example, are not monitored regularly for the effects of pesticide exposure. Once per year only cocoa sprayers reportedly are indirectly examined through hemoglobin blood counts and body ion and fluid analysis. Additionally, pesticide poisonings are believed to be occurring more frequently than reported or are diagnosed incorrectly when reported. Concerns over the chronic sublethal effects of long-term exposure remain unaddressed.

There is a soils laboratory in Grenada, a plant diagnostic laboratory, and a produce laboratory, all operated by the Ministry of Agriculture, as well as the CWC's water quality microbiological laboratory. However, qualified staff in each of these facilities is limited, and equipment is periodically non-functional. It has been suggested that all the labs should be combined to form a central government laboratory that could jointly serve several or all branches of Government, as is done in Trinidad and Antigua. An alternative approach, with specific reference to pesticide analysis, might be for Grenada to carry out only preliminary extractions on pesticide samples in-country, sending the specimens for more detailed analysis to CARICOM's Caribbean Environmental Health Institute in St. Lucia. The latter is a regional approach which needs to be pursued by Grenada and neighboring OECS countries.

In any event, an improved monitoring and control system for regulating the importation and use of pesticides in Grenada is urgently required. The fact that international standards on pesticide use are becoming stricter may force Grenada, a food-exporting country, to improve management of pesticide use sooner rather than later.

The broader environmental implications of agrochemicals were noted by Archer (1984) who pointed out that agrochemical use in Grenada may be having a more adverse effect on the marine ecosystems than the liquid discharges from the country's industrial sector. Unfortunately, the Water Commission's ability to assess and monitor agrochemical pollution is very limited at present, in part because training

in pesticide analysis is required for a chemist and because the agency's gas chromatograph is currently non-functional.

Caution is required in continuing programs that involve heavy use of imported agrochemicals, at least until the capability to manage these chemicals is well developed locally. Ideally, in view of the general fragility of tropical insular environments as well as a growing global concern over chemicals in food, Grenada needs to explore (or return to) productivity approaches that rely on less, rather than more, chemical inputs. A high priced market for organic produce is growing in North America and in Europe and, in fact, the Productive Farmer's Union in Grenada has been approached by a company in Miami to grow organic crops.

RESEARCH AND TRAINING

Babb, *et al.* (1984) note that "past research efforts [in Grenada] have helped in determining what can be grown successfully on stations, but there seems to be very little in the way of on-farm research to determine suitability to actual constraints faced by the farmer."

The Government does operate an agricultural training school and experimental farm at Mirabeau. Formally under the Ministry of Agriculture but now a part of the Grenada National College, the Mirabeau Agricultural Training School provides training for youths as potential farmers. Two programs are offered: a shorter, practical training course and a second, longer program for persons with potential for pursuing further academic training in agriculture at regional institutions.

GOG INSTITUTIONAL RESPONSIBILITIES

Grenada has a large Department of Agriculture which employs about half the overall staff within its Ministry. The Department's services include extension, research, soil and water conservation, plant propagation, pest management, and veterinary and livestock services. The functions of the Department and its relationships with other units of Govern-

ment are discussed in detail in Section 12. The Department's effectiveness in promoting soil and water conservation programs has been diminished by the fact that many former qualified officers have been lured away from Government to work with one of the various commodity boards. Some of the boards maintain their own extension programs (Bourne, 1987).

According to Lausche (1987), no existing legislation stipulates requirements for soil and water conservation on private lands or on non-forested state lands. However, the 1949 Forest, Soil, and Water Conservation Ordinance (updated in 1984) allows for private lands to be declared reserves and state lands to be deemed "protected forest". It also contains provisions for controlling squatting on state-owned lands. 1984 amendments to the law include lists of tree species to be protected on private lands as well as updated penalties for offenses.

Reportedly, the amendment relating to tree protection is not presently enforced, but given improved forestry-related extension work and advice to farmers in the future, it is hoped that such enforcement will be possible (A. Joseph, Min. of Ag., pers. comm., 1990).

COMMODITY ASSOCIATIONS AND COOPERATIVES

Three commodity associations -- Grenada Banana Cooperative Society (GBCS), Grenada Cocoa Association (GCA), and Grenada Cooperative Nutmeg Association (GCNA) -- have sole purchasing and exporting privileges for each major export crop.

Each commodity association is a statutory body established by enabling legislation. In addition to providing services for the collection, grading, bagging, storage, curing, processing, and marketing of exports, the commodity associations provide pest and disease control assistance, as well as fertilizer and pesticide procurement and distribution for their members.

Most farmers in the export market belong to more than one of the commodity as-

sociations. GBCS represents approximately 1,400 banana growers but with an average of five family members per grower, banana production directly affects about 7,000 people. The GCA comprises about 7,000 active cocoa producers; the number of persons directly affected by cocoa production is estimated at 35,000. About 6,000 mostly small growers cultivate nutmegs; overall, about 30,000 people are financially affected by production of this crop, and about 750 other workers are involved in the industry (Babb, *et al.*, 1984). There are an estimated 2,600 growers of minor spices (Finisterre and Renard, 1987).

Despite the political changes and upheavals that have occurred in Grenada over the past two decades, the country has had "a vibrant cooperative movement" since the inception of cooperatives in 1946 (Finisterre and Renard, 1987). All successive governments have placed considerable importance on and have supported cooperative development, despite any policy differences. The Cooperative Societies Ordinance, enacted into law in 1955, provides the legal basis for the operation of cooperatives in Grenada.

The Minor Spice Cooperative Marketing Society (MSCMS) represents a group of producers of spices other than nutmeg. An existing law gives this cooperative a monopoly in marketing the produce of Grenada's estimated 2,600 minor spice growers (Finisterre and Renard, 1987).

As of October, 1986, 119 cooperative societies had been registered but only 37 were considered fully functional. Some 20 of these were credit unions. Of the remainder, three represented agricultural interests, not including the aforementioned MSCMS. Two represented agricultural workers and one was involved in food processing (Finisterre and Renard, 1987).

Given the substantial membership base and influence of commodity associations and cooperatives in the Grenadian agricultural sector, these groups are in a position to influence the cultivation practices of its members. However, in the absence of well-defined land use or soil conservation regulations by Gov-

ernment, it is unlikely that these groups will assume such responsibilities.

5.3 POLICY RECOMMENDATIONS

FARMING SYSTEMS RESEARCH FOR IMPROVED PRODUCTIVITY

Given the number of people involved and their collective contribution to Grenada's GDP, farmer productivity should be a key government priority. According to Babb, *et al.* (1984), gains in productivity should be sought in small increments through better extension programs, fertilization, reductions in praedial larceny, improvements in pest and disease management, and diversification.

Among the recommendations of these authors is that a new approach to research, extension and training, based on Farming Systems Research (FSR), be adopted by the Ministry. Such an approach involves working with farmers in analyzing and planning for their total farm enterprises in light of available resources and prevailing conditions. It relies on a farmer's knowledge of what will grow, as well as available labor and marketability.

The approach should be well integrated with the country's marketing entities, including hucksters and private traders involved in non-traditional crops. An FSR approach can foster a mutually supportive system as traders will be more aggressive in seeking market opportunities if the Government's programs are supportive, and farmers will be more inclined to diversify if marketing opportunities are made available.

Babb, *et al.* (1984) point out that only minor structural reorganization of the Ministry would be required for an FSR framework as the key element is a re-orientation of approach.

The Caribbean Development Bank maintains a similar view on what is needed to improve the agricultural sector. It reports that "agricultural development in Grenada requires a consolidation phase with emphasis on insti-

tution building with long-term objectives and policies focussing on the [small] farmer as the center of [GOG] decision-making The entrepreneurial spirit that has led to the establishment of small farms deserves support in helping farmers to improve their management methods" (CDB, 1987).

A renewed focus on the small farmer as an active participant in a learning-by-doing process (almost an individualized or customized extension strategy) would presumably contribute to improved environmental management practices in the agricultural sector.

MODEL FARMS PROGRAM: A CAUTIONARY NOTE

As discussed above, beginning in 1986, with the objective of divestiture of about 3,400 acres of farm land from 24 Government-owned estates, the so-called Model Farms Project has methodically proceeded to date without any serious environmental problems. As of the end of 1989 the project has transferred 76 farms, averaging seven acres, or approximately one-seventh of the project's original goal. It has a long way to go. Initial funding for this program came from the World Bank, but more recently, for the 12 farms in the Paradise Estate, the EEC provided EC\$827,000 for roads, improved drainage, and a new irrigation system, averaging about US\$25,000 per farm in capital improvements. This investment will be at risk if proper environmental management strategies are not conveyed to the farmers by project leadership. As the number of new farmers on the remaining, yet to be distributed estate lands increase, there will be a significant need to press for land husbandry practices aimed at reducing erosion impacts. One promising aspect of the Model Farms privatization initiative is its linkage with the USAID- and CIDA-funded cocoa production assistance project which requires a degree of environmental sensitivity because cocoa crops grow so slowly.

PRIVATIZATION OF PUBLIC ENTERPRISES

While privatization of non-financial public enterprises in Grenada (mostly statutory

bodies) has proceeded as planned, some targets of the strategy, such as the agricultural commodity marketing boards and a few remaining active agricultural estates, suffer from continuing inefficiencies. Because of their congenital shortage of operating capital, and consequently their continued state of indebtedness, they have no funds to deploy for environmental programs aimed at either reducing farmer impacts on the landscape or improving the environmental management of product waste. Marginally solvent statutory bodies are disinclined to spend scarce funds on environmental technologies or conservation practices. Therefore, the successful privatization of at least some of these surviving public enterprises, especially those for which either production or processing activities involve an environmental risk, should include a program of environmental controls which presumably the converted, more profitable private-sector enterprise would be able to support.

ADDITIONAL RECOMMENDATIONS

- * GOG should establish more direct linkages between the expanding tourism sector and agriculture.

- * A pesticide application certification process for small farmers should be set up, using some combination of the Ministry of Agriculture's extension agent system and local farmers' associations.

- * GOG should establish procedures for the regular testing of potable water and food stuffs for pesticide residue (with special attention to groundwater).

- * It is extremely important to establish a centralized, fully-functional government laboratory testing system serving various ministries with either one large or a group of clustered laboratories, in order to maintain operationally redundant instrumentation and to thereby ensure back-stopping.

SECTION 6 ENERGY AND INDUSTRY

6.1 ENERGY

6.1.1 Overview

PRODUCTION AND CONSUMPTION PATTERNS

Energy consumption by resource type has been computed for Grenada by the Latin American Energy Organization (OLADE) for 1975-1980 (Koulen and Livingston, 1981) and was updated to 1983 by UNDP (1985). Table 6.1(1) (drawn from Alexander, 1978) illustrates this energy budget and provides a comparison with four neighboring island countries.

The table reveals that, as in all the OECS nations, imported petroleum products constitute Grenada's largest energy source, as a proportion of total supply. As in every OECS country for which published data are available, the most common petroleum fuels are gasoline and diesel oil. Gasoline is used almost entirely within the transportation sector. Diesel is used primarily for generating electricity but also for transportation and as an industrial fuel. All fuel used on the island is received at the Grand Mal Bay Petroleum Terminal and subsequently distributed by truck.

In 1980 a preliminary household energy survey was undertaken by OLADE. This has been the only attempt to date to precisely quantify consumption of commercial as well as non-commercial renewable sources of energy (e.g., firewood and charcoal) in Grenada. The survey results can be summarized as follows (Hodam and Associates, 1982; Alexander, 1987; see also Table 6.1(2) for comparison with four other Caribbean countries):

- 48 percent of the energy consumed in Grenadian households was obtained by burning firewood, mostly for cooking and baking. Almost 50 percent of all households sampled used wood as a cooking fuel, but the number varied greatly with location.

- Electricity accounted for 22.1 percent of household consumption. It was used mainly for lighting, refrigeration and ironing; cooking and water heating with electricity were very uncommon.
- 14.3 percent was derived from kerosene, used mostly for lighting and, to a lesser degree, cooking. About 75 percent of households sampled use kerosene.
- Liquid propane gas (LPG) provided 13 percent of total household energy consumption and was used almost exclusively for cooking.

Although the Grenada household energy survey has been widely quoted, its results were, in fact, later found to be flawed due to bias introduced by interviewers (UNDP, 1985). Many of the interviewers compromised the random nature of the survey design by avoiding targeted households that were not easily accessible in heavily forested, steep rural areas. The survey thus reveals more about energy usage along public roads (where electricity is more readily available) than about household energy consumption patterns in general.

While the 1980 household survey results are not entirely reliable, and assuming an overall bias toward roadside homes, it is still quite evident that a large proportion of Grenadian households use more than one source of energy, and that the rural residential sector consumed nearly all of the firewood and charcoal. Based on this survey, the OLADE energy balance for 1980 estimated that fuelwood and charcoal accounted for over 20 percent of the total energy supply (UNDP, 1985).

Table 6.1(1). Energy consumption by resource (TJ).

RESOURCE	ANTIGUA	GRENADA	MONTSERRAT	ST. LUCIA	ST. VINCENT
Electricity	135.7	76.7	29.5	167.8	80.1
Gasoline	515.6	328.0	72.8	701.2	313.1
Diesel	179.4	51.1	27.5	266.2	213.9
Kerosene	13.6	46.9	6.3	46.0	50.3
LPG	60.4	42.6	14.7	146.1	95.4
Fuel Oil	-	-	-	14.9	-
TOTAL PETROLEUM & ELECTRICITY	904.7	545.3	150.8	1,342.2	758.8
Firewood	-	166.1	-	115.0	115.0
Charcoal	23.7	8.5	15.3	211.7	106.5
Bagasse	-	-	-	-	89.5
Other Biomass	-	8.5	-	42.2	-
TOTAL RENEWABLE SOURCES	23.7	183.1	15.3	368.9	311.0
TOTAL ENERGY	928.4	728.4	166.1	1,711.1	1,063.8

Source: Alexander, 1987.

It is useful to compare statistics from different countries derived from survey estimates, and the data on per capita household energy consumption provide useful benchmarks. Table 6.1(2) shows in both absolute and per capita terms that firewood consumption figures for Grenada are the highest reported for any of the OECS nations. As noted above, the Grenada survey found that 70 percent of households use charcoal, compared to 80 percent in Antigua, 39 percent in Montserrat, and 88 percent in St. Lucia. Yet in Table 6.1(3) the figures for consumption of charcoal in Antigua and Grenada appear low in comparison with the other countries. The low figures are most likely due to an under-reporting of charcoal. In Grenada, in particular, it seems unlikely that a society which consumes such large quantities of firewood would consume so little charcoal (Alexander, 1987).

Problems with estimating the consumption of energy from New and Renewable Sources of Energy (NRSE) are common in all the OECS countries. Several factors account for this. First, the trading units employed for traditional fuels of charcoal and firewood are inconsistent. Second, various wood species with differing moisture contents are utilized; and, third, it remains difficult to select a survey sample for which the results will be representative of the broader population. As a result of these problems, consumption of energy from NRSE is *not* regularly reported (OAS, 1987). These database limitations have implications for institutional attempts at energy sector analysis and management strategies.

The estimated demand for fuelwood and charcoal in Grenada is on the order of 40,000 cubic meters roundwood equivalent

Table 6.1(2). Residential energy consumption by resource (TJ).

RESOURCE	ANTIGUA	GRENADA	MONTSERRAT	ST. LUCIA	ST. VINCENT
Electricity	57.4	72.4	6.6	52.4	36.6
LPG	38.5	42.6	12.9	106.9	82.6
Kerosene	7.7	46.9	5.7	46.0	46.9
TOTAL PETROLEUM & ELECTRICITY	103.6	161.9	25.2	205.3	166.1
Firewood	-	157.6	-	115.0	115.0
Charcoal	23.7	8.5	15.2	211.7	106.5
TOTAL RENEWABLE SOURCES	23.7	166.1	15.2	326.7	221.5
TOTAL ENERGY	127.3	327.1	40.4	532.0	387.6

Source: Alexander, 1987.

Table 6.1(3). Summary of usage of firewood and charcoal in households.

COUNTRY	% OF HOUSEHOLDS USING FIREWOOD	% OF HOUSEHOLDS USING CHARCOAL
ANTIGUA	N/A	Over 80%
GRENADA	50%	Approx. 70%
MONTSERRAT	N/A	39%
ST. LUCIA	43%	88%
ST. VINCENT	N/A	N/A

Source: Alexander, 1987.

(Kehr, 1986). The quantity of these products produced locally was estimated by UNDP at a roundwood equivalent of 14,923 cubic meters, a figure which Smith (1986; cited in Miller, *et al.*, 1988) believes to be unrealistically high. Nevertheless, even allowing for a large error in the estimates of fuelwood usage, it seems that fuelwood cutting may still represent a significant impact on the environment.

Electricity. The Queen's Park Power Station, sited just north of St. George's, is the only electrical generating station on Grenada proper. The total installed generating capacity in 1988 was officially 13,460 kW (although actual output is considerably less than this, perhaps as low as 9,700 kW; Blaize, 1989). The total annual electrical consumption was about 38 million kWh (V. Renwick, Director of Trade, pers. comm., 1989), although, again, this figure has been reported lower at 22.4 kWh by the former Prime Minister (Blaize, 1989). Total installed capacity is expected to increase to about 23,000 kW over the next 5 years (V. Renwick, Director of Trade, pers. comm., 1989).

Electricity is currently transmitted throughout the entire island via an 11 kV grid, although plans exist for the installation of 33 kV lines. Normal consumer voltage is 230/400 V, 50 Hz. The proposed grid improvements are shown in Fig. 6.1(1).

For the period 1970-1988, both the gross supply of commercial energy resources and the net final consumption show a fluctuating pattern with a marked trough in 1973-1974. The latter is probably a reflection of the increase in petroleum prices in 1973 combined with the local political instability in 1974. Supply increased between 1970 and 1988, from 17,700 Tonnes of Oil Equivalent (TOE) to 34,190 TOE.

In terms of petroleum fuel consumption specifically, the trends have shown a reduction in kerosene, increases in non-electricity-related diesel fuel, gasoline, and LPG, and large increases in electricity-related diesel fuel (V. Renwick, Director of Trade, pers. comm., 1989).

Energy costs in Grenada's transportation sector are higher than in any other, a pattern that is common in tropical, small island states. Presently there are no viable alternatives to oil.

In light of the above, it is important that a vigorous attempt be made to explore alternative energy sources in those sectors of the Grenadian economy where this is presently or potentially feasible and where such sources will contribute to greater self-reliance and improved environmental health. Several New and Renewable Sources of Energy (NRSE) are examined in the following sub-section of this chapter.

Since its establishment in 1980, the collection and compilation of data on commercial energy resources have been carried out by the Trade, Industry, and Energy Division of the Ministry of Finance. The Division uses four main data sources: imports of petroleum (from the Customs Department), sales of petroleum (from the petroleum marketing companies), electricity (generated, consumed, and lost in transmission and distribution), and price levels of refined products. Local retail prices for fuelwood and LPG should be added to the list of collected data.

NEW AND RENEWABLE ENERGY SOURCES

In Grenada and the other OECS countries, the only renewable energy source which currently makes a significant contribution to total energy consumption is biomass. Other renewable sources are relied on elsewhere in the region, but their total contribution remains small. These include wind energy in Antigua, bagasse (sugar cane residue) in St. Vincent, and solar water heating on several islands.

The following is a discussion of the renewable and/or new sources of energy which currently are used in Grenada or which have been studied.

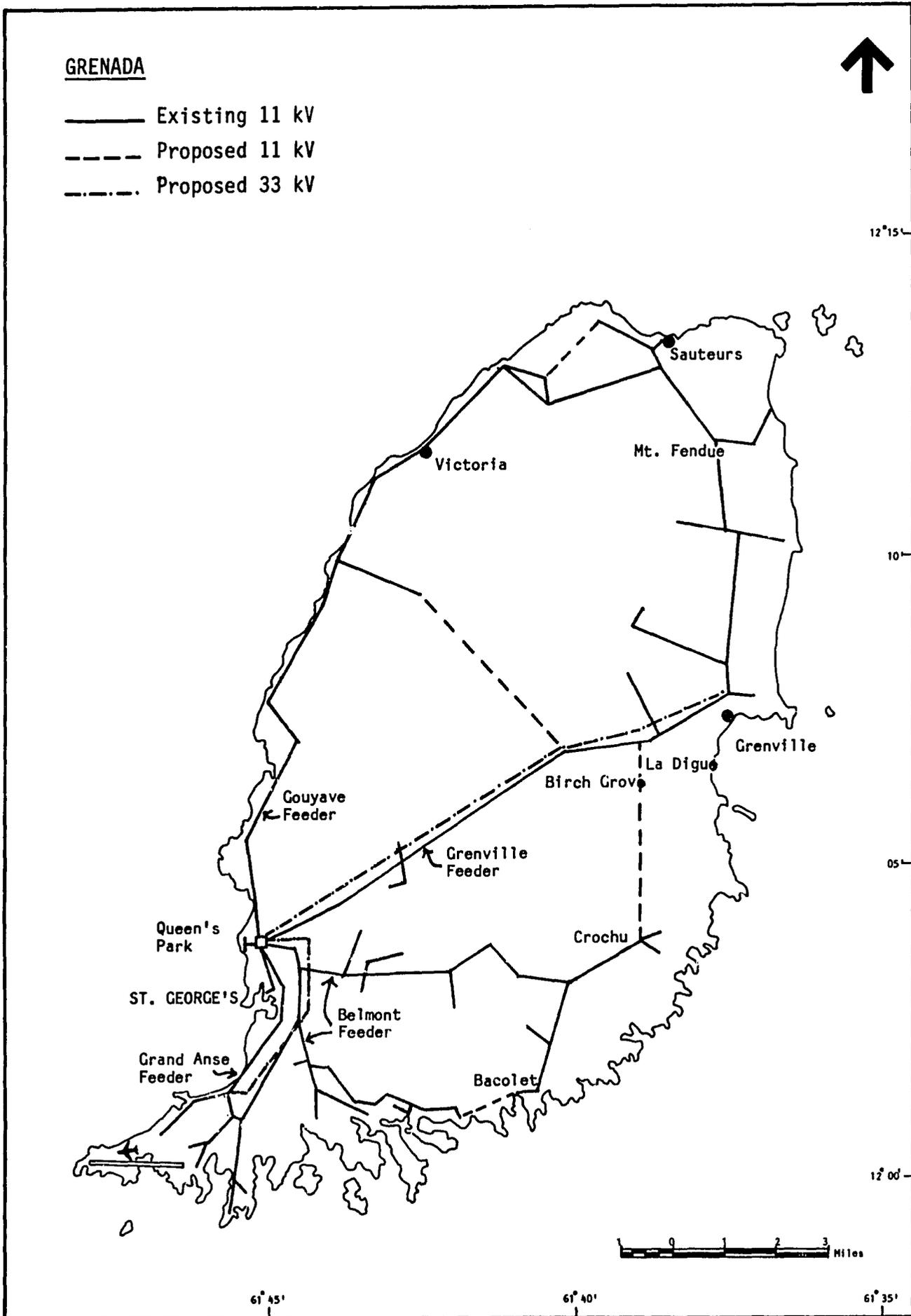


Figure 6.1(1). Existing and proposed electrical grid, Grenada (source: UNDP and Federation of Danish Export Council, 1986).

Biomass. As noted above, biomass is the only significant renewable energy source used in Grenada, mainly in the form of firewood and charcoal. These resources are used almost exclusively for domestic cooking, but, reportedly, firewood is burned in some of the country's commercial bakeries (OAS, 1987).

Coconut shells and husks, both by-products of the copra industry, are also used. Most are burned as a fuel to generate process heat in the copra factories while about 17 percent are used to produce charcoal (Alexander, 1987).

Bagasse (sugar cane residue) maintains some potential promise as a biomass fuel, but there are problems with: (a) costs related to transportation from the outlying areas, where cane crushing takes place, to the sugar factory at Woodlands and (b) the high degree of residual moisture in the bagasse. Use of agricultural wastes has many of the same problems, and, additionally, given the size of Grenada, the amounts available are likely to be small (UNDP, 1985).

Biogas (methane) is produced through anaerobic digestion of vegetable and animal wastes. Since it does not require centralized production and distribution, it is well suited to small farms and remote communities (Hinrichsen, 1981) and thus to use in a country like Grenada.

Ten biogas plants at Mirabeau and one at Mount Hartman have been commissioned since 1982 (but only six plants were completed). The technical feasibility of biogas production in Grenada has been amply demonstrated. However, the question not yet addressed is whether biogas can make a significant contribution in reducing Grenada's dependence on petroleum. According to UNDP (1985), the years of biogas experimentation undertaken by the National Science and Technology Council have "... merely endorsed the obvious fact that biogas can be produced, provided external funds can be obtained to construct and run the plants." Factors such as net production costs, optimal location of the plants, and social acceptability of the gas as an energy source have not been investigated. In fact, it appears to be generally

true that the main attraction of biogas technology is its capacity to dispose of agro-industrial and agricultural wastes, rather than its potential as an energy source (UNDP, 1985).

Alcohol fuels can be produced from aerobic fermentation of sugar or starch-bearing crops like cassava. These fuels can even be used as a substitute for gasoline (Hinrichsen, 1981). However, on the small islands of the Eastern Caribbean, any large-scale use of land to grow crops for this purpose rather than food production would undoubtedly be unacceptable and therefore not feasible.

With regard to the traditional biomass fuels, firewood and charcoal, it is apparent that significant gains in efficiency could be made. Firewood generally must be gathered close to where it will be sold and/or used as it can rarely support transportation costs and remain competitive with other available fuels. However, in producing charcoal from wood, a great deal of the raw material is wasted. As a result, there is some justification to support the argument in favor of agroforestry projects and community-based fuelwood plantations.

The conversion process in Grenada is much less efficient than it could be, even without substantially changing the systems currently employed. For example, Nelson (1981; cited in OAS, 1987) reports that firewood is stacked for only one to two days before it is put, insufficiently dry, in a charcoal kiln. Virtually all kilns in use in Grenada are earth kilns in which it is generally difficult to restrict combustion to only that portion of the total wood supply required to generate sufficient heat to char the remainder. Since the conversion efficiency of charcoaling is primarily a function of the wood moisture content and of the technology employed for the pyrolysis process, there is considerable room for improving efficiencies and reducing wastage.

With traditional, low-cost earth kilns, a maximum conversion efficiency of about 20 percent is attainable. However, the efficiency can vary a lot depending on the size of the kiln, the skill of the charcoalers, soil dampness, breeze, rainfall and the care provided to

control smoke (Jennings, 1979). With more modern charcoal kilns, the conversion efficiency rises to 25 and even 40 percent. If the gaseous and liquid products of pyrolysis could be captured and used, the efficiency could be increased to 80 percent. Nevertheless, the charcoal stoves used by individual households are more efficient than wood fires; presumably, a simple wood-burning cooking stove design could be made available at an attractive cost to improve efficiency at the consumer level.

Hydropower. Often promoted as one of the most promising forms of NRSE for Grenada, hydropower has the potential to reduce dependence on imported petroleum significantly (UNDP, 1985). The economics of small hydro-plants in Grenada may be favorable, but it is doubtful whether the net benefits would be quite so favorable if the environmental costs of construction of even small dams on extremely steep terrain were to be factored in. According to a pre-feasibility study of hydropower conducted in 1981 by S.C.E.T. International, the total power which could theoretically be derived from hydro is about 8,000 kW (8 megawatts). This is only a little less than present system capacity. Other studies on hydropower in Grenada include OLADE (1981), Kennedy, *et al.* (1983), Clark (1983), and Caribbean Institute for Meteorology and Hydrology (1983). A primary constraining factor in all these studies has been the lack of hydrological data.

Currently, hydropower is viewed by GOG as offering a partial solution to energy generation, probably effective only in the wet season. A pilot project of 150 kW is now being contemplated in the Marquis River; the next planned development site is in the Great River (V. Renwick, Director of Trade, pers. comm., 1989). Several other small-scale (100-300 kW) hydro-development projects are being considered for the St. Francis, St. Marks, Riviere Antoine and Concord watersheds. All watersheds are steep enough so that large dams are not required to build up the necessary head of pressure. However, the very steepness of the topography calls for careful attention to the control and mitigation of likely environmental impacts in the construc-

tion of hydro-plants, roads, dams and transmission lines.

Geothermal. A reconnaissance study of Grenada's geothermal energy potential was carried out by Geothermica Italiana (1981). The conclusions of this study are that the most promising area in Grenada for development of this energy source is Mount St. Catherine and that there is a high probability of finding sufficient heat resources for electric power generation. Two or three geothermal wells driving small (3-5 MW) generating plants would make a very significant contribution to electrical power capacity.

Nevertheless, there are serious technical problems or unknowns associated with such development. Some of these can be reduced through additional pre-feasibility studies (e.g., geological and hydro-geochemical studies and drilling of test holes), but, even then, there would be some risk of failure. Access to the area is difficult because of the rugged terrain, and this would further add to the costs of an already costly venture.

In light of these factors and the high costs associated with geothermal exploration, GOG feels that the benefits of investing in geothermal energy development appear to be marginal at this time. At the same time, Government remains interested in investigating the long-term development possibilities (V. Renwick, Director of Trade, pers. comm., 1989).

Wind Energy. A study of the feasibility of wind-generated electrical power in Grenada (based on a 130 kW NORDTANK Danish turbine design) was recently completed by UNDP/Federation of Danish Export Council (1986). Since the study relied on existing wind data which did not account for night time hours, the calculated energy production potentials should be considered rough estimates only. Winds appear to be strongest in the dry season, a condition which would nicely complement the availability of hydropower, but no long-term data are available. Five sites were recommended as suitable for construction of wind turbines: Lance aux Epines, Little Bacolet Point, Telescope Point, Artiste Point, and Bathway Beach.

Telescope Point is felt to be the most suitable of the five from the standpoint of wind conditions as well as economic factors.

Only one or two turbines were recommended for installation at each site, due partly to the limited availability of suitably situated Government land and partly to limitations of the existing electrical distribution grid. The total additional power which can be generated without major extensions of the grid system is about 0.9 MW, or about 10 percent of the existing installed power capacity. According to the study, three out of the five sites can produce energy at a lower cost than the existing power plant. At present, GOG is "moving cautiously" in looking at wind-generated power (V. Renwick, Director of Trade, pers. comm., 1989), and efforts are being made to obtain more complete data.

Despite their historical importance, wind-powered mechanical devices (pumps, etc.) are not much used in Grenada at present, due to their replacement by electrical devices and perhaps due to limited maintenance services. They may still be a useful and economically attractive option on the smaller islands like Carriacou and Petite Martinique (UNDP, 1985).

Solar Water Heating. A number of small-scale solar units in different applications are presently viable, including water heaters, water pumps, desalination devices, and crop driers. Such systems can contribute to improvements in the quality of life, particularly of rural people living in remote areas. Solar water heating, for example, is a very well-developed technology and the most immediate use of solar energy at present. Its adoption in Grenada, however, has been slow due to the disincentive provided by a 30 percent tax on the import of solar units (UNDP, 1985). Proposals for removal of this tax and other similar disincentives on energy-efficient appliances are currently being prepared by the Energy Unit of Government.

INSTITUTIONAL RESPONSIBILITIES

There is a single national electrical utility company, Grenada Electricity Services,

Limited (GESL or GRENLEC), which has been a fully-owned Government company since 1982. Throughout the 1980's, the company was plagued by a variety of problems, including an insufficient actual capacity, an inadequate tariff structure, low levels of technical expertise, and a host of general financial difficulties (World Bank, 1985). As noted above, capacity has been increased but the utility is presently facing an accumulated debt of about \$10 million. A Government report on the company notes that it "is in a serious crisis situation that can cause tremendous fiscal and political embarrassment to the Government of Grenada as its sole shareholder." The report claims that the troubling situation permeates all aspects of the utility's operations and recommends that its upper management be reorganized (*Virgin Islands Daily News*, Dec. 15, 1989).

On Carriacou and Petite Martinique, electrical generation is the responsibility of the Carriacou Electricity Department, part of the Ministry of Works and Communications. There are no formal links between this department and GRENLEC. Plans are underway, however, for GRENLEC to purchase and operate the Carriacou facilities (V. Renwick, Director of Trade, pers. comm., 1989).

6.1.2 Problems and Issues

Favorable strata for oil and gas resources exist in many areas of the Eastern Caribbean, including the South American coastal shelf, the Grenadines, and in deepwater areas to the east and west of Grenada. A report to GOG by Van Meurs (1981) assesses some of the issues involved in oil exploration offshore of Grenada. Follow-up seismic and geophysical surveys were conducted by Canada International Assistance Corporation in 1984 and Geophysical Services International in 1984. The primary constraints to further efforts are the lack of agreement regarding the maritime delimitation between Grenada and its neighbors, outdated laws pertaining to offshore exploration, and weak administrative infrastructure within GOG (UNDP, 1985). Petroleum and maritime laws have recently been updated, and GOG is now

making efforts to delimit its boundaries and interest companies in offshore exploration.

Obviously, an offshore oil strike would have a significant impact on the energy (and economic) picture of Grenada; unfortunately, it would also have the potential for significant environmental impacts, such as disturbances to bottom communities during exploration and installation phases and even more significant environmental risks during production phases, as a result of the potential for oil spills from tankers and/or oil well accidents.

A common problem with NRSE, illustrated by the biogas project, is the tendency of local administrators and technicians to focus on projects aimed at establishing the *technical* feasibility of energy sources, ignoring the fact that in most cases feasibility has already been well researched in other countries (UNDP, 1985). With the exception of geothermal and wind technologies, investigating technical feasibility of most NRSE in Grenada is simply a waste of resources. What needs to be addressed in the local context are the positive and negative socio-economic and environmental impacts, net energy cost/benefit accounting, raw material availability, and cultural factors affecting the acceptability and economic feasibility of alternative energy sources.

6.1.3 Recommendations

POLICY ISSUES

It is clear that Grenada is heavily reliant on imported petroleum products and, as a result, is depleting itself of badly needed foreign exchange. To counteract this undesirable situation, the country must:

(1) place greater emphasis on energy conservation;

(2) improve and develop simple technologies for more efficient energy conversion and utilization of indigenous resources (e.g., better charcoal kilns); and

(3) make a greater effort to promote and adopt alternative forms of energy which already are feasible in the Caribbean context.

According to UNEP (cited in Hinrichsen, 1981), Caribbean islands "seem well-suited to the large scale application of many non-conventional methods for the production of energy ... coupled with a strict energy conservation policy."

Furthermore, the use and sustained production of biomass fuels is obviously an issue of major importance for small island countries. It is rarely given the attention it deserves and may one day prove to be a greater barrier to development than the very serious one posed by the cost of sustaining and expanding oil imports (Kristoferson, *et al.*, 1985).

TECHNICAL ISSUES

(1) Biomass.

(a) Develop sustainable forestry management strategies for wood harvesting. The resource supply should be protected over the long term through careful management of existing and future resources, through multiple land use policies (e.g., agroforestry), and through effective use of agricultural process residues.

(b) Promote integrated land use systems (i.e., agroforestry) and community forestry throughout Grenada. This will help make fuelwood resources available on a more widespread basis and thereby reduce the need for charcoal, in light of the latter's lower systemic efficiency.

(c) Utilize more efficient systems for processing biomass into charcoal. Charcoalers should be encouraged to employ more efficient kilns in converting wood to charcoal. This has often been difficult in many countries because earth kilns require very low capital investment and provide much-needed employment. However, metal kilns of very simple design which are easy to build and maintain can be utilized. Such devices are often

transportable, i.e., assembled on-site from several previously constructed pieces, and can produce charcoal more efficiently and quickly than with the traditional earth clamp method. They may be constructed of sheet metal by local craftsmen in workshops equipped with basic facilities for cutting, welding, rolling, and drilling. Two men working a normal five day work week can produce 2-3 tonnes of charcoal with such kilns. They also can be operated in an alternative manner suitable for carbonization of small wood pieces or coconut shells.

(2) **Geothermal.** Several important questions need to be carefully studied and reviewed as the country moves to exploit its geothermal potential.

(a) The viability of geothermal electrical power generation is not assured. Studies in St. Lucia by the U.S.-based Los Alamos National Laboratories in 1984 indicated only a 30 percent cost advantage for geothermal power over a 30-year project life (CCA/IRF, 1988). Grenada might do well to monitor the experience of other Caribbean islands (especially St. Lucia) which have recently installed geothermal wells.

(b) There are a wide range of largely unforeseeable damaging environmental effects associated with development of geothermal-generating facilities. Some of these impacts include:

- Chemical and thermal pollution of stream water and air from the geothermal steam discharge, all of which have been reported; health impacts on workers from toxic gases and environmental injury to vegetation and wildlife have been reported at geothermal plants (e.g., in Sonoma County, California);
- Physical damage to the vegetation and soil erosion in the watershed resulting from construction activities and pollution of drinking water supplies by sediment, induced erosion, chemicals, and hydrocarbon wastes;

- The risk of siting incompatible industries in the area to use the waste heat from the generators;
- Diminishing the value of the Mount St. Catherine area for nature tourism.

(c) If successful, the project risks over-dependence on a very fragile producing system. A small geologic shift could sever all of a country's geothermal wells at the same time.

RESEARCH AND DEVELOPMENT

In the Caribbean, there is insufficient support for research and development activities by both the public and private sectors. This is as true with reference to energy as in other sectors. If technological development is left to extra-regional interests, local conditions will be given insufficient consideration and local development patterns will continue to be dominated by outsiders.

6.2 INDUSTRY

Following the military intervention in 1983, a substantial amount of foreign and private investment was optimistically expected. Unfortunately, the actual amount of investment has lagged behind these expectations, and the country's economy remains weak and in need of considerable external support. Industrial development, however, is still a national priority, and in view of long-standing Government enthusiasm and programs for encouraging industrial growth, as well as the possibility that this sector may grow in the future at a more rapid pace, it is increasingly important that the Government take steps now to protect against industrial-related environmental pollution.

6.2.1 Overview

In 1987, manufacturing grew by 16.5 percent, faster than any other sector (GIDC,

1987). However, in 1988 growth in the sector was down to 10.3 percent, lower than expected. Growth in 1987 was primarily based on the traditional commodities of beverages, cigarettes, and flour and related products. In 1988, paints and varnishes also showed a strong performance with 48 percent growth (Blaize, 1989). New manufacturing industries such as garments and foods are facing difficulties due to the virtual disappearance of CARICOM markets and to limited absorption into the local market (GIDC, 1987).

In 1989, a manufacturing growth level of 8.5 percent was projected, but Government also maintains that capacity in the sector has been underutilized and that therefore the future of Grenadian manufacturing might hold even more potential (Blaize, 1989). According to the Industrial Development Corporation, which may be a bit over-optimistic, "... Grenada is on the threshold of a period of rapid industrialization [and] this will require real transformation of the society" (GIDC, 1987).

Current manufacturing activities include preparation of food and food products, rum distilling, processing of copra to refined oil and soap, lime juice and lime oil extraction, ice cream making (using ice cream mix, skim milk and fat imports), milk production, three soft drink factories (using imported concentrate flavors), a cigarette factory, an animal feed factory (using imported concentrates), a brewery, a rice mill, a juice plant, a meat packing plant, a canning and bottling plant (using imported raw materials), three garment factories, a pre-galvanized sheet steel rolling mill, and auto tire retreading shops. Carriacou has a cotton ginnery and boat-building industry.

During 1986, with funding and technical assistance from USAID, major road works were undertaken, Point Salines airport was completed and became fully operational, and a project was begun to develop about 20 acres of land near Frequente into an industrial park under the Industrial Development Commission (IDC). The USAID-financed project at Frequente will total approximately 108,000 square feet of new factory space in fourteen buildings ("factory shells"). At pre-

sent only one building in the park remains unoccupied. The Caribbean Development Bank (CDB) has financed another 40,000 square feet of factory space in four buildings adjacent to the USAID project. Two other IDC projects involve the construction of a total of 60,000 square feet of "factory shells" in the vicinity of Mt. Gay/Tempe, which is already a major manufacturing area. (See Section 8.1.3 for a discussion of environmental impacts due to industries in these areas.)

GOG originally wanted to develop an industrial park at Pearls Airport, but reportedly rejected this site due to a negative environmental review and the presence of archaeological remains (Amerindian burials). CDB is now looking at funding the industrial park and is considering a site at Seamoan Estate.

INSTITUTIONAL RESPONSIBILITIES

The Industrial Development Corporation (IDC) was created by the Industrial Development Corporation Act (No. 2 of 1985). Its primary functions are to promote investment in tourism and manufacturing and to manage Grenada's industrial estates. The IDC acts as a one-stop agency serving both local and foreign investors by identifying investment opportunities, conducting sectoral surveys and feasibility studies, providing training, coordinating investments, and furnishing technical, financial, and marketing assistance to small, local entrepreneurs (World Bank, 1985).

The Grenada Development Bank was created in 1976 by the Grenada Agricultural and Industrial Development Corporation Act (No. 11 of 1976), as amended (No. 33 of 1980). The GDB provides technical assistance and loans to help the development of promising industries. It is closely linked to the Industrial Development Corporation through a common board which conducts separate meetings for each corporation.

6.2.2 Problems and Issues

The industries listed below, all common in the Caribbean, tend to generate high liquid waste loads which create treatment and disposal problems. In most cases, waste streams are subject to little or no treatment prior to disposal and thus contribute to coastal and marine pollution. The major industrial pollutants are biological oxygen demand (BOD), suspended and dissolved solids, and nutrients in the form of phosphates and nitrates (Archer, 1984b).

- cane sugar
- molasses
- rum or other alcoholic beverages
- beer
- soft drinks
- edible oil
- soap
- animal feed
- abattoirs
- poultry processing
- arrowroot production
- canneries
- margarine production.

Table 6.2(1) provides pollution data on the industries in Grenada, including waste loads and coastal marine impact. Wastes from the sugar factory and rum distilleries are discharged into rivers and approximately 75 percent reach the sea following natural aeration and dilution. Caustic waste from the brewery is neutralized prior to discharge to a stream via which a large portion reaches the sea. Dairy waste with high BOD is released to the marine environment as is that from the slaughter house with its nutrients and chloride content (Archer, 1984b).

Industrial waste loads in Grenada are low compared to other CARICOM countries. Grenada's agro-chemical and agricultural waste, as well as sewage, are considered more significant water pollution problems (see Section 8). Essentially, there is relatively little industry in Grenada at present and most of the newer industries, such as garment and furniture manufacturing and electronic components assembly, use little or no water for industrial processes. They therefore are noticeably absent from the table as their efflu-

ents were not analyzed in the Archer (1984b) study. In specific areas, industrial effluent contributes to specific problems. At St. George's, for example, the sewage problem is compounded by unchlorinated effluents from "badly operated package plants" at Grand Anse Bay (Archer, 1984c).

About 12 new industries have begun operation in Grenada in the last two to three years. All are reportedly "relatively clean" (R. Buckmire, IDC, pers. comm., 1989), with the possible exception of four or five plastics industries, most of which are using an extrusion process. One factory is considering manufacturing foam products. A codfish processing plant is being considered for the Telescope area.

CDB has mandated the avoidance of industries with heavy BOD or chemical effluents in future projects financed by the Bank. A CDB consultant is writing a manual for IDC on mitigating practices for industrial effluents harmful to the environment, especially for the plastics, paints and chemical industries. The Bank is also interested in starting a program to reduce the toxic content in the effluent of existing paint industries by 10 percent per year (R. Buckmire, IDC, pers. comm., 1989).

With regard to industrial solid waste, Archer (1984b) notes that in the fish processing industry, unknown volumes of scales and entrails are disposed of at sea or in dumps, contributing to coastal and marine pollution. Abattoir waste (bones, skin, and entrails) also are dumped at sea. Archer classifies bagasse (sugar cane residue) and banana trash as "industrial solid waste" and notes, "It seems that the greatest threat to the coastal ecosystem lies in the waste discharge from the banana agro-industry."

6.2.3 Policy Recommendations

According to Archer (1984b), Grenada and other CARICOM countries should develop a regional code of practice for industrial waste disposal to marine and coastal environments to ensure the protection of

Table 6.2(1). Grenada industrial waste disposal and its impact on the coast and sea.

Types of Industry/ Process	Total Waste Volume $10^3 \text{ m}^3/\text{yr.}$	Total Waste Loads/ Contaminants tons/yr.	Air Pollution	Impact On Coast and Sea	Remarks
Sugar Cane	7,236	BOD ₅ 127.60 COD 23.00	No air pollution problem except in the immediate leeward side of refuse burnt in dumps.	High BOD and discolored waste from brewery, distillery waste, and caustic effluents from oil, soap, and soft drink manufacture that are discharged to rivers and streams reach the sea at local areas in a diluted state.	There is need for better control over the treatment and disposal of industrial waste into rivers and streams.
Molasses and syrup		SS 172.70 TDS 114.00			
Distillery		Oil 0.80			
Brewery		Nitrogen Compounds 0.31 Zinc oxide 0.82			
Edible oil		Chlorides 0.20 Alkalinity <u>1.24</u>			
Coconut meal		Total 440.67			
Soap					
Dairy products					
Fruit cannery					
Abattoir					
Fish processing					
Soft drinks					
Flour Mill				Fertilizer wastes have been suspected in causing eutrophication in some coastal areas.	

Source: Archer, 1984b.

coastal ecosystems and amenities. Countries in the region should consider taking this one step further. It would be worthwhile for them to cooperatively set standards on the degree to which effluent and all other forms of industrial pollution must be treated before disposal and on methods of disposal, as well.

In reality, such measures would be very difficult to achieve. The need or desire for short-term economic benefits in virtually all developing countries is very great, and often there is little or no regard for long-term concerns such as environmental protection.

However, when it is realized that environmental impacts invariably involve opportunity costs, for instance by degrading fisheries or tourism amenities, it becomes more critical that at least some minimum pollution standards should be developed. Furthermore, in the absence of such standards, additional industrial development in the Caribbean may create a situation in which one country becomes a "polluter's haven," affecting not only existing industries and the quality of life in the polluted country but also in nearby islands that are seeking to maintain better environmental conditions.

SECTION 7 TOURISM

7.1 OVERVIEW

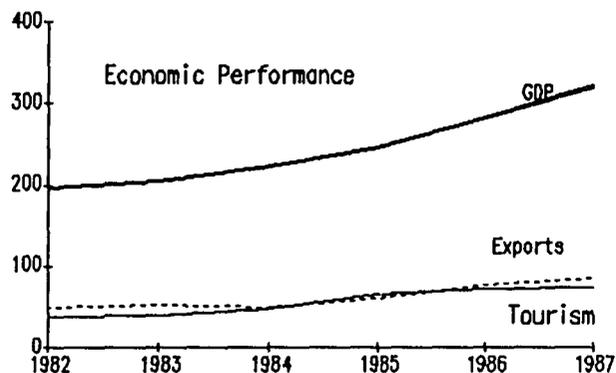


Figure 7.1(1). Economic performance: GDP, exports, and tourism (current \$EC millions), 1982 to 1987. (adapted from: World Bank, 1988, 1989).

A general comparative analysis of growth indicators in Grenada during a recent six year period is provided in Figure 7.1(1). At first glance, tourism does not appear to be particularly significant. The figure displays the comparative growth of GDP, total exports and tourism receipts from 1982 through 1987.

The ratio of tourism receipts in 1987 (\$EC75 million) to Gross Domestic Product (\$376 million) is less than .25 -- for many countries in the Eastern Caribbean, tourism to GDP ratios are over .50 (McElroy and Albuquerque, 1986).

Nevertheless, the Government of Grenada assigns a high priority to tourism development for the nation. One explanation for this assessment (despite the analysis in Figure 7.1(1)) is that tourism is the most dynamic growth sector of the economy. In Grenada, during the period since 1982, tourism appears to be growing significantly faster than the overall economy. This fact is illustrated in Figure 7.1(2) which displays the comparative growth rates for GDP, exports, and tourism for the period 1982 to 1987 (McElroy and Albuquerque, 1986).

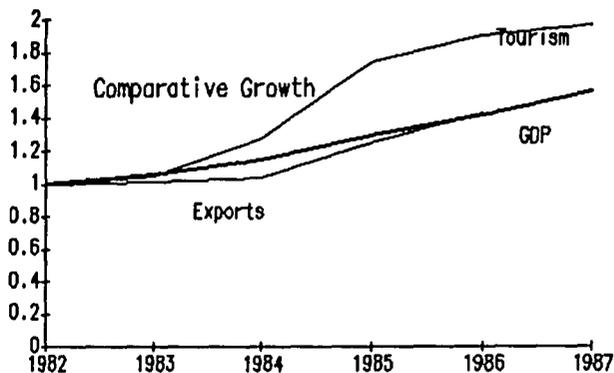


Figure 7.1(2). Comparative indices of economic growth since 1982 (adapted from Figure 7.1(1)).

McElroy, in the St. Lucia Country Environmental Profile (CCA/IRF, 1988), offers additional justification for assigning a high priority to tourism development.

- Tourism is an efficient earner of foreign exchange (in many Eastern Caribbean economies, each dollar of tourism expenditure generates approximately one dollar of foreign exchange).
- Tourism taxes tend to be progressive -- shifting some of the tax burden to richer consumers.
- Tourism is a fast growing *regional* sector, thus providing *symbiotic* growth for Eastern Caribbean islands which benefit from regional communication and transport systems built to support regional tourism.

From an environmental perspective, there are reasons to view skeptically unrestricted growth of tourism. There are abundant examples within the Caribbean, and even within Grenada's own experience, of tourism developments which have generated negative social and environmental impacts.

Furthermore, any tourism promotion plan for Grenada faces obstacles unique to that country, predicated primarily on the historical events of the past twenty years. It will take a prolonged effort to fully convince both visitors and potential investors that Grenada is a safe, serious place to do business. This is a special problem at this stage in the growth of Grenada's tourism sector which, nevertheless, like its sister OECS countries, needs to import capital and some private sector management talent to support significant sector growth.

On the other hand, Grenada's tourism potential has advantages over some of its Eastern Caribbean neighbors which need to be carefully evaluated. Among the major advantages are:

- Areas of relatively unbesmirched natural lands in the interior.
- An agricultural base which features high-value-added products which also offer attractive tourist experiences.
- Small hotels.
- No significant industrialization (with the potential of land use conflict with the tourism sector).
- A remembered history as a major yachting center and relatively easy access to world-recognized cruising grounds.
- A proposed system of national parks and protected areas with significant potential for further development of both local recreational and touristic attractions.

INSTITUTIONAL ROLES

There are three institutions with a major role in tourism development in Grenada. These include the Department of Tourism, the Tourist Board (which has been reconstituted and is scheduled to take over the functions of the Department of Tourism), and the Grenada Hotel Association. In addition, Grenada is a participating member of the Caribbean Tourism Organization from which it has received assistance in tourism planning. Assistance in the tourism sector has also been received from the OAS through its cooperative Integrated Development Project with GOG.

Less than five percent of government expenditures go to support tourism development and promotion (Moore, *et al.*, 1986). This low level of support is in line with the expenditures of other Caribbean countries, given the relative contribution of tourism to Grenada's GDP and tax revenues.

GOALS OF TOURISM POLICY

The Government's policy statement on the tourism sector (May, 1985) includes the following key goals:

1. To further integrate tourism with agriculture, handicrafts and fisheries.
2. To create and promote island-wide historical and environmental attractions.
3. To diversify the industry to cater [to] international, regional and local clientele, as well as high, medium and low income persons.
4. To strive for an appreciation by visitors of the authentic Grenadian culture.
5. Improvement in the Quality of Life. Standards of physical and mental health require adequate recreational opportunities be created for the positive use of leisure time.
6. The Generation of Employment. Employment generation is critical and policies must emphasize growth in activities such as tourism with employment multiplier effects. The capability for foreign exchange earnings is an added bonus.
7. Reduction of Geographic Inequity. The development of tourism attractions through the establishment of a system of parks and protected areas can assist integrating peripheral areas into the urban centered national growth process, and improving regional/rural economic conditions.

7.2 PROBLEMS AND ISSUES

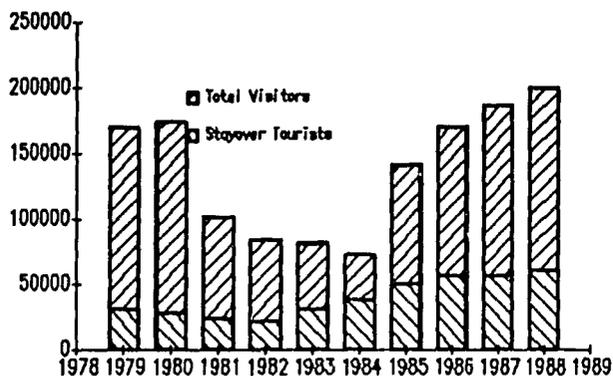


Figure 7.2(1). A decade of tourism stay-over and total visitors, 1979 to 1988 (adapted from: GOG, 1988a).

PAST PERFORMANCE

Figure 7.2(1) compares the number of stay-over visitors to the total number of visitors to Grenada during the last decade. The apparent regular growth of stay-over visitors, even including the turbulent period of the early 1980's, is caused by the inclusion of "Grenadians residing abroad" in the count of stay-over visitors, beginning in 1983. Casual inspection of the source data indicates that 10,000 or more additional visitors may be accounted for in this category in recent years.

When examining longer term trends of Grenadian tourism and their implications for the future, it is interesting to note that 1968 stay-over tourist arrivals totaled 23,164 (Bryden, 1973) and had increased only to 32,252 by the end of the 1970's -- suggesting very slow growth for a decade-long period (see Table 7.2(1)). More than any other single factor, it is this historic pattern of growth -- and the economic and political stress which underlie it -- which has the potential to deter future investment in Grenadian tourism.

Table 7.2(1). Tourism growth and rates.

Dates	Stay-over Tourists	Rate
1961-68	7,970 to 23,164	16.5%
1968-79	23,164 to 32,252	3.1%
1979-88	32,252 to 61,795	6.7%
Overall Average Compound Growth		7.9%

Developing reliable tourist expenditure information is very difficult. It is generally necessary to conduct detailed local surveys of both tourist expenditures and of the sources of goods and services which they buy. Furthermore, general estimates of "revenue" (or, more properly, expenditures) need to be carefully analyzed on a sector-by-sector basis to determine the real impact of expenditures.



Figure 7.2(2). Estimated tourism revenues (\$EC Millions), 1979 to 1986 (adapted from: GOG, 1988a).

Keeping these limitations in mind, Figure 7.2(2) illustrates that over the past ten years, revenues from cruise ship visitors have been only from one-tenth to one-twentieth the size of expenditures generated by stay-over visitors. This has significance for the design of future tourism development efforts in Grenada.

According to this analysis, on a per head basis, each stay-over visitor is worth about \$1,125, whereas each cruise ship passenger spends about \$33. That means each stay-over visitor is "worth" 34 times as much as each cruise ship visitor. Getting a stay-over visitor to simply stay one day longer (e.g., increasing his or her stay from 8.5 to 9.5 days) is roughly equal to recruiting four new cruise ship passengers. The implications for Grenada tourism planners seems clear -- the primary emphasis of the country's tourism development strategy should focus on stay-over visitors. This is not to say that such an emphasis needs to exclude Government's efforts to promote cruise ship tourism or that further efforts should not be made to increase revenues from such visitors during their short-term stay in Grenada.

SMALL SIZE

Tourism in Grenada is small in comparison to many other Eastern Caribbean areas -- both absolutely and relatively. As mentioned previously, tourism expenditures are less than one-quarter of Grenada's Gross Domestic Product. Nevertheless, the small relative size of the tourism sector is a potential advantage in planning future development. In addition, the small size of the typical hotel or resort in Grenada has meant that local businessmen have been able to finance the acquisition and management of these facilities. As a result, it seems that foreign ownership of hotels and resorts is lower in Grenada than in many other Caribbean areas.

There are, however, disadvantages to small size. The total supply of tourist rooms in Grenada is 1,040 (CTO, 1990), with about half of these in "guest houses, cottages, and apartments" (GOG, 1988a). In the Caribbean, hotels of less than 250 rooms are at a major disadvantage because they cannot afford the costs of a regular international marketing campaign. Grenada has only one hotel with more than 100 rooms.

Grenada employs only 85 people per 100 tourist rooms. (deAlbuquerque and McElroy, 1988) This low rate of employment generation is another reflection of the small scale of many hotels which are often run by owner-proprietors.

The most important source of tourists for the Eastern Caribbean in general is the United

States. With only 25 percent of its stay-over visitors coming from the United States, Grenada appears to be drawing even a smaller share of the U.S. market than might have been expected given its distance from the U.S. mainland. On the other hand, the country has not yet been able to take advantage of its location in order to draw Venezuelans and others from the South American mainland. (These markets have become very important to places such as Aruba and Bonaire.)

In spite of its previous history as a yachting center and the renown which it achieved as the home for Don Street's yacht *Iolaire*, Grenada lacks a strong foundation for increasing its yachting-based tourism. All of the existing bareboat and crewed charter operations lack direct U.S. (or other continent-based) reservation services and supply systems, which are generally necessary for a successful fleet operation of fifty or more boats.

THE NATURAL ENVIRONMENT

Half of all tourist facilities in Grenada are in apartments, guest houses and cottages. It is doubtful the environmental impact of tourists lodging in such facilities is distinguishable from other Grenadian residents. Indeed, these tourists may have an indirect, positive impact on the environment, to the extent that their presence and comments raise questions about environmental quality and amenities. In other words, the process of hosting tourists may have a "consciousness raising" effect on public awareness of environmental issues. An alternative way of expressing the same process is that tourism creates significant markets and increased economic values for environmental amenities.

Most of Grenada's hotel and resort rooms are clustered in the southwestern peninsula, with many located directly on Grand Anse beach. These facilities have made a disproportionate contribution to the two major environmental problems of this region -- scarcity of fresh water and polluted shorelines. They have also made a disproportionate contribution to the country's solid waste problem, but this is generally not recognized as being as critical as the potable water and marine pollution problems.

Hotels and resorts, however, are *not the cause* or even the predominant contributor to these problems because there simply are not that many tourists. To illustrate: Assume 500 hotel/resort rooms are located in the watershed between Goflands-Grand Anse and Point Salines. Assume each room is occupied by an average of 1.5 people, with an occupancy rate of 60 percent; the result would be equivalent to 450 residents. Even if tourists use water and generate sewerage (the two are related) at a rate equal to 10 full time local residents, the impact of these theoretical tourists would still be equivalent to only four or five thousand residents. There are already many more than 5,000 resident Grenadians now living between Goflands and Point Salines. Therefore, the negative environmental impacts of tourism on fresh water and on liquid and solid waste may be substantial and disproportionate to the tourist presence, but it is largely overwhelmed by the population pressures of almost 100,000 Grenadians living on a small island with limited arable land and limited, accessible fresh water resources. What is significant is the *cumulative* effect of negative environmental impacts generated by the Grenadian *plus* the tourist populations.

SOCIAL AND ECONOMIC EFFECTS

Additional negative effects are often cited as reasons to control or restrict tourism development. For example, it is generally felt that tourism results in the depreciation of local culture and values. In recognition of this danger, one of the goals of the official 1985 Tourism Policy (see page 172) is "to strive for an appreciation by visitors of the authentic Grenadian culture." Several other goals also stress the integration of tourism values and experiences with local culture.

The economic version of this argument is that tourism stimulates demands for goods which are not appropriate for the country at this point in its national development, thus resulting in wasteful imports. An opportunity to assess this effect is provided by evaluating the profile of imports to the country during the 11 years 1969 to 1978 (half a generation) when there was a very low rate of tourism growth. Thus far, there has been no reliable proof -- or disproof -- of this demonstration effect (McElroy and deAlbuquerque, 1986).

In recent years, numerous examples have been documented which illustrate the socio-cultural impacts of tourism. The lessons a pragmatist might take from such examples is that there is little profit to be gained from trying to control the spread of ideas and values. A better objective might be to teach universal respect for people in general and to seek to maximize choices and opportunities within the dominant values of a given society. This is also a fair paradigm for a strategy for environmentally sustainable development in Grenada.

INFRASTRUCTURE

Planning. Government has a special interest in a planning study of the adequacy of water and electrical power resources to support tourism, especially in the south and southwest. A variety of planning decisions for the sector could incorporate this data, many of them related to the scale of tourism which the country desires to promote and the costs that the country expects tourism investors to assume. That is, is it appropriate for the national government to pay for all water and power needs to support tourism, or should major investors be expected to bear a significant portion of these costs? Alternatively, can Government justify providing a higher level of public services to tourists than are available to the majority of Grenadian citizens?

Facilities. In recent years, the country has made significant advances in tourism infrastructure construction (see below, "Recent Advances"). Additionally, many of the recommendations for improved cruise ship services by the 1986 Task Force on a Short Term Action Program for the Development of Tourism in Grenada (Moore, *et al.*, 1986) have been completed. A remaining priority is construction of a sewerage collection and treatment system for the Grand Anse area (see also Section 8). The project is important for many reasons, several tourism-related:

- To protect the health of all people, Grenadians and tourists alike.
- To mitigate damage to the Grand Anse reef, which has been a significant tourist amenity.

- To eliminate a source of obnoxious odors in the midst of the island's best beach.
- To upgrade one of the most popular beaches used by a broad spectrum of Grenadian residents.
- To demonstrate the seriousness of Government's purpose in supporting and maintaining a minimum level of public services to attract stay-over tourists.
- To increase property values in the area to a level which would support new resort development.

INSTITUTIONAL CONCERNS

The first priority of the 1986 Short Term Action Program For Tourism (Moore, *et al.*, 1986) was to establish a streamlined institutional structure. This remains a priority which is in the process of being realized through the re-organization of the Tourist Board, which will assume the responsibilities of the former Department of Tourism.

Beyond these important steps, there is a continuing need to identify and support innovative strategies which allow public and private sector groups involved in tourism, as well as those with environmental program agendas, to work together.

For example, Grenada has an outstanding Hotel Association, which is, nonetheless, limited in what it can accomplish because of the small size of its membership dues base. The revitalized Grenada National Trust has the potential to serve as a central forum for public and private sector interests to explore cooperative ventures for the development of the country's cultural and natural resources, projects which serve both the local community and the tourism sector.

RECENT ADVANCES

[Statements excerpted from the Budget Speech of the Right Honorable H.A. Blaize, Prime Minister and Minister of Finance to The House of Representatives, 21 April, 1989.]

The recent decision of American Airlines to work toward commencing daily flights into Grenada has given a significant boost to the Tourism Industry. This is certain to spawn the construction of additional hotel accommodation for the increased influx of tourists.

Other significant developments have taken place to improve tourism. The Caribbean Tourism Research Centre (CTRC) and the Caribbean Hotel Association (CHA) have now been merged into the Caribbean Tourism Organization (CTO). Thus, for the first time, research, training and the information system would be under a common control with a combined technical staff of very high calibre. Complementing the Caribbean Tourism Organization is the Grenada Tourist Board which is in the process of becoming fully operational.

In addition, many projects are taking place as part of a tourist enhancement plan. The Carenage Pedestrian Plaza has already been officially opened, thus making the St. George's waterfront the finest in the Caribbean. Other projects for which work has already started, or will soon start, include the development of a new National Parks System and Fort Frederick which, together with Fort George represent significant tourist attractions. Work is also continuing at Grand Anse on the construction of the Camerhogne Park which, when completed, will include a car park, picnic area, wash rooms and a recreation area.

As a result of these government initiatives, stay-over visitors are conservatively projected to increase by 9 percent in 1989 and cruise ship passengers by about 4 percent. In terms of revenue to be earned from tourism, an increase of 8.5 percent is expected.

7.3 POLICY RECOMMENDATIONS

MAINTAIN DIVERSITY

Economic planners should see the relatively small size of Grenada's tourism sector as an advantage, i.e., the country is not (yet) over-dependent on tourism. By balancing future development between improvements in agricultural ex-

ports, a modest increase in industrialization, and tourism, the country moves closer to being "recession-proofed."

EMPHASIZE STAY-OVER TOURISM

As discussed previously, development of the stay-over visitor component of Grenada's tourism industry is important. It should be noted that many of the achievements recorded by the country in the tourism sector have resulted in improvements to the cruise ship visitor infrastructure, e.g., improvements to the waterfront and to Fort George and in the sewerage collection system in St. George's (development of the proposed parks system should benefit stay-over visitors, cruise ship visitors, and residents alike). It is important that improvements in systems which support the stay-over tourist also be given priority.

USE OUTSIDE RESOURCES CAREFULLY

Grenada faces many serious problems in both the short and longer term development of its tourism resources. From the standpoint of public policy, perhaps the most difficult problem lies in the process of trying to move from the tourism style characterized by McElroy and deAlbuquerque as "low density, long staying," to an intermediate style. (deAlbuquerque and McElroy, 1988) Generally, to accomplish this transition, a country finds it necessary to rely on outside sources of capital and management expertise. Unfortunately, in Grenada in the 1990's, these needs will run up against great pressures to reduce the balance of trade deficit. If it is to be successful in its development program, the tourism sector will need to be unusually efficient in the use of foreign exchange, including the use of innovative joint ventures between public and private Grenadian resource managers and outside investors.

USE LOCAL INPUTS STRATEGICALLY

As Grenada looks to larger scale tourism alternatives, it will be very difficult to maintain the current level of local resource utilization. In other words, as the number of tourists increases, there will be a tendency to increase the marginal purchase of imported goods and services to support them. For example, the issue will not be how to increase the sales of local produce; it is more likely to be one of how to *avoid reducing* such purchases. Resource managers from both the private and public sectors should meet from time to time with leaders of the tourism industry to identify those sectors which should be "abandoned" to imports and those where better planning can actually increase the local content of the tourist product. For example, by vigorous recruitment of overseas resident Grenadians, it may be possible to hold a large portion of middle and upper management positions in the tourism industry for local "repatriates," -- a reverse brain drain which can have multiple advantages from the standpoint of public policy.

PROMOTE YACHTING

Grenada needs to place a higher priority on reviving yachting-based tourism. Although there are virtually no economic or development studies comparing the impacts of yachting-based tourism with more traditional hotels and resorts, anecdotal evidence is that such enterprises, especially relatively large-scale bareboat chartering, have favorable employment impacts and relatively benign environmental effects, while making few demands on social capital infrastructure. Certainly the experience of the pre-eminent chartering center in the world, the British Virgin Islands, would seem to merit emulation by more emerging tourist economies.

Yachting also provides a low cost way of distributing some of the benefits of tourism to outlying communities and islands.

SECTION 8 POLLUTION AND ENVIRONMENTAL HEALTH

8.1 OVERVIEW

SOLID AND LIQUID WASTES

Island-wide solid waste generation for the island of Grenada is calculated at about 89 tons/day, or 32,485 tons/year, based on a waste generation rate of two pounds per person per day and an estimated population of 89,000 (Ministry of Health estimate, cited in Andrews, 1983). The total amount of waste is computed as the product of the population size times the waste generation rate, but since estimates of total population size vary widely (see Section 2), the waste figure given above is very uncertain.

Solid waste is a serious environmental problem in Grenada. Reports over the years have documented the extent of the problem and recommended various solutions. These have been summarized by Andrews (1988), a consultant working with GOG/OAS. Much of the discussion of solid waste in this section is taken from Andrews' report and a report by the Grenada Environmental Health Department (GOG, 1988c).

The Ministry of Health currently operates a refuse collection system for the major population centers and two solid waste disposal sites in Grenada. The main site is at Perseverance Estate, serving the western side of the island and the other is at Telescope Point, serving the eastern side of the island (Figure 8.1(1)). There is one disposal site in Carriacou at Brunswick near Hillsborough Village; no official disposal site is designated in Petit Martinique.

In 1984 the Ministry of Health requested assistance from USAID and Project HOPE in addressing the problem of solid waste. Vehicles, funds, training, and technical personnel were provided by these and other agencies, which resulted in increased collection of waste and the upgrading of the disposal site at Perseverance (adjacent to Halifax Harbor) to sanitary landfill status. Since the end of 1986, however, there has been a steady

decline in the effectiveness of collection and the condition of the Perseverance site, which has deteriorated once more to an unsanitary open dump. GOG's Environmental Health Department (GOG, 1988c) attributes the cause of this decline to budgetary constraints, resulting in lack of parts and maintenance to keep collection vehicles and disposal site equipment running. All other sites are also now operating as open dumps rather than sanitary landfills due to the lack of sufficient and appropriate cover, equipment for obtaining or hauling cover, and reliable landfill equipment.

The present landfill situation is a public nuisance and a health hazard because of fly, mosquito and rodent breeding, noxious odors, possible contamination of ground and surface waters and exposure to toxic and hazardous wastes (GOG, 1988c). Additionally, there are negative impacts on the tourism and investment sectors of the economy due to aesthetic concerns (e.g., litter, overflowing garbage collection containers, disagreeable odors, and unsightly dumps). All dump sites are located in wetlands close to the coast, where they destroy productive plant communities, displace wildlife and affect marine water quality via toxic leachates with a high Biological Oxygen Demand (BOD). Garbage from cruise ships also goes to the landfill at Perseverance, adding to the demands on this already overloaded site. Toxic or infectious wastes from the Municipal Hospital in St. George's are reportedly incinerated.

The town of St. George's is served by a central sewer collection system with pipelines from 150 mm (6 in.) to 200 mm (8 in.) maximum diameter, reportedly completed in the 1940's. There was no treatment of the effluent; two pumping stations lifted raw sewage to the western shoreline along the bottom of the cliffs below Fort George. The original sewer outfall pipe extended 91.5 m (300 ft.) offshore. Nevertheless, because of chronic pump failures, power outages, and

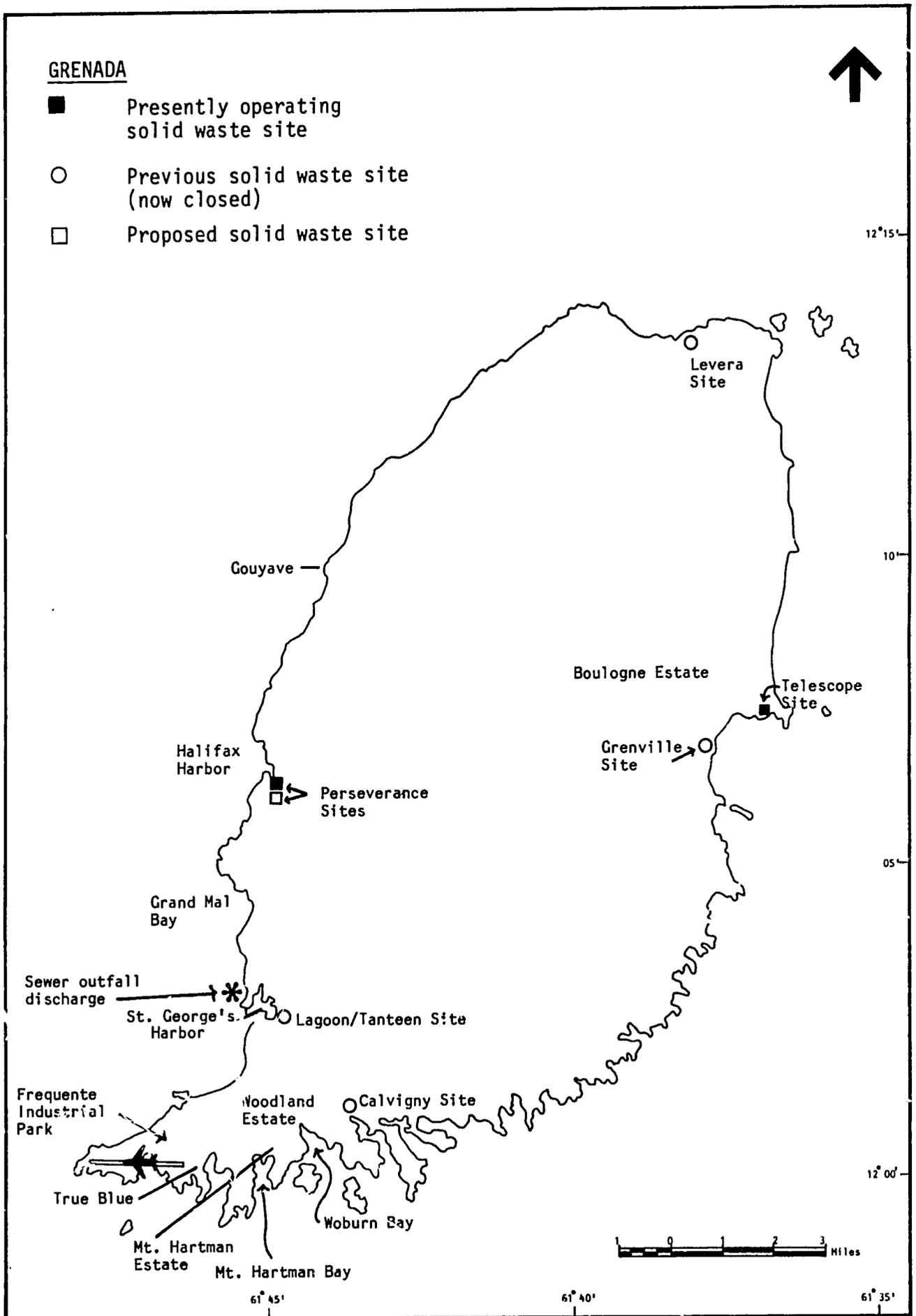


Figure 8.1(1). Location of pollution problem areas in Grenada outside of the St. George's-Grand Anse area.

apparent overloading of the system due to increased sewage flows as the town developed, sewage was often by-passed via a pipeline to the inner harbor at the Carenage. The outfall pipe was broken by Hurricane Janet in 1955, and until 1985 raw sewage was discharged just off the coast near Fort George (Archer, Prelim. Draft, n.d.).

A project funded by CIDA to upgrade the St. George's sewer system and extend the outfall was completed in 1988, following a study of the oceanographic conditions (currents, tides, etc.) at the proposed outfall location (MacGregor, 1987). Initiatives carried out during this project included replacement of pumps at the two major lift stations; installation of force mains; and eventual installation of a 375 mm (15 in.) marine outfall off Greenbridge near the mouth of the St. John's River (Figure 8.1(2)). The length of the outfall pipe offshore is now 1,250 ft., and discharge is at a depth of 85 ft.; the effluent still does not receive any treatment (Archer, Prelim. Draft, n.d.).

Septic tanks are the standard method of domestic and commercial sewage disposal in the suburban areas outside the central part of St. George's, and septic tanks and pit privies are also the disposal methods most used in the rest of the country. In a few areas where hard volcanic soil makes it virtually impossible to construct soakaways or privy pits, e.g., at Gouyave, pail closets are still used. The general practice, even in suburban areas, is to allow only wastes from the water closets to go into the septic tank. The gray water from laundries and kitchens runs into concrete and earth drains and finds its way to the rivers and coastlines. Rivers and coastal waters in densely developed areas such as St. George's, the St. John's River, Tempe and Grand Anse are therefore heavily polluted by a mixture of septic tank leachates and gray water.

OIL POLLUTION

Oil pollution in St. George's Harbor is reportedly serious (even in the relatively short time spent in-country, the CEP Project Team observed many oil slicks in the harbor). Some of the oil originates from bilge dis-

charges and boat refueling operations, but much of it apparently comes from the dozen or so garages and service stations in the area as well as from street surface run-off. Waste oil and grease from garages is simply dumped into storm drains and on the ground and then washed into the harbor during rains. The Department of Environmental Health is currently investigating the problem of surface oil pollution and underground leakage from gasoline station storage tanks into the water table. It has also been reported that oil pollution frequently occurs in Carriacou's Tyrrel Bay, discharged, perhaps along with bilge water, from the inter-island schooners anchored there.

The nation's oil and other petroleum products are brought to Grenada by tankers. The number of oil tankers per year has averaged about 63 during the period 1984-1987, with an average net registered tonnage of about 78,600 tons (statistics from Grenada Ports Authority; see also Table 4.4(2)). Apparently there have been few problems with oil pollution at Grenada's main petroleum off-loading and storage terminal, located at Grand Mal Bay north of St. George's.

The occurrence of petroleum tar on beaches is common throughout the region, and the problem has been monitored by the Caribbean Pollution Program of UNEP, known as CARIPOL (Atwood, *et al.*, 1987/88). Windward coasts throughout the Caribbean, including Grenada, are the most often contaminated with tar, indicating that the source of much of the tar is upwind and beyond the control of individual governments. Fortunately, most of Grenada's important tourist beaches are on the leeward side of the island.

CARIPOL monitoring data have shown that when beach tar values reach 10 grams per meter of shore front, persons using the beaches commonly report getting tar on their feet. When levels are close to 100 grams per meter, beaches become virtually unusable for tourism. Average levels of beach tar measured on some Grenada beaches between 1980 to 1986 were in excess of 10 grams per meter (Atwood, *et al.*, 1987/88).

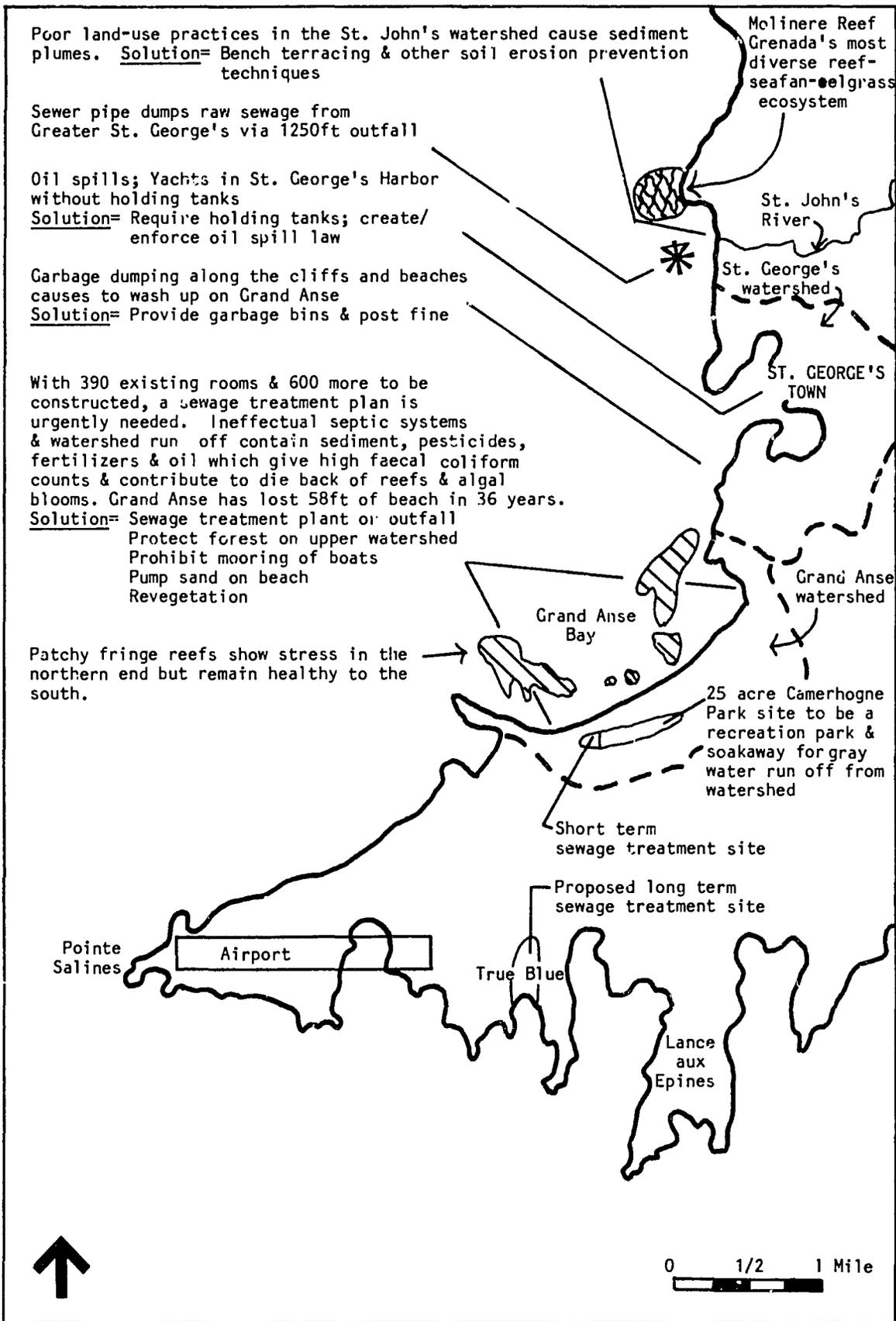


Figure 8.1(2). Some pollution problems in southwestern Grenada (source: GOG/OAS Grand Anse Beach Erosion Study).

INDUSTRIAL WASTES

In the 1960's there were only a few simple industries in Grenada engaged primarily in the processing of local raw materials for the manufacture of copra products, bay rum, beverages, garments and wood products. Today, as a result of a conscious public policy to encourage industrial production, the sector includes a wide range of small-scale industries producing both for the local market and export. While manufacturing is still in an early stage of development, its potential for employment creation and export expansion are ranked highly by GOG economic planners (see also Section 6.2).

No inventory (beyond the brief listing in Archer, 1984b) has been done with measurements or estimates of the quantities of industrial pollutants received by various watershed drainage systems. All watersheds ultimately discharge into the sea, but at present most of the industrial effluents are concentrated in the densely populated urban settlement areas along the St. John's River.

The only operating sugar factory and rum distillery in Grenada is at Woodlands Estate. High-BOD rum distillery wastes are discharged into a ravine which runs into Woburn Bay. Similar problems of high-BOD waste disposal occur at all cocoa processing fermentaries; the main one is at Boulogne Estate in St. Andrew's. The many nutmeg operations produce tons of shells; some dump them into the nearshore waters where they decompose.

The fish processing plant in Gouyave formerly discharged wastes directly into the sea but now has a septic tank to process the wastes first.

The coconut oil plant located on the St. John's River is now closed, but there are plans for re-opening it. A garment industry factory also discharges into the river, and there are three to four "heavy" industries, including a pre-galvanized sheet steel rolling mill and auto tire retreading facility located in this area. A fruit processing plant is also being planned for the river.

In the Frequente/True Blue Industrial Park area, there is concern about the impact of an existing paint plant near the Old Sugar Factory at L'anse aux Epines turn-off. The mangrove swamp across the highway from the Industrial Development Commission's factory shells appears to be under stress due to drainage changes, land filling and trash dumping which are obviously taking place in the area and perhaps also due to effluents from the Industrial Park. In addition to the industries located in the Park itself, which include the Viking Enterprises Juice Plant and Bartel Meats, there are a Carib Beer Brewery, a rice mill, and various other small industries along the highway which may potentially produce effluents harmful to the environment. A consultant for the Industrial Development Commission is reportedly looking into various means of reducing impacts of toxic wastes and developing standards for industrial discharges (R. Buckmire, IDC, pers. comm., 1989).

Sunshine Meats, Ltd. had proposed to build a 2,800-animal hog production facility and meat processing plant at Mt. Hartman Estate, with an annual production capacity estimated at 75,000 pounds of processed meat. This venture was to have been partially supported with USAID/HIAMP funds. It was estimated that the facility would produce an estimated 60,000 gallons of waste on a daily basis, with Chemical Oxygen Demand (COD) in the range 1,000-8,000 mg/L, BOD in the range 500-3,000 mg/L, and high concentrations of organic nitrogen, grease, and suspended solids (Earle, 1988). The facility would also have generated odors inevitably associated with hog production operations, no matter how clean and well-managed. Because of these factors, Mt. Hartman Estate was not the final site selected for this venture.

Mt. Hartman Bay has the most reef development on the south coast. Waste water discharge from operations such as the proposed hog farm, coupled with discharges from the large hotel/charterboat operation under development at Secret Harbor on the west side of the bay, can have a strong adverse effect on ambient water quality, water sports, and coral reef, seagrass beds and fish productivity in the bay. Unfortunately, there is virtu-

ally no baseline information on the status of reef systems and fishing in the coastal area.

TRENDS IN USE OF AGRICULTURAL CHEMICALS

Agriculture generally and banana growing in particular have become increasingly dependent on "inputs", not only of chemical fertilizers but also of pesticides and herbicides (the latter two classes of chemicals are collectively called biocides). There are fourteen importers of biocides in Grenada, and in 1988 they imported a total of 224,488 pounds of these chemicals (see DeGeorges, 1989, for a complete listing). This is a substantial increase from the 1986 (159,243 pounds) and 1987 (147,408 pounds) import levels. The imported biocides included 16 compounds listed as restricted and four listed as canceled by the U.S. Environmental Protection Agency (USEPA).

The banana-producing Windward Islands are the heaviest users of biocides in the OECS countries, and it is estimated that the banana industry uses 99 percent of the imported biocides and 99 percent of the USEPA restricted chemicals in the Windwards. However, Grenada is not as strongly committed to banana production as some of the other Windward Islands. The 12 biocides imported into Grenada during 1988 in quantities exceeding 1,000 Kg are listed in Table 8.1(1); together these account for 85 percent of the total imports. Gramoxone is used in the largest quantities, and together with Baygon, Bop and Furadan it makes up some 67 percent of imported biocides. Highly toxic chemicals on this list include the USEPA restricted Furadan and Gramoxone (restricted because of toxicity to humans).

As shown in Table 8.1(2), Grenada imports the lowest amount of biocides of any of the Windward Islands (although it imports the greatest number of USEPA restricted chemicals). To put these numbers in perspective, DeGeorges (1989) reports that an estimated four to seven pounds of active ingredients of biocide are applied annually per acre in agricultural production on the Windward Islands compared to 23 pounds per acre

in San Joaquin County, California, known as one of the world's most intensive areas for biocide use.

The second phase of a large cocoa rehabilitation program in Grenada, funded by CIDA, seeks to continue training farmers in propagation techniques and to increase the institutional capabilities of the Grenada Cocoa Association. Part of the CIDA project involves funding the reorganization of GCA's pest and disease control division and incentive programs to increase the use of agrochemicals for increased production. A USAID/PADF-supported Cocoa Rehabilitation and Development Project utilizes cocoa management demonstration plots to transfer lessons learned to cocoa farmers, including improved management practices and improved agrochemical use.

Although not quantified in this report, the usage of biocides and fertilizers by a number of other existing and proposed projects in Grenada is ground for concern over the possible environmental effects of these substances. For example:

- CARDI has a 10-acre experimental station in Caligny which has been reported to use large quantities of pesticides.
- Banana growers employ aerial spraying on their crops, using a mixture of mineral oil and fungicides.
- Nutmeg and cocoa growers use large quantities of Gramoxone (Paraquat) to keep down weeds.
- Sugar cane growers in the southeast area use heavy applications of fertilizers, and there have been suspicions of groundwater contamination.

PUBLIC HEALTH

In recent years there has been an increasing incidence of skin rashes and ear infections among persons swimming in the Grand Anse Bay area, where water quality sampling has shown high fecal coliform counts

Table 8.1(1). Biocides Imported into Grenada during 1988 in quantities exceeding 1,000 Kg (2,200 lbs).

BIOCIDE	QUANTITY (KG)
Baygon Spray	10,865
Benlate	1,383
Bop Insecticide	21,957
Calbin	2,950
Cooper Flykiller	1,476
Furadan	16,050
Gramoxone	19,095
Maiathion	1,122
Roundup Herbicide	2,199
Sevin 85% Sprayable	6,522
Shelltox Insecticide	2,089
Tilt	1,250

Source: DeGeorges, 1989.

(see Section 8.2 below). It is suspected but not proven that sewage pollution may be responsible for these infections. There is also a high incidence of gastro-enteritis and viral hepatitis in Grenada, two communicable diseases linked to water and sewage pollution. Statistics on the incidence of the latter two diseases are shown in Table 8.1(3).

8.2 PROBLEMS AND ISSUES

COASTAL SEWAGE POLLUTION

Investigations of coastal water pollution in Grenada have been carried out only in recent years and have focused mainly on the area from the mouth of the St. John's River to Grand Anse Beach. The major sources of pollution by liquid wastes on this stretch of coast are (see also Figure 8.1(2)):

(a) the St. John's River, which discharges industrial wastes, eroded silt and gray water;

(b) the discharges from the abattoir and fish processing plants immediately south of the river;

(c) an outfall pipe which dumps raw sewage from greater St. George's directly into the sea;

(d) hillside run-off from housing developments and yachts without holding tanks which dump small quantities of raw sewage into the water in St. George's Harbor;

(e) at Grand Anse, 390 existing hotel rooms which have ineffective septic tank systems and discharge gray water directly into storm drains and watershed run-off which contains sediment, pesticides, fertilizers, oil and animal wastes (Archer, 1984c; Taylor, 1986, 1987).

Table 8.1(2). Pesticide imports in the OECS countries.

COUNTRY	NO. OF IMPORTERS	PESTICIDE IMPORTS	NO. OF USEPA RESTRICTED PESTICIDES
St. Lucia	15	1/1 - 10/31/1989: 759,182 lb.	13
Grenada	14	1988: 224,488 lb.	20
St. Vincent	9	1988: 906,697 lb.	10
Dominica	9	1988: 2,345,712 lb.* or 847,076 lb.**	11
Antigua	9 minimum	1988: no quant. records	12 minimum
St. Kitts/Montserrat		Needs to be investigated	

* Based on Pesticide Control Board statistics

** Based on Dominica Banana Marketing Corporation statistics

Source: DeGeorges, 1989.

Table 8.1(3). Incidence of gastro-enteritis and viral hepatitis in Grenada, 1980 - 1986.

Year	Cases Reported	
	GASTRO-ENTERITIS*	VIRAL HEPATITIS**
1980	1,045	---
1981	334	---
1982	1,664	---
1983	994	---
1984	1,364	152
1985	621	34
1986	814	35

Sources: * Waal, 1987

** Archer, prelim. draft, n.d.

Discharges from the St. George's Sewerage System. The marine outfall pipe from the St. George's municipal sewer system discharges raw sewage 1,250 feet offshore from the mouth of the St. John's River, and the outfall area is now a favorite fishing location. Based on an estimated sewer population of 10,000, Archer (1984c) derived a total sewage flow of 2,500 cubic meters per day, or 0.66 million U.S. gallons per day. He estimated waste loads and pollutants discharged from the system, in tons per year, as follows: BOD = 197, COD = 440, suspended solids = 200, total dissolved solids = 365, nitrogen compounds = 0.33, phosphates = 4.

Discharges from the Lagoon. The Lagoon is a shallow harbor immediately south of the inner and outer harbor at St. George's, which is used by small craft and yachts. There is a marina here with service and haul-out facilities. Archer (1984c) estimates that 378.5 cubic meters or 100,000 gallons per day of gray water and 58.3 cubic meters or 15,700 gallons per day from over-flowing septic tanks flow into the Lagoon from uphill housing developments. Added to this pollutant load are wastes from yachts, repair shops, and persistent leachates from the old municipal refuse dump on the eastern banks of the Lagoon. The Lagoon is flushed mainly by tidal action and therefore retains wastes for long periods.

Discharges from the St. John's River. Archer (1984c) has listed the types of pollutants and has computed the industrial waste loads discharged on the coast north of Fort George Point, mainly from the St. John's River. Land uses in the river basin are a combination of farming (bananas, cocoa, nutmeg, root crops, fruit trees, sheep raising), light industry (an edible oil/soap/coconut meal factory, soft drink factories, a fruit cannery, a flour mill, a concrete block plant, mechanical repair shops), and dense housing development.

Industrial wastes (approximately 17,280 cubic meters during 1982-1983) are discharged directly into the St. John's River or its tributaries, and there is probably significant pollution of the river by pesticides and fertilizer residues, gray water and sewage. The nematocide Furadan, used on banana planta-

tions, is known to have a half life of three months and persists in water. Following moderate overnight rainstorms, there are heavy discharges into the river of sediments from eroded clay soils, leading to the conclusion that sedimentation may be at least as great a threat, if not greater, to marine life than the other pollutants (Archer, 1984c).

Miscellaneous Discharges. The abattoir and fish processing facilities immediately south of the St. John's River discharge small quantities of suspended solids and high nutrient wastes directly off the coastline (Archer, 1984c).

Discharges from the Grand Anse Bay Area. Taylor (1987) states that the area behind Grand Anse Beach, the site of the proposed Camerhogue Park, was originally a swamp which was an important natural drainage feature. The swamp was filled in during the 1940's, but the artificial drainage system installed on the site is very poor, consisting of paved shallow collector drains and earthen ditches terminating at the sea head west of the Spice Island Inn. The drain backs up at high tide, and the outlet is frequently clogged with sand. The Medical School, Ramada Inn and the Grand Anse Shopping Center have small individual treatment plants, which discharge their effluent into the drains. Toilet wastes from other hotels and buildings discharge into individual septic tanks, and because of the high ground water table septic tank effluent finds its way to the drains during heavy rains. Gray water from the buildings goes directly into the collector drains. Feces from often untended livestock also are washed into the drains by run-off. Water discharged at the sea head in the southern part of Grand Anse Bay next to the Spice Island Inn is therefore highly polluted.

Archer (1984c) conducted a four-week reconnaissance study of water quality parameters at both inshore and offshore stations from Grand Anse to the St. John's River, including nutrients, Biochemical Oxygen Demand, total and fecal coliforms, total suspended solids and volatile (organic) solids. He found substantial concentrations of suspended solids at the St. John's River mouth, the Carenage, the east bank of the Lagoon, off

Memorial Point, the Ship Channel, the water course near the Silver Sands Hotel and the northern seahead at Grand Anse. Volatile solids averaged 33 percent of the total suspended particulate matter, a figure typical of water polluted by fecal matter or some industrial wastes.

Fecal coliforms were present at almost every station, and there were very high counts at the St. John's River mouth, the northern seahead drain at Grand Anse and the Lagoon. Fecal coliforms at Grand Anse Beach far exceeded U.S. water quality standards for swimming areas. The results of Archer's study were rather inconclusive as to the effects of pollution on the reefs but indicated a severe public health risk if steps were not taken to ameliorate the existing levels of water pollution.

Surface currents have been measured off Grand Anse between Quarantine Point and Eloi Point by the use of drogues (Cambers, 1986b). During the flood tide, the current moved in a southwest to westerly direction at an average speed of 0.177 m/sec., which is in general agreement with the pattern shown in the ECNAMP data atlas (ECNAMP, 1980). During ebb tide the current regularly moves in a west to northwest direction at an average speed of 0.115 m/sec., slower than for the flood tide but still a significant water movement. The greater speed of the southwesterly flood current over the northwesterly ebb current indicated that there would be a net movement of polluted water from the St. John's River and St. George's area to Grand Anse. In the Grand Anse area, polluted water may simply move in a body parallel to the coast and not immediately out of the area as would be the case if there were a unidirectional current.

Between Quarantine Point and Point Salines the ECNAMP data atlas is somewhat vague, showing only occasional or intermittent currents. In actuality, there is a very strong flood current measured by Cambers at 1.162 m/sec., which agrees with the observations of currents reported by fishermen. Such strong currents indicate that this area may be favorable for the siting of future ocean outfalls for the southwestern section of Grenada.

On the basis of water samples collected at 25 stations on a single day (February 20, 1987), Hunte (1987a) found that nitrate and phosphate levels within Grand Anse Bay were higher than those within the Harbor/Lagoon water mass and higher than within the St. John's River/Fort George water mass. Pending further studies, Hunte tentatively suggests that the high nutrient levels in Grand Anse Bay result primarily from nutrient sources within the Bay itself, rather than from the importation of nutrients originating in other areas. Nitrate and phosphate levels at all locations sampled were higher than values typical of other non-polluted coastal waters in the Eastern Caribbean.

Several sewage disposal studies have been done for the Grand Anse/Morne Rouge area through the assistance of various international agencies including PAHO, OAS, CIDA, and USAID. A USAID-funded project to address sewerage problems at Grand Anse is now in the final planning stages. The most recent design and costing studies include Steiner (1985) and Berger, Barnard, Thomas (1988). The project will involve construction of a force main with a marine outfall and is intended to serve the current Grand Anse area population of 12,400. The estimated design capacity of 18,000 persons is expected to be reached in 20 years.

The level of waste treatment (if any) and the exact location of the discharge pipe have not been decided as yet. A recently completed environmental assessment study funded by USAID (Hunte, *et al.*, 1989) investigated four alternative locations for the outfall pipe and found that Point Salines was the site which offered minimal risk of coastal pollution, taking into account seasonally varying currents, acceptable dilution of pollutants, a seabed favorable for excavation and placement of the pipe, relatively unimportant biological bottom communities, and a readily available onshore treatment plant site.

This study recommended that in order to protect public health, achieve an acceptable dilution of nutrients, and yet be feasible from the standpoint of available technical skill and construction, operation and maintenance costs, the most preferred alter-

native is to combine "preliminary treatment" with a 350 meter (1,148 ft.) long outfall having a diffuser providing initial dilution of at least 100. The cost for this option is projected to be US\$360,000. "Preliminary treatment" means simply removal of grit, grease and large particulate matter, not "primary treatment" as that term is used in the United States.

ENVIRONMENTAL RISKS OF AGRICULTURAL CHEMICALS

Fertilizers. Chemical Fertilizers are in widespread use in Grenada. NPK (nitrogen/phosphorus/potassium) types of fertilizers are most commonly used. Sulphate of ammonia, a source of nitrogen, is also popular as an input to banana production. The greatest potential risks from such use in the environment are reported to be soil deterioration and nutrient overload in downstream and coastal receiving waters. Coral reef ecosystems are especially sensitive to the effects of over-fertilization of the nearshore waters.

At present there is insufficient information to determine whether there is significant pollution of the rivers and coastal waters by fertilizer residues, although some regard this as likely. Pollution levels were measured in a reconnaissance survey of stream water quality in Grenada's watersheds (Ternan, Williams and Francis, 1987). The results of this very limited survey indicated that fertilizer pollution of Grenadian rivers by agricultural activities at the time of the survey was not significant. The maximum nitrate concentration recorded (1.6 mg/liter) was in the Great River. Potassium concentrations were also found to be low. However, information received by the CEP Project Team from individuals with the Central Water Commission on the subject of fertilizer pollution in drinking water supplies is in apparent conflict with the results of the Ternan, *et al.* (1987) reconnaissance survey of water quality. More detailed and more recent testing is needed.

Biocides. The benefits of using pesticides are usually straight-forward and immediate, but environmental and health hazards caused by their use are much more difficult to

evaluate because they are often delayed in appearance, subtle, undetected or ignored (Larew, 1988). Properly assessing the risks posed by pesticides requires data on the fate of these compounds in the environment and the level of exposure of humans. The data on environmental impacts in the Caribbean are very limited, but alarming in at least some cases. A Jamaican study (Mansingh and Prasad, cited in Larew, 1988) found persistent pesticide residues in soil, fresh and salt water, and vegetables. Very limited sampling in Dominica and St. Lucia (cited in CCA/IRF, 1988) found only low levels of pesticide residues in the environment. Until monitoring is conducted in Grenada, it will not be possible to assess adequately environmental or human health risks.

Some biocides are applied by backpack sprayer, and some are sprayed from airplanes. The liquid carrier in both cases is a mineral oil, known generally as Spray-Tex. The oil, a light petroleum distillate, is mixed at different ratios with the various biocides selected. The oil alone is sometimes applied by ground crews for fungal control. Since a considerable quantity of this oil is applied, the question of its possible effects on wildlife deserves investigation.

Among the different insecticides, nematicides, herbicides and fungicides available, some are more critical than others from an environmental perspective. Each group has its own characteristics and represents a special challenge to the resource manager who must seek to use them with the least possible damage.

The organochlorine insecticides such as DDT, Heptachlor and Chlordane, although no longer in use in developed countries, are still used to some extent in Grenada, mainly for termite control. These chemicals, which can cause acute poisoning in vertebrates (including humans and fishes) are not easily broken down in the environment (i.e., decomposed), and hence they persist for long periods after application. If there is high surface water run-off in areas which are predisposed to erosion, residues of these organochlorines in bottom sediments of water bodies can be locally high, even though drainage water (i.e.,

water that has infiltrated the soil) from treated sites is almost free from contamination because of high absorption onto soil particles.

The synthetic pyrethroids, another class of commonly used insecticides that impact negatively on the environment, are not as persistent as the organochlorines. Examples of synthetic pyrethroids are Ambush, Decid and Karate. Like the organochlorines, these chemicals are toxic to fish and economic insects such as bees. Thus, in the absence of a well-managed, on-farm spraying regime, the chances of endangering aquatic and useful insect life will be substantial.

The safest class of insecticides are the organophosphorus compounds, such as Malathion, Metasystox-R and Phosalone. Preferential use of these insecticides is advocated in light of the fact that they are non-persistent and not very toxic to vertebrates and bees.

Nematicides, which are used to control the spread of nematodes and soil insects, are very toxic to vertebrates, invertebrates, and wildlife. Due to the fact that they decompose quite easily, fear of a potential build-up of residues of these chemicals in the environment may be unwarranted. Notwithstanding, care needs to be taken when these chemicals are applied to crops because the available granular formulations of the most commonly used nematicides -- Furadan and Mocap -- are very water soluble and therefore likely to leach into underground springs, rivers and other water catchments.

Benlate (Benomyl) and its primary fungitoxic degradation product, carbendazim, are used as fungicides. These compounds have low acute and chronic toxicity for higher plants, mammals and birds. In chronic feeding studies with dogs and rats, benomyl or its metabolites have not been found to accumulate in tissues. Benomyl is substantially more toxic to freshwater organisms. Earthworms and some mites are also sensitive to benomyl, but effects on soil insects have not been observed. In addition to spray applications on the surface of the leaves, higher plants absorb substantial amounts of benomyl from the soil,

and it subsequently concentrates largely in the foliage. Benomyl degrades relatively slowly in soils.

Among herbicides, most are toxic but do not pose serious threats to animal life because these compounds either are absorbed into soil particles or decompose quickly. An exception is Paraquat -- commonly known as Gramoxone -- which is widely used in Grenada for the chemical control of weeds, in spite of the fact that this chemical has an extremely deleterious effect on humans, other vertebrates and the environment. Its use is prohibited or restricted in developed countries.

SOLID WASTE

No solid waste management plan currently exists for the country; the numerous reports that have been done on solid waste do not address the problem in a comprehensive manner. Such a comprehensive plan is essential for the proper operation of the solid waste management functions of Government and in order to meet future needs (Andrews, 1988). Solid waste expenditures account for over 54 percent of the Environmental Health Department's budget.

Responsibility for management of both solid and liquid waste programs was to have been transferred to the Central Water Commission by March 31, 1988, but to date this has not occurred, leading to budgetary problems for the Department. This also means that the EHD continues to be in the awkward position of being responsible for both operation of these programs and enforcement of environmental health laws.

Because of the erratic manner in which the Perseverance landfill has been managed, concern has been raised about the possibility of toxic or high-BOD leachates contaminating the surface or ground water resources or Halifax Harbor itself. Waste oil from St. George's, from Government vehicle operations, and from electric generation facilities is dumped at the landfill and has severely contaminated the adjacent swamp (USAID, 1984d).

Andrews (1988) attempted an assessment of the likelihood of leachate generation at Perseverance, with the caveat that the requisite hydrogeological and meteorological data for identifying the leachate and predicting its movement within the substrate are not available. Results of this assessment were inconclusive, but Andrews noted that the procedure of burning the waste at the site may result in the combustion of much of the organic material, "possibly" resulting in low BOD levels in the leachate. No actual sampling of the composition of the leachate appears to have been done.

Andrews (1988) also presented techniques for sealing the Perseverance landfill site and recommended that the most feasible use of the sealed site would be for recreational purposes. After consideration of several alternative sites, he recommended that the preferred location for a combination new landfill/quarry would be immediately south of the existing Halifax Harbor disposal site in Perseverance Estate. The quarry operation would provide a ready source of cover to the sanitary landfill.

PUBLIC HEALTH

Responsibilities of the Environmental Health Department for pollution monitoring and control overlap broadly with other departments; e.g., the Central Water Commission carries out the actual work of bacteriological monitoring for fresh waters and gives reports to the Chief Environmental Health Officer. No agency monitors marine pollution on a regular basis, but periodic monitoring of the Carenage and Grande Anse Bay areas has been done by the Central Water Commission within a program directed by CEHI.

No regulations concerning specific *standards* for solid and liquid waste management/treatment, water quality in rivers or marine areas, or drinking water quality are in existence for the country. Officers of the Environmental Health Department "... make use of WHO and [US]EPA guidelines in determining the acceptability of waste management proposals" (Earle, 1988), but it appears to be a matter left to the discretion of Department

officials as to which guidelines apply to which projects.

Grenada's pesticide laws include the Pesticides Control Act of 1973 which established the Pesticide Control Board and rules for importation and safe use; the Pesticides Control (Amendment) Act of 1979 which pertains to the labeling of pesticides; and the Pesticides Control Regulations of 1979 describing the role of the Board in controlling importation and distribution. A Pesticide Control Board was set up in 1973 and is currently functioning; it appears to be effective in controlling the entry of pesticides to those on the approved list. All biocides must be licensed by the Pesticide Control Board before being sold; restrictions are usually by crop.

The law regarding safe use is inadequately implemented because of lack of inspection and enforcement personnel. Although two chemists have been trained in pesticide residue analysis, there are currently no analytical capabilities for pesticide monitoring; the two gas chromatographs in the country are not operational. No standardized programs to monitor worker over-exposure or contamination of food products or the environment by pesticides or herbicides are in place in Grenada.

No effort to monitor or report exposure of pesticide workers in HIAMP projects has been made; therefore, it is not surprising that no problems have been documented. The general lack of training in safe handling of pesticides combined with the toxicity of some of the proposed pesticides present an unacceptable level of risk according to one study prepared for USAID on its HIAMP projects (Larew, 1988) -- and the same may be said of most other projects which handle agricultural chemicals in Grenada. All parties interviewed by DeGeorges (1989) felt that programs to certify pesticide applicators and farmers and to monitor workers and the environment for pesticide residues should have a high priority.

CWC is experiencing chronic problems with agricultural fertilizers getting into the water treatment plant intakes and causing algal growth in the slow sand filters. CWC has no information on whether biocides in

drinking water are causing a problem at this time.

OIL POLLUTION

The rules and regulations of the Grenada Ports Authority (Sect. 15 of SR 14) cover discharges of various kinds from ships onto land. For example, no dirt, ashes, solid wastes or rubbish may be discharged from a ship onto a wharf, but discharge of oil or other substances from the ship into the sea is not covered. However, discharges from the land into the sea are prohibited. According to a Ports Authority official, at present there is no way of implementing these regulations because of lack of manpower and equipment for enforcement, control or analysis of discharged materials. No oil spill contingency plan now exists for any port or other coastal area in Grenada.

Since Grenada is near the major oil transportation routes from the oil producing and refining countries of Trinidad and Tobago and Venezuela, there is a high risk to coastal areas from marine oil spills. Based on early 1980's levels of production from marine sources in those countries, the U.S. Coast Guard estimated that oil spills of 26 million tons/year in Trinidad and 1.25 million tons/year in Venezuela are possible (Mitchell and Gold, 1982). Spills of such magnitude could definitely impact beaches in Grenada, especially if they occur during the times of heavy outflow from the Orinoco River. Spills from tanker accidents in Grenadian waters are also a significant threat. For example, in 1979 there was a tanker collision in the Grenada Channel which spilled 290,000 tons of crude; damage to the beaches was only averted by towing one of the tankers out to sea. Any spill which deposited a heavy coating of oil on tourist beaches could, depending on the size of the spill, diminish or even destroy the tourist industry for years.

Oil spills are not the only threat to the region. The source of as much as 50 percent of floating tar and beach tar throughout the Wider Caribbean is probably the adjacent North Atlantic oceanic gyre (current system). This tar comes from illegal tanker ballast wa-

ter and discharge and is carried through the region by prevailing winds and currents. Besides creating aesthetic problems for humans when it is blown ashore on beaches, floating tar has other adverse effects. Research indicates that threatened and endangered species of sea turtles feeding on floating tar balls often die after ingestion (Atwood *et al.*, 1987).

8.3 POLICY RECOMMENDATIONS

SOLID WASTE

* Financing for all recommended measures in this section is perhaps the most critical element in addressing long-term requirements. The development of innovative means of raising revenues is necessary to reduce the burden on the Government treasury. Possible options include: charging a levy to all hotels for waste collection and treatment services; selling franchises to private waste collectors for designated collection areas; and charging industrial and commercial users for waste collection and disposal.

* A solid waste management plan should be prepared covering a minimum period of twenty years (Andrews, 1988). A properly operated sanitary landfill is likely to be the most attractive option from a financial viewpoint in the short term. However, planning for ways to reduce the quantity of solid waste and to promote a variety of recycling options needs to be implemented as a collaboration between Government and the retail trade sector, in order to ensure that such schemes are organized on economically defensible grounds.

* Education programs directed at both school children and adults regarding proper waste storage, disposal and general cleanliness should be incorporated into the management plan. The Anti-Litter Act also needs to be enforced.

LIQUID WASTE

* The sewage treatment alternative suggested by Hunte, *et al.* (1989) for the Grand Anse area is probably the most cost-effective and ecologically sound solution that can be implemented given the technological and financial constraints which exist in Grenada. Since it is crucial to prevent both public health hazards and nutrient enrichment of nearshore waters, a long outfall with a diffuser discharging into an area of strong currents can achieve these ends without sacrificing environmental quality. The waste treatment system should be designed so that it will be easy to upgrade to a higher level of treatment should this prove to be necessary in the future.

* A long-term water quality and marine biological monitoring program should be implemented to determine the effectiveness of this solution in Grand Anse and to determine the need for remedial action in other areas. Laboratory and personnel capabilities in the country will have to be upgraded in order to accomplish this.

BIOCIDES

* Biocides which have been restricted or cancelled in the developed countries should be removed by the Pesticide Control Board from the list of chemicals approved for import. Donor agencies should place restrictions on the use of restricted or canceled biocides and should not fund projects which use them.

* A certification program for pesticide applicators, pesticide control inspectors, extension agents and farmers should be implemented and training in the safe use of pesticides should be a mandatory part of any donor-supported program.

* A monitoring program for biocide residues in farm workers, drinking water and the environment should be implemented. Strong consideration should be given to the centralization of all environmental monitoring capabilities in one laboratory (see also Section 5.3).

OIL POLLUTION

* An oil and hazardous materials spill contingency plan should be prepared and implemented. Legislation is needed to require proper disposal of oil and hazardous materials, and facilities to accomplish this must be provided.

INDUSTRIAL WASTES

* Government policy should be directed to attracting and subsidizing only industries which are relatively non-polluting. Environmental impact assessment reports should be required of all proposed industrial projects before they are granted construction and operating permits. Existing industries discharging toxic and/or high-BOD wastes into the environment should be identified and required to treat their wastes and clean up already polluted areas.

SECTION 9 LAND USE, PLANNING, AND DEVELOPMENT CONTROL

9.1 OVERVIEW

As late as 1986, a workable system of physical and environmental planning and development control had yet to be implemented in Grenada, despite the fact that several conceptual plans had been written, many technical assistance projects had been carried out, and numerous statements of good intention had been put forward by Government. A Master's Thesis (Frederick, 1987a), written by the present head of the Physical Planning Unit (PPU), traces the evolution of physical planning and development control and discusses some of the institutional weaknesses. A detailed discussion of the institutional framework for planning and development control in Grenada can be found in Section 12 of the Profile.

LAND USE PATTERNS AND MECHANISMS OF DEVELOPMENT CONTROL

Figure 9.1(1) presents a very generalized map of the major types of land uses in Grenada. At the present time, there is no detailed map of current land use information for the entire country. The most recent land use maps are the 1:25,000 scale series compiled for the Ministry of Agriculture's Land Use Division by Eschweiler in 1982. The information presented in these maps is summarized in Table 9.1(1).

Since 1982, mapping of land uses has only been carried out for specific planning projects such as tourism development in the southern portion of Grenada (known as "Zone 1"), the island of Carriacou, the proposed Levera National Park, and so forth. Soler (1988) states that there is an immediate need for new mapping of Grenada at a scale of 1:2500, which should be based on recent aerial photography. However, Frederick (pers. comm., 1989) points out that 1:2,500 scale maps are too small for day-to-day use and are incompatible with engineering scales; new mapping at a scale of 1:200 is needed for basic land use maps, comprehensive plan maps and zoning maps.

An up-to-date cadastral map and database do not exist for Grenada, making development control even more difficult because it is often not clear which parcels belong to whom. Although there is an official land surveyor's office at the Division of Lands and Surveys, several Government agencies employ their own surveyors, and apparently neither the public nor private sectors are required to register new land surveys and subdivisions. Because of this practice of subdividing land without registering it, preparation of a cadastral map would be a very difficult and time-consuming task, albeit an extremely useful one.

Development control as it is currently practiced in Grenada is only a loosely defined and poorly implemented process. Although legal responsibility for land development control rests with the Land Development Control Authority (LDCA), this body is often unable to perform its mission adequately. Between 1970 and 1980 only 12 percent of new residential developments applied to LDCA for permits, although most major tourism, urban, and industrial projects did come under its review (Mardones, 1985). One reason for this lack of effectiveness is that the LDCA has no enforcement arm; consequently, it is only able to deal with those developments which actually do apply for permits. Another problem which seriously hampers the LDCA is the lack of up-to-date information on actual land use and existing environmental impacts.

Other reasons for the limited effectiveness of the LDCA are related to the institutional structure of GOG. Theoretically, the LDCA and PPU are intended to function together as a single body in charge of planning and development control, even though they are administratively separate. In fact, this arrangement has frequently not worked very well when the Chairman of the LDCA and the Director of Planning have had differing interests and priorities. Furthermore, there are many other GOG agencies besides the PPU and LDCA which have overlapping and po-

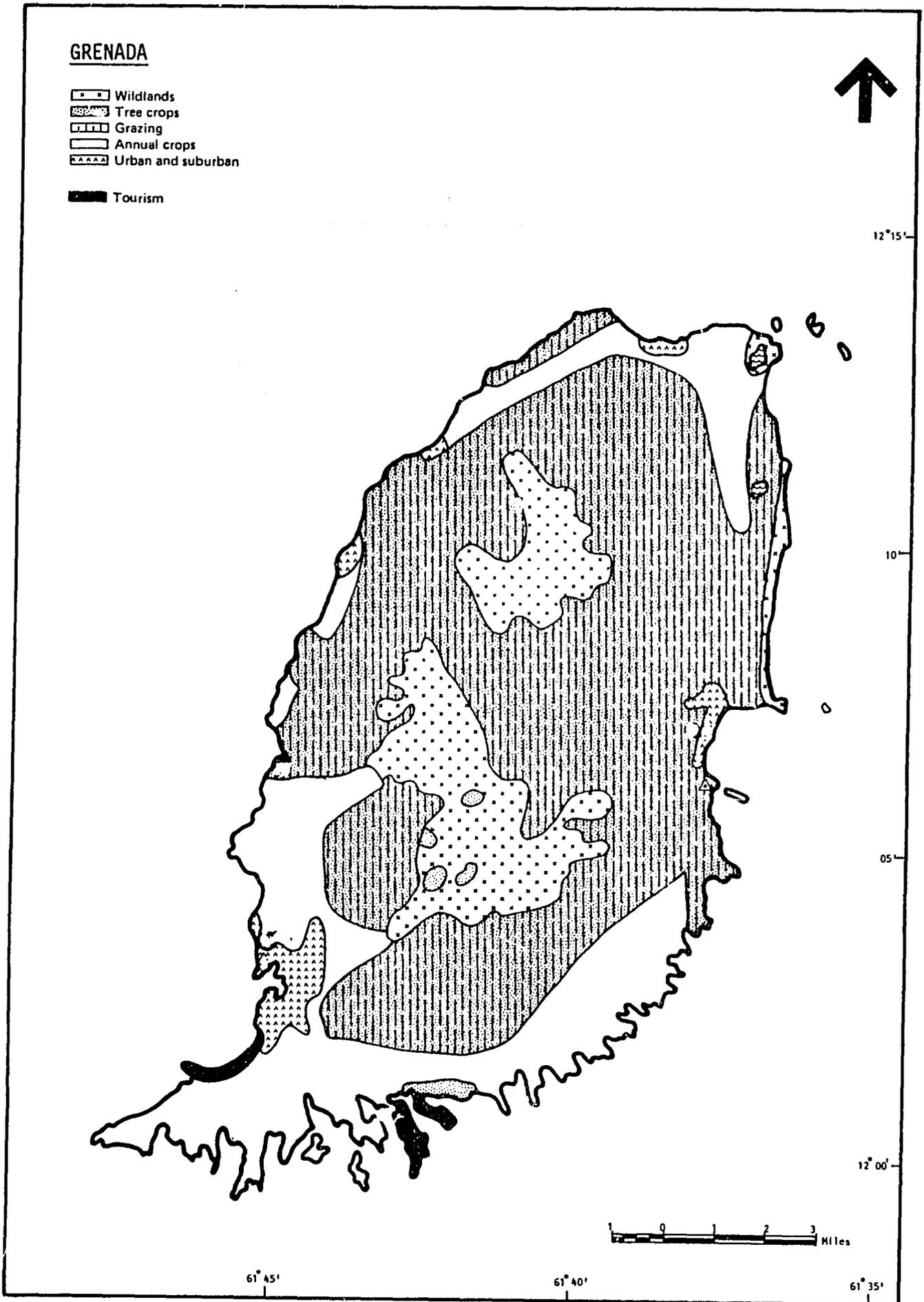


Figure 9.1(1). Generalized land use map, Grenada (source: ECNAMP, 1980a; Weaver, 1989).

Table 9.1(1). Land use summary for Grenada, based on Eschweiler map, 1982.

LAND USE CATEGORY	AREA	
	HA.	%
<u>Grenada and island dependencies</u>	34,830	100.0
Mainland Grenada	31,200	89.6
Carriacou and Petit Martinique	3,630	10.4
<u>Grenada mainland*</u>		
Food crops (maize and vegetables)	4,160	13.3
Sugar cane	530	1.7
Grassland (pasture)	170	0.5
Grassland and scrub	290	0.9
Tree crops		
Cocoa	4,460	14.3
Banana	3,560	11.5
Nutmeg and spices	3,780	12.1
Coconuts	940	3.0
Fruit trees	930	3.0
SUBTOTAL (Agriculture)	18,820	60.3
Woodland and scrub	5,270	16.9
Inland swamp	30	0.1
Mangrove	190	0.6
Forest**	3,970	12.7
SUBTOTAL (Natural vegetation)	9,460	30.3
SUBTOTAL (Other)***	2,920	9.4
TOTAL (All land)	31,120	100.0
<u>Carriacou and Petit Martinique:</u>		
Forest reserves****	136	3.8
Remaining lands	3,494	96.2
TOTAL (All lands)	3,630	100.0

* Source: Ternan, *et al.*, 1989.

** The proposed Grand Etang Park occupies 1,748 ha (1,526 government owned and 222 privately owned). Annandale watershed occupies 202 ha and Concord watershed 96 ha. Total area for Grand Etang region is 2,046 ha (6.6% of Grenada). The proposed Mt. St. Catherine Park occupies 573 ha, all government owned. The Mt. Hope-Clabony watershed adjacent to Mt. St. Catherine occupies 262 ha. This region encompasses 835 ha (2.7% of Grenada). The proposed Levera Park occupies 220 ha, 48 government owned and 172 privately owned, or 0.7% of Grenada. The proposed three parks, therefore, occupy 2,541 ha (8.1% of Grenada). However, only 2,147 ha (6.9%) are government owned. Perhaps only 1,000 ha, or about 3% of Grenada, are comprised of undisturbed climax forests.

*** The "other" category includes urban and suburban areas, roads, playing fields, airports, etc.

**** The proposed High North Park occupies 242 ha (32 government owned and 210 privately owned) and comprises 6.7% of Carriacou. All of Carriacou or Petit Martinique have been disturbed by fuelwood harvest and grazing.

Source: Weaver, 1989

tentially conflicting jurisdictions over the development process in Grenada (see Section 12.3). Even though they may have representatives sitting on the LDCA board, these agencies often do not submit their development plans for review. This fragmented institutional structure is perhaps the major constraint to effective planning and development control.

There is at present no legal requirement or institutional capacity for carrying out formal environmental impact assessments, even for major projects, and the LDCA's enabling legislation and regulations do not contain any prescribed standards for evaluating proposed developments. Until recently, when a very simple and basic set of guidelines was administratively adopted by the LDCA, each development was considered on an ad hoc basis. These guidelines provide information regarding format and contents for development applications and general standards for plot cover, parking capacity, setbacks from roads and property lines, sewage disposal, and building construction requirements. A coastal setback of 50 m from the high water mark (only in low-lying areas less than 3 m above sea level) is also incorporated. This setback has been recommended by many consultants due to increasing problems of coastal erosion in the country.

No specific slope standards aimed at erosion control from construction, logging, or road building activities appear to exist. Vernon, *et al.* (1959) made recommendations for slope standards relating to agricultural activities in Grenada, but even these have never been legally adopted.

Certain steps have been taken since 1986 to improve the situation regarding development control. Regulations for the LDCA as outlined in Sections 7 and 21 of the Land Development Control Act (No. 40 of 1968) have been put in place (SRO No. 13 of 1988). A tribunal of court appeals, in keeping with Section 11 of the Act, has now been established to review appeals from the decisions of the LDCA. Directors on the board of the LDCA are meeting more often, and as a result building applications are being processed more quickly, on average more than 40 per

month. Steps have been taken by the Physical Planning Unit to secure funding for drawing and digitizing new 1:200 scale land use maps and assigning an employee of the Unit to keep them updated.

It is anticipated that the basic planning data to be incorporated in the new large-scale land use maps will considerably enhance coordination between the LDCA and other agencies concerned with planning and development. It is intended that the task of updating cadastral information by establishing lot lines or property lines will be handled by the person(s) assigned to developing the new land use maps.

The PPU intends in the near future to draft a two-part environmental impact assessment procedure. Specific slope standards will be established as part of the procedure, based upon soil and geologic conditions. Where the soil is deemed unstable, adequate measures for controlling run-off and erosion during and after construction will be stipulated as part of the review process.

For all projects costing \$1,000 or more, a developer initially will be required to complete an environmental checklist, explaining the impacts of the project and the steps to be taken for mitigation. The checklist will then be submitted to the Chief Planner and Development Officer of the PPU, who will review the checklist. If he finds that all impacts have been identified and can be satisfactorily mitigated, then the project may be constructed. If this is not the case, a full detailed environmental impact assessment will be required.

The environmental impact assessment will be prepared by the developer and will cover all the impacts identified in the checklist plus those that are identified during its review. When completed, the environmental impact assessment will be submitted to the Chief Planner, who will forward copies to all GOG agencies or interested groups for their comments, to be submitted by a specified date. The Chief Planner will review all comments and make a decision as to the adequacy of the assessment, the mitigation measures proposed and whether the value of the

**GOG AGENCIES (other than the Land Development Control Authority)
WITH ROLES IN DEVELOPMENT CONTROL**

The *Lands Division* (under the Ministry of External Affairs, Agriculture, Lands, Forestry, Tourism, and Legal Affairs) is responsible for development control, management and use of all state-owned lands, including the Crown Lands.

The *Land Use Division* within the same Ministry plays a role in agricultural land use planning and zoning. Lacking legislative authority, the Division performs primarily an advisory role with reference to soil and water conservation on private or non-forested state lands.

The *National Housing Authority* (NHA) has full legal authority to carry out housing developments without the approval of any other agency, including the LDCA.

The *Industrial Development Commission* (IDC), a statutory body, can and does make financial and other agreements with investors before submitting plans to the LDCA, thus making it politically difficult for the LDCA to reject an application.

The Ministry of *Works and Communications* is responsible for Government construction and maintenance activities, for the building of roads, for beach protection, and for granting approval to applicants for the mining of beach aggregate.

The *Grenada Ports Authority* is presently carrying out its own planning for a major new cruise ship port to be located on the Esplanade. The project may have a major environmental impact on marine ecosystems as well as on the town of St. George's. On the other hand, a large new marina is under construction at Mt. Hartman Bay, which apparently is not being regulated by either the Ports Authority (it is outside their statutory jurisdiction) or the LDCA.

The *Environmental Health Department* (EHD) has responsibility for all construction projects relating to solid waste management facilities and waste water treatment facilities and for the general management and protection of the environmental health of the population, as well as urban and regional planning related to health issues.

The *Central Water Commission* (CWC) is a statutory body with authority over all projects and facilities dealing with the production, treatment and supply of drinking water.

The *Forestry Department* is the unit of Government responsible for forest reserves on state-owned land and any developments or exploitation schemes taking place within them.

The *Grenada Model Farms Corporation* (GMFC) is the institutional body by which GOG is divesting itself of the lands previously owned by the Grenada Farms Corporation. The transfer of lands for this program is done through the Lands and Survey Division, outside the control of the LDCA.

project justifies its construction even if there are impacts which cannot be mitigated. The Chief Planner will then send the assessment to

the Land Development Control Authority Board with all comments and with recommendations for approval or disapproval.

INTEGRATED PLANNING FOR THE NATURAL, RURAL/AGRARIAN, URBAN/INDUSTRIAL AND COASTAL/MARINE ENVIRONMENTS

Because it has a small staff and is occupied chiefly with day-to-day matters of development control, the PPU has not been able to give much attention to its intended forward-planning functions. Various international agencies have assisted GOG by preparing a number of sectoral plans (many of which are mentioned in other sections of the Profile). However, there is as yet no accepted national development scheme or national land use plan to guide decision-making by the LDCA.

International agencies have assisted GOG in preparing several planning documents which address many of the important issues that normally comprise a comprehensive national land use plan. Most of these documents share an *integrated* approach to development; i.e., they attempt to guide development so that activities in each sector will support those in other sectors, or at least will conflict with them as little as possible. Unfortunately, despite the fact that their preparation was requested by Government in the first place, none of these plans has been formally accepted by GOG.

In the 1970's the United Nations prepared a proposed Physical Development Strategy for Grenada (UNDP, 1977) focusing on integrated economic expansion via planning for land use, urban design, housing construction, sanitation and public health, education, and recreation. This effort also included sectoral reports on tourism and housing and a seven-month training course in development planning. This strategy was never formally approved, nor were its guidelines for development formally accepted by GOG, although they have been informally used by planners as a guide for planning and development control. The lack of acceptance of the 1977 UNDP report was due in part to the political situation in 1978 and the revolution which followed in 1979. Much of the database -- technical data, maps, and plans -- produced by this project has been lost or is now out of date (Frederick, 1987a).

In 1978, with UNDP assistance, a new Town and Country Planning Act was drafted which was intended to remedy many of the deficiencies of the 1968 Town and Country Planning legislation, specifically in the areas of long-range planning. This UNDP proposal contains many concepts and provisions which are still relevant today, but it has never been accepted and implemented by GOG (Frederick, 1987a; Mardones, 1985).

Researchers from the Dalhousie Ocean Studies Program produced a report titled *The Integration of Marine Space in National Development Strategies of Small Island States* (Mitchell and Gold, 1982) which complemented the UNDP study by addressing the role of Grenada's marine industries -- fisheries, tourism and sea transport -- in economic development. It pointed out the important role played by these industries in the nation's history and stressed the necessity for conservation and protection of the linked terrestrial and marine ecosystems if economic growth was to be sustainable. Its recommendations have also not been adopted as policy by GOG.

The Organization of American States (OAS) has an ongoing Integrated Development Project in Grenada aimed at enhancing the institutional capacity of GOG to plan and implement development projects and to coordinate projects financed by various donor organizations so that each supports the other to the maximum extent. A central focus is the rational management of the country's historical/cultural heritage and natural resource base, particularly in relation to tourism and agro-industries. There are five main components to the OAS effort:

- (1) Tourism and the environment -- to promote restoration and development of historical, cultural and natural heritage sites as tourist attractions; to encourage collaboration among the various ministries of GOG in developing linkages between development, tourism, and the physical and socio-cultural environments; and to enhance the environmental awareness of Grenadians through education.

(2) Land management -- to work with the Ministry of Agriculture in watershed management activities, the land divestment program and on planning for human settlements.

(3) Coastal zone management -- to assist in beach monitoring programs, revegetation of beaches, sewage treatment plans, and the planning of the Camerhogne Park.

(4) Grenada National Parks and Protected Areas Plan -- to create a plan for the establishment of a system of national parks and protected areas; and to implement various resource management actions and restoration projects for natural, cultural, and historic resources throughout the nation.

(5) Development of Carriacou -- to create a program for the integrated development of Carriacou; and to assist in the implementation of projects in agriculture, fisheries, national parks and protected areas, tourism, and aquaculture.

The OAS plan for a national parks and protected areas system has been completed and published (GOG/OAS, 1988d), as has the Carriacou integrated development program (GOG/OAS, 1988b). A detailed draft report recommending many necessary changes in land development policy has been prepared by Rojas and Charles (n.d.). None of these documents has been formally accepted by Cabinet to date, although several projects recommended by each are in various stages of implementation.

In the St. George's urban area, the PPU is currently preparing a detailed development plan for a corridor extending along the water front from Queen's Park and River Road to the marina area on Lagoon Road (Frederick, pers. comm., 1989). This plan will include the following projects:

(1) Queen's Park -- expansion of the industrial area for warehousing; building a new recreation facility to replace the old one; incorporation of a

convention center into the overall plan; building of a new road north of the St. John's River through Queen's Park beginning at the bus garage.

(2) Melville Street -- building of a promenade extending along the upper part of the sea wall from the fishing area to the tunnel. A special lane will be built for buses, and the facades of the buildings along the street will be renovated. The PPU considers the view from the sea particularly important as this is the "front door to Grenada."

(3) Historic area or Government administration area (i.e., library, post office, etc.) -- a landscaping project involving closing of the Wharf Road at Matthew Street, allowing only autos on official Government business to enter the area.

(4) Port warehousing and shipping facilities -- exploration of the feasibility of expanding the port facilities into the Lagoon area to tie into the heavy commercial development taking place along Lagoon Road. The marina would become a boat storage and repair facility.

In 1988, a Draft Interim Development Plan was prepared by the PPU, but this is more a strategic plan which lacks specificity as well as detailed plans for particular areas. More detailed, area-specific plans were later prepared with the assistance of OAS and USAID, e.g., for the Grand Anse area.

In 1990, the PPU launched a new one-year effort to produce a full Physical Development Plan for the country, which according to the Chief Planner (Frederick, pers. comm., 1990) will provide the foundation for evaluating development applications in the future. The planning process for 1990 includes a vetting process for the planning documents produced by the PPU (e.g., review by the LDCA, Ministers of Cabinet, and the public) before the completed Physical Development Plan is put to Cabinet for official approval.

For the future, the PPU hopes to begin addressing the problems of coastal zone management on a national level by dividing the shorelines of the sea, lakes and streams into environmental districts such as urban, rural, conservancy, etc.; specific regulations governing development in each district will then be written. Development within 250 feet of the water would be required to comply with the appropriate regulations for the district in which it is located (Frederick, pers. comm., 1989).

9.2 PROBLEMS AND ISSUES

FORWARD PLANNING AND COORDINATION

The failure of GOG to enact the necessary changes in planning legislation (e.g., the proposed Town and Country Planning Act, 1978) and the continued lack of any approved national development plan are major forces working against rational land use. This has meant that even though GOG has in the last two decades put forward many good policies on the conservation and wise use of the physical and biological environment, many land use decisions continue to be made on an *ad hoc* or discretionary basis.

The turbulent political scene in Grenada during the last two decades, as well as the fragmented institutional structure of the Government, have certainly mitigated against the success of integrated development projects. Many proposed plans and pieces of legislation have been prepared but never adopted as legally binding documents; instead they tend to be used as "administrative guidelines". It is doubtful whether any land use restrictions or zoning imposed in accordance with such guidelines could survive a legal challenge. Even if they could, there is no specific government agency which has the legal authority or the manpower to enforce them.

Poor institutional structure and lack of coordination in planning and development activities among local Government agencies are also serious problems. In several in-

stances where supposedly "integrated" development projects have been planned by international agencies, in implementing these projects the GOG has chosen to pursue a piecemeal approach which is the very antithesis of an integrated development scheme. This lack of coordination makes it very difficult to control and mitigate the environmental and socio-economic impacts of development or to take advantage of opportunities for linking mutually supportive programs.

For example, GOG's Agricultural Rehabilitation/Crop Diversification Program is helping the farmers who grow sugar cane for rum production on the Government-owned Mt. Hartman Estate. However, long-range land use decisions in this area, as elsewhere, are not being made by GOG alone. Proposals for major tourism and industrial projects are vetted and in some cases implemented by non-GOG entities. Consequently, there is uncertainty about the future of farming in this particular area. Furthermore, although the land is better suited to growing tree crops (Phillips, 1989), the Government's diversification program has supported the existing sugar cane farming operations since this crop does not require such a long-term investment.

On the other hand, the expansion of housing developments and the intensive agricultural land uses promoted by GOG in the area of Mt. Hartman Estate are destroying the scrub woodlands, the only habitat of endangered species such as the Grenada Dove and the Hook-billed Kite (see Section 4.3.2). Land use zoning and pollution control are essential if agro-industrial activities in the area are not to severely impact nearby tourist developments and marine water quality in Mt. Hartman Bay. If proper planning and land use control regulations were in place and enforced in this area, there is probably no reason why some mix of these land uses could not coexist with each other and with wildlife.

DEFORESTATION AND EROSION

Deforestation and consequent soil erosion due to agricultural, forestry, fuelwood cutting, road-building and construction activi-

ties on steep slopes and unsuitable soils is a problem which will become increasingly severe as the country continues to open up new lands for development. Land use planning and proper mitigation measures will be necessary to resolve the inevitable conflicts which will arise when various interests compete for available land, e.g., GOG agencies vs. user groups vs. private developers vs. the public interest. Although many Government officials do not believe erosion and deforestation are serious problems at present, this may well be based more on a lack of data than on the actual situation. There is some evidence that soil erosion impacts are already evident in rivers, nearshore marine waters, water catchments and treatment plants and on some agricultural lands.

As one example, the Grenada Model Farms Project has the potential to create significant environmental impacts if the recommended farm sizes, based on considerations of yield, input/output prices and environmental concerns, are not followed (Adams, 1986). If holdings are so small that the returns are not sufficient to cover the inputs, it is inevitable that forested slopes will be cleared for charcoal and to extend the planted area, further accelerating erosion. In general, gross farm sizes should not be smaller than about ten acres of cultivable land in hill areas or four acres in fertile alluvial flats (see also Sections 1.1.4 and 5.3).

LAND USE CONFLICTS

Frederick (1987a) has looked at land use conflicts in three general "zones" in Grenada. These are: the Northeastern Zone, where conservation versus economic development is the main issue; the Midwestern Zone, where the main conflicts concern housing versus agricultural development; and the Southern Zone (the most heavily developed area, also known as "Zone 1"), where there are a variety of competing land use interests including tourism, urban development, industry, natural and historical heritage conservation, and agriculture.

Most of the planning efforts which have been carried out so far have focused on

Zone 1, since it includes the main tourism plant at Grand Anse as well as the largest population and industrial centers. The OAS has prepared several land use and historical preservation studies for this area (OAS, 1933; Jackson, *et al.*, 1983; John, 1984); and USAID, along with other international aid agencies, has funded major infrastructural improvements, including planning studies for sewerage systems and construction of the Frequente Industrial Park and the Camerhogne Recreational Park. The proposed GOG/OAS system of parks and protected areas includes several sites in this zone but does not consider protective measures for the endangered bird habitat in the Mt. Hartman area.

Potentially conflicting land use proposals for the Mt. Hartman area include agricultural expansion, tourist hotel and marina development, quarries and a sanitary landfill. Liquid waste effluents from agro industry, hotels and charterboat operations also have the potential to impact reefs and other marine life, mangroves, fisheries, and recreational uses of Mt. Hartman Bay.

The Northeastern Zone includes some of the least developed and most scenic areas in Grenada, particularly in the vicinity of Chantimelle (where there is a scenic road with dramatic views of the St. Marks Mountains), Levera, Sauteurs, Lake Antoine and the eastern seacoast to Telescope Point. The natural and cultural resource values of the Levera area have been documented in several reports (e.g., Vincent, 1981; Goodwin, *et al.*, 1982; Renard, 1987; GOG/OAS, 1988d) and include recommendations for the proposed Levera National Park and several historical and cultural landmark sites. GOG's tourism development plans call for the Levera area to be the next zone developed for tourism.

There is concern among planners (e.g., Frederick, 1987a) that large-scale tourism development is inappropriate to the conservation of the natural resource values in this area; yet there is nothing to forestall it at present. Already there has been a proposal for the development of a 300-acre spa and health camp at the mineral spring and surrounding area between River Sallee, Rose Hill, and Bathway Beach. This development

would include the mineral spring, part of the archaeological site, and part of the proposed national park at Levera. There have been many proposals for the use of Government-owned lands in the Pearls Airport/Telescope Point area, including housing, an IDC factory-shell project, an energy-producing windmill installation, an existing dump, a quarry, and sand mining operations. The watershed of the Great River, which extends into the central mountain range in the vicinity of Grand Etang, is the site of a proposed logging scheme which would destroy the last large area of semi-natural forest in Grenada and very probably cause flooding and sedimentation problems for the densely developed communities and farming areas downstream.

The Midwestern Zone comprises the area west of the central mountain range between Duquesne in the north and Beausejour in the south, where the major activities are agriculture and fishing. Very little good information is available for this area, but it is known that its reefs and marine resources are under stress due to overfishing and poor land management. Most of the agricultural estates are now being subdivided and sold to small farmers and as residential plots, with the emphasis on residential development. Contrary to stated Government policies, the limited fertile agricultural lands in the flat areas are being converted to housing, while more of the steep marginal lands are being cleared for cultivation. Sedimentation impacts from poor land management practices are already evident in the marine environment (e.g., Molinere Reef, reputedly Grenada's best-developed corai reef and an important site for the dive-tourism industry).

No zoning or development plan exists for this area, and there is no Government department at this time which is exercising any development control or resource management efforts to resolve the existing land use conflicts.

HOUSING

The expansion of the housing sector in recent years has resulted in strong pressures on public and private agricultural land.

Authorities dealing with land management have apparently been unable to deal effectively with these conflicts (Soler, 1988). Housing demand continues to be very high, and housing construction is not able to keep pace with demand. Mardones (1985) states that an average of 570 new units per year were constructed between 1970-1980.

The issue of squatting on Crown Lands is also creating a serious problem in Grenada (Bourne, 1987; Frederick, 1987a); two areas where this problem is acute are Grand Anse Estate and Woodlands.

9.3 POLICY RECOMMENDATIONS

* The institutional structure and legal powers of the LDCA should be revised so it is able to function in a more integrated and efficient manner and so that it is able to require other GOG agencies to comply with its rulings. There is also a need to create an enforcement arm, to increase the personnel in the PPU, and to provide a monitoring capability for land-use changes.

* The PPU needs to create and maintain a functional land-use database, including new large scale aerial photographs and land-use maps, up-to-date cadastral maps, and land ownership information. Much useful information on setting up an appropriate system for small Caribbean islands, with options for eventual computerization, may be found in Potter, *et al.* (1988) and Island Resources Foundation (1989).

* Legislation is needed to require the preparation of environmental impact assessments for major projects, especially within the coastal zone and other critical areas identified in this Profile. Appropriate standards for development should be included in the legislation and then enforced. An institutional capability for interpreting, and later carrying out, the technical aspects of environmental impact assessment needs to be created within the PPU and other appropriate GOG agencies.

* The national Physical Development Plan now under preparation by the PPU needs to incorporate and update some or all of the many sectoral plans which have been written, focussing on the means of achieving sustainable development over the long-term. The most important condition for sustainable development is that environmental *and* economic concerns be merged in the decision-making process, as they are in the real world; otherwise even the best land use planning efforts are doomed to fail (MacNeill, 1989).

* The real costs of development projects need to include a process of internalizing environmental costs (e.g., the principle of "the resource user and/or the polluter pays") and of integrating resource accounts in national economic accounting systems. Reform of national economic policies, budgets and subsidies that actively if unintentionally encourage environmental degradation also needs to be examined. In this regard, recent OECS/NRMP work in Montserrat would be useful.



Islands may be small, but island ecosystems are complex -- appreciation of this comes with environmental awareness. Field trips, like the one pictured above at Grand Etang, help build understanding about the value of ecological diversity and the role of nature.

SECTION 10 NATIONAL PARKS AND PROTECTED AREAS

10.1 PROPOSED SYSTEM

The Government of Grenada and the Organization of American States in 1988 published a *Plan and Policy for a System of Parks and Protected Areas in Grenada* (GOG/OAS, 1988d). The purpose of this plan was to identify and provide a course of action for the protection and wise use of the country's outstanding natural and cultural heritage.

Under the proposed Grenada National Parks Systems Plan, the existing, protected forest reserves in Grenada and Carriacou would continue to be utilized as mandated under the Forest, Soil and Water Conservation Act. In addition to these existing protected areas, several new categories of protected areas were proposed (Figures 10.1(1) and 10.1(2)). The five new management categories were defined as:

- **National Parks:** to protect outstanding natural and scenic areas of national or international importance and provide recreational, scientific and educational activities. These are relatively large areas containing a diversity of ecosystems.
- **Natural Landmarks:** to protect natural features of a unique character which are in a near-natural state. These are generally small areas, rather than complete ecosystems, and provide recreational activities.
- **Cultural Landmarks:** to protect cultural features of a unique character, and to provide public access for educational and recreational uses related to the feature.
- **Protected Seascapes:** to protect outstanding littoral mangrove and island habitats, beaches and coral reefs which possess special aesthetic and ecological qualities.
- **Multiple Use Management Areas:** to manage large areas (e.g., water-

sheds) which are suitable for sustained production of water, wood products, wildlife, forage, and/or marine products and for soil conservation, outdoor recreation and education. Use of these areas would be primarily oriented to the support of economic activities, but zones may be established for nature protection.

In order to determine the degree of representation of the country's natural features within the proposed system of parks and protected areas, GOG/OAS planners identified and analyzed potential areas in the following ways:

- Representation of geological formations with regard to their significance as illustrations of the tectonic history of the island.
- Representation of the main types of natural habitats and ecosystems.
- Distribution of native species of flora and fauna, particularly those threatened with extinction.
- Protection of watersheds and water courses and maintenance of high standards of water quality and quantity.

GEOLOGIC REPRESENTATION IN THE PROTECTED AREAS

Grenada consists mainly of volcanic products and, to a lesser degree, of sedimentary rocks (see also Section 1.1.4). From the Miocene to Quaternary, volcanic activity has emitted a large quantity of products which vary both in chemical composition and in the way they were emitted. The resulting domes, flows and a wide variety of pyroclastics are related to eruptions with varying degrees of explosivity.

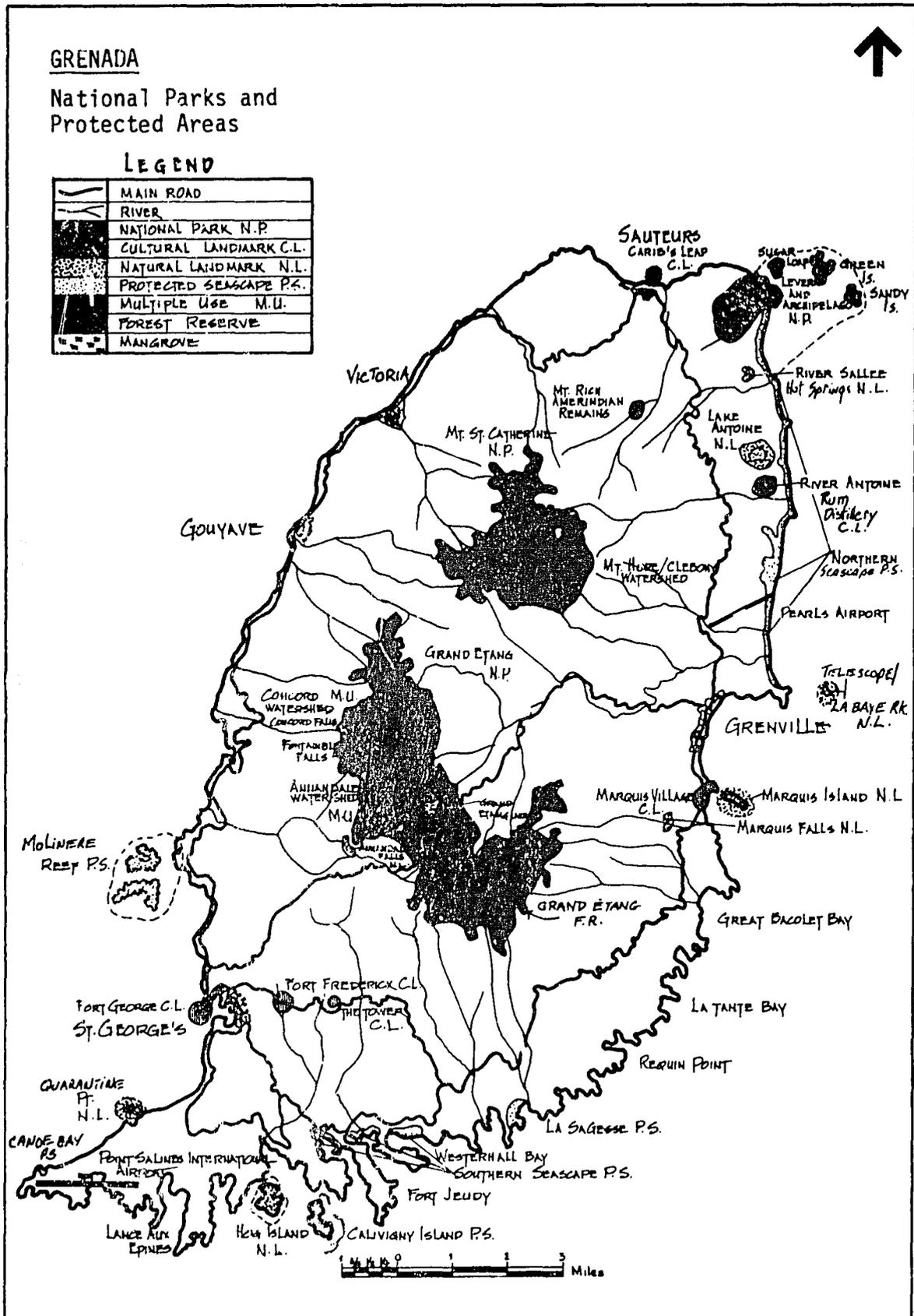


Figure 10.1(1). Proposed system of national parks and protected areas, Grenada (source: GOG/OAS, 1988d).

CARRIACOU

National Parks and Protected Areas



LEGEND

	MAIN ROAD
	NATIONAL PARK N.P.
	CULTURAL LANDMARK C.L.
	PROTECTED SEASCAPE
	CORAL REEF
	FOREST RESERVE F.R.
	MANGROVE

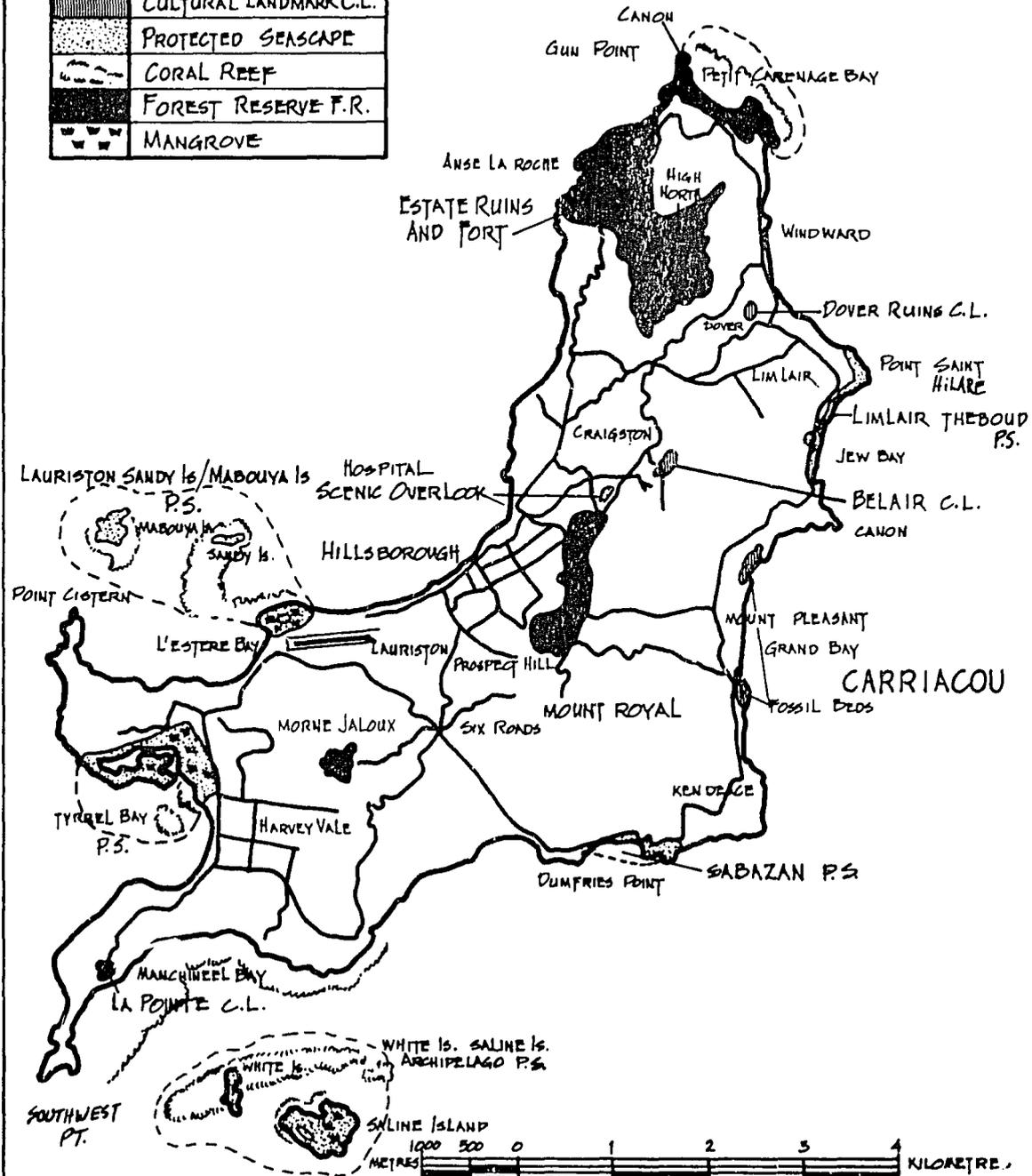


Figure 10.1(2). Proposed system of national parks and protected areas, Carriacou (source: GOG/OAS, 1988d).

Table II in the proposed parks plan (GOG/OAS, 1988d) presents a list of significant geological features, their location and their representation within the proposed system of protected areas. Some of the major geologic features represented within the proposed system of parks and protected areas include the following.

The Tufton Hall Formation (Annandale Falls). The volcanic series visible on the island are underlain by a sedimentary formation; areas where that sedimentary "basement" outcrops on the surface are known as the Tufton Hall Formation. This is made up of sandstones, siltstones and calcareous shales. The Tufton Hall Formation outcrops are mainly situated in the northwest part of the island; the only other clearly visible outcrop is at Annandale Falls, which is included within a proposed Natural Landmark.

The Central/Southern Part of the Island (Grand Etang Forest Reserve and National Park, south of the highway). The main area within this zone is the Mount Sinai - Mount Lebanon axis. Volcanic activity was most intense during the middle Miocene, Pliocene and Pleistocene.

The Volcanic Area of Mt. Granby - Grand Etang (Grand Etang National Park and northern part of Grand Etang highway). This area was affected by volcanic activity in the Pliocene and the Pleistocene. The well-preserved morphology suggests that volcanic activity continued until the very recent Holocene period in the Grand Etang area. In this area also are the eroded remains of Miocene vulcanite outcrops below Plio-Pleistocene products.

It is believed that Mount Granby, Mount Qua Qua and other intermediate peaks were separate centers of eruptions which emitted lava at different times. The most recent evidence of volcanic activity in this region seems to be the craters located in the Grand Etang area. There are three craters close together (one of them partially eroded) and a fourth at St. Margaret.

The Volcanic area of Mount St. Catherine (Mount St. Catherine National

Park). This volcanic edifice is of Pleistocene age and is characterized by a large crater with a diameter of about 1.2 km, open on the south side. The composition of various domes which have formed near the summit ranges from acid andesites to dacite; they constitute the main outcrops in the area. The area to the northwest of Mt. St. Catherine is dominated by a thick sequence of andesitic and dacite lavas and pyroclastic flows forming St. Mark's mountain.

Coastal Pleistocene Volcanic Cones (Levera National Park and offshore archipelago, Lake Antoine, and Quarantine Point National Landmarks). Those recent emissions, occurring primarily in the Southwest of the island, include St. George's Harbor, Queen's Park, the crater at Woodford Estate and Quarantine Point.

In the Northeast, Lake Antoine has morphological characteristics very similar to the typical tuff-rings produced by hydromagmatic eruptions. Lava from Lake Antoine yields an age of approximately 1.5 million years. The two craters near Levera Hill seem to have had very minor interaction between the magma and the sea. This volcanic area is characterized by a large andesitic dome, which is Levera Hill (848 ft. above sea level) and other smaller domes to the northwest of the area. The volcanic rocks of the Levera Hill area lie directly on the deformed Tufton Hall Formation which outcrops at various points on the nearby coast and is thought to have been formed about 7.1 million years ago during the upper Miocene period.

VEGETATION REPRESENTATION

One of the principal concerns of a national parks program is the protection of entire ecosystems as well as the individual species and assemblages of species contained within them. Table III and Table IV in the proposal National Parks System Plan (GOG/OAS, 1988d) present the vegetation types based on Beard (1949) and indicate which areas of the proposed system include the best examples (see also Section 1.1.5 of the Profile).

Additionally, the contribution of plant species to the development of medicines and other medicinal remedies has been well documented; thus, it was felt important to protect representative areas of various Grenadian ecosystems as any one might contain potentially valuable economic species. Furthermore, as most of the forests of Grenada and Carriacou have been converted into agriculture over the last two centuries, the best representative examples of forest ecosystems which remain in an unaltered or a good state of recovery have generally been recommended for inclusion within the system. The High North, Grand Etang, and Levera National Parks score highly in this regard, and as a result these units of the system have been recommended as the first priorities for park development.

The representation of vegetation formations in the proposed system of parks and protected areas can be summarized as follows

The Rain Forest and Lower Montane Rain Forest Formations (Wet Forest or *Dacryodes-Licania* association) have been greatly reduced by cutting and disturbed for agriculture. The only large, relatively intact example of this formation is in the Grand Etang Forest Reserve, in the vicinity of the Seven Sisters Falls. Another smaller area is between Mt. Qua-Qua and Fedon's Camp. Until now, the inaccessibility of these areas has made it uneconomical to harvest the timber or convert the area to agriculture. Representation within the proposed system is not considered adequate.

The Montane Thicket Formation is still common on all mountain peaks above 2,000 feet, as it is at Mount St. Catherine and Grand Etang. Representation within the proposed system is considered adequate.

The Elfin Woodland/Palm Brake Formation is confined to the summit peaks of Grand Etang and Mount St. Catherine. Representation within the proposed system is considered adequate.

Almost the entire *Evergreen/Semi-evergreen Seasonal Forest Formation* (Moist

Forest or "Middle Belt Forest") has been converted to agricultural production over time. This formation is very poorly represented in the proposed system; only minute areas are included at the Marquis River Natural Landmark. Today the best remnant of moist forest remaining in the entire country is found at Morne Delice, but this is outside the proposed system. Some other areas show signs of recurrence on abandoned agricultural estates.

The Deciduous Seasonal Forest Formation (Dry Forest) is only fairly represented in several small areas in Grenada but is also recuperating on some of the peninsulas on the southern coast and at Levera Hill due to abandonment of agriculture. Such areas should be considered for inclusion within the system. Fairly extensive but damaged stands remain in Carriacou in the forest reserves and in the proposed High North National Park.

The Swamp and Marsh Formations, namely the coastal mangrove swamps and the freshwater herbaceous ecosystems at Grand Etang Lake and Lake Antoine, are generally in a fairly healthy state. Mangrove cutting for charcoal has caused a deterioration of the resource in Levera and North East Seascape, but management actions to prohibit this activity have been initiated. These formations are adequately represented within the proposed system.

The Littoral Woodland Formation (Dry Evergreen Coastal Woodland) is relatively common, but most areas are being damaged by exploitation for charcoal and goat grazing. Representation within the system (Northern Seascape, La Sagesse, Canoe Bay, Levera, Hog Island, Calivigny, Southern Seascape) is adequate.

WILDLIFE REPRESENTATION

Tables V through VIII in the Grenada National Park System Plan (GOG/OAS, 1988d) indicate the status and habitat of threatened and endangered animal species and display the principal units of the proposed protected area system where they may be found. (For further discussion of

threatened and endangered flora and fauna in Grenada, see Section 4.3 of the Profile).

GOG/OAS park planners felt that wildlife should play an increasing role in the economic and social development of the country. Two hunters' groups consider hunting an important recreational activity as well as source of protein. Some local Creole dishes utilize wild meats which appeal to tourists and local people alike. Additionally, the agouti (*Dasyprocta albida*) is to be introduced into the wild.

INSTITUTIONAL RESPONSIBILITIES

At present, there is no formal Government policy on the establishment or management of a system of protected areas. Under the proposed National Parks Plan, the Ministry of External Affairs, Agriculture, Lands, Forestry, Tourism, and Legal Affairs would be designated as the agency responsible for planning, management and protection of all areas within the system. This will require extensive coordination and collaboration with other public and private agencies and the general public.

There is already a National Parks Unit within the Department of Forestry, which is staffed by a single Parks Officer. It is the intent of the proposed National Parks Plan for this agency of Government to prepare management and development plans for each unit within the proposed parks system and to develop a funding strategy to finance the system.

Marine areas to the high water mark are the property of the state; when and if marine reserves are designated, they would probably fall under the administrative responsibility of the Fisheries Division (*not* located within the designated Ministry). Some of the proposed national park areas are in existing Forest Reserves or are unsurveyed state lands. Forest Reserves (and presumably multiple-use areas) will be managed with input from both the Forestry Department and the National Parks Unit (which is housed within Forestry), as well as the Central Water Commission where public water supplies are concerned.

Lines of authority and responsibility are not at the present time very well defined.

Most of the protected areas within the proposed system are privately owned, and the plan allows for private land owners to retain limited management and development rights on their land, to be monitored by the Parks Unit. Although areas of outstanding national significance should be acquired by the state, other areas may be managed by individuals or private organizations, perhaps with financial contributions from Government. The issue of compensation to private owners for loss of property or development rights has not been resolved.

10.2 PROBLEMS AND ISSUES

The National Trust Ordinance legally establishes a basis for protecting areas with both natural and cultural resources; however, this legislation has not been used for such purposes to date. The Town and Country Planning Act provides certain tools for planning "common" areas but does not specifically mention national parks and protected areas or their management.

No existing legislation provides adequate authority to both establish and manage a system of national parks and protected areas or to protect adequately the natural resource base. Although existing and proposed legislation provides for the establishment of both forest and marine reserves, it defines the goals of such in only vague, general terms and does not adequately identify the management regimes which should be applied. Moreover, the central focus of such legislation is directed towards forestry and fisheries production and does not specify that management also should ensure the protection of natural and recreational resources falling within a protected areas status.

The National Parks and Protected Areas System (as proposed by GOG/OAS, 1988d) does not include the following important areas:

(a) the habitat of the endemic Grenada Dove and Grenada Hook-billed Kite (see Section 4.3);

(b) the Morne Delice remnant moist forest (see Sections 1.1.5 and 4.1);

(c) the historically and recreation-ally important wreck of the luxury liner *Bianca C.*, much valued by the diving public.

Additionally, the area of old-growth rain forest in the upper watershed of the Great River in the Grand Etang Forest Reserve (see Section 4.1) is still legally eligible for timber exploitation, even though it is included in the proposed protected areas system. It would instead be more appropriate to protect it from logging (Weaver, 1989), perhaps by including it under the management category of national park.

10.3 POLICY RECOMMENDATIONS

* The establishment of a viable National Parks and Protected Areas System in Grenada is of great importance and should be given priority attention by Government. The general plan which has been prepared (GOG/OAS, 1988d) includes priorities for action on protected areas and should be addressed by Government as soon as possible. This is particularly important so that more detailed planning regarding the specifics of financing the property acquisition and operating costs of the system can move forward. Individual management plans for each of the units need to be written; Weaver (1989) has provided some general guidelines for such management programs (see Table 16 in the Weaver report).

* The important sites which are listed at the end of Section 10.2 above should be included for protection under the proposed National Parks and Protected Areas System.



Old Church, Grenville. This Gothic Revival building has been identified by the National Trust as one of many extant historic sites that should receive priority consideration in future preservation/restoration programs in Grenada.

SECTION 11 PROTECTION OF HISTORICAL HERITAGE

In a developing country such as Grenada, still engaged in the difficult art of nation building and the day-to-day politics of transforming a dependent colonial society into a viable nation-state, the trade-offs between the long-term benefits of conservation and resource protection and the more immediate, short-term benefits of resource exploitation are not easily defined. With respect to the built environment and to the preservation of historical and cultural resources, this dichotomy has already resulted in the destruction of many valuable artifacts and historic landmarks.

For example, stones were stripped from the battlements of Fort Frederick in the 1930's to use as materials to extend the Public Library; in the 1960's the Government sold lands at "Old Fort," including the battlements and caves. More recently, in an effort to transport topsoil to another location, a large section of a valuable Amerindian site at Pearls was destroyed. Another structure of historic significance, Mockton's Redoubt, a fortification which stood on Government lands at the eastern entrance to the inner harbor of St. George's, was razed for hotel construction (A. Hughes, Grenada journalist, pers. comm., 1989).

Perhaps most glaring has been the lack of attention to preserving the rich architectural heritage of St. George's. A survey made in 1945 by the Georgian Society of Great Britain referred to the capital city as "the prettiest town in the British West Indies." No small part of its charm, the Survey Report said, are the red fish-scale tiles with which the houses are roofed, while "the buildings themselves are a delight" (Acwroth, 1951).

At that time, the Georgian Society prepared and presented to Government draft legislation to protect the architectural character of the town, but nothing came of this initiative. In fact, Town and Country Planning legislation enacted about the same time did not include provisions to protect "buildings of merit," and in the intervening decades many buildings have been lost and replaced with

modern structures not in keeping with the architectural and historical character of St. George's.

11.1 OVERVIEW

HISTORICAL, ARCHAEOLOGICAL AND ARCHITECTURAL FEATURES

Military Sites. Like its sister islands in the Eastern Caribbean, the principal historic sites in Grenada are associated with the island's military history and the Anglo-Franco colonial rivalries of the eighteenth century when possession of the island was contested several times. Its dramatic military history is best symbolized by Fort George, which protects the entrance to the harbor and is associated not only with colonial wars but also -- as the site of the assassination of the Prime Minister in 1983 -- with more recent historical events. Other surviving military monuments of primary importance are fortifications on Richmond Hill (Fort Frederick and Fort Matthews) and Hospital Hill, both overlooking St. George's.

Fort George and Fort Frederick were the subject of recent studies by USAID, in cooperation with the Tennessee Valley Authority (TVA). Both reports (Tichy, 1986a and 1986b) focused on plans for conservation of the historic structures and their enhancement as major tourist attractions. More recently, the TVA provided technical assistance to GOG for landscaping and interpretive exhibits at Fort George, while the CIDA-funded SPIF (Small Project Implementation Facility) is conducting a pre-feasibility and development study for Fort Frederick (Arthur Young, 1989).

Long-term plans for the Grenada National Trust call for the re-location of the National Museum from downtown St. George's to Ft. Matthew. With a small grant from UNESCO, the Trust has reportedly begun clean-up and grounds clearing activities at the fort. Additional funds for restoration must still be raised, but the Trust would like

to move the museum by the end of 1990, thus freeing the St. George's site for use as a Trust office and headquarters (M. Jessamy, National Museum, pers. comm., 1990).

Plantation Sites. Grenada still possesses remains of its once numerous sugar estates. Some of the most spectacular of the sites which still survive are those which had adopted giant water-wheels for power, e.g., Westerhall Estate, Calivigny Estate, and LaSagesse Estate. Most plantation structures are in ruins, although some still are functional, including the River Antoine Rum Distillery, the oldest intact and operational rum distillery and cane processing system in the Caribbean (Towle, 1978; GOG/OAS, 1988d).

Architecture. Fine examples of vernacular architecture can still be found, primarily in St. George's which, in addition to its exceptional setting -- situated as it is on both sides of a narrow ridge between two small bays -- is further enhanced by what was once an almost perfect architectural integrity. Unfortunately, as indicated above, its early charm is being compromised by major intrusions of incompatible buildings not in keeping with the architectural and historical character of the area.

Recent efforts to promote establishment of a St. George's Historic District resulted in the publication of *Architectural Design Guidelines* for the capital city (Burr, 1988). Developed for Government by TVA/USAID, the guidelines carry no official endorsement, nor are regulations in place to enforce the standards contained therein.

Simultaneously, and as an adjunct to the architectural guidelines project, the Grenada National Trust initiated a survey of the historical resources of St. George's. The current survey is a follow-up to an earlier effort undertaken for the Trust by members Alister and Cynthia Hughes in 1968; that effort focused not only on St. George's but on identifying and cataloguing historic man-made structures throughout the country. The two Trust-supported surveys, along with a forty year old report by the Georgian Society (Acworth, 1951) and an inventory undertaken by IRF/CCA in 1976 (Towle, 1978), represent

the primary efforts to document the historical resources of Grenada.

Archaeological Sites. Extant examples of Amerindian culture include archaeological sites located in every parish across the island. An archaeological survey conducted in 1986 under the sponsorship of the Foundation for Field Research, with assistance from American and Grenadian volunteers, recorded several dozen sites. Each was mapped and recorded on an Archaeological Site Record Form, the originals of which are on file at the Grenada National Museum. Additionally, samples of diagnostic artifacts were surface-collected from each recorded site, and these are also held at the Museum. Prior surveys were conducted in 1982 by Henri Petitjean-Roget and in 1962 by Ripley Bullen.

Several sites have been systematically excavated. Bullen excavated the sites of Pearls, Savanne, Suazey, Calivigny, Westerhall, Salt Pond, and Black Point (Bullen, 1964). The Foundation for Field Research sponsored two archaeological excavations: Grand Anse Beach in 1987 and Pearls in 1988, 1989, and 1990. Collections from these excavations are held at the Grenada National Museum, and reports are on file at the Museum and the Ministry of Education.

PROTECTION PRIORITIES

As part of the Country Environmental Profile process in Grenada, a committee of the Grenada National Trust identified historic sites and national landmarks which should be considered for protection (see Figure 11.1(1)). Sites listed by the Trust are displayed in general categories in Table 11.1(1), with the number of entries within each category also indicated. Architectural sites included in this inventory primarily were buildings and architectural features in St. George's, although the Old Bay Houses at Beausejour were also included.

Additionally, the Trust identified specific sites for *priority consideration* in future preservation/restoration programs. Sites so identified are:

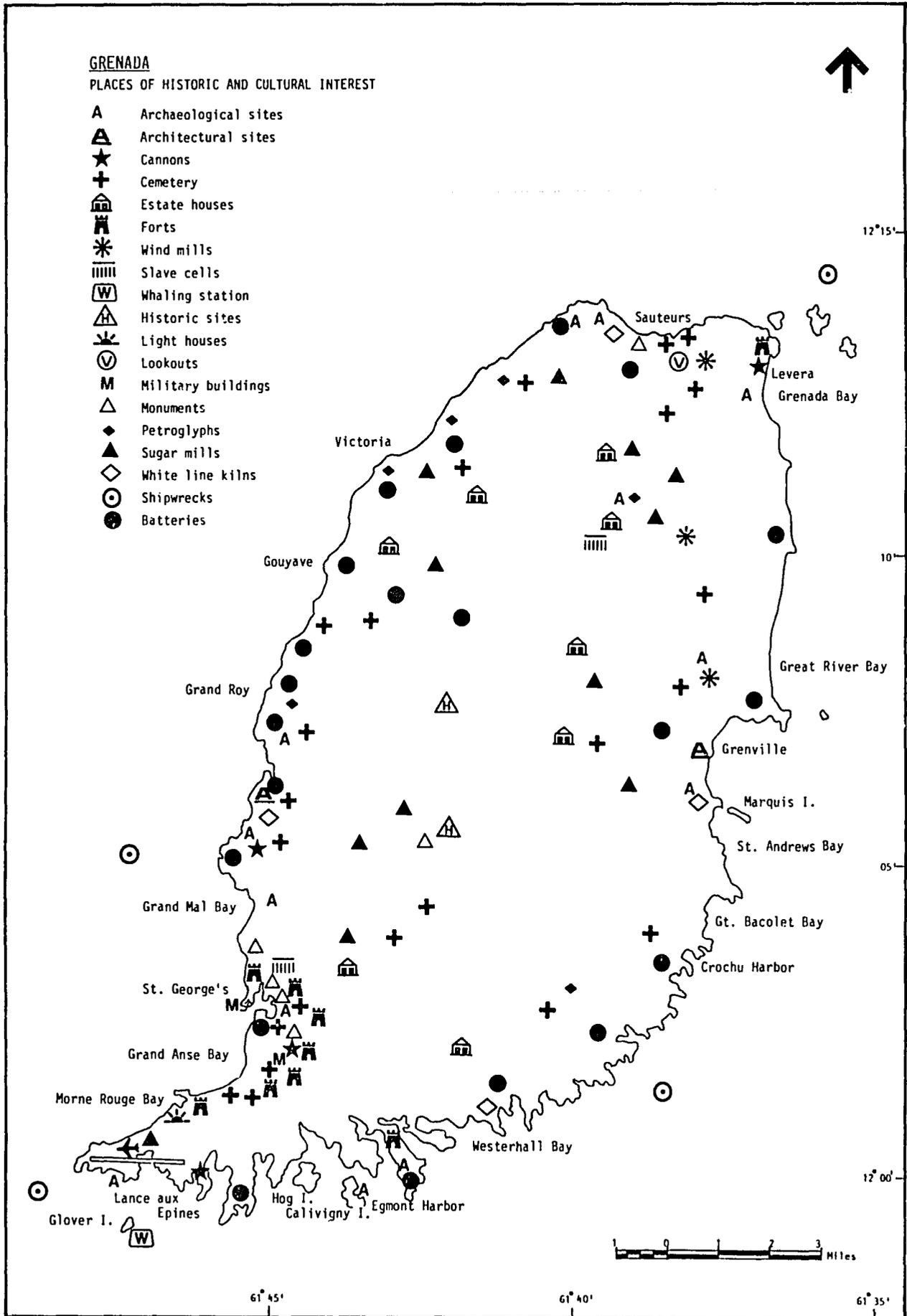


Figure 11.1(1). Places of historical and cultural interest as identified by the Grenada National Trust.

Table 11.1(1) Historic sites and national landmarks selected for protected status by the Grenada National Trust (see also Figure 11.1(1)).

Inventory Category	Sites Listed
Forts or Military Batteries	30
Historical Buildings	2
Natural Sites	2
Shipwrecks	4
Archaeological Sites	16
Estate Houses	52
Look-out Points	2
Slave Cells	2
Wind Mills	4
Military Buildings	2
Whaling Stations	2
Lime Kilns	4
Light Houses	2
Other Historic Sites (associated with Fedon's Revolt in the late eighteenth century)	2

Source: Grenada National Trust (prepared for CEP project, 1989).

- Carib's Leap at Sauteurs, St. Patrick's
- Pearls Archaeological Site (one of the largest prehistoric sites in the Caribbean)
- The Copland Monument, St. Patrick's
- Slave Pen at Hermitage
- Lavera Fort and National Park
- Fort Matthew, Fort Frederick, Fort George
- Moniniere, site of a coastal battery
- River Antoine Sugar Factory and Distillery
- Gouyave Catholic Church (for its copper spire, unique in Grenada)
- The tile roofs of St. George's (a generic category)
- Old Church, Grenville (Gothic Revival).

The Government of Grenada and the Organization of American States in its proposed Plan for a System of National Parks and Protected Areas (GOG/OAS, 1988d) established a Cultural Landmarks category of protection. These are sites which because of their

importance to the historical development of Grenada and because of their potential for education and tourism should be preserved and guaranteed protection. The plan further states that the designation of cultural landmarks should include representative monuments, sites, and structures from the different periods of the country's history, specifically: pre-Columbian; pre-emancipation; emancipation, and the contemporary period. Ten Cultural Landmarks were recommended for protection within the proposed system. They are:

- Carib's Leap (also recommended by the Trust)
- Fort George (also recommended by the Trust)
- Fort Frederick (also recommended by the Trust)
- River Antoine Rum Distillery (also recommended by the Trust)
- Westerhall Rum Distillery
- Belair Rum Distillery (Carriacou)
- Fedon's Camp (also recommended by the Trust)
- The Tower

- Marquis Village (for handicrafts from wild pine)
- Soubise (for hand-fashioned boats).

None of the sites targeted for preservation by either the National Trust or GOG/OAS currently enjoys any protected status.

MUSEUMS

The Grenada National Museum was established in 1976 under the auspices of the Ministry of Tourism and later was transferred to the Ministry of Education. Exhibits were put together with materials from the private collections of Grenadians and expatriates and include both Arawak and Carib artifacts and a variety of historical and natural history items. The Museum is presently housed on the ground floor of the Ministry of Education in St. George's and is operated by a non-governmental organization, the Grenada Historical Society, which was formed for this purpose in collaboration with Government. Some support is provided by the Ministry of Education.

Carriacou also formed an Historical Society and opened a Museum in August of 1976. The Society and its Museum were first housed in the storage room of a local rum shop, but shortly afterwards were moved to new premises in a building which had originally been the local coffin shop in Hillsborough. The back of this building was washed away in an unusually strong ground swell in 1984, along with half of the Amerindian collection. This disaster did not deter the Society which, in 1986, was able to buy the land and walls of the old cotton ginnery at below-market price from Barclay's Bank. A building fund for reconstruction of the walls, windows and roof of the ginnery was established, and eventually a second storey, made of wood in the old Caribbean style, was added. Grants from the U.S., Canadian, and British Governments all assisted with this reconstruction effort.

Displays are divided into several small sections which include exhibits of Amerindian artifacts, fragments of European

ceramics and glass, and an African section (Cummins, 1989). Like the Museum in St. George's, the Carriacou Museum is managed by a non-governmental entity.

INSTITUTIONAL CONSIDERATIONS

The National Trust Act of 1967 empowers the Grenada National Trust to identify, document and preserve buildings, monuments, and places of historic and architectural interest. The Trust can acquire property and raise funds, but its role is primarily an advisory one as the Act does not grant to the Trust the power to make and enforce regulations for the management of protected sites. Furthermore, there is no antiquities legislation regarding the ownership or disposition of artifacts salvaged from archaeological sites, including marine shipwreck sites.

The Trust came into being in the late 1960's not in response to either community or Government commitment to long-term conservation goals, but rather as a vehicle for promoting tourism. It soon lapsed into a long period of inactivity, to be revived again in the mid-1980's, once more as a means for promoting tourism-related projects (see also Section 12).

A proposed merger between the Trust and the non-governmental Grenada Historical Society had been under discussion since 1986 and was finally achieved in 1990. The objective was to create a stronger force for conservation in Grenada, but for several years there had been some reluctance on the part of the more active Historical Society (which operates the museum in St. George's) to link itself with the less active National Trust.

At approximately the same time the merger discussions between the Historical Society and the Trust began in 1986, the Trust requested that the Government's Legal Department update and modify the National Trust Act to strengthen the authority of the Trust to protect historical, archaeological, and architectural resources. Lacking such powers diminishes the effectiveness of the Trust in

promoting such recent initiatives as designation of Historic District status on St. George's. (See also Section 12 for a more detailed discussion of the National Trust and Historical Society.)

The proposed GOG/OAS (1988d) Parks and Protected Areas Plan gives the National Trust and the Historical Society an advisory role in recommending specific sites and resources to be incorporated within the system.

11.2 PROBLEMS AND ISSUES

The economic and social benefits to be derived from the protection of historic sites, architectural features, cultural landmarks, or archaeological resources have not been fully appreciated in Grenada. The result has generally been a Government policy of either benign neglect or in some cases deliberate destruction of these resources. To be more specific:

- The lack of a building code and design guidelines for St. George's, which require consideration of the town's unique architectural character in planning applications, has resulted in decades of fragmented and inappropriate development, substantially diminishing the intrinsic value and historical quality of the town.

- Historical and archaeological resources are without protection, even if vested in the Trust, for the Trust lacks authority to make and enforce regulations for the management of protected areas.

- The National Trust in Grenada, while over twenty years old, has throughout its history been a weak or inactive organization, enjoys only minimal support from Government, owns no property, and has lost considerable support in the last decade to the Historical Society (with whom a merger was proposed over three years ago).

- Recent efforts to promote programs for the conservation, development and protection of historical/cultural resources have been donor-driven (e.g., OAS, USAID) and have not generally emerged from initiatives within Government.

- The proposed GOG/OAS plan for a System of National Parks and Protected Areas is Grenada's first attempt to integrate historical/cultural resources within a long-term, comprehensive management plan. Prior to its inception, consideration of such resources in development planning was ad hoc, at best.

11.3 POLICY RECOMMENDATIONS

- * It is not too late to consider an "historic district" preservation/restoration policy in Grenada, although the integrity of its most significant district of historic and architectural value -- St. George's -- has been diminished through the indiscriminate employment of non-compatible uses. Consideration should be given to a Government policy which encourages adaptive use and restoration strategies in St. George's by the employment of economic incentives and to the adoption of design controls for new construction, along the lines of the recently published *Architectural Design Guidelines for St. George's* (Burr, 1988). Such guidelines need to be incorporated into the building applications required by the Physical Planning Unit.

- * GOG should also give consideration to enactment of some form of antiquities legislation to provide better protection of the nation's historical and cultural resources. Such legislation might include establishment of a Registry of Historic Places. Criteria could be set for the selection and certification of Registry sites (including buildings indicative of vernacular architecture). Standards for further development of such sites would need to be established, and authority vested in a designated agency to control development and use of the sites.

* Archaeological sites -- terrestrial and marine -- could be protected by their inclusion on the Registry. Such action would help deter disturbance of these sites except under the controls established in the antiquities legislation.

* Prior to any major development, a cultural resource survey should be carried out by professional archaeologists (developers should be required to pay for such surveys). Development control procedures should provide adequate time for the excavation of ar-

chaeological sites prior to commencement of development activities.

* The Grenada National Trust is the logical agency to be designated as overseer of the proposed Registry of Historic Places. However, before it could assume such a role, the Trust must take steps to become a more effective organization. This will not happen without increased support by Government for the Trust and its objectives, specifically, the strengthening of the legislative authority of the Trust and the provision of adequate operational support.

SECTION 12 INSTITUTIONAL FRAMEWORK FOR ENVIRONMENTAL MANAGEMENT

12.1 GOVERNMENT ORGANIZATION

The State of Grenada, an independent parliamentary democracy within the British Commonwealth of Nations, comprises the inhabited islands of Grenada, Carriacou and Petit Martinique. In addition, there are several small, uninhabited islands of the Grenadines which fall under the jurisdiction of the Grenada Government.

Following more than a century and a half of British Crown Colony rule, adult suffrage was introduced in 1951 (with a voting age of 21, subsequently reduced to 18), and Grenada became a State in Association with Britain in 1967. Under that constitutional status, the State was entrusted with complete internal self government, while Britain retained responsibility for defense and external affairs. Independence was gained in 1974 when the British Government terminated the status of Associated Statehood.

Grenada's Independence Constitution Order vests the executive authority of the State in the British Monarch and provides for a Governor General appointed by and representing the Monarch. The Constitution also provides for a bicameral Parliament comprised of a 15-member elected House of Representatives drawn from 15 constituencies, and a 13-member Senate appointed by the Governor General, on advice of the Prime Minister and Leader of the Opposition.

The Governor General appoints, as Prime Minister, the member of the House who appears likely to command support of the majority of the members of the House. The Governor General also appoints, as Leader of the Opposition, the member of the House who appears to command support of the largest number of members of the House in opposition to Government.

Acting on the advice of the Prime Minister, the Governor General appoints Ministers of Government from among members of the House and/or Senate. Those

Ministers, together with the Prime Minister, form the Cabinet with responsibility to advise the Governor General in the governing of the State. Except in a few instances where he or she is required to act in his/her own deliberate judgment (e.g., appointment of the Prime Minister), the Governor General must act in accordance with the advice of Cabinet. Effective executive power therefore rests with the Prime Minister and Cabinet.

The Cabinet is now comprised of five Ministers and seven Ministers of State (junior Ministers), three of the latter being drawn from the Senate. At present, the Government is organized as follows:

- Prime Minister and Minister for Home Affairs, National Security, Information, Carriacou and Petit Martinique Affairs, Finance, Trade and Industry, and Energy;
- Ministry of External Affairs, Agriculture, Lands, Forestry, Tourism, and Legal Affairs;
- Ministry of Education, Culture, Youth Affairs, Sports, Social Security, Local Government, Labor, and Fisheries;
- Ministry of Health, Housing and Physical Planning;
- Ministry of Works, Communications, Public Utilities, Cooperatives, Community Development, Women's Affairs, Civil Aviation and Leader of Government Business.

Local Government was introduced in 1905 when District Boards (with equal numbers of elected and nominated members), responsible for administration of certain details of government, were created in each of the six parishes of Grenada (see Figure 1.1(2) for designation of the six parishes). Carriacou

was given a fully nominated Board which later became partially elected. While each District Board had statutory control in certain matters over the entire parish in which the Board operated, in practice, each Board exercised little authority outside the main town of the Parish. The exception was St. David's, where no town exists.

In 1961, when the City of St. George's was made a municipality, the St. George's District Board was replaced by a City Council. The Council had responsibility for St. George's City only, and the rest of St. George's Parish was left without even the nominal local government it had before.

Local government bodies (District Boards and the St. George's Council) were dissolved by the Central Government in 1969, but the present Government has pledged to restore local government. For this purpose, draft legislation was prepared and three Bills were given their first reading late in 1986 (i.e., the St. George's Corporation Ordinance, the Carriacou and Petit Martinique Country Councils Ordinance, and the District Boards, Village Councils and Town Councils Ordinance). These Bills still await their second and third readings to be passed in law.

Grenada's legal system is based on British Common Law, and, according to the Constitution, the Supreme Court of the State is the Supreme Court of the Organization of Eastern Caribbean States (OECS). However, following the New Jewel Movement revolution of 1979, the Constitution was suspended, and the OECS Court was abolished and replaced with the Grenada Supreme Court.

The Constitution, with the exception of the section relative to the Courts, was restored after the military intervention of 1983, and the Grenada Supreme Court therefore remains in operation as a "Court of Necessity". The Grenada Government has made application to rejoin the OECS Court but has been advised that its application will not be considered until the Appeal case relative to the murder of Prime Minister Maurice Bishop and others (presently being heard) has been disposed of.

12.2 HISTORICAL DEVELOPMENT OF ENVIRONMENTAL MANAGEMENT

The legislative base for land use planning and development control in Grenada dates to 1946 with the enactment of the Town and Country Planning Ordinance. Patterned after similar legislation in the region, the law introduced urban and land use planning to Grenada. Almost two decades later, in 1965, a Central Planning and Housing Authority was set up to review development proposals and to establish some control over the development process, in the urbanized area of St. George's in particular. The Authority put forward a number of standards by which development proposals were to be evaluated, and these were enacted in 1965 as Regulations to the original Town and Country Planning Ordinance.

Despite these initiatives, the control of development (for the most part narrowly defined as building development in the town of St. George's) was a matter of controversy for over 20 years, from the late 1940's to the late 1960's. In the first place, the St. George's District Board (replaced by the City Council after 1960) maintained that it had authority over building development within the town's boundary, putting it in conflict with the Central Government's Planning and Housing Authority.

Not only were lines of responsibility unclear, but conflicts arising out of political and personal considerations helped to ensure that such development controls as did exist would not be effective. For example, advisors to both the District Board/City Council and the Housing Authority accepted private work to prepare building plans which they were later called upon to evaluate. Furthermore, the District Board/City Council had no inspectors to monitor approved applications, while the Housing Authority had only one. Finally, while the Town and Country Planning legislation contained authority for Government to prepare zoning or land use plans (called "schemes"), such plans were not undertaken by the Authority, resulting in a lack of standards or guidelines to be used by either

the Authority or the St. George's District Board/City Council.

The result was an almost complete lack of development control throughout the 1940's, 1950's and into the 1960's. The consequences could be seen in the loss of architecturally important buildings in St. George's, the erection of new buildings not in keeping with the historical character of the town, and the failure to plan effectively for inevitable increases in urban population and traffic.

When the St. George's City Council was dissolved in 1969, the control of building development in the town reverted entirely to the Central Government. As it happened, at about the same time a new law, the Land Development (Control) Act, created a new centralized authority in 1968, the Land Development Control Authority, which to the present time is responsible for the administration of the older Town and Country Planning Ordinance and Regulations and the more recent 1968 Land Development (Control) Act, as amended in 1983 (see also Section 12.3 below).

During the period 1966-1971, the United Nations provided technical assistance in physical planning to the Government of Grenada. Among other tasks, the UN team assisted in the drafting of the new Land Development (Control) Act and prepared a number of local area plans including a master plan for St. George's which was approved by GOG.

In 1976, the Government of Grenada again requested and received planning assistance from a UNDP-sponsored, region-wide Physical Planning Project, which helped in drafting a proposed Physical Development Strategy (1977-1990) for Grenada, including guidelines for development. The 1977 Strategy was never formally accepted by Government, in part due to internal unrest just before the 1979 revolution. Nor did it completely live up to expectations for long-term planning. Some of its projections were wrong, most particularly those for population, which did not account for continuing out-migration. Nevertheless, the Physical Development Strategy of 1977 remains the most comprehensive

attempt to date for national physical planning; it is still being used as a guideline by local planners (Frederick, 1987a).

The problems of inter-agency coordination and the need for coherent government action in confronting environmental issues resulted in the formation of the Environment Conservation Council in April of 1983. The Council was to have authority to coordinate GOG policies and programs for the preservation and utilization of the country's natural resources; its role was to be both a coordinating and advisory one. Only one meeting of the Council was held in 1983, and, perhaps as a result of political changes later that year, the Council has remained inactive ever since, although its revitalization is still under discussion (Frederick, 1987a).

Following along the lines of similar legislation in other Eastern Caribbean countries, Grenada now has in place legislation to protect its water catchment areas (Forest, Soil and Water Conservation Ordinance), its beaches (Beach Protection Law), its wildlife (Birds and Other Wild Life [Protection of] Ordinance) and its national heritage (National Trust Act). It has in the last ten years updated the Land Development (Control) Law (in 1983, with Regulations in 1988) and the Forest, Soil, and Water Conservation Ordinance (in 1984), and has enacted a new Fisheries Act (1986). In 1988, with assistance from the OAS, a plan and policy for a System of National Parks and Protected Areas was put forward.

Yet, despite this body of legislative authority and new initiatives such as the national parks plan, Grenada does not have a strong institutional framework for environmental management. In the first place, some critical legislation is seriously outdated (e.g., the Public Health Ordinance which provides the basis for pollution control); other legislation lacks necessary rules and regulations to make the laws effective (e.g., the Water Supply Act). But perhaps more importantly, in Grenada, unlike some of its sister islands in the Eastern Caribbean, no single government agency can be said to have emerged as a strong leader or voice for environmental concerns in the country; nor has this leadership

been forthcoming in the private sector. Such a situation might be attributed to the political turmoil which has beset and distracted the nation for more than a decade; whatever the cause, it has hindered development of a strong institutional framework or comprehensive public policy for the environment. Additional institutional concerns are discussed in more detail in Sections 12.3 and 12.6.

12.3 GOVERNMENT INSTITUTIONS CONCERNED WITH ENVIRONMENTAL MANAGEMENT

Responsibility for environmental management in Grenada is dispersed among a number of Departments which are divisions of several Ministries of Government. A recent study by the OAS (Bourne, 1987) identifies ten such divisions which are displayed (with additions and updated modifications) in Table 12.3(1), along with enabling legislation. Additional resource management legislation reviewed in a recent OECS survey (Lausche, 1986) is provided in Table 12.3(2).

No single agency of Government is charged with responsibility for the environment. Furthermore, because Government has a limited capacity for inter-agency coordination, accountability for the environment at the national level remains fragmented and diffuse. Such GOG functions as planning, development control, resource protection, conservation, regulatory oversight, and resource development, as these pertain to the environment, are generally implemented on an ad hoc basis (in the absence of an approved planning and development control framework) and focus primarily on short rather than long-term policy objectives.

The various units of Government with environmental functions are unable to significantly influence policies and programs for environmental planning and control and too often are unable to act collectively on critical environmental policy issues (Frederick, 1987b). As noted by Lausche (1986), such coordination within Government as does exist for resource management appears to occur principally through two mecha-

nisms: (1) Cabinet deliberations and (2) the physical planning process.

A discussion of the key divisions of Government with environmental responsibilities follows.

PHYSICAL PLANNING UNIT

The Physical Planning Unit (PPU) is a Civil Service Department which has been in operation since 1982. It is presently located within the Ministry of Health, Housing and Physical Planning, although, until 1984, it was housed within the Ministry of Finance. Physical Planning was originally a unit of the Government's Macro Planning Division which was disbanded by the Prime Minister in 1984 because it had become the main controlling arm within the PRG. It was also felt that the division was overriding the power of other ministries, the Ministry of Finance in particular. Thus, the Economic Planning Unit was made a smaller division under the Ministry of Finance, and the PPU was transferred to the Ministry of Health and Housing (C. Frederick, PPU, pers. comm., 1989).

The PPU was set up to perform the dual functions of development planning and development control. At present, however, very little of its work is devoted to development planning; as pointed out by Bourne (1987), the day-to-day work of the PPU is largely focused on development control, which can primarily be interpreted in Grenada to mean building rather than planning control.

The Physical Planning Unit also functions as technical staff for the Land Development Control Authority, a statutory body (see below). The Head of the PPU is Executive Secretary to the Authority and has responsibility for processing planning applications (including consultation with other GOG agencies), submitting applications with summary comments to the Authority for decision, conveying the decisions of the Authority, and finally monitoring approved developments for compliance. The Chairman of the Land Development Control Authority was until 1988 the Director of Budget and Planning in the Ministry of Finance; upon his resignation, the

Table 12.3(1). GOG agencies with resource management functions (expanded from Bourne, 1987), with principal legislation and key responsibilities.

AGENCY	RESOURCE MANAGEMENT LEGISLATION	RESOURCE MANAGEMENT RESPONSIBILITIES
<u>MINISTRY OF HEALTH AND HOUSING</u>		
- Physical Planning Unit	Town & Country Planning Ord. (Cap. 293, 1946) Town & Country Plan'g (Amend.) Ord. (No. 36, 1966) Town & Country Plan'g Regulations (SRO No. 44, 1965)	Responsibility for the planning, development and use of lands
- Environmental Health	Public Health Ord. (Cap. 237, 1925), as amended, and Regulations (SRO No. 218, 1957) Abatement of Litter Act (No. 35, 1973)	Maintenance of environmental health
<u>MINISTRY OF EDUCATION</u>		
- Fisheries	Grenada Fisheries Act (No. 15, 1986) Grenada Fisheries Act Regulations (SRO No. 9, 1987)	Promotion and management of fisheries; protection and preservation of marine reserves
- National Trust	Grenada National Trust Act (No. 20, 1967)	Protection and preservation of Grenada's national heritage
- National Science and Technology Council	People's Law No. 28 (1982)	Science policy arm of Government
<u>MINISTRY OF WORKS AND COMMUNICATIONS</u>		
- Central Water Commission	Water Supply Act (No. 23, 1969) Water Supply (Amendment) Law (No. 30, 1979)	Administration of potable water supply; construction and maintenance of water works
<u>MINISTRY OF EXTERNAL AFFAIRS, AGRICULTURE, LANDS, FORESTRY, TOURISM</u>		
- Agriculture		Extension services; plant propagation and pest management; research on food crops; veterinary and livestock services; agronomy and conservation
- Pesticide Control Board	Pesticides Control Act (No. 28, 1973, as amended and Regulations on Labelling (SRO No. 9, 1979) and Approval (SRO No. 10, 1979)	Enforcement of Pesticide Regulations
- Forestry and Parks	Forest, Soil and Water Conservation Ordinance (Cap. 129, 1949) Forest, Soil, and Water Conservation (Amendment) Ordinance (No. 34, 1984) Crown Land Forest Produce Rules (SRO No. 85, 1956) Protected Forests Rules (SRO No. 87, 1952)	Protection and management of the nation's forests; soil and water conservation

Table 12.3(1) [continued]. GOG agencies with resource management functions (expanded from Bourne, 1987), with principal legislation and key responsibilities.

AGENCY	RESOURCE MANAGEMENT LEGISLATION	RESOURCE MANAGEMENT RESPONSIBILITIES
- Lands Division and Land Use Division	Crown Lands Ordinance (Cap. 78, 1896) Crown Lands Rules (SRO No. 36, 1934) Crown Lands (Amend.) Rules (SRO Nos. 3, 19, 39, 1965)	Administrative and technical support for Government's land policy; responsibility for management and use of state-owned lands
- Tourist Board	Tourist Trade Development Board Ordinance (Cap. 292, 1947) Tourist Industry (Protection) Act (No. 47, 1972) Tourist Industry (Protection) Regulations (SRO No. 2, 1986) Tourist Industry (Vendor's License) Regulations (SRO No. 2, 1986) Tourist Board Act (No. 29, 1988)	Tourism promotion and marketing
<u>MINISTRY OF FINANCE, TRADE AND INDUSTRY</u>		
- Budget and Planning		Focus of Government's budget and planning process
- Land Development Control Authority	Land Development (Control) Act (No. 40, 1968) Land Development (Control) (Amendment) Law (People's Law No. 7, 1983) Land Development Regulations (SRO No. 13, 1988)	Decision-making authority for planning applications
- Industrial Development Corporation	Industrial Development Corp. Act (No. 2, 1985)	Promotion of industry development in Grenada

Chief Technical Officer in the Ministry of Works and Communications took over as Chairman. Under this arrangement, the head of the PPU is answerable both to his own Ministry (Health and Housing) and, as Executive Secretary of the Authority, to the Land Development Control Authority Board.

The principal legislation for development control, including procedures for enforcement of planning controls, is the Land Development (Control) Act, 1968, as amended, and Land Development Regulations (Statutory Rules and Orders No. 13 of 1988). Earlier planning legislation (the Town and Country Planning Ordinance of 1946, as

amended) was strengthened in areas of land development control by the 1968 Land Development (Control) Act (and enacted Regulations thereto). At the same time, the original planning legislation continues to be used by the PPU to regulate building construction. The Town and Country Planning legislation also contains authority for GOG to prepare legally-binding "schemes" (zoning or land use plans) for the country or parts of the country (Lausche, 1986). Despite this provision, there is no approved national development plan for the State, which makes the PPU's task of development control that much more difficult, i.e., carried out as it is in the absence of an accepted planning framework. A new Physical

Development: Plan for the country is currently under preparation by the PPU, scheduled to be completed by early 1991; see also Section 9. Current development control regulations do not contain provisions which effectively recognize and protect the unique character of Grenadian architecture, in particular, the St. George's townscape.

According to Bourne (1987), the existing manpower capacity of the Physical Planning Unit is inadequate. The head, who holds the title Chief Planning and Development Officer, is assisted by a non-clerical staff of seven. Only one Building Inspector and two persons are assigned the task of "site inspection," clearly inadequate for a country the size of Grenada.

Frederick (1987a), the current head of the PPU, maintains that while the Unit likes to think that it has responsibility for environmental management, in actuality very few of its functions are directly related to such tasks. In fact, according to one consultant (Bourne, 1987), this Unit of Government, which has the potential to serve as the major agency for coordinating GOG's long-term approach to environmental management, has neither the capacity nor the capability to do so at the present time.

Furthermore, the ministerial functions for environmental management have officially been placed in the portfolio of the Minister of Education (formally with the Minister of Works and Communications). Many observers, however, would agree that the core function of environmental planning more properly belongs within the PPU (C. Frederick, PPU, pers. comm., 1990).

LAND DEVELOPMENT CONTROL AUTHORITY

The Land Development Control Authority (LDCA), a statutory body, was established by a law of the same title in 1968 (amended in 1983); regulations were enacted in 1988. The Authority consists of a Chairman and not more than eight other members appointed by the Governor on advice of Cabinet. Membership of the Authority is man-

dated to include the Chief Technical Officers in charge of Physical Planning, Public Works, Health Services, Agriculture and Housing. As indicated above, the Executive Secretary of the LDCA is the head of the Physical Planning Unit, which provides staff for the day-to-day functioning of the Authority.

Authority for making decisions on development applications is vested in the LDCA. However, the Authority may refer an application to other GOG departments and agencies for guidance in reaching its decision. Furthermore, Cabinet may advise the LDCA that it has granted permission to a particular application, subject to any considerations to be defined and approved by the Board (C. Frederick, PPU, pers. comm., 1989). With the enactment of regulations to the Land Development Control Act in 1988, certain development proposals of Government departments and statutory boards must now be submitted to the LDCA for approval. Nevertheless, the Land Development Control Authority is not always the agency first approached in the development approval process. Lausche (1986) points out that there have been cases where developers had plans and concession packages approved by the Industrial Development Corporation before an application was submitted or approved by the LDCA. Also, People's Law No. 38 of 1981, which created the National Housing Authority, gave full power to that body to implement housing developments without prior approval from the LDCA (Frederick, 1987a); this authority was removed with enactment of the 1988 Regulations to the Land Development (Control) Act, but this section of the new regulations is not yet seriously enforced by the LDCA (C. Frederick, PPU, pers. comm., 1989).

The provisions of the Land Development (Control) Act do not require that the Authority consult with any person or body, within Government or external to Government, in the performance of its responsibilities. Thus, the development planning process suffers from a lack of public input and participation, effectively reducing the information available to the LDCA from the non-government sector and diminishing potential public support for its decisions. With respect to input from GOG agencies, the head of the PPU

Table 12.3(2). National resource management legislation in Grenada as identified and updated from Lausche (1986).

PLANNING	<ul style="list-style-type: none"> - Town and Country Planning Ordinance (Cap. 293, 1946) - Town and Country Planning (Amendment) Ordinance (No. 36, 1966) - Town and Country Planning Regulations (SRO No. 44, 1965)
DEVELOPMENT	<ul style="list-style-type: none"> - Land Development (Control) Act (No. 40, 1968) - Land Development (Control) (Amendment) Law (No. 7, 1983) - Land Development (Control) Act Regulations (SRO No. 13, 1988) - Industrial Development Corporation Act (No. 2, 1985) - Grenada Agricultural and Industrial Development Corporation Act (No. 11, 1976); name changed to Grenada Development Bank by No. 23, 1980 - Grenada Agricultural and Industrial Development Corporation (Amendment) Act (No. 2, 1977) - Grenada Agricultural and Industrial Development Corporation Regulations (SRO No. 3, 1978)
CROWN LANDS	<ul style="list-style-type: none"> - Crown Lands Ordinance (Cap. 78, 1896) - Crown Lands Rules (SRO No. 36, 1934) - Crown Lands (Amendment) Rules (SRO Nos. 3, 19, and 39, 1965)
AGRICULTURE	<ul style="list-style-type: none"> - Pesticides Control Act (No. 28, 1973) - Pesticides Control (Amendment) Law (No. 88, 1979) - Pesticides Control (Labelling of Pesticides) Regulations (SRO No. 9, 1979) - Pesticides Control (Approval of Pesticides) Regulations (SRO No. 10, 1979)
FORESTS	<ul style="list-style-type: none"> - Forest, Soil and Water Conservation Ordinance (Cap. 129, 1949) - Forest, Soil and Water Conservation (Amendment) Ordinance (No. 34 of 1984) - Crown Lands Forest Produce Rules (SRO No. 85, 1956) (5/340) - Protected Forests Order (SRO No. 86) (5/357) - Protected Forests Rules (SRO No. 87) (5/358) - Protected Forests (Tuilleries - Bagatelle) Rules (SRO No. 88) (5/360) - Grand Etang Forest Reserve Ordinance (Cap. 135, 1906)
WATER	<ul style="list-style-type: none"> - Water Supply Act (No. 23, 1969) - Water Supply (Amendment) Law (No. 30, 1979)
TOURISM	<ul style="list-style-type: none"> - Tourist Trade Development Board Ordinance (Cap. 292, 1947) - Tourist Industry (Protection) Act (No. 47, 1972) - Tourist Industry (Protection) Regulations (SRO No. 20, 1975) - Tourist Industry (Vendor's License) Regulations (SRO No. 2, 1986) - Tourist Board Act (No. 29, 1988)

[continued]

Table 12.3(2) [continued]. National resource management legislation in Grenada as identified and updated from Lausche (1986).

BEACHES	- Beach Protection Law (No. 67, 1979)
PROTECTED AREAS	- Grenada National Trust Act (No. 20, 1967) - National Botanical and Zoological Gardens Act (No. 25, 1968) - National Botanical and Zoological Gardens Rules (SRO No. 55, 1968)
WILDLIFE	- Wild Animals and Birds (Sanctuary) Ordinance (Cap. 314, 1928) - Birds and Other Wildlife (Protection of) Ordinance (Cap. 36, 1957) - Birds and Other Wildlife (Protection of) (Amendment) Ordinance (No. 26, 1964)
MARINE RESOURCES	- Grenada Fisheries Act (No. 15, 1986) - Grenada Fisheries Act Regulations (SRO No. 9, 1987)
WASTE MANAGEMENT/ POLLUTION CONTROL	- Public Health Ordinance (Cap. 237, 1925), consolidated with revisions through No. 20, 1952 - Public Health (Amendment) Law (No. 40, 1981) - Public Health (Amendment) Law (No. 9, 1973) - Public Health (Amendment) Law (No. 17, 1973) - Public Health (Amendment) Law (No. 29, 1973) - Public Health Regulations (SRO No. 218, 1957) (6/953) - Abatement of Litter Act (No. 35, 1973)

and his staff -- serving as the technical arm of the LDCA -- routinely refer applications to persons within Government considered appropriate before submitting them to the Authority. The Board of the Authority is often comprised of those same persons so consulted, plus representatives of a few other bodies such as the Chamber of Commerce. The head of the PPU reports that there is presently no environmental expertise within his office (C. Frederick, PPU, pers. comm., 1990).

Lausche (1986) points out that generally speaking the body of existing planning and development control legislation in Grenada is one of the strongest of the six OECS countries she reviewed, particularly in specifying provisions on enforcement. Nevertheless, Lausche and others have pointed to weak-

nesses in the LDCA and in the overall planning/development control process. Lausche attributes this to poor coordination across institutional lines (see also Section 12.6).

Additional problems associated with the LDCA were pointed out in 1977 by a United Nations consultant attached to the UN Physical Planning Unit in Grenada. According to the consultant, one weakness of the LDCA can be traced to the provisions of the 1968 Land Development (Control) Act which provide only for the restrictive side of planning (Mardones, 1985). Over time, this has produced negative perceptions about the work of the Authority. When combined with the fact that development control decisions are made by the Authority in the absence of an official physical development strategy, the resulting lack of confidence by decision-makers

in Government as well as the general public in the LDCA is perhaps not surprising (Frederick, 1987a).

ENVIRONMENTAL HEALTH

The Environmental Health Department of the Ministry of Health, Housing and Physical Planning is the agency responsible for monitoring and enforcing the health and sanitation provisions of the Public Health Ordinance (1925), as amended. Responsibilities include solid waste management, liquid waste disposal, meat and food sanitation, water quality control, sanitary burial, occupational health, and port quarantine.

Pollution control under the Public Health Ordinance follows the legal theory of "nuisance," which the enabling legislation defines to include any accumulation or deposit which is injurious to health. The difficulties of proof under nuisance theory, plus the very outdated provisions and the extremely low penalties of the law, weaken its enforcement by Environmental Health officials. Lausche (1986) calls for a complete review and updating of Public Health legislation in Grenada and states that both substantive and procedural sections need to be modernized and strengthened.

The country is divided into three "environmental health" districts, each headed by a senior Environmental Health Officer who, in turn, supervises District Environmental Health Officers -- three each in the Eastern and Western Districts and seven in St. George's, which includes the airport and seaport. Generally speaking, district officers are required to function in all areas of environmental health. There is also one officer with primary responsibility for food inspection and sewerage matters.

Functional interrelationships between Environmental Health and other units of the Grenada Government include the presence of the Chief Environmental Health Officer on the Board of the Land Development Control Authority and on the newly revitalized Pesticides Control Board. Furthermore, the Department's responsibilities for pollution mon-

itoring and control overlap broadly with the Central Water Commission (see below). At the present time, the Commission carries out the actual work of bacteriological monitoring for fresh waters but provides reports to the Chief Environmental Health Officer. Also, aspects of the Department's port quarantine and environmental health mandate are linked to the responsibilities of the airport and seaport authorities.

FISHERIES DIVISION

The Fisheries Division is currently housed within the Ministry of Education, Culture, Youth Affairs, Sports, Social Security, Local Government, Labor, and Fisheries, with which, unfortunately, it shares a limited number of common objectives. Bourne (1987) describes the unit as "a one man show" (i.e., the Chief Fisheries Officer) with all other positions attached to the Artisanal Fisheries Project, a quasi-governmental activity externally funded and designed to provide technical support for development of a small-scale, indigenous fishing industry (see Section 4.4.1). More current information places the Fisheries staff at 12, including -- in addition to the Chief Fisheries Officer -- two fisheries biologists, five district officers, a fisheries trainer, an aquaculture specialist, a technician, and an officer in charge of statistics (R. Huber, OAS and J. Finlay, Fisheries Division, pers. comm., 1989).

Much of the day-to-day work of the Fisheries Division according to Borne (1987) is the management of the public fish markets (staffed by positions which are all classified as temporary). Other activities are focused on implementation of extension work and enforcement of fisheries regulations. Fisheries was also designated in the draft GOG/OAS plan for a National Parks System as a cooperating agency to assist Forestry by managing protected seascapes and multiple use marine areas (GOG/OAS, 1988d).

Although the Artisanal Fisheries Project office operates as a semi-autonomous agency within the Ministry, dealing with the commercial aspects of the fisheries sector, there has been discussion of the Project be-

coming a statutory body, leaving the Division free to carry out resource management and protection programs as well as provide extension services. To date, no action has been taken.

Relevant legislation, the Grenada Fisheries Act (1986), provides for the promotion and management of fishing and fisheries in Grenada. Additionally, it gives the Minister the authority to identify and declare as marine reserves those areas requiring special status in order to protect and preserve the natural breeding grounds and habitat of aquatic life. Such protection can also be afforded to preserve and enhance an area's natural beauty or to promote scientific study and research. Prohibited activities within reserves are specified and penalties are set.

MINISTRY OF WORKS AND COMMUNICATIONS

The Beach Protection Law of 1979 gives to the Minister of Works and Communications responsibility for protection of the beaches and regulation of sand mining. Specifically, the law prohibits the removal or digging of sand, stone, shingle or gravel from any beach or seashore in Grenada except with the written permission of the Minister.

The Minister, however, may declare any beach exempt from the law and will announce at regular intervals which beaches are open to mining. Any police officer may make an arrest for violation of the law. Bourne (1987) found that the institutional arrangements to control sand mining were weak, causing sand mining to remain largely uncontrolled, with the Ministry of Works as one of the chief offenders (see also Section 4.4.2).

The Ministry of Works and Communications is also responsible for maintaining sea defenses (e.g., seawalls) as well as the planning, development, and maintenance of other major infrastructure, including roads. Such activities make the Ministry a significant "developer" in the country. Nevertheless, the Ministry, like other government departments, was not required to present plans for its development activities to the LDCA for vetting

and approval until new Regulations to the Land Development (Control) Act were passed in 1988. However, the new regulations remain relatively untested, and it has not yet been determined exactly how effective they will be.

CENTRAL WATER COMMISSION

The legislation governing the supply of potable water and the construction and maintenance of waterworks is the Water Supply Act of 1969 (as amended). This legislation established the Central Water Commission (CWC), a statutory body, and transferred to the Commission the assets and responsibilities of the water authorities existing before 1969. The Commission has powers to levy water rates, acquire property, and control all groundwater abstraction through the issuance of licenses and permits. Water supply on Carriacou and Petit Martinique is the responsibility of the Public Works Department under the Ministry of Works and Communications.

The Commission's Board of Directors includes representatives from the Ministries of Finance, Agriculture, Works, and Health, with the engineer from the Ministry of Works and Communications serving as Chairman. Until recently, the chief executive of the Commission -- i.e., the Manager/Secretary who also serves as Secretary to the Board -- was a member of the Land Development Control Authority, but this link no longer exists (Bourne, 1987). The seat is held by a public utilities representative.

The Board is fully autonomous and does not refer to the Ministry or Cabinet even in decisions affecting rate increases; it implements its programs based almost exclusively on revenues from water levies (Bourne, 1987; Lausche, 1986).

The enabling legislation charges the Commission with the prevention of pollution or contamination to rivers, springs, wells, catchment areas or other water source or supply. However, regulations have not been enacted (although available in draft), thus making enforcement of pollution control standards difficult, if not unlikely. Furthermore, management and conservation

responsibilities for catchment areas also fall under the mandate of the Forestry Department under the Forest, Soil and Water Conservation Ordinance. Additionally, responsibility for monitoring water quality lies with the Ministry of Health; nevertheless, the Commission does its own monitoring including water quality testing.

Thus, the CWC shares administrative authority with Forestry (for the protection of water catchment areas) and with Health (for water quality). There is also an inter-agency water resources unit (primarily concerned with the collection of rainfall data and the measurement of stream flows), which was set up in 1985 under the joint responsibility of the Ministry of Agriculture and the CWC -- although it is effectively under the control of the Commission.

Given these overlapping responsibilities, inter-agency coordination between the CWC and other government departments (e.g., Forestry, Environmental Health, Agriculture) is reportedly not as effective as it should be (Bourne, 1987; Lausche, 1986); this fact, is highlighted by the absence of the Commission's chief executive from the Board of the Land Development Control Authority.

DEPARTMENT OF AGRICULTURE

The Agriculture Department is a part of the larger Ministry of External Affairs, Agriculture, Lands, Forestry, Tourism, and Legal Affairs, with Agriculture accounting for almost half of the Ministry's program heads. The considerable size of this Department has been a matter of some concern; i.e., excluding Forestry and Parks, the Lands Division, the Land Survey Division and the Land Use Division (which will be discussed in more detail below), the permanent staff of the remainder of the Department numbered 192 persons three years ago (Bourne, 1987).

The functional responsibilities of the Department focus on extension services, plant propagation and pest management, research, veterinary and livestock services, and soil and water conservation. Some of the effectiveness of the Department in providing extension ser-

vices or in promoting soil and water conservation is diminished by the fact that the Commodity Boards (Grenada Banana Cooperative Society, Grenada Cocoa Producers Association, Grenada Cooperative Nutmeg Association) have attracted a good number of the better qualified officers from the Department. Some of these Boards also have their own extension service programs for farmers (Bourne, 1987). Furthermore, Lausche (1986) identified no specific legislation in Grenada mandating soil and water conservation practices for agricultural production on private lands or non-forested state lands.

PESTICIDES CONTROL BOARD

The Pesticides Control Act of 1973, as amended with regulations on labelling and approval, established a Pesticides Control Board which formerly operated through a subcommittee, screening all applications for pesticide import. The Board was revitalized in 1987 and now comprises eight members (Chief Medical Officer, Government Chemist, agronomist, Agricultural Officer, Environmental Health Officer, Plant Protection Officer, one farmer and a chemist) (G. Marcelle, GOG Chief Chemist, pers. comm., 1989).

The Board meets once a month to review applications for new pesticides. It serves to advise the Ministry and Government on the use of pesticides in the country, but it is limited in its functions as it employs no pesticide inspectors and lacks the capacity to monitor pesticide residues in humans or in food products. (See also Section 5.2 and Section 8.2.)

FORESTRY AND PARKS

Although the first Grenadian forest reserve was designated early in this century (Grand Etang Reserve Ordinance, 1906), the principal legislation in this sector is the Forest, Soil and Water Conservation Ordinance of 1949, with regulations, and as amended in 1984. This legislation provides authority for Government to declare forest reserves on state-owned land or protected forests on private land, establishes provisions for control-

ling squatting on state-owned land, and authorizes extensive enforcement powers for forest officers (unfortunately, the latter are not effectively used due to budgetary and personnel constraints). The 1984 amendments added a broad forestry policy statement to the basic legislation, including up-to-date conservation concepts, a list of tree species to be protected on private lands, and revised penalties for offenses (Lausche, 1986).

From 1979 to 1984, during the time of the People's Revolutionary Government, forestry functions were assigned to a new statutory body called the Forestry Development Corporation. A self-financing government body, the Corporation's emphasis was on resource harvesting, and its specific mandate was to reduce reliance on foreign wood imports, earn foreign exchange and provide employment. With the enactment of the 1984 amendment to the original Forestry, Soil and Water Conservation Ordinance, a new Forestry and Parks Department was re-established within the Ministry of Agriculture.

This Department, which includes the Botanical Gardens, is presently divided into three units, each headed by a Forester (Annandale, Queens Park and Grand Etang), with a separate unit for Carriacou (served by a Ranger). Another unit for National Parks and Protected Areas, including wildlife protection responsibilities, is staffed by a single Parks Officer who serves as head of the unit.

The Forestry Department was selected as the most appropriate administrative unit to manage the proposed National Parks and Protected Areas System. This decision, by a multi-agency committee, reflected, among other considerations, the Department's legislative authority to protect forests, watersheds, fauna, flora, and soil and water resources as well as the motivation of staff to implement a protected areas management program (GOG/OAS, 1988d).

However, Bourne, in 1987, found that for the most part Forestry's staff was inadequate for the proper performance of required functions. He found the Department was relying almost entirely on short-term technical assistance staff and that while there was a

training program in place, largely at the professional level, counterparts were not available to benefit from the presence of visiting personnel. Middle-level management was identified as a major source of weakness. Other sources indicate that the Department has been strengthened significantly since Bourne's analysis by the return from England of two graduates in forestry management (R. Huber, OAS, pers. comm., 1989).

THE LANDS DIVISION AND THE LAND USE DIVISION

The Directorate of Lands and Survey comprises three departments within the Ministry of Agriculture: the Lands Division, the Land Use Division and the Land Survey Division; as a whole, they provide administrative and technical support for the Government's land policy, while the first two also have resource management functions. The Chief Land Use Officer heads a unit concerned with land use and water conservation, and the Chief Lands Officer directs a unit which deals with the use and development of Crown Lands.

Soler (1988) identified the key activities of the Land Use Division as: agricultural land use planning and zoning, agro-meteorological and hydrological studies, geological and soil survey and capability mapping, land and crop suitability studies, cadastral and other related surveys. All development applications related to agricultural land are forwarded by the PPU to the Land Use Division for evaluation, and the head of the Division sits on the Land Development Control Authority.

The Lands Division exercises authority over Government-owned land, including control over grants, sales, exchanges, and leases, with the power to attach reasonable conditions to any of these transactions. Any transfer of public land which implies a shift in use is channeled through the Division by other GOG agencies, for example, the laying out of a subdivision by the National Housing Authority on previously undeveloped or agricultural lands. While such land transfers must ultimately be approved by Cabinet, they are

not required to be forwarded to the PPU for technical consultations.

TOURISM

The former Department of Tourism (within the Ministry of External Affairs, Agriculture, Lands, Forestry, Tourism, and Legal Affairs) will cease to exist early in 1990 when the newly created Grenada Tourist Board (a statutory body created by legislation in 1988) becomes fully operational. These changes grew out of recommendations of an OAS-funded task force on tourism development which had called for a streamlining of the institutional structure supporting tourism development in Grenada (Moore, *et al.*, 1986).

The new Board is empowered to develop all aspects of the tourist industry, including the development of tourist amenities such as (according to the enabling legislation) those related to the conservation of local flora and fauna. It may be assumed the Board will work with the National Parks Unit of the Forestry Department in the development of tourist attractions -- as did its predecessor, the Department of Tourism (e.g., for the development of the Grand Etang Visitors Center). The proposed Parks and Protected Areas Plan (GOG/OAS, 1988d) calls for the Government's tourism arm to focus some of its promotion activities on protected area sites, both as recreational and educational attractions, and to help train tour guides for such areas.

INDUSTRIAL DEVELOPMENT CORPORATION (IDC)

The Industrial Development Corporation is a relatively new statutory body (created by legislation of the same title in 1985). Its principal mandate is the promotion and development of industry in Grenada (including hotel developments) by, for example, the offering of concessions and investment incentives. The IDC's program includes development of an industrial park near Frequente, where factory "shells" have been constructed and leased to investors.

IDC functions are complemented by those of the Grenada Development Bank (created in 1976 by the Agricultural and Industrial Development Corporation Act, renamed the Grenada Development Bank Act in 1980). The Bank provides technical assistance and loans to promising national industries. The two bodies are linked through a common board, although the meetings of each corporation are conducted separately. This Board is not represented on the Land Development Control Authority.

The role of the IDC Board is advisory, and it can only finalize decisions in specific areas, such as disposal of factory shells. Decisions on incentive packages are made by Cabinet, while matters with financial implications must have the prior approval of the Minister (Bourne, 1987).

As pointed out above, development application procedures in Grenada have not been standardized. Specifically, the IDC may and does approve development plans and concession packages before applications are submitted to or approved by the Land Development Control Authority. This confusion is exacerbated by virtue of the fact there appears to be little coordination or consultation between the LDCA and IDC boards.

GRENADA NATIONAL TRUST

The National Trust Act of 1967 created the Grenada National Trust, a statutory body administered by a Council and currently answerable to the Ministry of Education. This legislation empowers the Trust to protect and preserve sites of historical and cultural interest or areas of natural importance. The Act gives the Trust authority to act in an advisory capacity, to raise funds, and to acquire property.

Nevertheless, Lausche (1986) points to serious deficiencies in the legislation, specifically, the little substantive authority granted to the Trust and its lack of power to make and enforce regulations for the management of protected areas. Nor does the Act provide for different categories of protection, management objectives relevant for each

class, or power to prohibit and control certain kinds of activities in protected areas.

Shortly after the formation of the Trust in 1967, a new Government came into power which, if not actually hostile to the idea of a Trust, was decidedly unenthusiastic. While early records of the Trust no longer survive, the recollections of those who were a part of its formation put peak membership at between 60 and 80 persons. Of this number, no more than about a dozen were Grenadians, the others being expatriates, primarily North Americans with winter homes in Grenada. With no Government support and little popular enthusiasm, the Trust soon existed only on paper (A. Hughes, Grenada journalist, pers. comm., 1989).

In 1975, with prompting from the Government, a Museum Committee was formed, followed by the establishment of a Museum and one year later the launching of the Grenada Historical Society, created principally to oversee the management and operation of the Museum (see also Section 12.4). More recently, the Government has sought to rehabilitate the Trust and to achieve a merger between the Trust and the Historical Society. One of the primary motivations for renewed interest in the Trust appears to be the need to identify a suitable vehicle through which to channel donor funds for tourism projects. To this end, USAID funds have been provided for a number of projects (e.g., rehabilitation work at Fort George, beautification of the Carenage, installation of plaques at points of interest in St. George's); these activities were carried out by the U.S. Tennessee Valley Authority in cooperation with the Trust.

A proposed merger between the National Trust and the Historical Society, under discussion for over three years, was formally entered into in early 1990 when both bodies, in joint session, elected a president and other officers under the name of the Grenada National Trust and Historical Society.

A modestly revitalized National Trust was named in 1989 as the executing NGO for the Grenada Country Environmental Profile project. A project office and Trust documentation/reference library were established and

staffed. It seems clear, however, that the future of the Trust is linked to the Government's support of and commitment to the Trust and its objectives. This can be accomplished only if Government demonstrates a willingness to strengthen the authority of the Trust, to update its legislative mandate, to assist in providing operational support, and -- most importantly -- to give priority to the concerns and goals of the National Trust.

THE NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

Another statutory body with environmental responsibilities is the National Science and Technology Council (NSTC), which serves as the science policy arm of the Grenada Government. The Council was established in 1978 and was reorganized and given statutory power in 1982 under the People's Revolutionary Government. Board membership currently includes representatives from the Ministries of Education, Agriculture, Health, Works, and Finance as well as representatives from the Commodity Boards, from the IDC, from the Association of Professional Engineers, and from the medical/pharmaceutical profession (D. Pitt, NSTC, pers. comm., 1990).

Under the aegis of the Council, a variety of research programs (often donor-driven) have been carried out since the establishment of the NSTC in the early 1980's, including aquaculture, folk medicine, beach erosion and alternative energy studies (Towle, *et al.*, 1987).

Closely linked to the NSTC is the Division of Research and Scientific Services of the Grenada National College. The College was established in July of 1988 with the following divisions:

- Division of Arts, Sciences and General Studies
- Division of Professional and Technical Studies
- Division of Adult and Continuing Education

- Division of Research and Scientific Services.

The first three divisions listed above have deans; the last has a director who, at the present time, is also the Principal of the College and Director of the NSTC. At some point, the College is scheduled to become a statutory body (D. Pitt, NSTC, pers. comm., 1990).

In 1986, the Prime Minister specifically named the NSTC as the focal point for environmental concerns in the Grenada Government but did not spell out any specific responsibilities relative to that mandate. To date, this role has most generally been an advisory one, although -- given the broad nature of its Board membership -- the Council has the capacity to provide a coordinating function, particularly in identifying either gaps or omissions in the environmental monitoring process in the country or, alternatively, in identifying and addressing areas of administrative redundancy or overlaps among GOG agencies having environmental responsibilities.

Lausche (1986) and Bourne (1987) identify the physical planning process as the primary mechanism for inter-agency coordination on behalf of resource management concerns within the Grenadian Government. It seems clear, however, that, despite its present relatively ill-defined mandate, the National Science and Technology Council could provide a further means for more effective coordination of environmental functions within Government -- a particularly critical role in a Government where such functions are diffuse and fragmented and where relevant agencies are too often unable to act collectively on critical environmental policy issues.

At the same time, it needs to be recognized that whatever expanded environmental role which the Council might assume in the future, it will continue to be hampered by several existing constraints, i.e., the fact that the Council has no oversight responsibilities, no enforcement powers, no environmental quality control duties, and no authority to establish

environmental standards or monitor those standards.

12.4 THE NON-GOVERNMENTAL SECTOR IN ENVIRONMENTAL MANAGEMENT

The universe of non-government organizations (NGOs) in Grenada has been described by one observer (Pansini, 1985) as a heterogeneous one: diverse in interests and objectives, legal status, size, expertise, management capability, financial resources, support base, community influence and modes of operation. There is a long-standing tradition of NGOs in the country, especially as they have been attached to church-related or social welfare objectives. Furthermore, Grenadian NGOs, like NGOs in other small places, are more visibly connected, for example in terms of overlapping memberships and leadership.

Most NGOs in Grenada are small, with the work of these organizations carried out by volunteers with limited or no paid staff. NGO leaders are, simultaneously, policy makers, administrators, fund raisers, and project implementers, while the organizations they head are often over-extended in terms of program objectives (Towle, *et al.*, 1987; Pansini, 1985).

On a more positive note, during a 1986-87 survey of non-government organizations in the Eastern Caribbean, Island Resources Foundation found that, generally speaking, the leadership of NGOs in Grenada was excellent to superior when ranked against comparable service-related and volunteer groups in the region (Towle, *et al.*, 1987). However, whether the country's "environmental" NGOs are equally capable of meeting this high standard remains to be seen.

GRENADA HISTORICAL SOCIETY

The Grenada Historical Society was formed in 1977, in part to fill a void caused by the inactivity of the National Trust (see Section 12.3, *Grenada National Trust*). Unlike the Trust, which is a statutory body of Gov-

ernment, the Society is chartered as a privately-organized, non-profit group; nevertheless, it seems to have enjoyed some support from Government throughout its history.

When a museum was established in Grenada in 1976, partly at the urging of Government but with substantial support from the island's expatriate community, the need for an institutional structure to administer that facility became apparent. Thus, the Historical Society came into being. Its 14-year old museum is now designated the "Grenada National Museum" but is operated and managed by the non-governmental Society with some support from the Ministry of Education.

A proposed merger between the National Trust and the Historical Society, under discussion for over three years, was formalized in early 1990 when the two groups reorganized under the name of the Grenada National Trust and Historical Society. This newly constituted body represents the only "traditional" conservation group (excluding Carriacou, see below) which draws upon a community-derived membership base.

CARRIACOU HISTORICAL SOCIETY

The Carriacou Historical Society was formed in 1976 with the general aims of preserving historical artifacts related to the history of the island, encouraging an interest in the history of the island (by both Carriacouans and visitors); and establishing a museum. The group describes itself as a completely non-governmental organization, supported by Carriacouans at home and abroad and by friends from the U.S., the U.K., and Canada. The group also maintains that it set an ambitious agenda for itself, given the small population size of the island and the fact that the organization was determined not to request Government financial support.

Despite the fact that the Society's Museum was destroyed in 1984 (see also Section 11.1), the group has persevered, and with financial assistance from members and grants from USAID and CIDA, it has re-established a Museum in a reconstructed building (the old cotton ginnery) in Hillsborough. The Carri-

cou Museum is the only museum in the Southern Caribbean that is completely self-supporting and not dependent on government support.

OTHER NGOS WITH ENVIRONMENTAL INTERESTS

Non-government, community-based support for environmental programs in Grenada is very limited and must be extended beyond the National Trust and the Historical Society if the private sector is to exert a stronger leadership role, both in increasing public awareness about environmental issues and in providing a broader, participatory approach for the achievement of environmental goals. Several development-oriented NGOs have begun to integrate limited environmental issues into their programs and have the potential to increase such concerns.

These include:

- The *Grenada National Development Foundation*. With competent leadership in place, this NDF has incorporated some environmental concerns into its program evaluation process.
- The *Grenada Hotel Association* (GHA), which also ranked high in leadership skills in a regional survey of NGOs (Towle, *et al.*, 1987). The Association recently republished its Handbook for members to include details on GHA activities on behalf of and positions related to local environmental concerns.
- The *Agency for Rural Transformation* (ART), a locally-based NGO which sees itself as a catalytic agent for rural development activities. It draws upon a variety of donor groups for support in assisting existing or emergent organizations in the country's rural areas.

The cooperative movement is also significant in Grenada. According to one recent study (Finisterre and Renard, 1987), all successive governments since the inception of

cooperatives in 1946 have given support for their development. Finisterre and Renard report that 119 cooperative societies were registered in 1986 under the Cooperative Societies Ordinance of 1955, although only 37 were considered fully functional. While cooperatives are primarily preoccupied with economic issues, they also have potential for the mobilization of community-level resource management activities. This is particularly true with reference to agricultural and fisheries cooperatives.

It might be assumed, given the long tradition of NGO activity which Pansini (1985) found in Grenada and the general quality of NGO leadership described by IRF in 1987 (Towle, *et al.*, 1987), that there should be a larger number of local NGOs which could be brought together in a kind of private sector "environmental network." There has been some discussion of such an approach under the leadership of the Trust which, although a governmental body, is also viewed as an NGO, particularly given its current relationship with the Historical Society.

For the present time, however, private sector environmental leadership in Grenada is relatively weak and has not had any significant impact on the development of public policy.

12.5 EXTERNALLY-SUPPORTED ENVIRONMENTAL RESEARCH AND RESOURCE MANAGEMENT PROGRAMS IN GRENADA

12.5.1 Planning, Research and Training

In late 1986 the Grenada Government and the *Organization of American States* (OAS) signed a technical support agreement for the execution of an Integrated Development Project. The project called for technical cooperation in five areas relevant to the management of Grenada's natural resources: (1) development planning for agricultural lands; (2) management of Grand Anse Beach as a tourist development area; (3) establishment of a policy and system for national parks and

protected areas; (4) assistance in specific natural resource development and protection projects in Grenada's sister island of Carriacou; and (5) such other information, training, and planning activities as will be useful for other government agencies.

The project is supported by OAS's Department of Regional Development which, until late 1989, maintained an office and full-time representative in Grenada.

The *Organization of Eastern Caribbean States' Natural Resources Management Project* (OECS-NRMP) was set up as a cooperative program of OECS with OAS and GTZ (the German Agency for Technical Cooperation); it was launched in the Eastern Caribbean in 1986. Its overall program objective is to improve the capacity of OECS member countries to plan and manage natural resource management programs. To date, there have been no major OECS-NRMP project activities focused specifically on Grenada, but the island of Carriacou was the beneficiary of a recent water resources management project sponsored by OECS-NRMP. Grenada has also been included in regional surveys sponsored by OECS-NRMP (e.g., environmental legislation, self-help organizations) and has participated in OECS-NRMP-sponsored workshops.

The *Caribbean Agricultural Research and Development Institute* (CARDI) is the agricultural research arm of CARICOM. With primary laboratories in Trinidad, CARDI also maintains representatives and a full program in each member island, including Grenada.

The *Windward Islands Banana Growers Association*, known regionally as WINBAN, provides assistance to the respective growers associations on the islands of Grenada, St. Lucia, Dominica, and St. Vincent, through coordination of shipping and marketing for banana exports and the implementation of research activities on banana production. WINBAN operates a research center in St. Lucia, the largest agricultural research unit in the Eastern Caribbean; activities there benefit all participating islands, including Grenada.

The *Inter-American Institute for Cooperation on Agriculture* (IICA) is an intergovernmental agency comprised of member states in the Americas and the Caribbean; the Institute enjoys a specialized relationship with OAS. Its mandate is to encourage, promote and support the efforts of member countries to improve agricultural development and to achieve rural well-being.

In Grenada, IICA's recent programs have focused on: an agricultural sector study and policy analysis; study of low incomes and farmer response to praedial larceny; technical assistance in the form of an irrigation specialist; support for technology generation and transfer systems; strengthening of plant protection and quarantine capabilities; and support for farmers organizations.

12.5.2 International Donor Assistance

The *U.S. Agency for International Development* (USAID) maintains an office in Grenada, and its HIAMP (High Impact Agricultural Marketing and Production) Project also supports an on-island program. The overall aim of HIAMP is to improve the investment climate for agricultural (including fisheries) enterprises in targeted countries such as Grenada, specifically by providing equity investment loans to finance large projects and commercialization grants to support small agricultural and fisheries enterprises in transition to becoming fully viable commercial ventures.

Other resource management-related programs supported by USAID have included assistance for: a sewage system at Grand Anse Beach, the beautification of and a pedestrian plaza for the Carenage in St. George's, landscaping and lighting to enhance Fort George as a tourist attraction, renovation of the Grand Etang Forest and Annandale Falls Tourism Centers, major improvements for the island's water supply and solid waste disposal systems; an increase in the country's electrical power generating capacity, and revitalization of the agricultural sector including support for the Model Farms Project and the Cocoa Rehabilitation and Development Project.

The *Canadian International Development Agency* (CIDA) has also provided substantial support for resource management programs in Grenada. The Canadians have provided funds for the extension of the St. George's Sewerage Outfall, for expansion of rural water systems, for a small community sanitation program, for a major cocoa rehabilitation project, and for the development and upgrading of natural, historical and scenic places (specifically Grand Etang).

British aid, through the *British Development Division* (BDD), has primarily focused on the Model Farms project, forestry development and management programs, and infrastructure expansion for the country's water system. Additionally, a planning and design consultant was seconded for two years through the United Kingdom's Overseas Development Administration to assist the Physical Planning Unit.

The Government of Venezuela, through the *Venezuela Investment Fund*, has made a major contribution in support of the ongoing Artisanal Fisheries Project.

Multilateral assistance for resource management has been provided by the European Communities through its *European Development Fund* (EDF), most significantly in support of the Model Farms Project. The *United Nations Development Program* (UNDP) was actively involved in planning activities in Grenada in the 1970's (see Section 12.2) and more recently has provided funding for Model Farms and to support the position of a parks manager in the Forestry Department. The UN's *Food and Agriculture Organization* (FAO) has provided assistance for agricultural programs, including Model Farms, for the Mardigras Soil and Water Conservation Project, and for forestry development; while a specialized agency of the UN, the *International Fund for Agricultural Development* (IFAD), has given significant support to the Artisanal Fisheries Project.

The regional *Caribbean Development Bank* has actively supported resource management projects in Grenada, including a major reforestation program and water pro-

jects. With USAID, the CDB provides funds for the Annandale Agroforestry Project.

12.6 OVERVIEW ASSESSMENT OF THE INSTITUTIONAL FRAMEWORK FOR ENVIRONMENTAL MANAGEMENT

The most comprehensive recent study of the institutional framework for environmental management in Grenada was the survey and analysis of GOG resource management agencies completed by the OAS in 1987 (Bourne, 1987). Some of the findings of the OAS consultant can be summarized as follows:

- In almost all departments of Government, the consultant identified problems of quantity and in many instances of quality as well. Middle-level management staff was of particular concern. Some GOG officials were pursuing training overseas, and their places were often filled by expatriate technical assistance personnel. However, not enough attention was paid to training local persons as counterparts when such assistance was available.
- Coordination between the departments of Government is poor, and in almost all cases seems to take place exclusively at higher levels with heads of departments interacting with one another at meetings. This often means that such officials are required to make decisions with little prior opportunity to secure technical input from within their departments.
- There was little evidence of long-term planning in most departments.
- External loans and grants from regional and international development assistance agencies accounted for almost ninety percent of the 1987 capital budget of Government, one indication of how far GOG is from being

able to support self-sustaining programs for resource management.

Others have pointed to weaknesses in the planning process and in development control procedures (see also Section 12.3). The Physical Planning Unit (PPU) and the Land Development Control Authority (LDCA), housed in different ministries, are primarily concerned with building control and lack the resources to carry out long-term land use planning. Review of development applications within Government is often by the same persons who comprise the Board of the approving authority (the LDCA), while virtually all development activities undertaken by the public sector were not subject (until very recently) to LDCA review (it remains to be seen how effective the new Land Development (Control) Act Regulations will be in regulating the development actions of GOG agencies).

Several departments of Government, cutting across a number of different ministries, are involved in land use and resource management activities which carry environmental responsibilities. But such responsibilities are ill-defined without clear guidelines about functional relationships between agencies, and -- most importantly -- show little evidence of accountability. As pointed out by Lausche (1986), Frederick (1987a), Bourne (1987), and Soler (1988), inter-agency coordination among these departments is weak with limited channels available for inter-sectoral cooperation, particularly important when legislative authority for natural resource management and environmental monitoring activities is shared by several agencies.

Recommendations for structural, procedural, and legislative action or changes are provided in this section. They serve as a guide to GOG in improving its ability to integrate environmental considerations into the decision-making process and to facilitate its resource management responsibilities.

(1) *Improve the formal mechanisms within Government for inter-sectoral and inter-agency cooperation and coordination.* Improved coordination is perhaps the most critical issue confronting Grenada in the resource

management sector. It is particularly important because (1) the overall institutional base for environmental management in the country is weak and (2) resource management functions are spread among several departments of Government.

The proposed Environmental Impact Assessment procedures which the PPU intends to draft in the near future (see Section 9) represent a positive step in the direction of improved inter-agency coordination. Although the PPU now forwards development applications on an "as needed" basis to other GOG agencies, formal EIA requirements would force a more holistic integration of technical data and expertise, while at the same time guaranteeing more systematic input into project planning across departmental lines.

GOG also needs to address and strengthen the role of the National Science and Technology Council as a vehicle of inter-sectoral/inter-departmental environmental coordination. The specific responsibilities of the Council need to be clearly defined, and its capacity to establish and monitor environmental standards needs to be explored.

(2) *Approval of a National Land Use Plan.* Inadequacies in the planning process have been attributed, in part, to the lack of a planning framework. Although a Physical Development Strategy was, with the assistance of UNDP, put forward in 1977, it was never formally accepted by Government. It continues to be used informally as a guide by local planners, but as it does not carry official Government approval, decisions about changes in land use and approval of new development activities tend to be based on short-term considerations and are executed on a case-by-case basis. Furthermore, local planners maintain that the lack of an official land use plan slows the development approval process and makes more difficult the work tasks of the already busy and understaffed PPU.

The Physical Planning Unit is now engaged in the process of preparing a new Physical Development Plan for the country, scheduled to be completed by early 1991. The Plan is to be put before Cabinet for review; if approved, such action would then lend the

force of law to many of the "zoning" and land utilization allocations which it is anticipated the Plan will include.

(3) *Creation of a new Planning and Development Authority.* For at least three years there has been discussion within Government of the need to abolish the LDCA and replace it with a new Planning and Development Authority (PDA), which combines planning and development control functions in one body responsible to a central ministry (Robinson, 1987, Frederick, 1987b). There has also been a proposal to place the Lands Division and the Land Survey Division of the Ministry of Agriculture (see Section 12.3) under the new Authority (Robinson, 1987).

These proposals reflect widespread dissatisfaction with the planning and development control process as presently carried out by two related but different governmental units, the PPU and the LDCA. Centralizing these functions within one statutory body, its proponents maintain, will improve the coordination necessary for improved planning and land development decision-making. The proposed PDA would have a strong forward planning mandate. For example, one proposal (Robinson, 1987) calls for the PDA to develop a Land Use Policy, a broadly-based land use policy statement by Government, to be followed by detailed development plans for areas under the greatest pressure.

Several reviewers have pointed to the potential of the Physical Planning Unit to assume an expanded role in guiding spatial development and in providing environmental leadership in Grenada (Frederick, 1987a; Bourne, 1987; Soler, 1988). Yet, such studies have also acknowledged the inability of the present staff to carry out stated functions, particularly regarding forward planning and monitoring/enforcement tasks. The reorganization of planning functions within the proposed PDA might help to increase both the size and capabilities of the Government's physical planning staff by placing it at the center of a key public sector authority.

At the same time, it must be recognized that merely centralizing and expanding planning/development control staff will not

solve all the recognized problems. As recommended in Section 9, there is also a need to create an improved monitoring/enforcement capability for land-use changes within Government.

GOG should take these various proposals under early consideration as deficiencies in the present planning and development control process have been identified by both internal and external reviewers.

(4) *Updating of environmental legislation where required; harmonization and rationalization of all environmental law to avoid unnecessary overlaps in institutional responsibilities.* The provisions of two specific environmental laws need to be updated and strengthened.

(1) **Public Health Ordinance.** In a recent review of natural resource legislation in Grenada, Lausche (1986) points out the need for a review and updating of Public Health legislation, noting the difficulty of pollution control procedures under the existing law which dates to 1925 (regulations enacted in the 1950's). Not only are its provisions outdated, but its extremely low penalties would trivialize the best of efforts aimed at pollution control.

(2) **National Trust Act.** Lausche (1986) also points out the inadequacy of the 1967 National Trust legislation which gives the Trust little substantive authority and no express power to make and enforce regulations for the management of protected areas. These deficiencies are particularly important in a country lacking more specific protected areas legislation -- other than the provisions of the broadly-inter-

preted Forest, Soil and Water Conservation Ordinance and the more recently enacted Fisheries Act. The Government's failure to update and amend the Grenada National Trust Act has seriously impeded the recent initiatives to reorganize and revitalize the 20-year old Trust.

Furthermore, as identified elsewhere in this chapter, there are areas of overlapping institutional responsibility in the resource management sectors of Government, some of which have been authorized by statute and some of which are procedural. Key among these are: development control and planning approval, development of public lands, conservation and protection of watersheds, pollution control and maintenance of water quality.

What is required at this time is a more tightly defined analysis of extant environmental law and of GOG institutional responsibilities than that provided in the recent OECS/OAS overviews (Lausche, 1986; Bourne, 1987). Such an analysis needs to update and build upon these studies by more specifically identifying those areas of (1) existing or potential conflict in institutional responsibilities and (2) shared or overlapping legislated or assumed authority. Recommendations for modification of existing legislation need to be included as well as guidelines for improved coordination procedures. The objective is not to eliminate overlap per se but to capitalize on opportunities for shared monitoring, to identify common goals, and to provide better procedures for control, oversight and enforcement activities.

The most expedient method to accomplish this task would be for GOG to approach an appropriate donor agency for assistance.

SECTION 13 SUMMARY OF POLICY ISSUES

13.1 ESTABLISHING DIRECTIONS

One of the reasons for embarking on the present Environmental Profile for Grenada was to identify which emerging resource use conflicts were locally perceived as growing worse, which ones have been documented or labelled by the experts as threatening, which are being dealt with, and which are not.

Therefore, the previous twelve sections of this CEP report have scrutinized in some detail the current status of Grenada's natural resources and environment and the effects of recent growth and development initiatives on those resources, some of which are often taken for granted as being "free goods." This final section seeks to highlight extant and emerging environmental problems and presents a summary of suggested resource management policy directions and recommendations that would help shape a national framework for environmental management in Grenada.

Amidst the political drama and changing social and economic agendas of the past two decades, it is not surprising that Grenada has fallen behind most of its neighbors in the Eastern Caribbean when it comes to devising new environmental programs to deal with unprecedented growth impacts, land use planning, pollution control and resource depletion. But, in another sense, Grenada has been fortunate. By virtue of its semi-isolated position at the southern end of the Lesser Antilles, it has avoided the direct impacts of the most exotic, industrial pollutants from North America. The closest it has come to flirting with expanding volumes of toxic materials has been the export agriculture sector where a growing dependency on chemical fertilizers and a variety of herbicides, pesticides and fungicides has become increasingly worrisome. Furthermore, the country has virtually no life-threatening groundwater pollution, no overcrowded beaches or clear-cut forest, and no major crop failures from disease in recent memory.

Yet all is not well. Beneath the surface, Grenada's natural resource base has been bearing an increasingly heavy burden of expanding levels of human use, growing loads of waste materials including sewage (especially in the urban area of St. George's and the tourism area of Grand Anse), a diminishing wildlife population, and evidence of an accelerating watershed and shoreline erosion problem which is linked, respectively, to deforestation and sand mining. Political events of the past decade have caused Grenada's growth curve to wobble a bit with sectoral ups and downs and with changes in social policy and development theory; through it all, Grenadians seemingly have maintained a relative disinterest in the environmental side of the effects of national growth. Government reportedly has tended to view developmental objectives and environmental protection as being in conflict, with the former almost always taking precedent. Within this framework, the Government of Grenada appears reluctant to translate even the more obvious environmental warning signals into regulatory or incentive-based environmental policies. However, ignoring emerging environmental problems and issues did not and still does not make them go away. The evidence is fairly clear -- for Grenada, they are getting worse.

13.2 IDENTIFYING THE ISSUES

The Grenada Country Environmental Profile has served as a "catchment" for identifying environmental issues within the state. Most issue statements which surfaced during the writing of the Profile and which are elaborated upon within this document constitute a national work list for which some modicum of consensus has been established. They could also be used constructively as the guide for a nationwide environmental education program.

Under the best of circumstances, this Profile and its action recommendations could

and should lead directly to the design and implementation of a national conservation strategy or its equivalent. At the very least, the document stands as an addendum to Grenada's development strategy and public sector investment program. What is most needed at this juncture is a policy framework and a schedule of implementation.

There are two groupings of issues addressed within the Profile. The first is derived from the sector review and analysis which constitute the preceding chapters. For the convenience of the reader, the sector-specific issues and recommendation summaries accompany each sector overview statement and are clearly identified within each section or sub-section.

The second, smaller group of issues, more national and less sectoral in scope, has been singled out and presented below in the remainder of this chapter to offer some policy direction. Although a sequence of problems is presented separately and individually, there is a risk in doing this, for no issue should be considered in isolation. There are some very important linkages, and the inter-relatedness of elements within both natural and human ecosystems constitute an important concept for the would-be Grenadian resource manager. Solutions generally require interdisciplinary and inter-ministerial cooperation and coordination and are seldom as neat and orderly as their presentation in list form would suggest.

ISSUE: GOVERNMENT FRAGMENTATION AND LINES OF RESPONSIBILITY

Grenada's fragmented approach to the administration of environmental affairs, the absence of any official environment protagonist within Government with clear lines of authority and responsibilities, and the financial constraints under which various GOG resource managers must work tend to hinder implementation of effective environmental management strategies for sustainable development.

ISSUE: DEFORESTATION

Pressures to increase export cultivation necessitate the clearing of more and more new land which impinges upon steeper slopes highly susceptible to erosion. Small farmers are also being forced into more mountainous areas. Soil erosion and downstream siltation are the common result of such land clearing and the resultant deforestation. While erosion has serious implications for reduced agricultural productivity, it can also raise the risk of landslides and diminish the value of valley land by contributing to excessive flooding. Generally, land clearing for farming and fuelwood harvesting on very steep slopes or in water catchment areas and forest reserves should be eliminated.

In the case of much of Grenada's forested landscape, these lands are less productive than they could be. Forest land that is cleared, in some cases illegally, for shifting agriculture has seldom been reforested. This is also the case with much of the secondary forest areas targeted by landless farmers, fuelwood harvesters and charcoal burners. Reforestation planting schedules in the past have simply not kept up.

ISSUE: WATERSHED MANAGEMENT AND WATER SUPPLY

Upper catchment and forest reserve areas are not being adequately protected against deforestation, and these important protected areas are not, unfortunately, being expanded by land acquisition to guarantee a water supply for future generations of Grenadians. Additionally, there is some evidence that the widespread application of various pesticides and herbicides in upland areas is contaminating downstream water supplies. It has proven difficult for Government to regulate activities on private land in upland watershed areas.

ISSUE: COASTAL ZONE DEGRADATION

Six related problems impinge upon the quality of Grenada's coastal ecosystems. These are: (1) badly managed solid and liquid

waste disposal facilities and practices; (2) excessive beach sand mining; (3) coastal erosion; (4) improper coastal engineering and construction practices; (5) uncontrolled land-based sources of mostly nutrient discharge; and (6) a general zoning and planning failure regarding land use along the coast. The complexity of the problem requires the design and implementation of a national coastal zone management strategy.

ISSUE: PUBLIC INVOLVEMENT AND PARTICIPATION

The challenges of environmental management and sustainable development in smaller island systems have proven to be quite amenable to the broad application of the principles of participatory planning and public involvement. In Grenada's case, there is a need to facilitate both formal and informal involvement of communities and private sector groups in resource management activities, ensuring that their concerns are properly taken into account. In this regard, it is especially important to pay serious attention to groups and whole communities which rely heavily on natural resources. The effectiveness of this approach has been demonstrated elsewhere in the region by successful pilot projects incorporating user participation in resource management.

ISSUE: LEVEL OF ENVIRONMENTAL AWARENESS -- INSTITUTIONS

By comparison with other nearby island areas, Grenada's indicators of environmental concern and awareness are perhaps as much as a decade behind. There is little coverage of environmental issues in the local press; no well organized, financially solvent environmental NGOs have come forward to take the lead on a broad agenda of environmental concerns; environmental education programs are modest and intermittent; and among middle-level technical and professional people, it is difficult to identify the kind of "critical mass" for environmental leadership which has emerged on most other OECS islands. As a result, the country has an imbalance or skew factor regarding natural re-

source protagonists -- they are few in number, they have only relatively weak institutions with which to work, and as a result there is little national consensus about environmental goals, objectives, and desired policies.

ISSUE: ENVIRONMENTAL AWARENESS -- GRASS ROOTS LEVEL

Since much of the environmental damage taking place in Grenada occurs at a grass roots level, any indication of an emerging environmental awareness among both rural and urban populations warrants attention. This, of course, is a longer-term developmental process which is currently hindered by the absence of any clearly articulated national environmental policy. Community-level NGOs and self-help groups should be enlisted in the effort to build environmental consensus, which would be strengthened by greater involvement of the public in the planning process and in the defining of national and community-level development goals and projects which affect natural resources and local environments.

ISSUE: AGRICULTURE

Agriculture is critical to Grenada's social system and is the dominant economic sector in the economy, contributing more than 25 percent of GDP. It is the major source of foreign exchange and provides employment for about one-third of the labor force. But it is also not very productive or profitable, even for larger commercial operations. It must be recognized that at present marginal farmers tend to pay little attention to and cannot afford to invest capital and labor in conservation practices. Therefore, the Ministry of Agriculture (probably with donor assistance) needs to work at the development of a series of low-cost, grass roots-based, demonstration programs for soil and water conservation aimed at the small, marginalized farmer group. Some incentive-driven options would be useful, perhaps even essential. A very modest, built-in monitoring effort would improve the design, focus and impact of subsequent farm and rural area, resource conservation and environmental awareness initiatives.

ISSUE: AGRICULTURAL COMMODITY ASSOCIATIONS AS VEHICLES FOR IMPROVING RURAL ENVIRONMENTAL PRACTICES

The four commodity associations which deal with bananas, cocoa, nutmeg and minor spices (see Section 5) provide many services beyond marketing. Some of these services -- like warehousing, curing, processing, pest and disease control, and fertilizer procurement -- involve waste products and toxic materials. All four of these associations need to develop and implement both internal environmental quality control policies for staff and external environmental service programs for their respective members and farmer clients. A waste management plan would be an example of the first, and a soil conservation and enhancement program is an example of the second. Since there is some overlap with the extension service administered by the Ministry of Agriculture, good coordination could result in reinforcement and broader geographic coverage while avoiding redundancy. Until a national environmental policy framework is established, the four commodity associations should devise, adopt and seek external funding for an interim or pilot program.

ISSUE: LAND USE PLANNING -- IMPROVING ALLOCATION

Grenada's prime lands must satisfy the nation's needs for food, housing, recreation, waste disposal and many other human activities. And they must provide these things on a continuing basis for an expanding population of residents and visitors if the country is to remain both ecologically and economically viable. Yet, at the same time, land allocation for Grenada's newest sector -- the tourism industry and its spatial demands for specialized infrastructure and supporting amenities -- introduces expanded demands as well as the potential for conflicts. Especially in a small island system like Grenada and Carriacou, each with limited physical space, the tasks of allocating and anticipating future land use requirements for various national purposes is critical to orderly and efficient development. Grenada's land use planning policies, facilities, and practices are collectively inadequate

to the task ahead, and a significant investment is needed. Any staffing upgrade should include both an environmental planner and a coastal zone management specialist or planner.

ISSUE: SOIL CONSERVATION AND EROSION

As the pressures of the market as well as inflation encourage individual land owners and tenants to produce more per acre, the land resource itself comes under pressure, carrying capacity is sometimes exceeded, and the land is intensively farmed or exploited to meet short-term objectives. The management inputs of both goods and services for conservation activities needed to maintain the land and the landscape (e.g., terracing to control run-off and erosion) may simply be out of financial reach.

The agricultural sector has so far been the one most directly affected by soil degradation and erosion impacts with resulting adverse effects on crop yields. In most of Grenada, increased use of fertilizers, pesticides, and herbicides (for weed control) have offset declines in natural productivity, but only at considerable added costs to producers.

One of the more visible conservation issues in Grenada at the present time (for example, in the Annandale watershed) involves soil erosion from privately owned, excessively steep hillsides which have been cleared and planted in bananas or root crops. While few measurements or even estimates of the affected hillside areas are available, circumstantial evidence suggests the scope of the problem is substantial and growing. Thousands of tons of silt and sediment are being eroded in the rainy season from carelessly, often illegally, de-vegetated upland areas and carried seaward by excessively rapid run-off.

The economic consequences of this kind of erosion are significant but unquantified in the absence of suitable monitoring by any Government agency. The costs of damage from the erosion process are mostly hidden and seldom discussed publicly as an officially recognized land use management problem. Perhaps the most important first step in the

direction of solving some of these problems would be to design and implement a targeted resource base monitoring program that would quantify losses, not just of land and soil but also tax revenues, productivity, income, and opportunity.

ISSUE: WATER -- CONSERVATION AND MANAGEMENT

Erosion is not the only problem linked to excessive clearing of steep slopes for expanding agriculture. In combination with road building, illegal logging, squatting and fuelwood harvesting on the elevated ridges and upland slopes, de-vegetated areas soak up less water, and the paved and cleared areas permit more direct sheet run-off. This results in less water infiltrating the soil to underground storage and instead produces immediate, more rapid run-off downslope.

ISSUE: ECOSYSTEM DAMAGE, REPAIR AND SUSTAINABILITY

On the basis of the evidence assembled during the course of this profiling effort, it is reasonable to foresee a worsening problem in the environmental sector in Grenada -- not so much the catastrophic kind as the persistent, nagging kind, cumulative, pernicious and imperiling (sometimes actually damaging) basic resources like forests, water, reefs, wildlife, or beaches. In those cases where resource misuse results in serious damage, as in the case of deforestation, groundwater pollution, or the gross removal of beach sand, there may be a need for an environmental repair job, sometimes called "ecological restoration." Because of past environmental indiscretions and their destabilizing effects on the landscape, development project sustainability and environmental maintenance (and repair when necessary) are equally important elements in any national economy. This point has been elevated recently as a focal point in the findings of the Brundtland Commission (the World Commission on Environment and Development), which confirmed the need to seek economic solutions to environmental problems and environmentally-sustainable solutions to economic problems.

13.3 STEPS TOWARD BALANCE AND SUSTAINABILITY

Essential features on which policies depend are called key inputs, variables, or imperatives; they are critical for future development and must be addressed. Imperatives are not options from which a government may choose a policy. If any of them is disregarded, the policy will fail and, in extreme cases, some kind of national catastrophe (environmental, economic, social or political) will follow. In short, imperatives are not negotiable.

Imperatives may be used as a yardstick by which to measure the success of previous policies and as a basis for comparing the merits of alternative future strategies. They are interrelated and need to be kept in balance with one another. In practice, over-emphasis of one may divert resources from others in the short term, but over a longer period they are mutually reinforcing.

CRITICAL FACTORS OR IMPERATIVES

Six key "imperatives" have been identified by McHenry and Gane (1988).

(1) *Water*: maintaining and improving the island's capacity to collect and store water for domestic, industrial and agricultural use, and safeguarding water quality by proper management of the watersheds and forest resources.

(2) *Soil*: preventing loss of soil from erosion and maintaining and improving soil fertility by managing the natural vegetation and planting trees and crops in accordance with sound land use practices.

(3) *Heritage*: safeguarding the national heritage for present and future generations by preserving features of particular landscape value and sites of cultural, historic, scientific or educational significance; protecting endangered or threatened species of wildlife; controlling the rate of exploitation of economically useful species; preserving examples of terrestrial and marine ecosystems and maintaining the habitat of plants and animals

in designated areas; creating national terrestrial and marine parks for the public to enjoy this heritage.

(4) *Sustainable Production*: generating the largest possible output of products from each sector, on a sustainable basis. This means that the growth of each sector and its effects on all other sectors must be monitored so that no sector grows at the expense of the others. Any given sector should be allowed to grow only to the point where it makes its optimal contribution to gross domestic product, foreign exchange, employment and investment opportunities, while maintaining the quantity and quality of the natural and human ecosystem. This will allow the potential of each sector for meeting the nation's socio-economic needs and aspirations to be realized over the long term.

(5) *Participation*: widening the range of participation in all aspects of development, especially land and natural resource allocation decisions, so that all elements of the community have an opportunity to become involved in the process. Private citizens and non-government organizations should share in the costs and the work of conserving the national heritage, thereby reducing the demand on the public treasury.

(6) *Public Awareness*: increasing awareness about the vital role of natural resources in national socio-economic development, in order for all citizens to appreciate the extent to which they depend on these resources for their survival.

OBSTACLES TO PROGRESS

Effective action to sustain and develop all natural resource sectors is seriously hampered by several major socio-economic obstacles in Grenada at the present:

(1) *Inadequate basis for resource management*. Most historical, cultural, and natural resources cannot be effectively protected or managed until the land they occupy is secured. Government control through purchase or long-term lease followed by designation as a specially managed or

protected area is the simplest way to achieve this.

An ambitious national park system has been proposed for Grenada, including several categories of protected areas. The proposed national park system may be beyond the limits of what is practicable or affordable in Grenada at the present time. A more modest scheme may be achievable in the short term.

A phased process for development of the proposed national parks system has in fact been suggested by GOG/OAS, and various areas have been assigned priorities (see GOG/OAS, 1988d, Tables XIV, XV and XVI). The process of safeguarding the resource base takes time but is an urgent task because attrition continues in the meantime -- and once non-renewable resources are thoughtlessly or deliberately destroyed, they cannot be replaced.

(2) *Misuse of the land in watersheds*. Government ownership of land at higher elevations in the mountainous interior of Grenada could enable most of the catchments above water supply intake points to be kept unoccupied and free of cultivation. Lower down, most land is privately owned, and there is little effective control of its use. Cultivation on precipitous slopes affects stream flow, causes serious erosion and siltation, and may endanger lives due to landslides. The use of agricultural chemicals by small farmers carries the risk of polluting water supplies.

Although it raises sensitive political issues, some curtailment of owner's rights is unavoidable if these issues are to be addressed in the national interest. The consequences of continuing to disregard such problems are serious enough to warrant immediate action for the most vulnerable areas, either by legislative steps or by incentives to alter current land use practices. A visible forewarning of the costs of continued mismanagement of the natural landscape is apparent in Carriacou, where soil degradation has reached an advanced stage, and the water-retentive capacity of catchments has been destroyed by the practice of free-roaming livestock grazing for a large part of each year.

(3) *Economic capability.* The economies of the small island countries in the Eastern Caribbean are for the most part not sufficiently developed to take on the broad range of resource management activities which are increasingly expected of modern states. The variety of scientific and technical expertise needed to cope with the management of forest resources, degraded catchments, pollution control, wildlife and national park management, and the like requires a larger, better trained staff than most Eastern Caribbean countries, including Grenada, can afford to employ or keep fully occupied. Training in a variety of specializations cannot be provided locally; overseas training is long and costly, and qualified applicants may not be available. Infrastructure can also become a problem. Improved infrastructural facilities are most often built and funded by external aid agencies but then must rely on local financial resources and local technical staff to support and maintain efficient systems, not always an easy task in the developing world.

13.4 LAUNCHING A PROGRAM: FIRST STEPS

MOBILIZING GOVERNMENT

While the idea of government as guardian of selected environmental resources is not new, what is new and still in experimental stages (in Grenada as elsewhere in the region) is the idea of trying to choreograph various ministries, government departments and even statutory bodies into a coordinated resource management system.

What is also new is the rapid growth and acceptance of the world-wide, citizen-based, environmental movement in which community groups -- from labor unions to churches, civic organizations and NGOs -- begin to put pressure on governments to do something about environmental abuses in order to protect communities from environmental hazards and to guarantee the conservation and survival of certain environmental amenities.

MOBILIZING PEOPLE

The days of passive conservation for many natural resources in Grenada are fast disappearing. Any new national conservation program for Grenada for the decade of the 1990's will inevitably require expanding levels of more direct kinds of governmental intervention. In turn, this presumes an antecedent national strategy and plan for ecosystem restoration and management.

But since most environmental intervention and all resource management involves people, as land owners, tenants, voters, constituents and resource user groups, it follows that a national program for ensuring public participation is equally important. Evidence from around the region in this regard is compelling. Public involvement enhances the planning process, minimizes conflict between the government regulator and traditional resource users, enlists the cooperation of the latter and thereby reduces system maintenance costs in the longer term. In fact, an active public participation element is the easiest and best way to ensure both more and better information in the decision-making process. Grenada will, sooner or later, have to find a way to deal with this, or it will be overwhelmed by its own growth and by external forces and competition from within the region.

This is a classic case where open, imaginative leadership is just as important as public funding because an enlightened, independent sector, properly encouraged, will develop its own institutions (NGOs) and its own funding and cadre of paid professionals and volunteers who can be of great assistance to Government. Although most government leaders appreciate the value of natural resources, few take the position that institutional capacity is also a scarce and valuable resource and that optimizing its growth and use can greatly accelerate the realization of development goals and strategies.

Enlisting people in any longer-range endeavor takes persuasion. Recruiting a team of supporters for a national environmental management strategy will require, among

other things, a visionary kind of "persuasion model," one that conveys the beauty, intricacy, vitality and even the complexity of Grenada's ecosystem but does not drive people away with trivia, detail, and controversy. But for all this to work, an environmental framework is needed, one that spells out mutually shared goals and objectives and the mechanisms by which public and private sector institutions can work both separately and together towards the desired ends of maintaining a quality environment for this and future generations.

THE ENVIRONMENT AND HUMAN RESOURCE DEVELOPMENT

People, however, are the real key to sustainable development and the maintenance

of a high quality ecosystem in an island like Grenada. To ensure that their enthusiasm, commitment, energies and ingenuity are harnessed, it is important to make certain that the national framework, sector plans, and in fact all aspects of environmental programming are sensitive to local priorities and resources. Environmental initiatives at the national level, if they are to be truly sustainable, must have a dimension that strengthens local communities and optimizes human resource potential at the grass roots level, the true environmental frontier. The effort required to mount this top and bottom level strategy is clearly greater than that required to issue a few national guidelines. But the ultimate return on the investment of time and energy will not only be much greater, but it is the only way truly sustainable development can be achieved in a democratic society.

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CARIBBEAN CONSERVATION ASSOCIATION



The *Caribbean Conservation Association (CCA)* is a regional, non-governmental, non-profit organization dedicated to promoting policies and practices which contribute to the conservation, protection and wise use of natural and cultural resources in order to enhance the quality of life for present and future generations. In fulfilling its mission, the Association establishes partnerships with organizations and groups which share common objectives; it focuses attention on activities designed to anticipate and prevent, rather than react and cure.

Established in 1967, CCA's membership comprises Governments (currently 19), Caribbean-based non-governmental organizations, and non-Caribbean institutions, as well as Associates (Individual), Sponsoring and Student members. CCA's activities span five major program areas: (1) the formulation and promotion of environmental policies and strategies; (2) information collection and dissemination services; (3) promotion of public awareness through environmental education activities; (4) research about, support for, and implementation of natural resource management projects to foster sustainable development; and (5) assistance for cultural patrimony programs.

CCA's support is derived from Caribbean Governments, membership contributions, international donor agencies, private corporations and concerned individuals. It is managed by a Board of Directors, while its day-to-day activities are supervised by a Secretariat comprising a small core of dedicated staff. For more information, write: Caribbean Conservation Association, Savannah Lodge, The Garrison, St. Michael, Barbados. Telephone: (809) 426-9635/5373; Fax: (809) 429-8483.

ISLAND RESOURCES FOUNDATION

The *Island Resources Foundation (IRF)* is a non-governmental, non-profit research and technical assistance organization dedicated to the improvement of resource management in offshore oceanic islands. Established in 1970, its programs focus on providing workable development strategies appropriate for small island resource utilization through the application of ecological principles and systems management approaches that preserve the special qualities of island life.

Key program implementation areas include coastal and marine resource utilization, land use planning, environmental impact assessment, national park and tourism planning, cultural resource development, and resource sector policy studies. In 1986 the Foundation launched a program of assistance to non-governmental organizations in the Eastern Caribbean designed to improve the capabilities of such groups to provide private sector leadership for achieving environmental goals in the region.

Foundation funding is derived from private foundations, government agencies, international organizations, and through donations and contributions. IRF publishes research and technical reports and maintains a publications office for distribution of these documents. Its reference libraries in the Virgin Islands and Washington, D.C. are widely recognized as a unique collection of over 10,000 documents on insular systems and resource management, with a primary emphasis on the Caribbean. The Foundation is based in the U.S. Virgin Islands, with a branch office in Washington, D.C. and a program office in Antigua. For additional information, write: Island Resources Foundation, Red Hook Center Box 33, St. Thomas, U.S. Virgin Islands 00802. Telephone: (809) 775-6225; Fax: (809) 779-2022.

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