BELIZE

COUNTRY
ENVIRONMENTAL PROFILE

Robert Nicolait & Associates Ltd.

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BELIZE

Country Environmental Profile

A Field Study

by

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Preface

This Country Environmental Profile (CEP) of Belize is one of a series of environmental profiles funded by the U.S. Agency for International Development (USAID), Bureau for Latin America and the Caribbean (LAC), Office of Development Resources (DR), and AID mission to Belize. The scope of work for this in-country study was developed jointly by Neboysha Brashich, USAID mission to Belize, and James Talbot, USAID Caribbean Regional Environmental Management Specialist (REMS/CAR).

Robert Nicolait & Associates Ltd. (RN&A), Belize City, contracted team leader, Gary Hartshorn, and local specialists to prepare sector reports during the second half of 1983. Consultants for the institutional and legal sector reports were contracted through the International Institute for Environment and Development (IIED). Gary Hartshorn prepared this synthesis and analysis of the status of the environmental and natural resources in Belize. Lynne Hartshorn edited the final report.

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LAND OF THE FREE

O, Land of the free by the Carib Sea,
Our manhood we pledge to thy liberty,
No tyrants here linger, despots must flee
This tranquil haven of democracy.
The blood of our sires which hallows the sod,
Brought freedom from slavery oppression's rod,
By the might of truth and the grace of God.
No longer shall we be hewers of wood.

> Arise! ye sons of the Baymen's clan,
> Put on your armour, clear the land!
> Drive back the tyrants, let despots flee–
> Land of the free by the Carib Sea!

Nature has blessed thee with wealth untold,
O'er montains and valleys where prairies roll;
Our fathers, the Baymen, valiant and bold
Drove back the invader; this heritage hold
From proud Rio Hondo to old Sarstoon,
Through coral isle, over blue lagoon;
Keep watch with the angels, the stars and moon;
For freedom comes tomorrow's noon.

by Samuel A. Haynes
Belize National Anthem

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INTRODUCTION

HISTORY, CULTURE AND HUMAN RESOURCES

NATURAL RESOURCES

Metric Conversions

Approximate Conversions to Metric Measures

Symbol	When you know	Multiplied by	To find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lbs)	0.9	metric ton	t
		VOLUME		
qt	quarts	0.95	liters	L
gal	gallons	3.8	liters	L
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	degrees Fahrenheit	5/9 (after subtracting 32)	degrees Celsius	°C

Approximate Conversions from Metric Measures

Symbol	When you know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	metric ton (1000 kg)	1.1	short tons	
		VOLUME		
L	liters	1.06	quarts	qt
L	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	degrees Celsius	9/5 (then add 32)	degrees Fahrenheit	°F

(Source: U.S. Department of Commerce, National Bureau of Standards, Washington, D.C.)

Abbreviations & Acronyms

BAS	Belize Audubon Society
BCB	Banana Control Board
BDF	Belize Defense Force
BEB	Belize Electricity Board
BELCAST	Belize College of Arts, Science and Technology
BIAS	Belize Institute of Agricultural Sciences
BMB	Belize Marketing Board
BNCN	Belize Nutrition Communication Network
BNDF	Belize National Development Foundation
BSA	Belize School of Agriculture (Central Farm)
BSB	Belize Sugar Board
BSI	Belize Sugar Industry
BTA	Belize Telecommunications Authority
BTB	Belize Tourist Board
CARE	Cooperative for American Relief Everywhere
CARICOM	Caribbean Community
CATIE	Tropical Agricultural Research and Training Center
CBB	Central Bank of Belize
CBDF	Commercial Bank Discount Fund
CBI	Caribbean Basin Initiative
CDB	Caribbean Development Bank
CDC	Commonwealth Development Corporation
CDSS	Country Development Strategy Statement
CFC	Caribbean Finance Corporation
CFNI	Caribbean Food and Nutrition Institute
CGA	Citrus Growers Association
CIC	Caribbean Investment Corporation
CIDA	Canadian International Development Agency
CITES	Convention on International Trade in Endangered Species
CMO	Chief Medical Officer (MHHC)
DFC	Development Finance Corporation
EDB (F)	European Development Bank (Fund)
EEC	European Economic Community
EHD	Environmental Health Division (MHHC)
GDP	Gross Domestic Product
GIS	Government Information Service (MEC)
GNP	Gross National Product
GOB	Government of Belize
IBRD	International Bank for Reconstruction and Development (World Bank)
ICBP	International Council for Bird Preservation

IDB	Inter-American Development Bank
IDRC	International Development Research Centre (Canada)
IMF	International Monetary Fund
IMSWE	Investigations of Marine Shallow Water Ecosystems (Smithsonian Institution, USA)
IUCN	International Union for the Conservation of Nature and Natural Resources
MEC	Ministry of Energy and Communications
MHHC	Ministry of Health, Housing and Cooperatives
MNR	Ministry of Natural Resources
MTI	Ministry of Trade and Industry
MW	Ministry of Works
NYZS	New York Zoological Society
OAS	Organization of American States
ODA	Overseas Development Administration (U.K.)
OPG	Operational Program Grant (AID)
OPIC	Overseas Private Investment Corporation
PADF	Pan American Development Foundation
PAHO	Pan American Health Organization
PCI	Project Concern International
PC(V)	U.S. Peace Corps (Volunteer)
PHI	Public Health Inspector
PHS	Public Health Service (MHHC)
PVO	Private Voluntary Organization
RARE	Rare Animal Relief Effort
REAP	Rural Education and Agriculture Project (CARE)
	Belize Rename: Relevant Education for Agriculture and Production
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
VSO	Voluntary Service Overseas (U.K.)
WASA	Water and Sewage Authority (MEC)
WHO	World Health Organization
WWF	World Wildlife Fund

I.

Executive Summary

This country environmental profile of Belize (BCEP), financed by USAID, was carried out during the second half of 1983 by Robert Nicolait & Associates Ltd. of Belize. Sixteen specialists contributed sector analyses (individual reports at RN&A) to the BCEP. Included in the field study are syntheses of the country's cultural heritage and history, human resources, natural resources, as well as institutional and legal aspects of environmental issues and natural resources management.

Situated south of the Yucatan Peninsula, Belize has 22,963 km^2 of land area (including 689 km^2 on 450 offshore cays), 280 km of coastline, 23,657 km^2 of territorial sea (extending 20 km into the Caribbean Sea) and a spectacular barrier reef that is second in length only to Australia's Great Barrier Reef. Seaward of the barrier reef are three beautiful atolls.

At 15-19°N latitude Belize is in the subtropics, with typical temperature regimes. Rainfall ranges from about 1,500 mm/yr in the north to over 4,000 mm/yr in southern Toledo district. Belize has a history of devastating encounters with tropical cyclones.

After steady economic growth through the 1970's, Belize's economy has stagnated since 1981. A 60% drop in world sugar prices reduced export earnings by B$12 million in 1982, causing serious balance of payments problems for such an import-oriented economy. The Belize dollar (B$) is officially tied to the US dollar at the rate of B$2=US$1.

History, Culture and Human Resources

The cultural factor is especially important in Belize's history and identity. Several hundred archaeological sites in Belize attest to the exceptional Maya civilization that flourished for more than a millennium. The present population of about 150,000 consists of eight major ethnic groups: Creole, East Indian, Garífuna (Carib), Kekchí, Ladino, Mennonite, Mopan and Yucatec. Though Mennonites and North American landowners are a small, advanced component of the population, they have the technological facilities to greatly alter the landscape.

Not surprisingly, 80% of the Belizean populace is multilingual; English is the official language. Over 90% of the population is clustered in cities, towns and villages, leaving about 75% of the country virtually uninhabited. Over the past decade Belize had an annual rate of natural population increase of 3.6%, giving it 50% of its population under 18 years old; but because one of every eight Belizeans emigrates, the average annual net increase was a modest 1.9%. Nevertheless, 11% of the 1980 population was foreign-born, reflecting the long tradition of immigration. Civil strife and warfare in Central America have brought numerous refugees to Belize. Estimates of Salvadoran refugees in Belize range from 2,000 to 15,000; however, only 1,585 is the estimate for this CEP. The GOB-sponsored Valley of Peace project is attempting to resettle 200 agrarian families from El Salvador and Belize.

Contamination

Water pollution is the principal contamination problem. Most communities depend on surface waters for potable water, thus the dumping of faecal material, sugar-processing effluents and industrial wastes into streams has caused some public health problems and fish kills. Belmopan is the only urban area fully served by a sewage system. A CIDA-funded project is constructing potable water and sewage systems for Belize City. Solid wastes are a source of roadside eyesores and beach debris. Air and noise pollution are insignificant.

Coastal and Marine Ecosystems

Few countries have the coastal and marine richness of Belize, with extensive coastal lagoons, mangroves, sea grass

beds, coral reefs and cays. Belize's barrier reef is the second longest in the world, supports the country's most economically important fishery (spiny lobster) and atracts a growing tourist trade to this world-class resource.

Fisheries exports in 1982 earned US$6.2 million, ranking second in export earnings after sugar. Lobster exports account for 81% of fisheries export earnings, with conch exports a distant second with 11% The fishing industry is organized in four major cooperatives. Lack of capital is the major constraint to expansion of the industry to deep water fishing. Mariculture and aquiculture projects have recently been started.

Because of the prominent role of cooperatives in the industry, the Fisheries Unit is part of the Ministry of Health, Housing and Cooperatives. Notwithstanding a solid legal base for resource management, the Unit is hampered by a lack of enforcement capabilities. Foreign poaching of lobster and conch in southern Belizean waters is the most serious problem affecting the country's fisheries.

Despite recent upgrading of Belize's port facilities, the country lacks a natural deep water port. There is no evidence that environmental considerations are examined prior to port maintenance (e.g., dredging) or development activities.

Belize is particularly vulnerable to hurricanes because most urban centers are on or near the coast. Because of continued vulnerability to hurricanes, the capital was moved inland to Belmopan and the GOB has an elaborate plan to cope with natural disasters.

Belize's coastal area and the more attractive cays are largely privately owned. Notwithstanding legal instruments such as the 1939 law and the 1973 Aliens Landholding Ordinance, foreign speculation and beach access for local residents are occasional problems. The 1982 Land Tax Act, which taxes land on unimproved value, may result in value being determined by foreign buying demand, especially in popular tourist areas such as Ambergris Cay and the Placencia peninsula.

Environmental issues involving coastal development (including the cays) include improving basic services to the community, conservative uses of natural resources to support settlements, evacuation plans in case of natural disasters, improvement of human and corporate waste disposal systems, and providing additional housing. These issues are most evident in Belize City, which is situated on a mangrove peninsula. Beach erosion is a problem in the Commerce Bight area and near the mouth of the Sibun River. Perhaps the most serious coastal development problem is the provision of potable water. Fresh water is scarce and drawing down the water table leads to saltwater intrusion. Contamination of groundwater aquifers from other sources is also a growing problem.

The principal sector recommendation is to increase the administrative, monitoring, enforcement and educational capacity of the GOB to effectively manage the development of the country's coastal and marine resources. These complex resources require a multi-sectoral approach involving administrative units responsible for fisheries, ports, public lands, potable water, sewage, mangroves and tourism.

Geology

The mainland is dominated by the low Maya Mountains, of which the Mountain Pine Ridge is a remnant of the oldest land surface in Central America. The northern half of Belize consists of heterogeneous sediments deposited on the Yucatan platform. Except for the Maya Mountains, limestone and sediments derived from limestone are the dominant geologic features. Karst topography is common on the perimeter of the Maya Mountains.

Of the seven geologic formations described, the *Coban limestone* is the probable source of petroleum. The *Campur limestone* formation will probably prove to be the major aquifer underlying Belize's lowlands.

Several economically important minerals such as barite, bauxite, cassiterite and gold occur in Belize, but none has yet been found in commercial quantities. Dolomite and hard limestone quarries on the periphery of the Maya Mountains are sources of excellent road ballast.

Since 1955, over 40 petroleum test wells have been drilled with about 65% showing oil. However, poor structural and seismic data have hindered the petroleum exploration efforts. The new Petroleum Office does not have environmental guidelines or regulations for the exploration, production or processing of crude oil.

Hydrology

Surface water resources are abundant in Belize except on the Vaca Plateau where streams disappear in the porous limestone. Surface water from streams is used for domestic purposes by 70% of the population, including Belize City. Pollution of drinking water is not yet a serious problem, although faecal and detergent contamination is a pervasive risk. Streams descending the Maya Mountains offer numerous sites for potential hydroelectric generation, but comprehensive studies will be necessary before development of this resource.

Belize's groundwater resources are poorly known, but appear to have considerable potential as a source of potable water. Both water-table aquifers and artesian aquifers exist, but few wells go deeper than 30 m. Of the seven groundwater provinces described, two have abundant groundwater supplies: The *Campur limestone* formation underlying the Coastal Plain and Shelf province and the *Sepur* formations in Toledo province.

Guidelines and regulations for drilling into artesian aquifers are needed to protect this high quality resource.

Governmental coordination is required of those agencies responsible for well-drilling, water supply and potability.

Soils

Twenty-three subunits in seven principal landforms are used to describe the major soil features of the country. The siliceous soils of the Mountain Pine Ridge (landform N° 1) have low fertility and high erodability. The siliceous soils of the Maya Mountains (2) are singularly unsuited for agriculture due to low fertility, mostly steep terrain and high erosion risk. It appears that the ancient Maya did not use the poor soils of these two landforms for agriculture.

The calcareous soils of karst landscapes (3) occur over a wide range of topography and rainfall. Although these soils have good natural fertility, many are inaccessible or have moisture limitations. The Toledo lowlands of Tertiary mudstones, shales, and sandstones (4) are restricted to Toledo district. The soils are generally fertile under long-fallow milpa agriculture or permanent tree crops, but rapidly lose fertility under short fallow cycles or annual crops.

The calcareous soils of the northern lowlands (5) cover 35% of the country with a complex array of marine and delta sediments. Of the nine subunits, soils derived from hard Miocene limestone (5c) and from soft siliceous limestone (5e) are the best for agriculture. The former is most extensive in northern Cayo district, whereas the latter is abundant in the northern sugar cane region.

The siliceous soils of the lowland pine ridge (6) are the most problematic soils of the country. The oldest soils (Puletan series) are very acid, strongly leached of nutrients and with a compact clay pan in the subsoil. The littoral complex of organic soils and sandy soils (7) occurs along the coast and on the cays. Although of no agricultural importance, much of the human population lives here and the mangroves are important nursery areas for marine organisms.

Land Use

Ancient Maya farmers concentrated their agriculture on calcareous soils of hilly and rolling landscapes. Modern agriculture began in Belize little more than a century ago, thus the country's soils have not been seriously degraded by erosion or overuse. However, recent immigrants and refugees who practice slash-and-burn agriculture are causing erosion problems on hilly terrain.

About 4,500 km^2 (19% of Belize's land) are suitable for mechanized agriculture, particularly the calcareous soils of the northern lowlands (landform N° 5). Production forestry is the most appropriate land use in much of the **Mountain Pine Ridge** (1). Most of the siliceous soils of the **Maya Mountains** (2) should be maintained in protection forest. The calcareous soils of **Karst Landscapes** (3) are most appropriate for milpa production of corn; however, this landform is under increasing pressure for mechanized farming and cattle ranching operations. Milpa and modern agriculture are common on the **Toledo Lowlands** (4), where land use in some areas is nearing maximum human carrying capacity.

The country needs a detailed classification of land use capability based on principal landforms and ecological life zones, as well as technological uses. Such a classification would identify the most appropriate areas for agricultural development and should be used to resolve land use conflicts in the Maya Mountains complex.

Agriculture

Including forestry and fisheries, agriculture is the largest contributor to the national economy—employing one-third of the work force and generating about half the gross domestic product. Sugar accounts for 60% of Belize's agricultural exports. Other important exports are orange and grapefruit concentrates, bananas, mangoes, rice and honey.

Milpa farmers of Toledo district produce most of the hogs for the national market. Milperos, who are considered subsistence farmers, also produce some corn, rice and beans for market. However, most of the food consumed nationally is produced by small farmers. Medium-sized Mennonite farms supply the country with dairy products, poultry and vegetables. Large farms are oriented to export crops and beef cattle.

The GOB's priority is to develop the agricultural potential of the country by increasing production of export commodities and local substitution of imported food. Major constraints to agricultural development are the lack of all-weather roads, difficulty in obtaining credit and capital items for small- and medium-sized farmers, and contemporary attitudes about farming.

USAID has a major project to upgrade several aspects of the livestock industry by reducing production inefficiencies, expanding product markets and involving small and medium producers. The USAID project will focus on improving pastures and cattle management rather than encourage expansion of pastures.

Numerous pests and diseases affect Belize's agricultural crops. The increase in mechanized farming and monoculture crops can only increase the need for careful monitoring and control of pests and diseases. It is strongly recommended that pest control be integrated with agricultural development. A mixture of biological, agronomic and chemical controls is the most promising approach to pest and disease problems. Legislation to regulate the importation, handling, storage and use of pesticides in Belize has been drafted but the laws have not been promulgated.

Forests and Forestry

The Belize flora is estimated to include about 4,000 species of flowering plants. Although the flora is poorly known, few endemic species are restricted to Belize. Exploitation of logwood and mahogany provided the basis for British settlement and three centuries of geo-political identity. Six major ecological life zones (these define the natural vegetation of the area based on latitudinal region, altitudinal belt, potential evapotranspiration ratio, humidity and annual precipitation) occur in Belize. Mangroves are a prominent feature along the Belize coast, as well as on many of the cays.

According to official statistics, 93% of Belize is classified as "forest land", but this figure excludes only urban areas and agribusiness operations and ignores the extensive areas of milpa agriculture in western Cayo and southern Toledo districts. Fifteen forest reserves have legal status, covering 6,367 km^2 (28%) of the country. Although forest reserves are considererd as lands for permanent forestry, 22% of the land in forest reserves is unofficially considered as protection forest. Some forest reserves are under increasing pressure for agricultural use, but the Forest Department does not have the political support to protect the country's forest patrimony.

The Forest Department, a dependency of the Ministry of Natural Resources, concentrates forestry activities in the principal forest lands with exploitable or productive potential, such as the Mountain Pine Ridge and Chiquibul Forest Reserves and the Cockscomb Basin. Although total timber production has increased modestly over the past several years, 1981 forestry exports earned only B$2.4 million, equivalent to 1.5% of foreign earnings. The annual cut of timber is only about 5% of the potential harvest on a sustained-yield basis. However, that potential will only be possible if the production forests are protected from slash-and-burn agriculture, local wood processing facilities are improved, effective forest management plans are implemented, and the technical and administrative capabilities of the Forest Department are strengthened.

Though plantation forestry began in Belize over 35 years ago, only about 3,500 ha of plantations exist. Much Forest Department effort has been focused on fire control in pine forests. The extensive stands of 20-30 year-old pine attest to the success of the Department's fire control program. Pest problems are minor on Belize's forests and plantations.

The principal sector recommendation is for the Forest Department and private enterprise to cooperate on developing viable management programs for the country's productive hardwood forests. This should involve not only mahogany but secondary hardwoods as well. A few key timber concessions should be lengthened so as to encourage private industry in sustained-yield forestry.

Wildlands Conservation

The 1981 National Parks System Act is the legal base for national parks, natural monuments and wildlife reserves. Legally established conservation units only focus on major sea-bird rookeries. A portion of Half-Moon Cay, 100 km offshore on Lighthouse Reef, was declared a bird sanctuary in 1928; then in 1982 the Cay and surroundings were converted to Belize's first Natural Monument. In 1977 seven small mangrove cays were declared bird sanctuaries, but due to the absence of wardens, all but one cay have been destroyed by hunters and fishermen. Guanacaste Park is a 21 ha reserve near Belmopan. The Rio Grande reserve was lost to Indian milpa farmers. The GOB recognizes some other small units but their status is uncertain.

The Belize Audubon Society is proposing three candidate areas as wildlife reserves: Upper Bladen; Crooked Tree Lagoon; and Cockscomb Basin. In the latter area, the New York Zoological Society is conducting a long-term study of jaguar ecology and behavior. Thirteen other potential areas for wildlands conservation are also briefly described.

The GOB has proposed to UNESCO that Belize's barrier reef and atolls be designated a World Heritage Site. Such a designation would bring international recognition to this world-class resource and provide advice and some funding for rationally developing multiple uses of the marine resources while ensuring their conservation.

Critical to the development of a viable wildlands system is an adequately funded GOB agency with trained personnel. International conservation organizations should be invited to help build this institutional capability in the Ministry of Natural Resources. Without the necessary institutional support, there is no merit in creating on paper the proposed conservation units. It is also recommended that experts evaluate the ecological and conservation potential of the existing as well as the proposed conservation units.

Terrestrial Wildlife

Because of her extensive forests, Belize has excellent populations of birds and large mammals, many of which are considered endangered in much of the rest of Central America. Even such species as jaguar, tapir, Ocellated Turkey, and American and Morelet's Crocodiles appear to have healthy populations in Belize. The Forest Department has effectively shut down illegal trade in wild animal hides and pets. Although exploitation of sea turtles is permitted by the 1977 Fisheries Ordinance, these endangered species need complete protection.

Several wildlife species such as brocket deer, paca, and peccary are commonly taken for food, a permissible harvest controlled by the 1982 Wildlife Protection Act. Some wildlife species are pests on crops or livestock, or they transmit diseases. Introduced rats and mice are much more of a pest problem than the native species.

Native species of Belize that are considered endangered or threatened with extinction include 15 mammal species, 33 bird species and 7 reptile species. Belize's endangered animal (and plant) species should be studied to gather basic natural history information and to determine present status, threats, and management possibilities.

Energy

Virtually all of the energy consumed in Belize is produced from imported petroleum products, of which the majority is used by the transportation sector. Electricity is produced by petroleum-fueled generators under the aegis of the Belize Electricity Board (BEB). Total available electricity has remained constant for several years at 70 million KWH/year. Abnormally high transmission losses and frequent generator failures are two of the major problems affecting delivery of electricity. The BEB needs to develop an overall strategy to supply present and future electricity needs.

Belize has considerable potential sources of renewable energy, such as hydroelectric, biomass and solar. These possibilities, as well as the proposal to buy Mexican-generated electricity, need to be thoroughly explored and evaluated.

Institutional and Legal Aspects of Environmental Issues

Belize has the typical British Commonwealth parliamentary system, headed by the Prime Minister. The Cabinet is the principal instrument of policy to direct and control government.

Natural resources and environmental management responsibilities are scattered among ten ministries. There are also several quasi public, statutory boards responsible for crops (bananas) commodities (sugar, market) and services (tourism, telecommunications, electricity). The only significant local conservation organization is the Belize Audubon Society (BAS), which is an effective private force behind GOB conservation legislation. A veritable roster of international conservation groups has contributed to BAS efforts in Belize.

Since Independence, the GOB has passed several laws, ordinances and acts that have greatly strengthened the legal bases for natural resources and environmental management. However, much of this impressive but broad legislative program has not been implemented due to lack of specific regulations and substantive standards. Thus, any application becomes a rule-making process without precise guidelines.

Barriers to effective implementation of environmental programs include jurisdictional disputes between ministries, lack of trained middle- and lower-level public servants, lack of enforcement capability, severe fiscal constraints and lack of knowledge among the general public about the importance of conservation and rational use of natural resources.

Environmental Issues and Potential Actions

Belize's population and good state of natural resources must be allowed to develop fully according to GOB plans and financial resources. However, development need not lead to destruction nor to overexploitation of resources. Various aspects of management of renewable resources and control of non-renewable resources must be identified and studied, and plans should be detailed to secure a continued healthy and productive environment.

The following issues and potential actions are summarized in this section in no special order of priority to give the reader an environmental status report on Belize's natural resources and to suggest potential activities for decision makers directly responsible for Belizean resource management programs. It is hoped that the international development assistance community also will find these recommendations useful in guiding financial support programs in natural resources.

Contamination or pollution of the environment results when the natural system's ability to absorb and process waste is exceeded. This is a social and cultural problem. Belize's primary contamination problem is water pollution. Most communities depend upon surface water for their potable water supply and the general public health depends on potable water.

- Improve facilities for dumping faecal matter where sewage systems do not exist.
- Render harmless all sugar processing effluents and industrial wastes, especially toxic chemicals like cyanide.
- Prevent chemical effects and sedimentation of rivers and the coastal waters that will eventually kill the coral reefs.
- Locate dumping facilities for solid waste away from areas where potable water in drawn.
- Monitor potable water supplies by providing adequate laboratory facilities, technology and trained technicians.
- Address public health education, water use and contamination.
- Enforce strong legislation to prevent contamination of groundwater aquifers and rivers.
- Analyze potable surface water for pesticide residues derived from agricultural runoff (non-point source) and heavy metals or other contaminants from industrial operations (point source).

Coastal and Marine Development will depend upon the establishment of an adequate data base. Before fisheries exploitation can be expanded, the resource must be thoroughly evaluated.

- Provide funding to undertake the necessary basic inventory research.
- Stimulate mariculture and aquiculture of preferred species.
- Protect preferred species from overexploitation.
- Introduce less-preferred species to the domestic market.
- Control poaching.
- Set and enforce fishing limits for preferred species such as conch, lobster, grouper, and snapper.

Coastal development will depend upon water and sewage facilities.

- Evaluate location and potential of water resources including quality and supply.
- Limit development in relation to potable water supplies.
- Improve urban and industrial waste disposal systems.

Forestry in Belize still has tremendous potential.

- Inventory all plant species.
- Identify less preferred tree species and assess their potential uses.
- Enforce minimum cutting sizes for harvesting hardwoods.

Sustained yield forestry depends upon forest protection from slash-and-burn agriculturalists.

- Develop forest management programs for hardwood forests.
- Encourage private industry participation in sustained yield forestry.
- Involve mahogany concessionaires in forest management.

Deforestation will become an issue as the need for agricultural land increases.

- Assess land use capability of existing and potential forest reserves to clearly define production forests.
- Assess land use potential before releasing land for agriculture.
- Return lands not suited to agriculture to forest.

Agriculture, forestry and fisheries employ a third of the work force and generate half of the GDP. The GOB has the potential to produce all of its food. Agricultural development depends on road improvement so that farmers can reach their markets.

- Provide all-weather roads and maintain them to serve this sector.

The GOB is addressing traditional preferences and practices concerning home grown foods.

- Increase production of agricultural crops.
- Produce more foods and process them locally to meet and possibly exceed the level of those foods now imported.
- Provide facilities and training for drying, storage and refrigeration to small and medium size farmers to upgrade their production.
- Instill contemporary attitudes in farmers to integrate traditional techniques with modern technology and needs.

Modern agricultural technology brings its own pest and chemical problems. Potential agricultural problems can be reduced or eliminated by actively educating farmers and the general public about their responsibilities in safeguarding the land from chemical abuses, as well as the public from accidental poisonings.

- Continue and/or develop training in integrated pest management (IPM) programs at Central Farm for teachers and extension agents.
- Draft and enforce legislation to secure the safety of use, handling and storage of potentially harmful chemicals.
- Integrate crop management with biological and chemical pest control.

Health and Nutrition problems stem primarily from Belize's geographical location in the tropics/subtropics. Malaria, potable water supply and sanitation (mosquitos and water/sewage facilities) are the major issues, compounded by lack of trained health staff, facilites, and equipment.

- Define areas of the country with *Anopheles* and *Aedes* mosquitos and maintain checks on their populations.

- Intensify the mosquito control program to control populations of *Anopheles* and *Aedes* mosquitos.

- Provide potable water facilities to all settlements.

- Provide sewage/sanitation facilities in all urban areas.

- Provide information and guidance about sewage/sanitation in rural areas.

- Keep food sanitation standards high.

- Define Public Health staff priorities and provide financial resources to carry out their work.

Nutritional status depends upon the function of food intake and health of the person. Nutritional diseases affect everyone but children under five are the least able to sustain illness combined with insufficient or unbalanced diets.

- Continue to upgrade health education programs incorporating sanitation measures with food habits.

- Continue to alleviate anemia by prescribing iron supplements through district clinics.

- Continue to concentrate on preventive medicine techniques to reduce illness and improve health and nutrition.

Endangered Species and Wildlands Conservation must be addressed together because they are interrelated.

- Identify populations of endangered or threatened species and protect their habitats. Some examples are the green turtle, iguana, harpy eagle, spoonbill, wood stork, certain hawks and cagebirds, including parrots.

- Eliminate hunting pressures on endangered species through enforcement of protection laws.

- Educate the public about the necessity to maintain the balance of nature.

- Protect cays and wildlands, that have been designated as reserves, from poachers and habitat destruction.

- Evaluate for potential education/tourist development areas that have been identified for historic, natural history, scenic or archaeologic value.

- Institute a curriculum in environmental sciences, specifically parks management, at BELCAST.

- Begin a curriculum in archaeological studies at BELCAST.

- Expand secondary school curricula to include tourism management and natural resources development.

The National Conservation Strategy, sponsored by IUCN, to evaluate conservation potentials and needs was initiated in 1983, but it is currently inactive.

- Provide the necessary fund/staff to complete the Conservation Strategy.

- Promote UNESCO's designation of the Barrier Reef as a World Heritage Site.

Soils of a country are the stock from which all other land resources spring. Belize has land areas where the soils are suited to forestry, agriculture or cattle ranching. Human use of the land determines whether it will be maintained at a high level of productivity, or if it will be left as useless for the future.

- Conduct a detailed land-use capability classification of the country.

- Legislate for the proper use of the land and strongly enforce the law.

- Restrict colonization and settlement to lands suitable for sustained agriculture.

Information Access in Belize is severely lacking, especially of environmental baseline data, natural resources and cultural resources. It is important for the GOB to establish archives with access (materials placed in the system and easily retrievable) to all information generated by nationals and foreigners.

- Encourage the Ministry of Education (in charge of the Archives) to play a more active role in collection of reports and country information.

- Introduce data base technology for storage and retrieval of information. Train data processors and provide for technical review of information processing.

- Require that natural resource and archaeological reports be deposited in the National Archives in Belmopan.

- Require all scholars working in Belize to submit copies of their work to the Archives.

Water Resources are available in Belize, but the GOB must protect its potable water sources to ensure viability of development and growth.

- Use state-of-the-art drilling techniques especially where there is danger of salt water intrusion into the well.
- Create a National Water Council with responsibilities for water quality, technology, and provision.

Limestone geology indicates that Belize is rich in groundwater resources.

- Identify areas where the groundwater resources are plentiful.
- Protect all aquifers from contamination.

II.

Introduction

The purpose of a country environmental profile (CEP) is to aggregate in one definitive document the information, data and analyses on national environmental problems and to identify possible environmental improvement programs that could be undertaken by the government of Belize (GOB) and/or private sector with financial assistance from international agencies. Specific CEP objectives are to identify major existing and potential problems and areas of concern for Belize's natural resources and environmental management; to conduct an analysis of the effects of these problems on the environment, society and the economy; and to provide an overview of GOB institutions and policies that relate to natural resources conservation and environmental management.

This CEP was carried out for USAID/Belize during the second half of 1983 by a team of local and regional specialists contracted by Robert Nicolait & Associates, Ltd. of Belize. Sixteen specialists prepared sector documents that were condensed and integrated into the present synthesis by Gary Hartshorn. Lynne Hartshorn edited the final report.

Belize is the second smallest (22,963 km^2 of land area) and newest country on the western hemisphere mainland. Though physically located in Central America (Fig. II-1), Belize has strong cultural and economic ties with the Carribbean, especially the former British colonies comprising the Caribbean Community. Since independence in 1981, Belize has attracted considerable development assistance from many international sources. Though Belize does not yet suffer any severe environmental problems, her population density, now low, will increase and lands will begin to be exploited more intensively. This report serves as a basis for further analyses of development plans and projects as they affect the environment and natural resources of Belize.

II–A. GEOGRAPHY

Belize is located in northern Central America, bordered by Mexico on the north and Guatemala to the west and south (Fig. II–1). Including territorial waters in the Caribbean Sea, Belize's geographic coordinates are 15° 53' to 18° 30' N latitude and 87° 15' to 89° 15' W longitude. Using an offshore territorial limit of 20 km (12 miles) the national territory covers about 46,620 km^2 (18,000 mi^2), of which 49% is land. Belize's land mass includes 450 tiny islands known as cays (pronounced keys), totaling about 690 km^2 (266 mi^2). However, there are about 1540 km^2 (595 mi^2) of lagoons on the mainland, reducing effective land area to some 21,400 km^2 (8,263 mi^2). The average dimensions of the Belize rectangle are about 260 km north-south and 180 km east-west; the mainland has 280 km of coastline.

The principal geographic features have NNE-SSW or WNW-ESE orientation in conformity with major fault lines. The NNE-SSW faults generally show a steeper escarpment topography facing east and gentle slopes dipping westward. The coral reefs, cays, and mangrove-covered shoals are located along the crests of NNE-SSW trending submarine ridges. Faulting (or perhaps warping) along WNW-ESE axes has produced less conspicuous topographic features. Northern coastal features suggest uplift followed by a long period of stability. The central coastline is sinking slowly; however, the southern coast is rising, forming low cliffs and inland lagoons.

Belize's most spectacular feature is its barrier reef--the second longest in the world and the longest in the northern hemisphere. The barrier reef extends 220 km from the Mexican border to Sapodilla Cays (Fig. II-1). Along Ambergris Cay the barrier reef is only a few hundred meters offshore, whereas it is over 40 km (25 mi) offshore at Placencia.

Seaward of the barrier reef, the continental margin is a series of discontinuous marine ridges with NNE-SSW orientation. On two of these ridges coral atolls have developed, separated by waters 360–1100 m deep. Seaward of the marine ridge supporting Glover's and Lighthouse

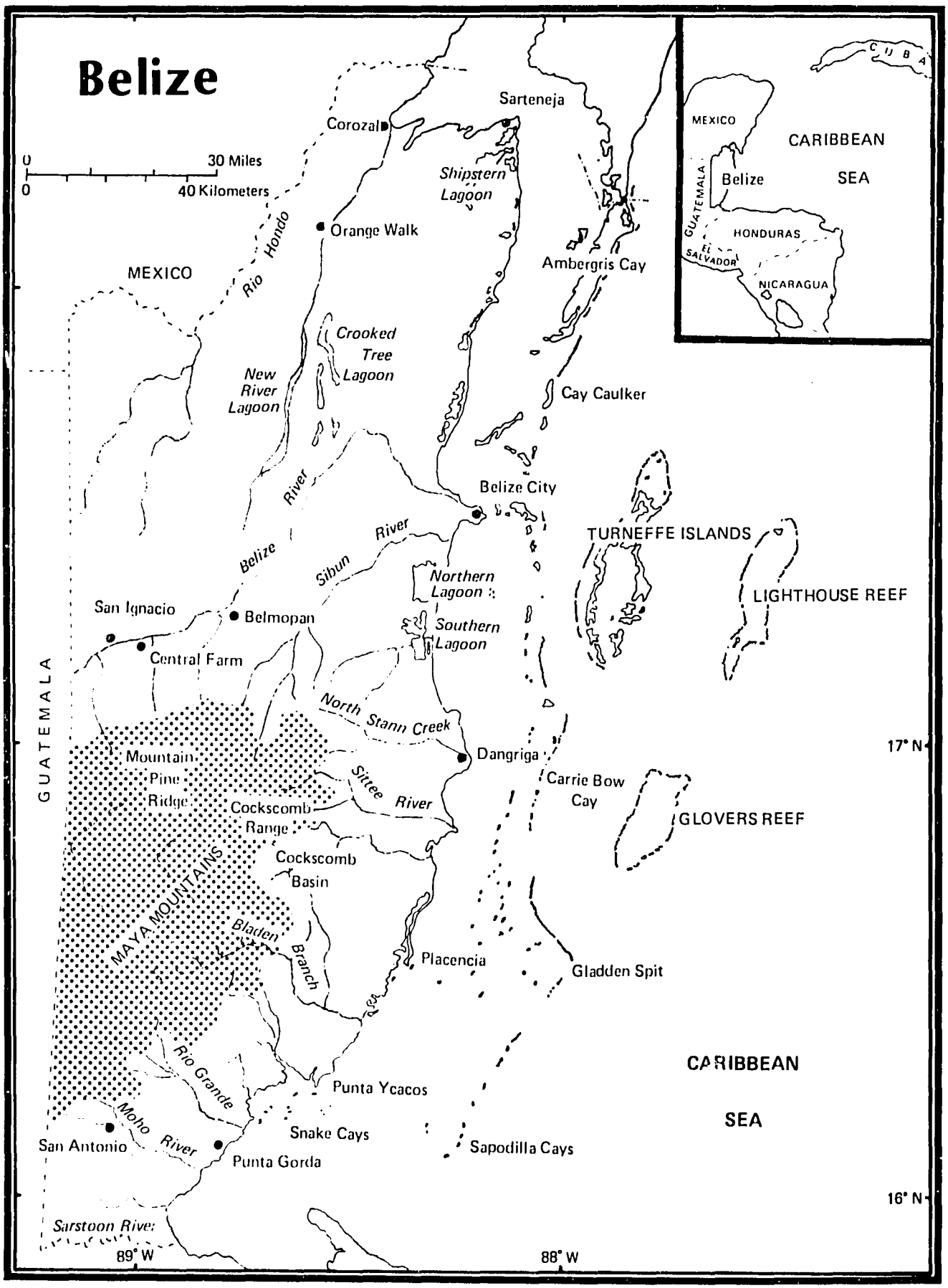


Figure II–1. — Geopolitical map of Belize. See Fig. III–5 for district boundaries.

Reefs is an escarpment descending more than 4000 m into the Cayman Trough.

The most prominent physiographic feature of the Belize mainland is the mountainous region in the south-central part of the country generally referred to as the "Maya Mountains". The core of this mountainous block consists of granite and ancient (Paleozoic) sediments, exceedingly low in minerals capable of providing nourishment for growing plants. The Maya Mountains are surrounded by major faults (Fig. II-2); a cumulative process of uplift began some 180 million years ago. During the Cretaceous period, when mainly limestones were being deposited, a part of the ancient Permian landscape of the original Maya Mountains stood above the level of the Cretaceous ocean as a low island, giving rise to the oldest land surface in Central America. The "Mountain Pine Ridge" plateau is a remnant of this ancient land surface.

The thick beds of dense white crystalline limestone deposited during the Cretaceous period originally covered the flanks of and completely surrounded the island of Paleozoic rocks (as found in the Maya Mountains). During the very long period of erosion that followed, much of the limestone was dissolved and stripped from the Paleozoic rocks, leaving the latter exposed to erosion. Only a few high points of more resistant rock, such as the quartzites of the Cockscomb Range, testify to the original thickness and extent of the Paleozoic rocks.

The mountainous and hilly landscapes of the west, southwest and south (Cayo and Toledo districts) are formed from Cretaceous limestone and show typical karstic landforms.

The boundary between Cretaceous limestone and the much younger Tertiary sediments is always sharp in Belize. The Tertiary sediments form landscapes of subdued relief, seldom exceeding 225 m above present sea level. In the far south (Toledo district) these Tertiary calcareous sediments are mostly shales, mudstones and sandstones; in the north (Belize, Cayo, Orange Walk and Corozal districts), they are mainly limestones, marls, 'reef rock' and beach gravels. Advanced karstic features are not found in these Tertiary limestones.

Flattish landscapes occur on the central and northern parts of the coastal plains, built up during the Quaternary by the deposition of alluvium carried down from the mountains. Large amounts of quartz sand and silica in dissolved form were deposited on, or within, the calcareous sediments on the coastal shelf. Over the northern half of the country, the pattern of sedimentation suggests alluvial deposition in the form of a delta. The main rivers originally flowed northward but gradually deflected in a more easterly direction as the northern part of Belize was subjected to gentle uplifting.

The last period of volcanic activity to affect the Belize landscape was some 200 million years ago. Minerals probably derived from volcanic ash (which may have drifted from distant sources) occur in some of the Cretaceous limestones and in a few of the Tertiary limestones. Volcanic material was obviously deposited on the reef limestone before it was uplifted in the Quaternary. Volcanic ash from contemporary volcanic activity seldom reaches Belize in any significant quantity, despite relative proximity of volcanoes in Guatemala and southern Mexico.

II–B. CLIMATE

At 15–19° N latitude, Belize lies in the outer tropics or subtropical geographic belt. The subtropics have higher extreme and mean temperatures than occur in tropical latitudes (0–13°). The three highest temperatures recorded in Belize are 42.8° C (109° F) at Sibun Hills and 40.6° C at both Punta Gorda Agstat and Stann Creek Agstat (Walker 1973). Mean monthly minima range from 16–17° C in winter to 24–25° C in summer, while mean monthly maxima range from 28° C in winter to 32–33° C in summer. Temperatures are noticeably cooler in the mountains. Along the coast (and on the cays), the on-shore breeze moderates the daily high temperature. The Belize coastal area is exposed to southeast tradewinds averaging 10–13 knots that attain greatest constancy in July.

The northern coastal plain of Belize receives about one third the rainfall of southern Toledo district (Fig. II-3). Annual rainfall averages for 76 stations (Walker 1973) range from 1347 mm (53") at Libertad (Corozal district) and 1323 mm (52") at Benque Viejo del Carmen (Cayo district) to 4526 mm (178") at Barranco (Toledo district). Seasonal effects are greatest in the central and northern regions where January through April or May are dry (less than 100 mm/month). The dry season is shorter (February-April) in the south-central region. A minor, less-rainy period usually occurs in August.

Two meteorological disturbances, northers and cyclones, can greatly alter typical weather patterns. "Northers" are cold, wet, northeast air masses occasionally pushed far to the south from November to February by arctic air masses. Local effects are cooler-than-normal temperatures, heavy rains and choppy seas. Potentially more dangerous are cyclones--non-frontal, low pressure, large-scale systems that develop over tropical waters with a definite, organized circulation (Neuman et al. 1978). Depending on wind speed and sustainability, cyclones are classified as tropical depressions, storms or hurricanes; hurricanes are the most powerful cyclones with minumum sustained winds of 64 knots (119 km/hour).

Though only 5% of the cyclones recorded in the tropical Atlantic Ocean reached Belize between 1886 and 1978, the country has a history of devastating encounters with tropical cyclones (Fig. II-4). The 1931 hurricane nearly destroyed Belize City, taking an estimated 1000 lives. Hurricane Janet in 1955 destroyed Corozal town. In 1961 Hurricane Hattie struck the mainland near Mullins River with winds of 300 km/hr, killing 275 people with 4 m tides and destroying agricultural crops and forest (Lindo

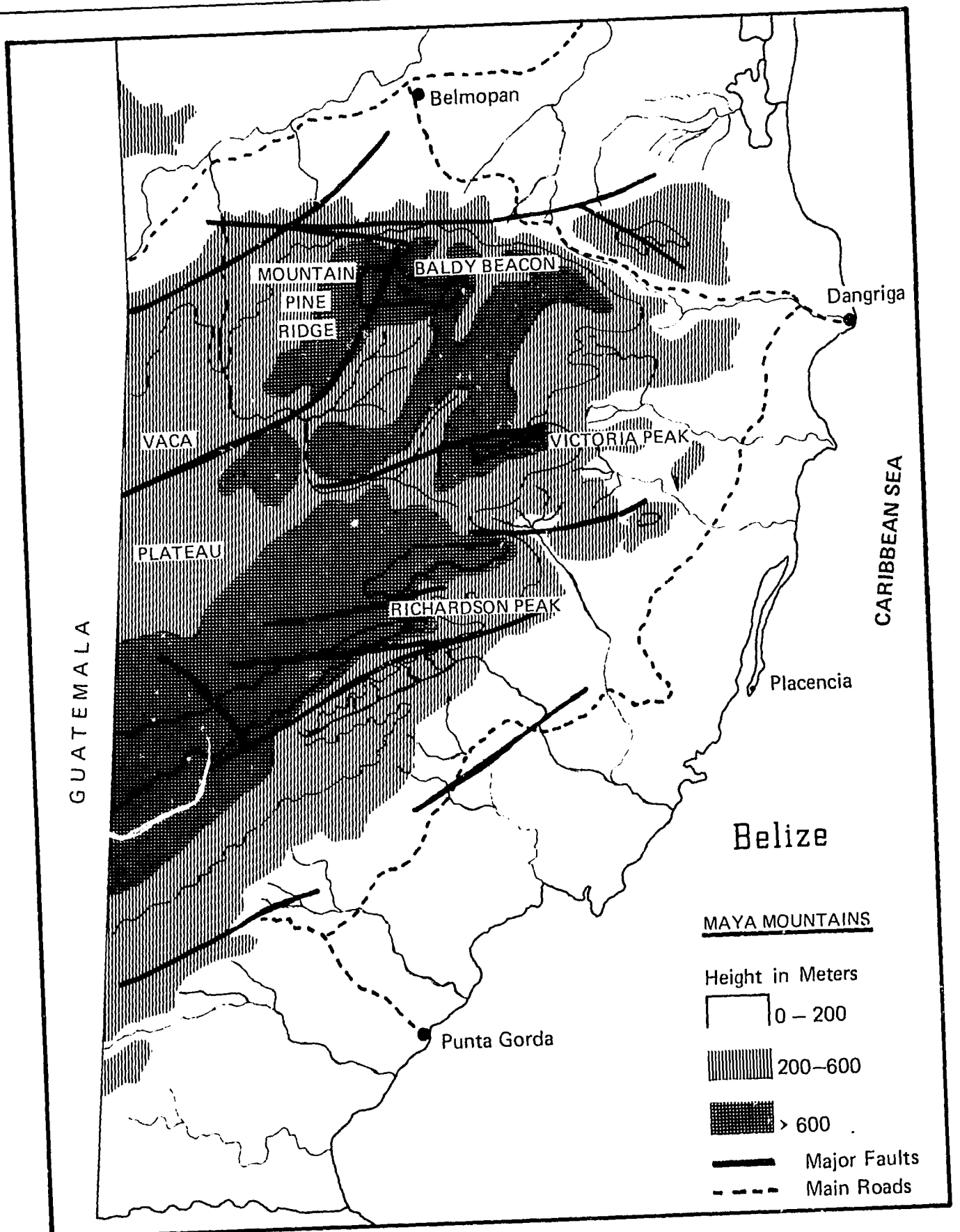


Figure II–2. — The Maya Mountains showing major fault lines and physiographic features. Before uplift, the Maya Mountains constituted a low island in the Cretaceous ocean.

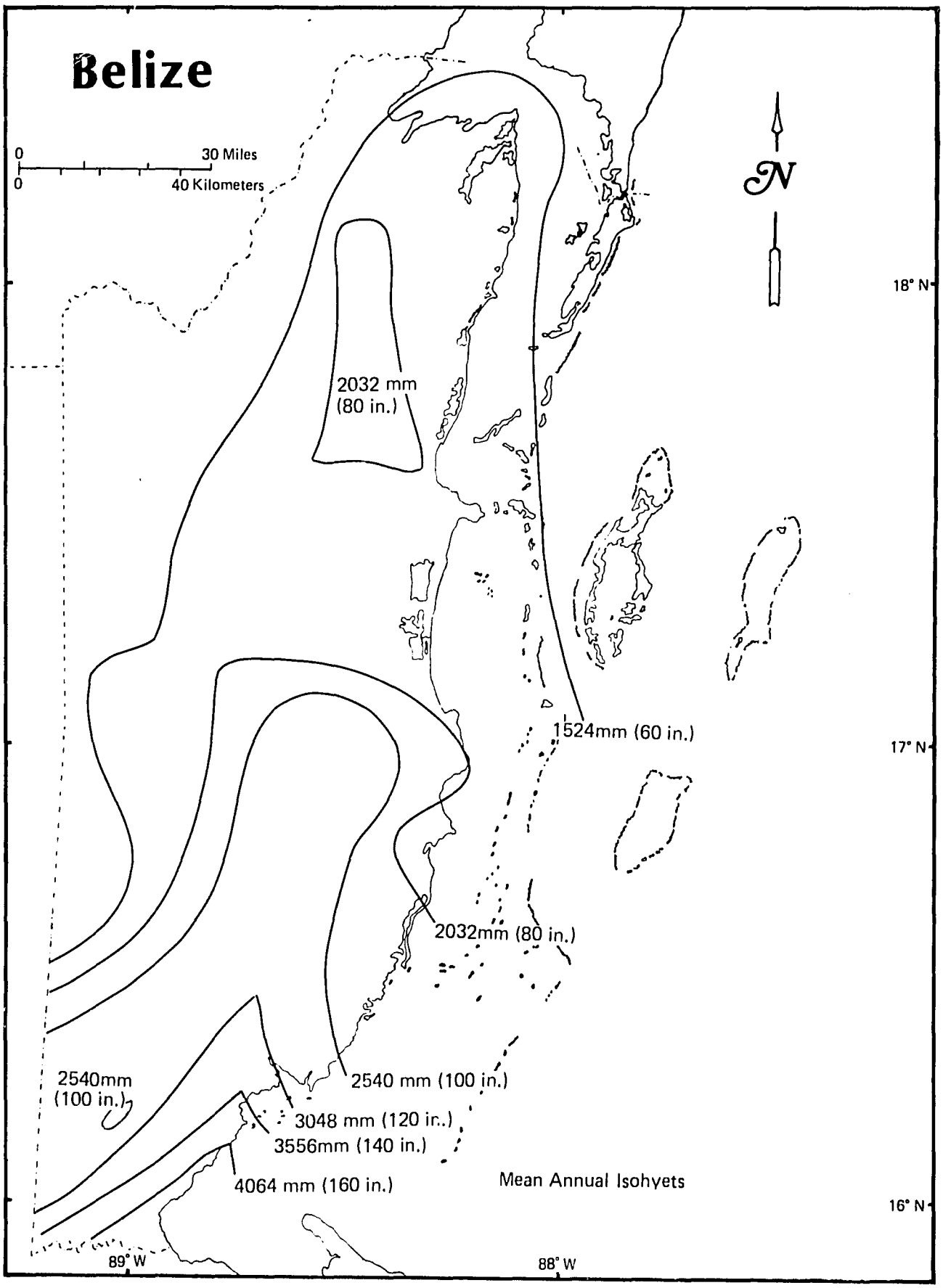


Figure II–3. — Rainfall distribution for Belize. (Walker 1973). See also Fig. II–1.

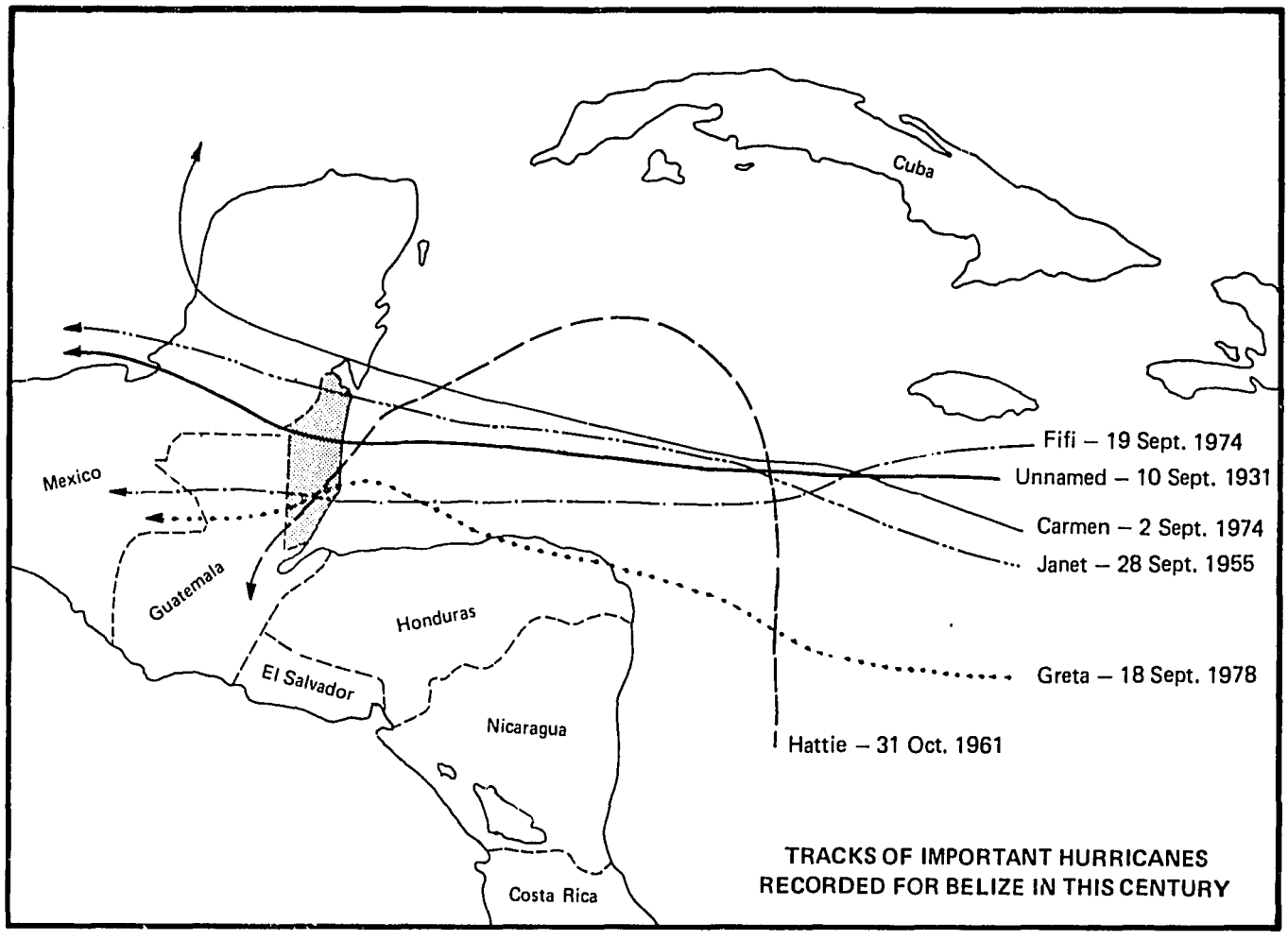


Figure II–4. — Hurricanes whose courses have affected Belize, 1931-1978.

1967). Damage from Hurricane Greta (1978) exceeded US$25 million in crop and economic losses and left 1,000 Belizeans homeless. Chiefly because of Belize City's vulnerability to hurricanes, the capital was moved 80 km inland to Belmopan in 1971. Gibson (1983c) suggests that hurricanes affecting Belize have certain characteristics: their peak occurrence is in September (43%) with significant frequencies also in August and October; they originate east of 60° W longitude; and they maintain strong westerly tracks.

II–C. ECONOMY

Status and Trends

Belize can look optimistically to the future because of its literate and trainable work force, a history of social and political stability, a government that encourages both domestic and foreign investment, relatively slow population growth, and abundant natural resources (especially agricultural land) to sustain economic growth. But Belize must repair its economic infrastructure, replace certain cultural and social attitudes especially as they apply to the traditional importation of goods and farming, diversify industry to prevent dependence on one industry for foreign exchange, improve its money market, and attract entrepreneurial talent.

During the past decade Belize experienced steady economic growth that peaked during 1978–1981 (Table II–1) when the GNP increased 4.9% annually (in constant prices). Belize achieved virtually no growth during 1981–82 due to the worldwide recession and declining prices for her principal exports. The 17% decline in investment can be attributed to high U.S. interest rates on loans, and the effort of the Central Bank of Belize (CBB) (Ministry of Finance) to keep interest rates aligned with U.S. rates. (The Belize dollar has been tied to the U.S. dollar at the fixed rate of exchange of 2B$ to 1US$ since 1976).

The 50% decline in national savings (Table II-1) can be attributed to three factors: (i) the drop in the world price of sugar (Belize's most important agricultural and export commodity) sharply reduced profits and income to local growers; (ii) some Belizeans transferred savings to external financial institutions to take advantage of higher

interest rates; and (iii) Belize has experienced high rates of inflation in the recent past. Although official statistics are unavailable, local retailers estimate inflation has been around 15–20% per year.

Although domestic exports and re-exports (goods imported and exported without processing) increased steadily over the years, the gap or deficit in the balance of payments has widened (Table II-2). From 1977 to 1981, domestic exports increased by 68%, while imports (especially petroleum products) increased by 79%. Trade deficits have been a continuing problem for Belize; the outflow of capital makes the country more dependent on external financial assistance.

The importance of sugar to the national economy cannot be overstated (Table II-3). The 60% drop in world sugar prices from 1980 to 1981 along with reduced yields and foreign exchange depreciation reduced sugar export earnings by B$12 million. Aside from the immediate effects of reduced export earnings, the off-year for sugar also reduced tax revenues and had a depressing effect on gross savings and domestic investment.

Foreign trade accounts and the associated problems with export earnings and foreign exchange illustrate Belize's situation as a member of the world economy. Domestic exports represent 46% of GNP (Table II-1). The total value of foreign trade (total exports plus total imports) is approximately 175% of GNP. With such heavy dependence on foreign trade, external events can severely distort the national economy. When world markets decline, Belizean dependence on reduced export earnings causes internal financial problems. More than two-thirds of domestic

Table II-1. Gross economic indicators from 1978 to 1982. (Source: MF 1981; World Bank 1983).

	BELIZE $ MILLIONS	PERCENT OF GNP	RATE OF GROWTH, CONSTANT PRICES 1978-81	1981-82
Gross National Product 1981	321.4	100.0	+ 4.9	-3.7
Gross Domestic Investment 1981	89.2	27.7	+ 4.1	-16.6
Gross National Savings 1981	44.8	13.9	- 4.6	-54.3
Total Exports* 1981	238.0	74.1	0.0	-13.0
Total Imports 1981	323.9	100.7	+ 5.9	-10.9

* Includes re-exports

Table II-2 Balance of trade for 1977-1982 in B$ millions. (Source: MFED 1981; GOB 1983 g).

	1977	1978	1979	1980	1981	1982
Domestic Exports	88.9	110.6	121.5	164.1	149.5	119.6
Re-Exports	35.2	49.7	60.3	57.6	88.5	67.9
Total Exports	124.1	160.3	181.8	221.7	238.0	187.5
Total Imports	180.1	212.9	263.8	299.5	323.9	262.9
Total Imports (Domestic)	144.9	163.2	203.3	241.9	235.3	195.0
Trade Balance	-56.0	-52.6	-82.0	-77.8	-85.9	-75.4

Table II-3 Major domestic exports for 1978-1982 by percent value, excluding re-exports. (Source: MFED 1982; GIS 1983).

	1978	1979	1980	1981	1982
Sugar, molasses	61.8	55.0	60.7	58.4	56.4
Citrus products	7.5	7.3	7.7	8.7	11.8
Bananas	3.1	5.5	4.2	2.9	3.5
Garments	16.9	17.8	17.6	14.8	10.6
Fish products	3.3	7.2	4.9	9.6	10.5
Sawn wood	1.6	2.6	1.3	1.5	3.2
Others	5.8	4.6	3.6	4.1	3.9
Total Value (B$ millions)	110.6	121.5	164.1	149.5	119.6

export earnings are derived from primary products (sugar, molasses, citrus and bananas) with low income elasticity in major markets. The fluctuations of world prices for these commodities will continue to complicate export earnings.

The distribution of imports has remained relatively unchanged among food products and manufacturers (Table II-4), except for fuel. Since 1973 petroleum products have increased from 6.7% to 18.8% of total imports. Even though much of this increase can be attributed to higher costs, the increase in fuel is also indicative of a growing economy with more vehicles being used for commerce.

Table II-4 Imports for domestic consumption by percent value. (Source: MFED 1981).

	1979	1980	1981
Food	25.1	22.9	26.8
Manufacturing	26.9	26.9	25.4
Machinery	22.1	20.2	19.5
Fuel	13.9	19.9	18.8
Chemicals	8.2	6.5	8.2
Other	3.8	3.6	1.3
Total Value (B$ Million)	203.3	241.9	235.3

Belize's economy is dependent upon imports. Retail merchants mainly sell imported products; the small market size precludes manufacturing for local consumption. Belizean manufacturers process agricultural products such as milled rice, flour (from imported wheat), molasses and citrus concentrates, and sew garments from imported textiles.

Foreign trade also plays an important role in public finance. Approximately half the government's recurrent expenses (ordinary costs for salaries, rent, utilities, equipment, etc.) are covered by customs duties. Legislators are left in a quandry: raising import duties increases revenue, but this weakens the foreign trade balance. As customs duties are levied to support the government, any reduction in these funds limits what services the GOB can provide. Customs duties range from 2.8% on raw materials to 190% on products such as beverages and tobacco. Fuel and oil products have duties of 17% and 54%, respectively.

Agriculture is the largest contributor to gross domestic product (earnings within Belize, GDP) (Table II-5). The modest sector decline can be attributed to the recent drop in world sugar prices. Agriculture (including forest and fisheries products) will continue to support the economy although tourism and possibly fossil fuels (should oil and/or gas be discovered in sufficient quantities) may capture larger shares of GDP.

Petroleum exploration and eventual exploitation are not being ignored. Liberal exploitation licenses are issued for three to five years with extension options (Rao 1982). Royalty clauses call for 18–20% of total production to accrue to the GOB. Annual rentals run roughly US$0.25/ha with an administrative fee of US$10,000/year (Gardiner 1982). Current petroleum exploration licenses in Belize do not have depth restrictions.

The Labor Force

Most of the Belizean work force is unskilled. Most workers are employed in agriculture (Table II-6) and much of this work is seasonal. More women work in professional/technical, clerical, sales and service professions than men. Still, there is a scarcity of professionals, including technicians, administrators and managers. According to the 1970 census data, foreign-born persons held 60% of the administrative/managerial and professional/technical positions. This type of data was not collected in 1980.

Table II-5 Gross domestic product by origin as percentage. (Source: World Bank 1983).

Sector	1980	1981	1982
Agriculture (+ fish + forest)	46.3	43.6	39.6
Manufacturing	8.4	8.2	7.0
Construction	5.7	6.6	5.7
Trade, Restaurants, Hotels	11.7	12.2	12.1
Transportation	3.9	4.5	5.8
Public Administration	12.6	12.3	14.3
Rent, Royalties	5.8	6.3	7.7
Others	5.6	6.3	7.8
Total GDP (B$ millions)	300.4	321.4	309.4

Table II-6 Percent of work force employed by economic activity. (Source: GOB 1982c).

Economic Activity	% of Work Force
Agriculture[1]	42.4
Manufacturing	10.1
Government	12.0
Commerce[2]	14.3
Construction	5.1
Transport[3]	4.7
Other	6.9
Not stated	4.5
Total Work Force	39,806

[1] Includes forestry and fishing
[2] Includes communications services
[3] Includes storage and communications

Only 15% of the working population has received any formal occupational training, while 5–6% received technical training. Skilled laborers are usually self-taught or receive their training abroad. Of the adult non-student population, approximately 92% completed primary education. Uncommon among developing nations, roughly 90% of the adult population of Belize is classified as literate.

Public Finance and Credit Accessibility

As mentioned earlier, the GOB is dependent upon customs duties for 50% of its recurrent revenue. Other major sources are excise taxes, income taxes, revenues from government agencies and postal fees. Of these, taxation accounts for roughly 34% of total revenue.

National economic goals (GOB 1980c) call for reliance on and development of agriculture. The national investment program for 1980–1983 called for a total investment of B$204 million, of which 29% was allocated directly for agriculture, including establishment of an agricultural training school, establishment of an agricultural machine maintenance facility (both at Central Farm), irrigation projects, resettlement, development of access roads and other related projects. An additional 39% was earmarked for improvements in economic infrastructure, particularly existing roads. Facilitating the transport of commodities to markets or distribution points is crucial to development of the agricultural sector.

The GOB estimated that roughly 60% (B$120 million) would be required from external sources to complete the projects. While much work has been initiated, many projects outlined in the 1980 to 1983 plan remain unfinished. This is primarily due to lack of funds; through March 1982, B$50 million had been spent on capital projects.

In recent years, the GOB has depended increasingly on the domestic sector to meet budgetary obligations. Although data are inconsistent, the CBB reports that government borrowing increased from B$29.5 million to B$38.5 million during 1981. Furthermore, during 1982, bank credits increased by 24%. Loans to the government rose by 100% while loans to private enterprise were up by only 14% (World Bank 1983).

The CBB plays an important role in maintaining exchange rate stability, adequate credit flow through the economy, and a consistent and stable money supply. The CBB balances the other Belizean banks' reserves. The Central Bank can purchase or sell short or long-term certificates and/or guarantee government certificates. Obviously, the economic development of Belize, especially the building of assets and capital, are greatly affected by Central Bank policies and actions.

Domestic Credit

Financing for private enterprise is provided by three major sources: commercial banks, credit unions and the Development Finance Corporation. Commercial Banks represent the largest single lender with loans exceeding B$100 million in 1981. The distribution industry, which consists primarily of retail and wholesale merchants, received the largest share (33%) of domestic credit from commercial banks. Agriculture received 22% of commercial bank credit in 1981 with distribution to the sugar industry (55%), citrus (9%), rice (12%), and bananas (12%). Although agriculture has been designated by the GOB to receive the largest share of public investment funds, the relative share of commercial bank credit to this sector has declined in recent years. Since 1976, when agriculture received roughly a third of all commercial bank credit, its share has declined steadily, though the total loan amount has increased. Central Bank and commercial bank officials state that despite the economic importance of agriculture, loans to other sectors are substantially less risky.

The Development Finance Corporation (DFC) is a GOB statutory body that essentially acts as a broker of funds from external sources, offering medium to long term development loans. Its major source of funds is the Caribbean Development Bank (CDB). Despite the low cost loans (9–12%/year), the DFC has experienced difficulty in collections, and only about 75% of the loans are current (World Bank 1983). Many enterprises receiving loans have performed poorly and the DFC itself is beset with high administrative costs. With approximately 65% of DFC loans allocated to agriculture, relatively poor performance partly explains the reluctance of commercial banks to extend greater credit to agriculture.

Credit unions provide smaller loans that are generally for personal purposes. Credit union membership exceeds 35,000, provides access to credit to all members, and serves Belizeans living in rural areas where regular banking services are sporadic or unavailable.

Other Factors

While official data serve to illustrate gross indicators of the economic relationships operating in Belize, some indices such as gross domestic product, gross savings (Table II-1) and the foreign exchange balance are not as low or severe as these data indicate. This is for three reasons. First, many businessmen regularly hoard foreign exchange. The tourist or traveler in Belize has no difficulty exchanging US dollars at the fixed rate of exchange virtually anywhere in the country. Many businessmen state that foreign exchange hoarding is both a regular practice and a necessity in order to travel abroad. In some instances, hoarded foreign exchange is used to purchase vehicles or other items for which customs duties must be paid. in this manner, official statistics are overstated on the one hand (imports requiring "official" foreign exchange transfers), and understated onthe other (the amount for foreign exchange available).

Second, many Belizeans regularly hoard the national currency because bank services are often limited in smaller communities. In larger outlying communities, banks provide once-a-week services, whereas no banking services are available in small villages. Credit unions enable persons to save and borrow, but loans are generally small. Transactions in distant locales are generally by cash; when credit is extended, it is between individuals on a short term basis.

Hoarding represents an uncounted portion of gross domestic savings and serves to lessen the amount of credit available through money market institutions and leads, in an economic sense, to less efficient allocation of national resources. The amount of hoarding is unknown, but it may be significant, as roughly 40% of the population live in areas not regularly providedwith banking services. Another factor contributing to the purchasing power of Belizeans is the remittances (money orders) sent by relatives living abroad that may contribute as much as 10% to the GDP (Krohn 1978a; J. Heriot, pers. comm.).

Third, in spite of GOB cooperation with the USDEA to eradicate illegal cultivation of marijuana through spraying programs with paraquat, substantial amounts of marijuana are smuggled from Belize. Limited enforcement capabilities make control difficult. Marijuana is grown in virtually all areas of Belize (91 ha were sprayed with paraquat in 1982, and 592 ha were sprayed with paraquat in 1983; J. Talbot, pers. comm.), and persons arrested for cultivation or distribution have ranged from illegal immigrants to members of respected families. However, the paraquat spraying program is considered to be 95% effective. The quantity and value of marijuana on an annual basis is not know, but it is substantial. Illegal exportation of marijuana brings substantial foreign exchange that is partly used to purchase imported items, thus the negative trade balance (Table II-1) is somewhat overstated in official statistics.

While these phenomena are common to virtually all countries, the relative effects on the national economy may be greater in Belize because of its small size and low population, and its relative isolation to many markets. Accordingly, economic planning and the evolution of national economic goals are a more difficult process.

Economic Development

The GOB actively pursues private foreign investors to undertake capital investment and productive ventures through a variety of incentives and policies. Its general goal is to attract foreign investments that: (i) help the country diversify its economic base; (ii) increase exports and foreign exchange earnings; (iii) utilize local raw materials; (iv) create their own means of financing; (v) produce an inflow of technological and managerial resources not otherwise available in Belize; and (vi) provide for the gradual transfer of both skills and control to Belizeans. Livestock projects and agro-industries are top priorities, but the GOB also encourages investments in forest products processing, tourism, light manufacturing industries, aquiculture, mining and mineral exploration, handicrafts, deep sea fishing and processing, and assembly plants for garments, electrical components and other goods. Domestic transportation services, commercial merchandising, beekeeping, barrier reef fishing, sugar cane cultivation, and restaurants and bars are examples of industries generally regarded as reserved for local entrepreneurs.

Although the GOB does not have a statistical breakdown for investments, the industries most clearly dominated by foreign investors are manufacturing, sugar and citrus processing, banking, insurance, tourism, mineral exploration and cattle ranching. The largest foreign investment, Belize Sugar Industries (BSI), is held by a subsidiary of the Tate and Lyle Co. Few large, well-known U.S companies have investments in Belize, but U.S. investors control a large percentage of all foreign investment in Belize as a result of investments by many businessmen or small companies, particularly in tourism and livestock.

The GOB offers tax holidays of up to 15 years, exemption from some import duties, liberal repatriation, and various other incentives to potential foreign investors. In order to receive these benefits, however, each foreign investment project must be granted a Development Concession under the *Development Incentives Ordinance* (1960, revised 1973). It is during this process that an investor discloses to the government the financial details of the proposed project, the number of jobs it is expected to create, and information on numerous other aspects of the operation. As part of this application, the investor is required to declare whether any noxious effluent will ensue from the operation, and whether plans and fiscal resources have been developed to provide for its disposal.

The government has long claimed that the entire development concession process should take only 60 days, but many potential investors complain that the lack of clear procedures and the need to consult with many Ministries has led to a much longer and highly uncertain sequence. In order to deal with this criticism, the GOB is streamlining the process by creating a Cabinet-level Investment Task Force to integrate the requirements of all Ministries, and arrange for DFC and investor communication.

While the GOB is concerned about negative environmental effects of foreign investment projects, and reserves the right to attach environmental controls as a condition for the Development Concession, there is no systematic environmental review. It does, to some extent, draw on the technical expertise of various international groups when a large project is proposed, as discussed in chapter VI–B. USAID Regulation 16 (22CFR, Part 216, Environmental Procedures) ensures that environmental protection needs and measures receive a fair hearing as well as possible inclusion in a project as a condition to funding. For example, the recently approved USAID roads project (No. AID 505–0007) (see Chapter V–A) includes a

covenant prohibiting use of funds on any road going through a national park or wildlife reserve.

Though the number of development concessions (proposals granted tax relief) granted to new foreign investors has been relatively small–since Independence in 1981, 19 have been granted and three more are being considered (N. Hall, pers. comm.)–the real problem is that the informal, arbitrary procedures for evaluating potential environmental problems will not be sufficient when Belize experiences a surge of foreign investment. The greatest potential for rapid environmental deterioration during the country's development will come from projects that depend on foreign capital.

III.

History, Culture and Human Resources

III–A. ARCHAEOLOGY

The Maya civilization–the greatest pre-Columbian civilization known to modern man–flourished in northern Middle America for more than 1,000 years. It is only paralleled among other nations by the continuous cultural tradition of the Chinese (Burland 1970, p. 105). During the Classic Period (250-900 AD) the Maya population in what is now Belize is estimated to have been between 400,000 and one million (J. Boriek and W. Branche, pers. comm.). The Maya legacy includes several hundred archaeological sites in Belize, almost exclusively in limestone areas. Only five sites–Altun Ha, Xunantunich (Fig. III-1), Cerros,

Figure III–1. — Archaeological site Xunantunich showing restored stucco frieze of astronomical significance. Current research at the site includes geophysical and remote sensing. (See Table III–1 and Appendix A) (photo L. Nicolait)

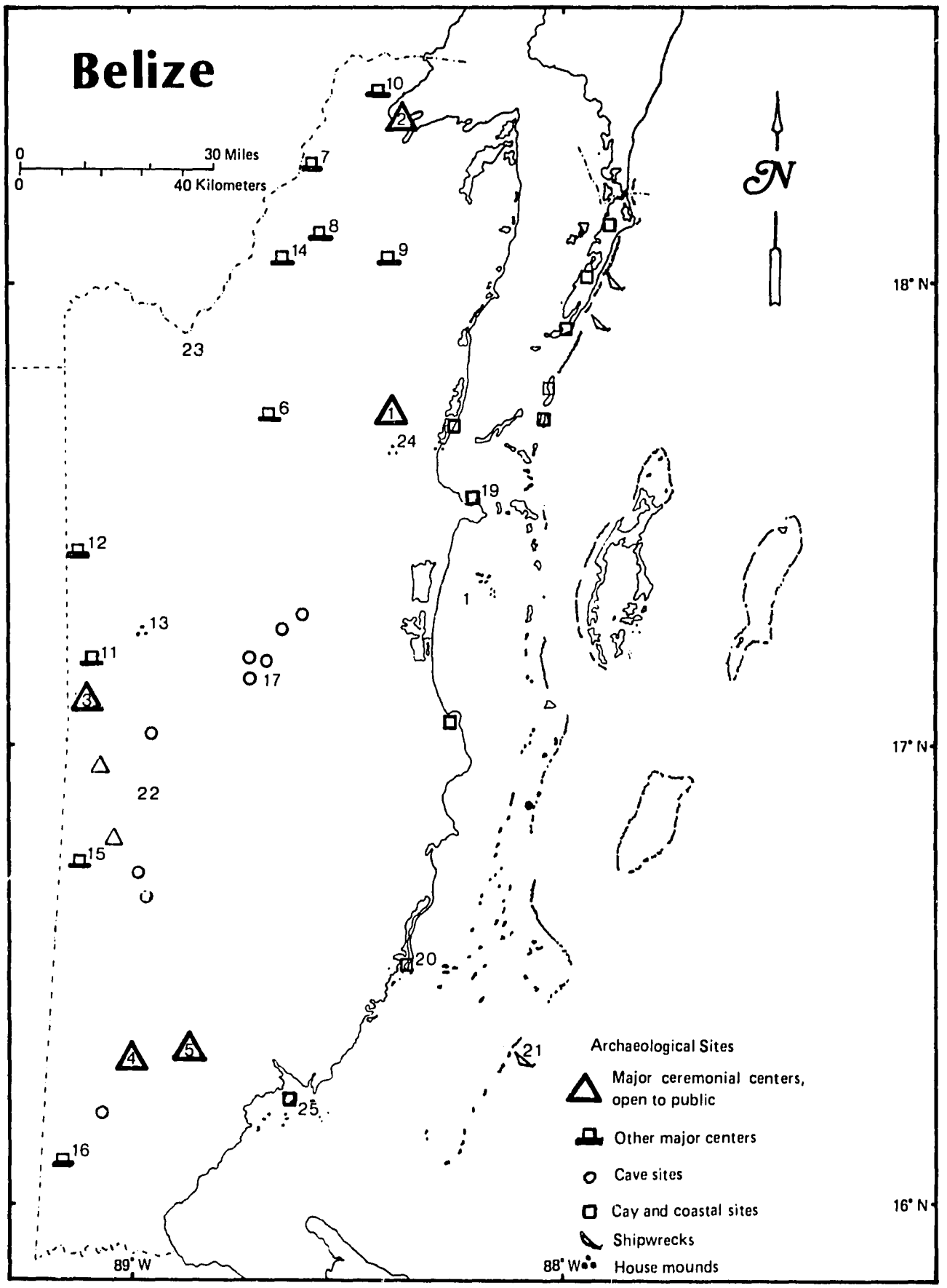


Figure III–2. — Archaeological sites of major importance or interest. See key, Table III–1 and Appendix A for further information.

NimLi Punit and Lubaantun—partially cleared, restored and protected, are open to the public (Fig. III-2).

The Department of Archaeology

Under the Ministry of Trade and Industry, this department is responsible for the management of all pre-Columbian and historical resources in the country. The staff is inadequate to meet this responsibility. The archaeology commissioner, two archaeologists, two assistants, five caretakers, and one foreman make up the entire archaeology staff. Currently, three trained Peace Corps volunteers work in the Department of Archaeology, and various other volunteers, mostly untrained, augment the staff on an irregular basis. One archaeologist recently resigned from the department to work on an advanced degree. The Commissioner of Archaeology and one assistant are also absent from the country pursuing advanced studies.

The archaeology budget is about BS110,000 to cover salaries, vehicle maintenance, fuel, and site maintenance (recurrent expenses). However, the Department of Archaeology accrues additional benefits from foreign research programs. Archaeological projects funded from abroad donate 15% of their project budget to the archaeological program. This contribution may be in the form of equipment and supplies at the end of the project or, in the case of architectural structures, the stabilization of the structures on the site. Archaeological projects funded and staffed by foreign institutions, including Southern Methodist, University of Pennsylvania, and the Royal Ontario Museum, have increased substantially during the last decade (see Fig. III-2, Table III-1), due to political stability of the country, to recent recognition that Belize once supported a large, advanced Mayan population, and to the discovery that some sites were occupied as early as 2500 B.C. (Hammond 1982) by people culturally Mayan.

Little would be gained by an extensive archaeological survey at this time. The Department of Archaeology has already mapped hundreds of sites but is reluctant to publish specific information because of an anticipated increase in "grave robbing". Much time and money is expended in investigating reports of site degradation caused by looters and the Department fears that releasing information on specific sites will only contribute to the illegal trade in Mayan artifacts. Site protection from vandals and preservation of uncovered sites from the elements are greatly needed, but since there would be little economic return for funds invested, this will continue to be a low priority national

Table III-1. Recent archaeological research projects, major institutions involved with the site, and research design or special features. Numbers on Fig. III-2 correspond with map code numbers listed below for selected sites (Source: Department of Archaeology, Belmopan)

Map Code	Site Name	Project/Researcher	Year(s)	Research/Special Features
1	Altun Ha	Royal Ontario Museum Dr. David Pendergast	1964- 1970	Mayan distribution center in the northern Belize area; the largest carved jade from a Mayan site was found here.
2	Cerros	Southern Methodist U. Dr. David Freidel	1973- 1980	Development of a Mayan coastal trading center in the late Preclassic period.
2	Cerros	Southern Methodist U. Cathy Crane	1982	Mayan agricultural practices and wild plants utilization.
3	Xunantunich	GeoOntological Society Don Marken, Merle Robertson	1984	Geophysical and remote sensing.
3	Xunantunich	Royal Ontario Museum Dr. David Pendergast	1979	Salvage excavations due to heavy looting.
4 5	Lubaantun NimLi Punit	SUNY, New York, Albany Dr. R. Leventhal	1982- 1984	Archaeological survey.
4 16	Lubaantun Pusilha	Harvard U. Dr. R. Leventhal	1979- 1980	Survey of southern Belize from Lubaantun to Pusilha, and preliminary excavations at Pusilha.

Table III-1 — (Continued)

4	Lubaantun	British Museum, Cambridge U.; Peabody Museum, Harvard U. Dr. Norman Hammond	1970-1972	A Classic Maya center.
6	Lamanai	Royal Ontario Museum Dr. David Pendergast	1974-1984	This Mayan site was continuously occupied from the early Preclassic (200 BC) to historic (18th Century). Special features include tall pyramidal structures, Spanish 17th Century colonial church and 19th Century industrial sugar mill.
7	Nohmul	Rutgers U. Dr. Norman Hammond	1982-1983	Settlement area and economic base of the Mayan community at Nohmul.
8	Cuello	Rutgers U., National Geographic Dr. Norman Hammond	1978-1980	Earliest know Maya lowland site in northern Belize dating to 2500 BC.
9	Colha	U. Texas, San Antonio Dr. Tom Hester	1978-1984	Lithic manufacture at Colha and other lithic workshops in adjacent areas.
10	Santa Rita	U. Pennsylvania Drs. Arlen & Diane Chase	1979-1984	Post classic (900 AD, 1250 AD) period of Mayan civilization.
11	Cahal Peck Buena Vista	San Diego State U. Dr. Joseph Ball	1982-1984	Rural community structure in the late Classic Maya lowlands.
12	El Pilar, Yaxox Belize River	U. California, Santa Barbara Dr. Anabel Ford	1983-1984	Settlement patterns and subsistence in swamp and riverine zones.
13	Barton Ramie	Peabody Museum, Harvard U. Dr. Gordon Willey	1950-1956	Settlement patterns in the Belize River valley.
14	El Pozito	Univer. of the Americas Dr. Mary Neivens	1974-1976	Ceremonial center.
15	Cayo; Caracol Zayden Creek Pacbitun Caledonia	Trent U. Dr. Paul Healy	1979-1980	Mayan agricultural terracing in southwestern Cayo.
17	Petroglyph Cave	U. Texas, Austin Dorie Reents Barbara MacLeod	1978	Mayan cave utilization.
19	Moho Cay	Trent U. Dr. Paul Healy H. McKillop	1979	Archaeological mapping and excavations of a coastal Mayan site.
20	Point Placencia	U. Wisconsin Dr. J. J. MacKinnon	1984	Maya utilization of a coastal area in southern Belize.
21	North Spot wreck	Cedam International Jack B. Irion	1981	Excavation of a 17th Century Spanish merchant vessel.

Table III-1 – (Continued)

22 (no symbol)	Chiquibul	American Karst Research Organization Dr. Tom Miller	1984	Karst development and associated archaeology of Chiquibul area, southwestern Cayo.
23 (no symbol)	Rio Hondo/ Albion Island	Florida State U. Dr. Mary Pohl	1982-1984	Agricultural practices of the Maya in swamps and wetland areas of the Rio Hondo.
23		U. Texas, San Antonio Dr. R. Adams	1981	
23		U. Minnesota Dr. Paul Bloom Dr. Dennis Puleston	1980	
23		U. British Columbia Dr. Alfred Siemens	1974; 1978; 1979	
23	PullTrouser Swamp	U. New Mexico Dr. Peter Harrison	1979-1981	Ecology of the raised field agricultural system.
23	PullTrouser Swamp Larve	U. Oklahoma Dr. Bill Turner		
24	Lowe Ha Sand Hill	Belize Archaic, Archaeological Reconnaissance. Peabody Foundation Dr. R. MacNeish	1980-1983	Archaeological exploration to discover the lowland archaic sites 9000 BC to 2500 BC.
25	Wild Cane Cay	U. California, Santa Barbara Dr. Heather McKillop	1982	Mayan coastal trade center.
X	Potts Creek Lagoon, Sarteneja	U. California, Los Angeles Mathew Boxt	1982	Survey of central and northern Belize coast and ancient Mayan trading centers.
X	Belize Cay Expeditions	University of York Dr. J. Hood R. Shoesmith	1981	Environmental archaeology of Belize cays, integrating archaeological and marine biological studies.
X	Stann Creek (district)	Cambridge U. E. Graham	1975-1976	Exploration, mapping and testing of sites.
X	Corozal (district)	British Museum, Cambridge U. Dr. N. Hammond	1973-	Survey and test excavations of various sites in northern Belize.
X	Corozal	U. California, Los Angeles Dr. R. Sidrys	1974	Archaeological identification of regional production distribution systems in northern Belize.
X	Macal Tipu	Hamilton College Dr. R. Kautz, Dr. G. Jones Dr. E. Graham	1980-1984	Archaeological and ethno-historical study of a Mayan community at the time of Spanish contact

X denotes that the site is not located on the map, Fig. III–2.

objective. Unfortunately, few in Belize realize what an investment this would be for scientific and general tourism!

A cultural museum to be located in Belmopan is planned by the Ministry of Education and Economic Development, but nothing substantial has developed. The Federal Republic of Germany expressed an interest in helping the GOB finance a museum of archaeology and training in artifact conservation, but because of the GOB failure to define realistic goals, German involvement is doubtful (I. Schuler, pers. comm.). Germany has recently offered to contribute a storage building for artifacts.

CIDA has completed a five-year program for education in the Department of Archaeology. The grant was recently renewed for three years. This program also provides undergraduate scholarships for one or two Belizeans to attend Trent University in Ontario, Canada, (usually on a rotating basis to prevent a depletion of the staff of archaeologists in the department), and training of laborers in consolidation and restoration techniques in Mexico.

Protection of Archaeological Resources

Archaeological sites in Belize are distributed throughout the country (see Appendix A, Fig. III-2). The MTI administers the department and the *Ancient Monument and Antiquities Ordinance* (1971) defines regulations. Protection of every site is impossible, but sites with features unique to Belize or those areas that illustrate specialized land use should be identified and every effort made to preserve and stabilize them.

Areas of historical importance and marine archaeology sites should also be identified and appropriate action taken to preserve them. Artifacts on the sea floor should not be removed without permission of the Department of Archaeology, but in the absence of enforcement several wrecks along the reef have been looted. The Department of Archaeology and law enforcement agencies must share the responsibility and determine what sites need protection and how best to satisfy explorers and the Department of Archaeology.

III–B. CULTURAL HISTORY

Land use depends to a great extent upon the cultural heritage of the people who use the land. Modern Belize includes the history of its human occupants, present composition and distribution of its population (demography), immigration, and the effects on opening new lands by settlers. A one-month field study (July-August 1983) and raw data from the 1980 National Census (GOB 1982a) are the primary sources for this chapter. For more detailed analyses see the bibliographies by Minkel and Alderman (1970), Posnett and Reilly (1973) and Woodward (1981).

Recent archaeological evidence suggests an aboriginal village population lived near Cuello as early as 2500 B.C. There is little information concerning the period from the demise of the Maya civilization (ca. 900 A.D.) to the Spanish arrival. Spanish explorers reported little that aids in a reconstruction of native life. Maya Indians traveled the waters between the Chetumal area (around the mouth of the Río Hondo) and northern Honduras; several sites along the Belizean coast and on the cays yield evidence of Maya occupation. Indians fleeing the Spanish settled in the Chetumal area (including Belize) during the 1500's.

Permanent post-Conquest settlement of Belize by Europeans was initiated in the Seventeenth Century by English-speaking buccaneer-logwood cutters and their crews (Craig 1969). These "Baymen", so-called because they traveled within the Bay of Honduras, were not isolated within the Spanish realm, for they had other English-speaking contacts throughout the western Caribbean.

When the harvesting of logwood (used for dye) along the coasts and accessible lagoons waned during the mid-1700s, the Englishmen and their slaves explored the interior via the major northern rivers (Belize, Sibun, Hondo and New) in search of a new export--mahogany. The move to the interior often brought conflicts with the resident Maya and attracted Spanish colonial forces stationed at Bacalar (Mexico), who occasionally tried to oust the English interlopers. Spanish battles with the Baymen, when successful, were not followed by Spanish occupation, so the Englishmen returned only to be threatened again.

The ability to resist the surrounding power of Spain is surprising, particularly in view of the small resident population. Before the arrival of 2207 slaves and freed persons from the Mosquito Coast in 1787, the Baymen of Belize numbered less than 800 and had fewer than 2600 slaves. Virtually all of them lived north of the Sibun River, such as near the mouth of the Belize River, along a few northern lagoons and streams, and on a few cays (Dobson 1973). The last Spanish attack, unsuccessful against the defenders at St. Georges Cay, on 10 September 1798, now is commemorated as a national holiday.

Following abolition of slavery in 1833, a gentle dispersal of population proceeded from the Belize City core. The name British Honduras dates to 1840 (Hilty 1982). However, it wasn't until 1861, one year before establishment of British Colony status, that the first detailed census listed 14 zones of settlement; the census also reported 40 nationalities (Dobson 1973). Even in these early days, 60% of the population was of mixed ancestry, that is, counted as mestizo, mulatto or zambo (Table III-2).

Early Ethnic Populations

"Caribs" or Garífuna, are not native to Central America. Their history can be traced to the Lesser Antillean Island of St.Vincent, where, during the 17th Century, black Africans from slave ships gradually mixed with native Carib Indian islanders (Davidson 1982). The growing hybrid population, physically Negroid but with Amerindian culture

Table III-2. Ethnic distribution of the Belize population, 1861 –1980. (Source: GOB 1861 and 1980 censuses)

Ethnic Group	1861 CENSUS DATA Population	%	1980 CENSUS DATA Population	%
Creole	(7,849)	30.5	57,700	39.7
Mulatto	4,423	17.3	–	
Zambo	898	3.5	–	
African	2,528	9.7	–	
Ladino (Mestizo)	9,754	38.1	48,100	33.1
Garífuna (Carib)	1,937	7.6	11,050	7.6
Maya	4,675	18.2	(13,850)	9.5
Yucatec + Mopán	–		9,900	6.8
Kekchí	–		3,950	2.7
European	1,164	4.5	–	
Mennonite	–		4,800	3.3
East Indian	9	0.04	3,050	2.1
Others*	247	1.0	6,800	4.7
TOTAL	25,635		145,350	

* Includes influential white community with ties to Europe or the U.S.

traits (hence, "Black Caribs") dominated St. Vincent until the late 18th Century when the British exiled most of their population to the Western Caribbean in the spring of 1797 (Davidson 1982).

The exiles were deposited on the uninhabited island of Roatan, just off the north coast of Honduras. From there, most went to Trujillo on the adjacent coast. Over the next four decades Garífuna spread around the Bay of Honduras. As early as 1802 Garífuna were noted in Belize, and by 1823 many had settled permanently at the mouth of North Stann Creek. The largest contingent settled in 1832 along the British-controlled coast south of Stann Creek to the Sarstoon. This contingent had left other Central American republics after losing some battles to revolutionaries (Davidson 1982).

A mid-19th Century conflict in Yucatan–the famous Caste War–provided the impetus for the massive immigration of **Yucatecan Maya-Mestizos**. Mestizos are descendants of Spanish colonists and Amerindians. As battles between the Maya and upper class Spanish-Mestizo overlords grew more intense, the small plot agriculturalists, both Maya and Mestizo, were often caught between factions and many fled south across the Río Hondo (see Fig. II-1). A much smaller number crossed into Belize via the west central border near the upper Belize River. By 1850, the northern one-fifth of Belize was dominated by the Maya-Mestizo who reportedly numbered near 10,000 (Dobson 1973).

Virtually all **East Indians** who live in Belize are descended from immigrants who arrived between 1861 and 1891 (Table III-2). For the most part, the East Indians were indentured servants from overcrowded British India who were dispersed to south and east Africa, the Guiana coast, Trinidad and Jamaica. It was via Jamaica that most East Indians reached Belize. These East Indians were attracted to two areas of sugar cane cultivation--north of Punta Gorda and south of Corozal Town. Five generations of East Indians have now lived in these areas associated with the sugar industry or small scale agriculture (Davidson, unpubl. data).

The **Mopan Mayas**, living south of the Yucatecans in the forests south and east of Guatemala's Lake Peten Itza, entered southwestern Belize near San Antonio, Toledo district, during the 1880's in search of new milpa lands (Dobson 1973), Then came the **Kekchí**, another Mayan people from the southwest, surrounding the Guatemalan department of Coban. The Mopan left their homeland because of repression while the Kekchí were, also refugees, imported to work in the expanding cacao plantations of the Sarstoon River valley (such as the Kramer Estate) (Wilk 1981). After the plantation operations were abandoned in 1914, most Kekchí remained, returning to subsistence agriculture (Dobson 1973).

III–C. DEMOGRAPHY

Twenty-two censuses were attempted for Belize before the British colonial period and 11 more-detailed censuses have been made since then (Fig. III-3) (Dobson 1973). Many original census manuscripts are in the National

Archives in Belmopan. During the colonial period population increased annually by about one percent, in spite of significant immigration from neighboring countries. Since the Second World War the population has increased about 30,000 persons each decade, equivalent to 1.9% per year.

The most recent census (May 1980) includes data on age, sex, marital status, residence, birthplace, race, religion, language, migration, education, occupation, economic activity, fertility and housing. These data have been computerized and are available for planning and scholarly purposes (GOB 1983f). Field checks indicate that the census is extremely accurate by Latin American standards (W. Davidson, unpubl. data).

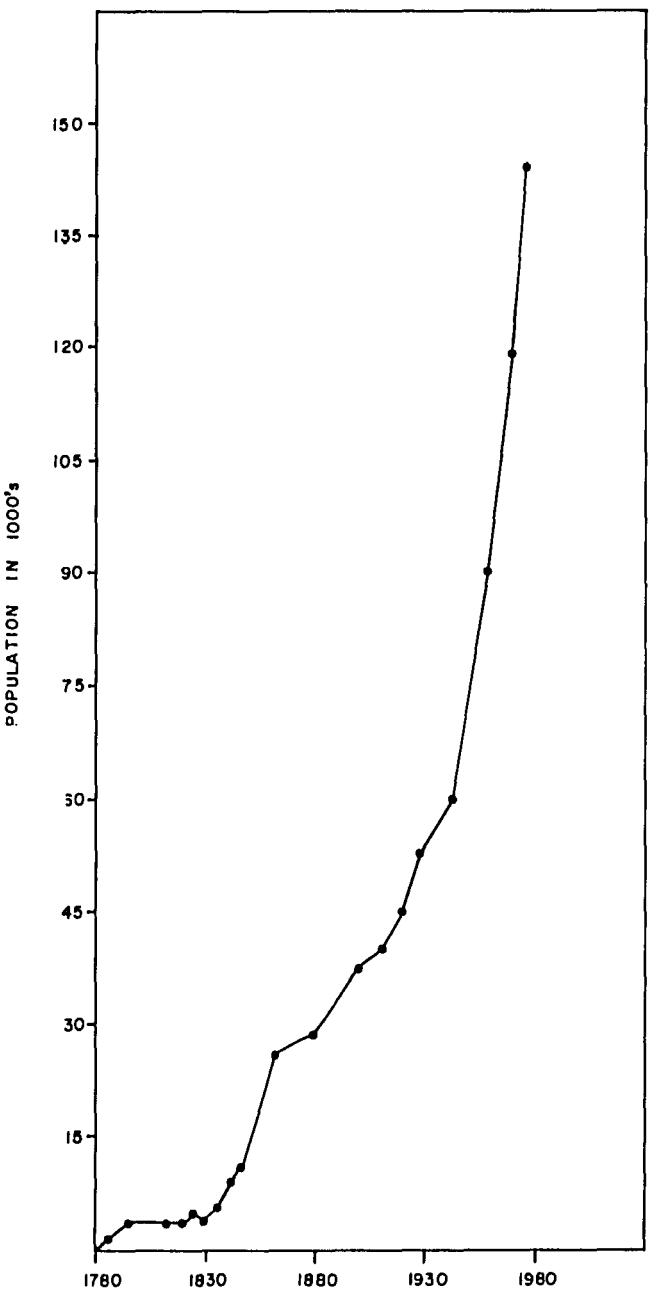


Figure III–3. — Demographic expansion of the Belizean population based on census data (each dot) from 1790 to 1980. Fifty percent of the 1980 population was under 18 years old.

Ethnicity

Belize's cultural distinctiveness (probably best termed *ethnicity*) carries the name *race* in common speech as well as in official GOB documents such as the 1980 census. However, for practical purposes, race–referring to physical anthropological differences–has little meaning in Belize. The population is simply and overwhelmingly racially heterogeneous. Still, according to self-classification in the 1980 census, ethnic distinctions abound. Each of the ethnic groups has over 3,000 members (Table III-2) and a dispersed distribution. Each ethnic group has a recognizable core territory (Fig. III-4). Some cultures have expanded beyond their original territory (Kekchí, Mopan, Mennonite, Ladino, Creole) or contracted from acculturation (Yucatec Maya), while others (Garífuna, East Indians) have maintained their original settlements.

People who call themselves *Creoles* share two distinctive traits: some degree of African ancestry and the use of the local English Creole dialect. Skin color runs from very dark to very light, but European ancestry is usually apparent. Creoles often believe themselves to be "true Belizeans" because their ancestors are thought to have been among the first settlers. This may not have been the case, however. Aside from the claims by resident Amerindians and European Baymen to first occupancy, many Creoles are descended from immigrants who entered the country years after the Garífuna, Maya, East Indians and Ladinos. Slaves were traded among the British colonials until slavery was abolished in 1833.

The Creole core territory is Belize City and one-half of the ethnic Creoles comprise over three-fourths of the Belize City population. Rural Creoles are located along the highway between Belmopan and San Ignacio, in isolated clusters in northern Belize district, and in a few coastal spots to the south (Gales Point, Mullins River, Mango Creek, Placencia, Monkey River). Creoles constitute a 57% majority in Belmopan–an indication of their political importance.

Spanish-speaking Belizeans, descended from Amerindians and Europeans, normally are labeled *Mestizos*. While that term is appropriate in a racial connotation, *Ladino* better describes the cultural attributes of Mexican and Central American immigrants. Once the predominant population of Belize (following immigration from the Yucatecan Caste War), Ladinos are now the second most populous ethnic group (Table III-2). They occupy the century-old "Mexican-Mestizo corridor" that runs along New River between Corozal and Orange Walk (Fig. III-4). It is from here that acculturative forces have reached into the adjacent Maya zone. In west central Belize around Benque

Viejo and San Ignacio, Ladinos from Guatemala have recently added to the earlier Spanish-speaking immigrants from Yucatan. Ladinos are the least likely Belizeans to remain isolated; almost 5,000 Ladinos currently live in Belize City.

Long called "Caribs" in Belize, *Garifuna* are black beach residents of the southern coasts who have recently experienced a surge in group identification. Today, one is much more likely to hear the native term *Garifuna* (which they prefer) to denote their distinctive language and culture. Arriving from Honduras during the first half of the 19th Century, the Belizean Garifuna established five coastal enclaves that still serve as fragmented cultural cores (Fig. III-4): these settlements extend inland for agriculture and seaward for fishing. Though Garifuna haven't established new territories, some individuals have left settlements.

Three modern Mayan peoples are distinguished in Belize, and it is common for locals to call *Mopan* and *Yucatecans* by the term *Maya*, and to separate the *Kekchí* as a non-Maya group though they, too, are Mayan. Together the three comprise almost 10% of the total population of Belize (Table III-2). While some fusions have taken place in their regional distributions and activities, some differences remain clear.

The Mayan settlements are found in southwest Toledo, the upper Belize River valley, and northwest Corozal-northern Orange Walk (Fig. III-5). Grossly generalized, Indian settlements in these areas have a south to north pattern of Kekchí-Mopan-Yucatec (Fig. III-4). In Toledo, Mopan live just north of the Kekchí core sttlement; in the Cayo borderlands the Mopan and Yucatec are contiguous with dominance by the latter; and the north is Yucatec land.

The Yucatec, who have had the most contact with Ladinos, have experienced the most change. For example, at Yo Creek (Orange Walk district), once an all-Maya agricultural village, Spanish is the primary language and more Yucatecans now work for wages outside the village. Only 34% of current residents have Maya surnames.

German-speaking *Mennonites* are the most recent group to enter Belize on a large scale. Originally from the Swiss Alps, members of the Protestant sect moved to northern Germany and southern Russia, then to Pennsylvania about 1700, to Canada a century later and to northern Mexico following World War I. Recurring local government restrictions on their isolated agrarian lifestyle have caused migration to be a normal occurrence.

Most of Belize's Mennonites (4800 in 1980 census) migrated from Mexico between 1958 and 1962. A few came from Peace River in Canada. They purchased large blocks of land totaling over 60,000 ha, and the process of settlement began at Shipyard (Orange Walk district) by a conservative wing, and at Spanish Lookout (Cayo) and Blue Creek (Orange Walk) by more progressive members (Fig. III-4). Recent expansions have taken place at Richmond

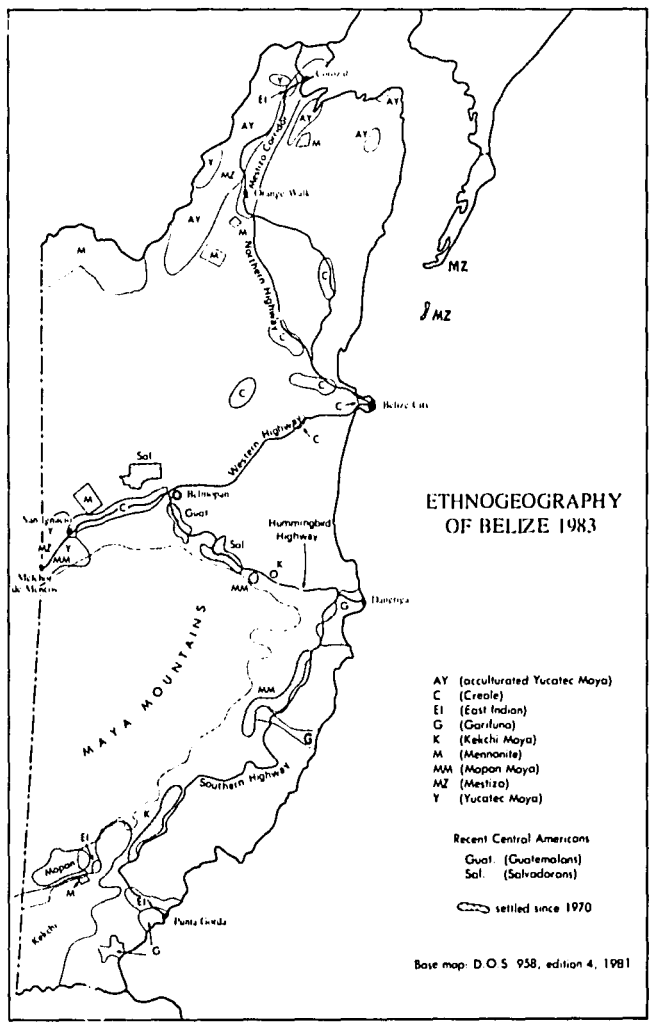


Figure III--4. — Ethnogeography of Belize. Core settlements are indicated as well as new settlements since 1970. (W. Davidson 1981).

Hill, Santa Elena, Little Belize, and Blue Creek (Toledo district).

In hope of averting future problems with the government, Mennonites and Belize officials made agreements that guarantee freedom to practice their religion, to use their language in locally controlled schools, to organize their own financial institutions and exemption from military service. Over the 25 years they have been in Belize, Mennonites have slowly merged into national activities. Although they practice complete separation of church and state and do not vote, their innovations in agricultural production and marketing are felt throughout the country.

East Indians have two settlements that are readily discernible: Calcutta (Corozal district) and Forest Home near Punta Gorda (Fig. III-4). About 47% of their ethnic group live in these settlements and the rest live outside, especially in nearby urban centers. Corozal has 125, Punta Gorda has 106; but Belize City (600) and Belmopan (100) have greater attraction. East Indians who remain in their

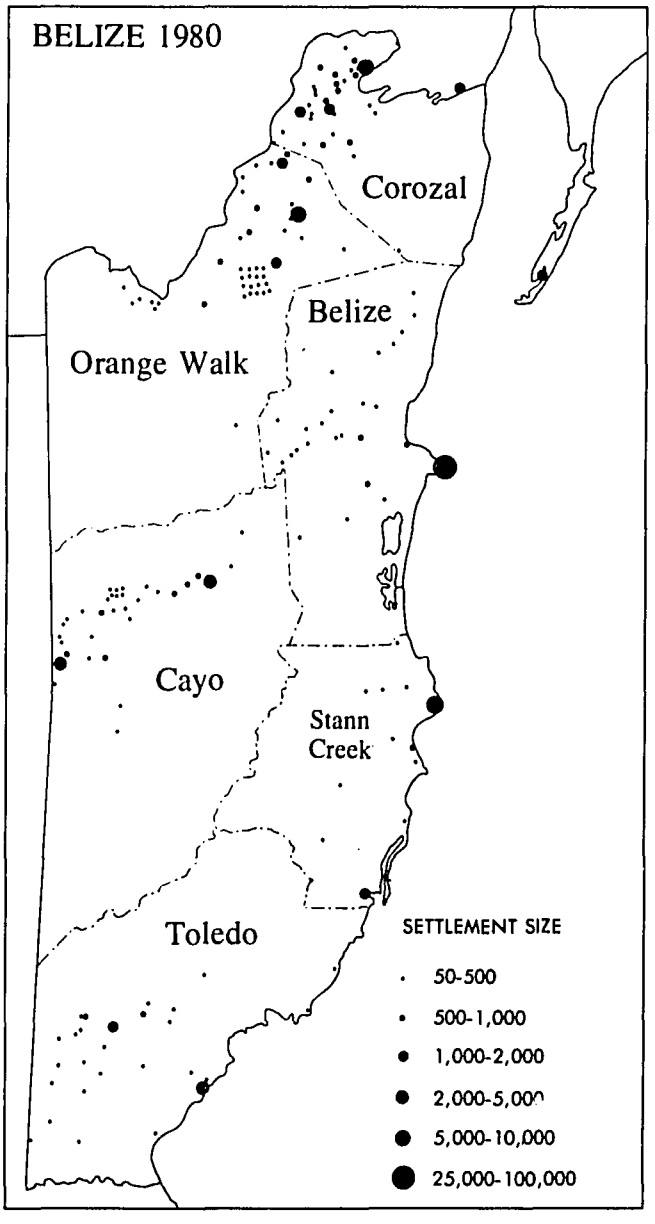


Figure III–5. Settlement size of Belize for 1980. Note clustering of villages outside cities. (W. Davidson 1981). Also, see Fig. III–4. District divisions and names are shown.

settlements have large families and maintain small farms and orchards adjacent to their houses. A few trade in pigs and dry goods on a small scale. Apparently, no one descended from the original immigrants of the late 19th Century speaks Hindi. Creole and Spanish are normally spoken by East Indians. A small number of Hindi-speaking East Indian merchants live in Belize City and Orange Walk, but they are relative newcomers and have no cultural ties with descendants of earlier immigrants.

Language

Belize is a multilingual country. While over 50% of the population prefer to speak English or its Creole derivative and over 30% prefer to speak Spanish (Table III-3), an impressive 62% of the population speak two languages, while 16% are trilingual and 38% speak only one language. English is the official language of Belize and 86% of the people speak it and its variant, Belizean Creole, while 51% are fluent in Spanish. In addition, German, Garífuna, Maya and Kekchí are spoken in regional clusters. Such differences in language in a small country make Belize an exciting place for linguists.

Table III-3. Preferred* language usage in Belize, based on 1980 census statistics. (Source: GOB 1983b)

LANGUAGE	POPULATION	PERCENT
English/Creole	73,549	50.6
Spanish	45,932	31.6
Garífuna	8,721	6.0
Maya (Mopán, Yucatec)	5,523	3.8
German	4,797	3.3
Kekchí	3,779	2.6
Other or not stated	3,049	2.1

* Does not include proficiency in other languages.

Language is perhaps the prime cementing factor of ethnic grouping. When language changes occur, cultural alterations are probably occurring, too. In the three areas where Spanish, English, and Maya are the prominent languages–Corozal, Orange Walk and Cayo districts–statistics on race and language (GOB 1983b) suggest some acculturation is underway. Change is occurring at varying rates and in different directions. Corozal, Orange Walk, and San Ignacio towns are 60–70% Ladino, but their surrounding villages are only 50–62% Ladino.

Perhaps because it is closer to a dynamic southeastern Mexican frontier, Corozal district maintains its Spanish language and former Maya areas nearby now accept Spanish as a major language. More to the interior of the country such as in Orange Walk district, English usage is increasing, but the acculturated Maya maintain a preference for Spanish. In Cayo district English is preferred by the Ladinos of San Ignacio. The rural Maya of Cayo have preserved their language.

Elsewhere in the country, English (and its Creole variant) is the language of national communication. Garífuna often speak English outside their districts; Ladinos in Belize City also speak English. The Kekchí and Mopan Indians of Toledo and the Belize City Creoles prefer the exclusive use of their own languages.

The Belizean government, recognizing the country's geographical position in Spanish Latin America, and realizing the importance of interacting with neighbors, has promoted "ladinoization" by requiring Spanish to be taught in secondary schools. But English is the official language (state and education) and it will probably remain so for the foreseeable future. With the possible exception of the Mennonites, all schools are required to use English as the first language including those in Indian villages. However, Spanish is taught as a second language in many primary schools.

Religion

Belizeans consider themselves to be religious people. The Prime Minister quotes scriptures from the Bible in virtually every speech; Radio Belize offers numerous religious programs; local newspapers publish frequent religious messages; and churches are ubiquitous in rural and urban landscapes. According to the 1980 census, over 91% of the population declared a specific religious preference, of which 61% are Roman Catholics.

Since the middle of the 19th Century Belize has attracted an inordinate number of missionaries, especially from the southern U.S. Being so close to the USA with English as the official language, Belize is ideally suited for evangelical missions. With their heritage of interest in religion and their receptive nature to foreigners, Belizeans do little to hinder outsiders. Missionary activities bring revenue into the country; church construction and projects designed to aid new converts are normally funded from abroad. On the other hand, battles among missionaries for Belizean souls sometimes create social tensions that have alienated some individuals from their families and neighbors.

Of the nine major religious denominations listed in the 1980 census (Table III-4), only a few have been sufficiently important to establish regional footholds. Catholics, the choice religion in all districts, make up 68% of those practicing religion in Belize district, where most of the long-established Anglicans and Methodists are found. Mennonites maintain their religious services in Orange Walk and Cayo districts. Seventh Day Adventists have converts in Corozal district and Pentecostals have followers in Cayo and Toledo districts.

Table III-4. Religious preferences in Belize. (Source: GOB 1983b).

RELIGION	PERCENT
Roman Catholic	61.7
Anglican	11.8
Methodist	6.0
Mennonite	3.9
Seventh Day Adventist	3.0
Pentecostal	2.2
Nazarene	1.1
Jehovah's Witness	1.0
Baptist	0.9
Other or not stated	8.4

Patterns of Settlement

Belize is usually characterized as a sparsely populated country. In relation to Central American and World standards, this is true; population density averages 6.3 people per km^2 (=16.4/mi^2). However, a more meaningful picture of the sparse population emerges from the distribution of population in small towns (Fig. III-5). Belizeans appear to be an unusually social people. Over 90% of the population congregate in places of over 50 people and 51% of the population live in towns larger than 2000 persons. Such clustering leaves about 75% of the land virtually uninhabited, with less than 1 person per km^2. Defining the eight centers of over 2000 population as "urban", the remaining "rural" density amounts to only 3 people per km^2 (8/mi^2). Clustering of the population gives a density of less than 1 person per km^2 in each district outside villages, towns or cities.

Specific definitions of rural and urban populations vary widely over the globe. Some countries attempt to compare the essential character of life in urban places (commercial, economic activities) to that in rural areas (subsistence activities) and then to relate those places to population figures. For example, minimum size of an urban place in Denmark is 250 persons and in India the figure is 5000. Other countries relate city size to political administration.

The Belizean system may be unique for Latin America in its classification of city-town-village settlements, as determined by the legislature. While the legislature is technically free to name a settlement, population is an obvious consideration as can be seen in the recent reclassification of Monkey River to a village because of reduction in population from 277 in 1970 to 191 in 1980. In the future it seems that population size might be the most reliable indicator used in the classification of settlements.

Given international variations in definitions, the United Nations has suggested the standardization of statistics (Table III-5). In the case of Belize, the insertion of an additional category (50–500) seems appropriate because 50 is a reasonable figure to distinguish population clusters from the extended family settlement. A group of 6–7 households might conceivably be only one extended family compound.

While settlements of 50–500 (78%) are usual, Belize cannot be called a "country of villages" because over half the inhabitants live in the 8 major urban areas: Belize City, Orange Walk, Corozal, Punta Gorda, Dangriga, San Ignacio, Belmopan, and Benque Viejo (see Tables III-5 and III-6).

Regional Changes in Population, 1970–1980

Quantitative change in the Belizean population over the last decade can be determined roughly by calculating the population increase (births and immigration minus deaths and emigration). With an increase of just under 25,000 for the last decade, the annual rate of growth amounts to 1.9%, an unusually small figure for Central America. Given the age structure and fertility rates of Belizeans, one would expect a population increase of 2.8–3.2%. (The 1960–70 rate was 3.28%). According to one recent report (de Blij 1981), Belize had an annual rate of natural population increase of 3.6%, the *highest in the world.* With such high natural growth rates, the actual increase of only 1.9% points to very high rates of emigration. At the rates proposed above (2.8–3.2%), it is estimated that 1,200 to 2,000 inhabitants left Belize each year. The population statistics suggest that *during the last decade perhaps as many as one out of every eight Belizean residents emigrated.*

The major emigration occurred from Belize City and Dangriga. Elsewhere in Belize there was some balance in the redistribution of population; four zones lost population and four increased (Fig. III-6). Amerindians leaving southwestern Toledo district opened new settlements along the Southern Highway; population loss in the Stann Creek valley accompanied gains in coastal Stann Creek district; people abandoned sawmill settlements in southern Cayo and moved into the upper Belize River valley. Only in the north, between Corozal and Orange Walk was there sustained population growth.

Table III-5. Distribution of Belize population by settlement size in districts based on 1980 census statistics. (Source: GOB 1983a). The number in parentheses is the relative percentage of district population in that size class.

Community Size	Belize District	Cayo District	Corozal District	OrangeWalk District	StannCreek District	Toledo District	Country Total
100,000	1 (78)						1 (28)
25,000							–
10,000		1 (25)	1 (30)	1 (37)	1 (48)		4 (19)
5,000		2 (24)				1 (19)	3 (5)
2,000	1 (2)		3 (17)	2 (11)	1 (11)	1 (9)	8 (7)
1,000	5 (6)	6 (20)	9 (29)	6 (20)	1 (5)	2 (12)	29 (14)
500	25 (9)	30 (25)	18 (23)	40 (30)	20 (26)	31 (42)	164 (21)
50							
Total Communities	32	39	31	49	23	35	209
Dispersed Rural Population	2,216 (4)	1,653 (7)	280 (1)	617 (3)	1,245 (9)	2,067 (18)	8,078 (6)

Table III-6. Urban population densities in Belize based on 1980 census statistics.

COMMUNITY	POPULATION	AREA (km_2)	DENSITY (per km^2)
Belize City	39,771	6.9	5,764
Orange Walk	8,439	1.6	5,445
Corozal	6,899	1.4	4,928
Dangriga	6,661	1.9	3,581
San Ignacio	5,616	1.7	3,383
Belmopan	2,935	0.9	3,335
Benque Viejo	2,466	0.9	2,901
Punta Gorda	2,396	0.6	4,204

Recent Immigration, Refugees, and Land Alteration

Belize's cultural history clearly demonstrates the country is a product of immigration. The proportion of foreign-born population has consistently been high. According to the 1980 census, 11% of the population was foreign-born, over half of which were Central Americans: Guatemala (20%); Mexico (19%); Honduras (10%) and El Salvador (7%). About 7,000 other immigrants were from the U.S., U.K., Canada, West Indies, India and other places, or did not list their origin. With the exception of Hondurans, who are in Belize primarily as sojourners, most foreign-born Ladinos censused are being incorporated into Belizean society, feel themselves to be Belizeans and intend to stay in their adopted country.

Within the last five years, however, a controversy has developed over the presence of refugees from El Salvador. Though publicity surrounding the issue has probably been generated by those wishing to promote a certain position, the actual impact of new immigrants in Belize has not been assessed.

Since the spring census of 1980 many refugees from El Salvador's civil war have arrived in Belize. It is estimated, however, that Salvadoran refugees in Belize are less than 1% of those who have fled their homeland. Those in Belize are primarily from the war-torn departments of Cabañas, Chalatenango, San Vicente, La Libertad and Morazán. Previous estimates of the number of Salvadoran refugees in Belize ranged from 2000 to 15,000. Like most else surrounding the "refugee problem", these figures reflect how little is known about their status. For this CEP we estimate (as of mid-August 1983) 1,585 Salvadorans classified as refugees (W. Davidson, unpubl. data). They are located as follows: 1115 on rural lands as milpa agriculturalists (210 concentrated along the Hummingbird Highway, 530 at Valley of Peace settlement, 250 northwest of New River Lagoon, and 125 scattered elsewhere); 145 on rural lands as wage-laborers, including Stann Creek valley and northern sugar lands; and 325 in urban areas as wage-laborers. Apparently the flow of Salvadoran refugees into Belize has slowed or perhaps now stopped.

Aside from Salvadorans, other Central Americans cross the Belizean border almost daily. Most of these are young Ladino men (16–30 years old) from Honduras, and, to a lesser extent, from Guatemala. Few Mexicans now enter the country to stay. Virtually all Central Americans arrive without proper documentation and without permission to work. Quite frequently they include skilled workers –carpenters, electricians, masons, and plumbers–in addition to the majority who are wage agriculturalists. Some indicate they left to escape army duties.

Most Hondurans arrive in southern Belize, but a few enter Mexico first and cross the Río Hondo. Of the approximately 1600 Honduran immigrants, many come from Tegucigalpa, La Ceiba and the area south and west of San Pedro Sula, including Quimistán, Atima and Tiuma. Except for the 10–12 Kekchí families who enter each year in extreme southwestern Toledo, the Guatemalans cross via Melchor-Benque Viejo. These immigrants head for Belize City, the upper Belize River valley and the northern sugar lands, but a few are scattered throughout the country.

Land Alteration by Recent Immigrants

During the last decade, the opening of new lands by immigrants for small-scale slash-and-burn agriculture has

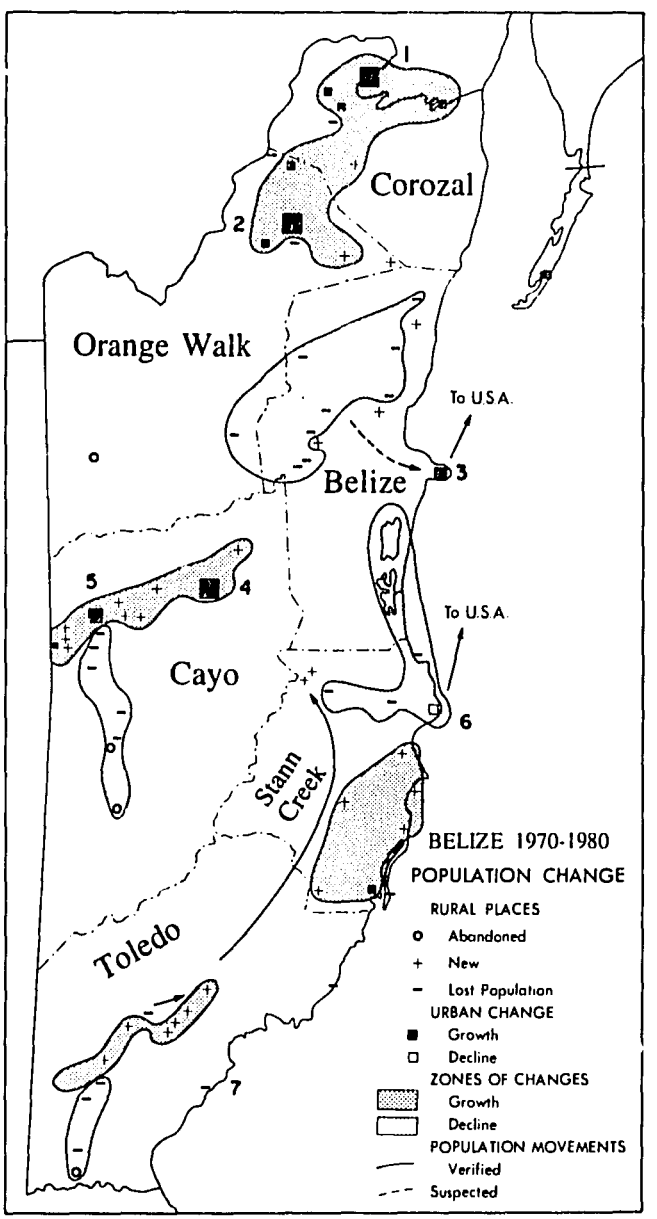


Figure III–6. — Population change in Belize 1970–1980. Note the losses of population from Dangriga and Punta Gorda. Numbers represent major cities: (1) Corozal Town; (2) Orange Walk; (3) Belize City; (4) Belmopan; (5) San Ignacio; (6) Dangriga; (7) Punta Gorda. (W. Davidson, unpubl. data)

Figure III–7. — Visual impact of slash-and-burn agriculturalists along the Hummingbird Highway. (photo L. Nicolait)

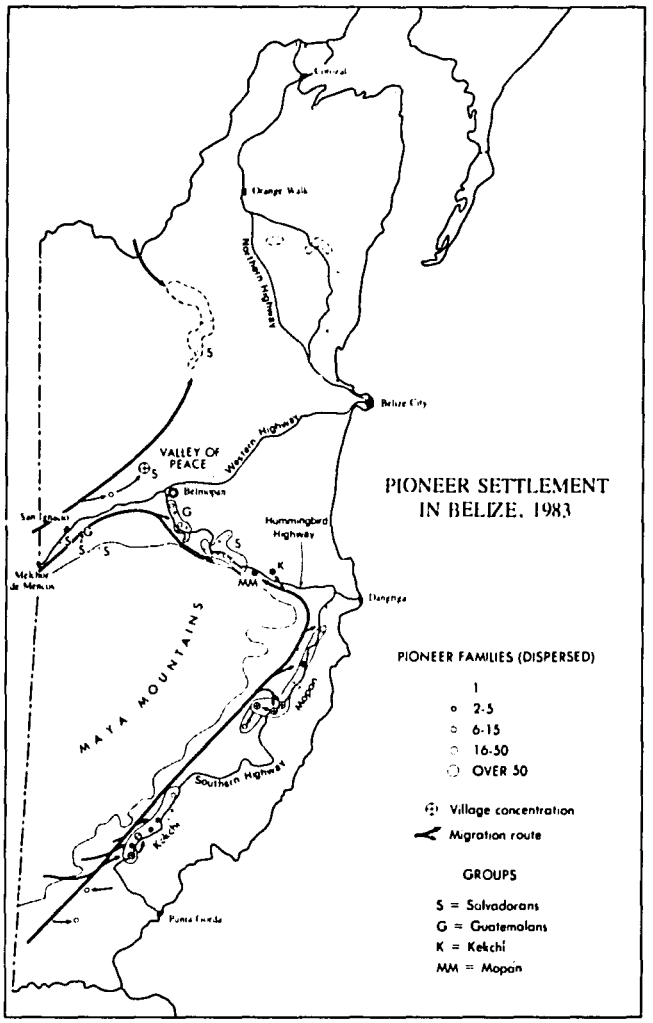


Figure III–8. — Pioneers who are opening new areas of Belize include immigrants from Salvador and Guatemala, and Kekchi and Mopan Mayas. (W. Davidson, unpubl. data)

attracted attention within Belize. The visual impact of forests cleared along the Southern and Hummingbird Highways has led some observers to misjudge the relative extent of landscape alterations at the hands of newcomers (Fig. III-7). Virtually all new settlements have occurred in linear clusters by four distinct groups: two groups of Central American immigrants and two of Belizean Indians. Outside the four clusters located on the piedmont fringe of the Maya Mountains, isolated single family clearings are scattered sparsely over the country (Fig. III-8). The total of scattered clearings is no more than 150. It is often suspected locally that many of those more isolated plots are related to marijuana cultivation.

Since Amerindians settled southwest Belize in the late 19th Century, expansion into new lands has been gradual. However, during the last decade they have broken out of the traditional zone and moved north along the Southern Highway. According to Indian accounts, the movement has been spurred by land pressures within Indian settlements, family squabbles, desires to be near market roads and government incentives to open new lands for agriculture.

Surveys along a 33 km stretch of the Southern Highway between Big Fall and Deep River were conducted during the summers of 1981 and 1983 to measure the amount of Kekchí movement outside their core settlements (W. Davidson, unpubl. data). During the two year interval new settlement and land clearing occurred primarily around the Indian Creek complex near Nim Li Punit, an archaeological site. Within 4 km of the site on the west side of the highway 16 new houses have been constructed; eight families were from Big Fall and eight were from farther south.

Movements by Kekchí Indians within their settlement are less well-known, obscured by inaccessibility. New Kekchí are still arriving in southwest Belize from the homeland in Guatemala at a rate of 10–12 families annually. The routes have remained the same for generations: along the upper Temash and Hiccatee rivers into Dolores and on to Otoxha, which serves informally as an orientation center, then through the lowland between Poite and upper Moho rivers into San Benito Poite. Otoxha seems to have been the source center for most resettlement in the nearby zone. New settlers at Corazon (established 1972), at Marbel Ha (now 8 families), and at San Lucas all came from Otoxha. In August 1983 San Lucas residents were preparing to move 5 km east to the headwaters of Roaring Creek because the swampy lands around the village were believed to be unhealthy. The other significant movement in the far south is by newly converted "Brethren" of Laguna who are moving 7 km west to establish their own colony, River Jordan.

Over the last decade Mopan Indians have moved from near San Antonio (Toledo) with sporadic northern movements along the Southern Highway. Compared with the Kekchí, Mopan settlements are larger, more compact and in village form. However, they are less socially stable, and movement out of the settlements has been frequent. Thirty one families (almost 1/3 of the total settlers) have moved during the last two years from five new Mopan settlements. Apparently family strife, often due to religious differences, causes these movements.

Both Kekchí and Mopan Indian pioneer settlements open relatively good farm land. All settlements are located along the road transecting the piedmont of the Maya Mountains. Some Indians attempt to farm the lower slopes of the mountains. On Cabbage Haul Creek behind Maya Centre, the Mopan have the largest clearing (8 ha) on hilly land. Kekchí have about twice that amount in new cultivation behind Indian Creek and at Golden Stream.

Settlement by Central Americans along the Hummingbird Highway (a 13 km stretch beginning about 5 km south of Belmopan) is made up of 38 households of Guatemalans, primarily on the east side of the highway. Approximately 205 people have cleared 28 plots from the forest to plant about 200 ha of maize, plantains, beans,

ginger, etc.; another 58 ha are in fallow. The first settler arrived in 1972, and he still has occasional contact with friends and relatives in Guatemala and is given credit for attracting others to join him in Belize. Most have secured land by renting from a large landholding company at an annual rate of about B$5.00/ha (B$2/acre). Originally from Jutiapa, Sipacate, Jalapa, Champerico and Escuintla, most Guatemalan immigrants do not speak English. However, they enjoy being in Belize and intend to remain. They cannot be considered refugees.

Spontaneous settlement by Salvadorans is occurring along the same highway of the Guatemalans. In a 12 km stretch between Sibun Camp and upper Stann Creek valley there are 36 households of some 223 people. While there are more Salvadorans than Guatemalans, the latter (who have been on the land longer) have over twice as much agricultural land per household (Table III-7). High population densities in El Salvador limited land available for crops, and Salvadorans have traditionally used smaller plots than in Guatemala; this custom may be persisting in the new Salvadoran settlements. Aerial reconnaissance indicates the more recent, often undocumented Salvadorans have a few additional fields in the near interior.

Table III-7: Central American pioneers along the Hummingbird Highway (W. Davidson, unpubl. data, August 1983).

	Guatemalans	Salvadorans
Original entry (year)	1972	1979
Number of households	38	36
Approximate population	205	223
Land cleared (ha)	256	82
Land in cultivation (ha)	197	72
Land in fallow (ha)	59	10
Cultivated land per household (ha)	5.2	2.0
Houses under construction	1	0
Houses abandoned	3	1

Few housing changes and no new construction indicate few recent Salvadoran arrivals. Likewise, there seems little evidence of houses abandoned, or of migration. The Guatemalan immigrants seem only slightly less stable; they have recently abandoned three houses and one is under construction.

Valley of Peace Project

The GOB has been joined by the United Nations and the Mennonite Central Committee in an effort to permanently settle several Salvadoran families at the Valley of Peace, 13 km northwest of Belmopan. National land (55,000 ha) has been set aside across the Belize River for the eventual location of 200 agrarian families from El Salvador and Belize. By December 1982, 36 families had each been granted a 20 ha plot; by July 1983 the group had increased to 80 families. Maize, rice, beans, squash, melons and peppers are being grown near the two clusters of houses that are in the center of the developing road network. The agricultural project will provide food to the Belizean market and incorporate the refugees into local society. Many immigrants work seasonally in the Stann Creek citrus harvest, where they have gained the reputation as "hard workers" from bosses and peers.

There is ample precedent in Belize for such government sponsored settlements. Garífuna and the southern Amerindians have been organized in land settlements for over 100 years. Particularly after the worst hurricanes, resettlement has been a common GOB response. After the 1961 storm, relocations resulted in new towns at Hattieville, Silk Grass and Georgetown.

Challenges to Development Programs

Any analysis of environment and man in Belize immediately considers two features: the physical area is small and the sparse population is unequally distributed. Including the great diversity of culture, Belize is a veritable "laboratory" where manageable-scale "experiments" can be tried. Good results of such efforts in economic development may be applied to other Latin American areas where experimentation may be difficult or impossible.

What distinguishes Belize from Central American countries is the unique cultural milieu. Each culture has a perspective on how its environment should be utilized, as well as a capability to alter it. In general terms, cultural influence on the environment can be categorized as to degree of technology and availability of capital to utilize natural resources, including land. Mennonites and North American landowners are a small component of the population but they have the technological facilities to alter greatly the landscape. The Amerindians, East Indians, some Central Americans, Garífuna and Creoles make up a group of manual laborers or employers of farm laborers who cultivate 1-5 ha yearly (Table III-8), but the amount deforested yearly is appreciably less because of the use of fallowed land. Of less concern are the urbanites, such as Creoles, Chinese, and East Indians, who have little effect on the rural environment, but can contribute to urban problems such as pollution.

Perhaps one reason for an optimistic view on environmental alteration is that Belizeans, unlike neighboring Latin Americans, are not typically rural or agrarian. Fully half the Belizean population has little to do with natural resources on a daily basis. Unlike the rest of tropical America, Belize has a great opportunity for development while being able to minimize environmental damage.

Table III-8. Average field size per household used by small-scale agriculturists of different ethnic groups (W. Davidson, 1983 unpubl. data).

ETHNIC GROUP	Hectares per Household
Guatemalans	5.2
Yucatec Maya	4.0
Mopán & Kekchí (Toledo)	3.0
East Indians & Creoles	2.1
Salvadorans	2.0
Garífuna	0.9

If Belize has a lesson for the rest of the world, it is that multi-ethnic societies can live peacefully together. There is a Belizean nationalism throughout the country. Belize may not be united by heritage, a common language or cultural oneness but in that cultural heterogeneity there is a nationalistic spirit. Hopefully, with their feeling of justice before the law, Belizeans will understand the value of environmental considerations in the quest for economic development and continued political stability.

III–D. HEALTH AND NUTRITION

The Country's Draft Health Plan for 1983-1987 (MHHC 1982, in revision) rescheduled for submission to Cabinet in 1984 has goals that are realistic. A corps of Belizeans and foreign health and nutrition professionals, foreign government and voluntary organizations, and financial aid, should help make the goal "Health for all by the year 2000" in Belize, a reality long before that date. However, much will depend upon efficiency in the administration of the broad programs to bring potable water and sanitation facilities to all villages of 50 or more people, continue with immunization and other public health programs, stimulate good nutrition practices especially through the use of home grown foods, and the practice of preventive medicine.

In April 1983, the MHHC made administrative changes to integrate environmental health programs under one Environmental Health Division (EHD). While the EHD integrates staff and programs to address the number one health problem, malaria, programs that had been divided between the Public Health Inspectorate and the National Malaria Control and *Aedes* (Dengue and Yellow Fever vector) Program were combined. However, as of April 1984, malaria control has become a vertical program under the MHHC.

Major Health Problems

Mortality and morbidity (sickness) figures from health reports must be considered suspect as diagnostic capabilities outside Belize City Hospital are not generally reliable. WHO lists Belize's mortality and morbidity figures in an "unreliable" category due to under-reporting of infant deaths in rural areas (MHHC/PAHO 1983). In addition, cases of malaria and dengue fever are not "confirmed" unless laboratory tests have been made for the victims. Because laboratory testing is insufficient outside Belize City, the number of reported cases is believed to be a substantial underestimate of their incidence and effects on the Belize population.

Malaria and Dengue Fever

Belize's moist, lowland environment is excellent habitat for mosquitos that transmit malaria, hence it will be difficult to eradicate the mosquito vector. Not only is malaria Belize's top health problem, it has recently been out of control. Since 1980, there has been a 30% annual increase in cases (Fig. III-9). However, the increase was slowed in 1983. *Plasmodium vivax* has been the usual disease organism but *P. falciparum* cases, previously unknown to Belize, have increased significantly (31% over 1982 to 1983).

Though malaria does not usually kill its victims (only one malaria death has been confirmed in the last 10 years), it is a debilitating disease. The recent upsurge in cases (Table III-9) gives Belize a high per capita incidence of malaria for Central America (MHHC 1984a).

The GOB reduced its mosquito spraying program in the early 1970's (there were only 33 malaria cases in 1970/71). Even though DDT has long been used to control *Anopheles* mosquitoes, apparently the mosquitoes have not yet developed resistance to DDT. The recent spraying campaign has slowed the increase in malaria incidence, but the *P. falciparum* (634 in 1983) attacks (MHHC 1984b) are worrisome. The 1982–83 trend showed a 15% increase in new localities reporting malaria cases, with 72 localities in the six districts affected by malaria (MHHC 1984b). Only Belize City, a few surrounding localities, and the cays, can be considered free of the *Anopheles* mosquitoes that transmit malaria (PAHO/AID 1982).

The MHHC has stepped up its education plan to reduce malaria. Malaria victims must be protected from *Anopheles* mosquitoes to prevent the spread of malaria. Announcements on radio and television instruct Belizeans to empty open water containers, clean up garbage and, in general, understand the breeding grounds of mosquitoes; other disease vectors are also mentioned. However, the allocated budget and spraying program, as well as the medication scheme and follow-up medical reporting, are insufficient. PAHO's contribution of BS400,000 in 1984 should provide the vehicles and support equipment needed to help control the *Anopheles* mosquitoes (MHHC 1984b).

Malaria control activities are supervised by a Chief of Operations, MHHC, and include various administrative, technical and support staff. The *Aedes* control program is under the EHD and has its appropriate staff.

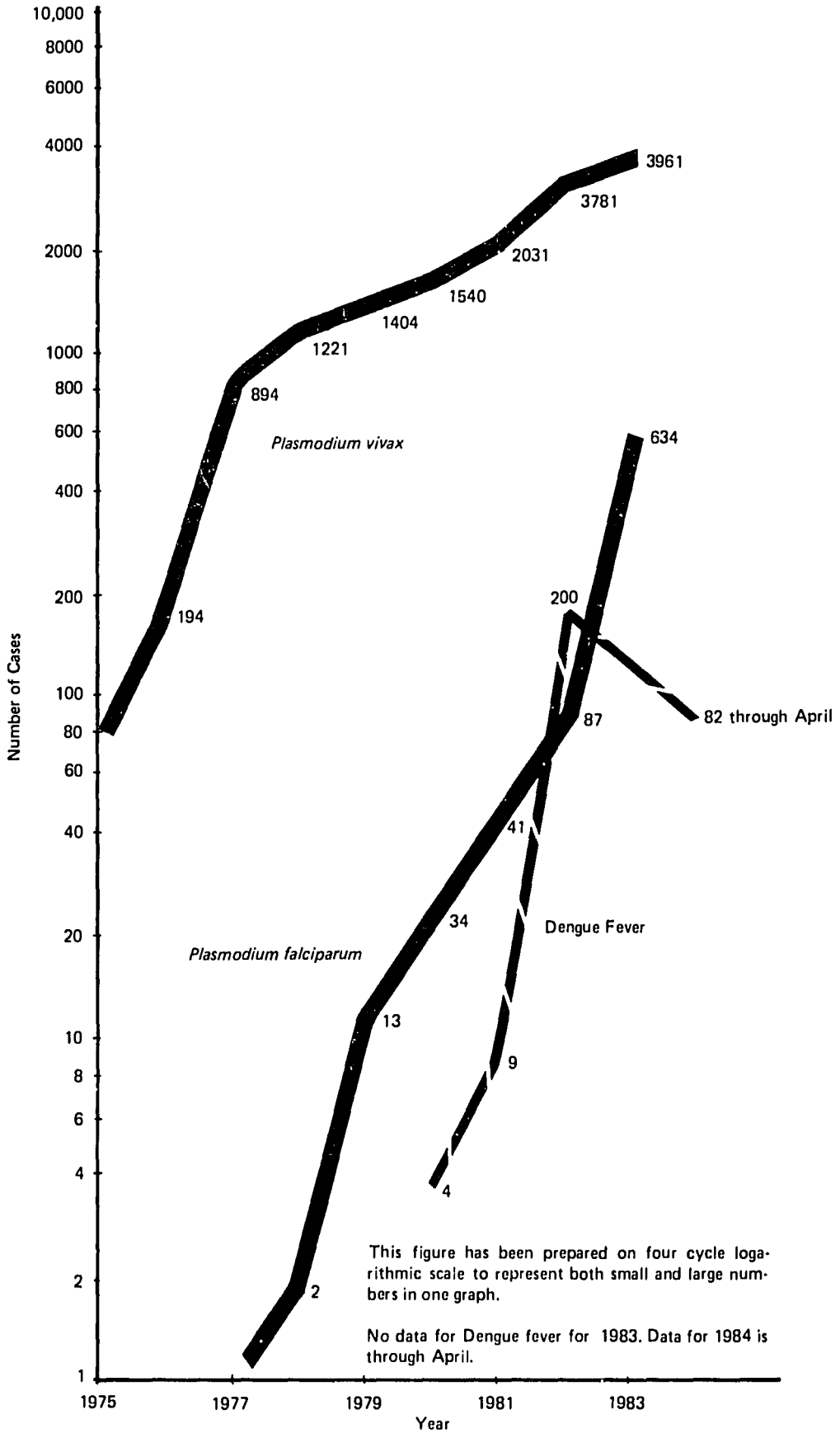


Figure III–9. Malaria and dengue fever cases in Belize 1975-1984. (Sources: E. Vanzie; F. Smith; W. Hawley; MHHC 1984 b)

Table III-9. Malaria statistics for Belize. About 52% of Belize is protected by residual spraying of 100% or 75% DDT to kill mosquitoes. Many cases of malaria are not confirmed and the last confirmed death due to malaria was in 1976. (Source: E. Vanzie, MHHC).

Year	Population	Total Confirmed Malaria Cases	Annual % Increase	% Population w/Confirmed Malaria	Pop. Protected by Spraying
1980	145,353	1540	10	1.1	–
1981	147,000	2072	34	1.3	–
1982	155,370	3868	87	2.5	47% (73,323)
1983	159,262	4595*	19	2.9	82% (131,112)

* 1983: *P. vivax* (3961) and *P. falciparum* (634).

Believed to have been eradicated in Belize in 1957, *Aedes aegypti* mosquito populations have recovered, developed resistance to DDT and by 1982 infested 68 localities with 73% of the country's population. A 1982 confirmed outbreak of dengue fever was followed by sporadic, unconfirmed cases. (Dengue fever is transmitted by mosquitoes carrying group B arbovirus; *A. aegypti* also carries yellow fever and a type of this yellow fever is transmitted to monkeys). For many years there have been no cases of human yellow fever, although the sylvan variety may occur in the forest canopy. There is a general need for better training, more equipment and interministerial coordination to control *Aedes aegypti* mosquitoes. Laboratory facilities are needed to confirm the dengue fever virus in Belize. Currently, all confirmations of dengue fever are made by foreign laboratories.

Infant Mortality

Life expectancy at birth in Belize is 67.7 years (1977 PAHO estimate). Infant mortality has been reduced in Belize by 33% over the last four years to 27/1000 in 1983 (MHHC/PAHO 1983). However, infant mortality may be higher since Indians in remote villages rarely report infant deaths (R. Wilk, pers. comm.). Anemia among pregnant women is being addressed and UNICEF is providing iron-folate supplements through health clinics (MHHC 1984a). Though mortality from diarrhea diseases is being conquered, these diseases are still serious health problems in Belize (F. Smith, pers, comm.). The education program of Oral Rehydration Therapy (ORT) has been successful in Belize; hospitals have fewer infant patients suffering from dehydration related to diarrheal disease. (A. Courtenay, pers. comm.). Women's groups (with guidance from the Ministry of Social Services, home economics departments, and the Women's Bureau) are anxious to improve their health, sanitation, and nutrition programs. Social workers help generate enthusiasm for improved health through community participation (BNCN Meeting, 27 III 1984).

About 10% of all deaths in Belize relate to conditions originating in the perinatal period (at the time of childbirth), and 5% to cerebro-vascular accidents. This latter figure may include traffic accidents as there is no category for traffic deaths in the hospital statistics (C. Harry, pers. comm.) (see Table III-10).

Other Health and Sanitation-related Diseases

Seventeen cases of rabies were documented in 1980 among domestic cattle, cats and dogs. More recently, no more than six cases annually have been reported. One case of human rabies was documented post mortem in 1981 and 20 to 30 persons per year receive post-exposure treatment with rabies antiserum.

Leptospirosis is carried by rats and perhaps contracted by domestic animals. Though there is no rat eradication program, rodenticide is provided on request by the Public Health Inspectorate.

Gastroenteritis is a persistent problem but the etiology is rarely documented. The number of reported cases in 1983 has increased by more than 150% since 1981–82, but this is considered to be the result of improved reporting associated with the Diarrhea Control Program. The mortality rate from gastroenteritis is decreasing dramatically with the widespread use of ORT.

Immunization

Belize follows WHO's recommendations for immunization. Vaccines for diphtheria, whooping cough, tetanus, poliomyelitis, measles (rubeola) and tuberculosis (BCG) are provided by the MHHC with the cooperation of the PAHO revolving fund. Full protection is scheduled for completion within the first year of life; however, immunization records suggest that almost 100% coverage is not attained until about five years of age (PAHO/AID 1982).

Accidental Poisonings

Mortality and morbidity due to toxic substances are poorly documented. There have been cases of agricultural

workers sustaining burns when improperly applying urea. Insecticide and paraquat poisonings are not uncommon. Four hospitals showed a total of 17 poisonings from 1979–82, with nine deaths (A. Cawich, pers. comm.). The overwhelming chemical liability is the herbicide paraquat, used not only to destroy marijuana crops, but also in sugar cane and banana production for weed control.

An educational campaign as well as documentation of poisonings are needed to help prevent accidental poisonings. Many bulk items, such as paint thinner and pesticides, are retailed in recycled drink containers (e.g., beer and liquor bottles). Liquid medicines are usually dispensed in containers provided by the patient and these are frequently food or drink bottles. Some poisoning deaths may also be included under "signs and symptoms and ill-defined conditions" (Table III-10).

Traffic Accidents

Traffic accidents are a frequent cause of serious injury (53/year) or loss of life (36/year for 1980–82) (MHHC 1982). Accident data collected include the following: inattention or misjudgement; excessive speed; negligent pedestrian or negligent passenger; in that order. Alcohol intoxication is not listed in accident reports. An intensive public education campaign about the risks of traffic accidents could save 25% of the lives lost annually and lessen serious injuries.

Occupational Health

Occupational health and safety are the responsibility of the Ministries of Health, Labor and Social Security. There is no easily identifiable GOB office for the provision of services. It is estimated that 38,500 persons are employed with 50% to 65% engaged in agricultural activities. A consultancy in 1980 identified the following occupational health problems: (i) Injuries associated with cutting of sugar cane and bananas; (ii) Poorly documented, acute poisonings from improper pesticide use and handling; (iii) Severe heat exposure in the production of citrus concentrate and canned foods; and (iv) Organic dust in sugar mills, especially from handling the dry bagasse.

Because of the existence of only light industry, occupational noise is not generally a problem although it is of concern in power plants. Toxic chemicals (including chromates, zinc and cyanides) from the galvanizing operation near Belize City have caused extensive fish kills during the past two years.

Table III-10. Leading causes of death in Belize for 1981 and 1982*. (Source: MHHC 1984a)

	1981			1982		
CAUSE	Number	(%)	Rank	Number	(%)	Rank
Perinatal Complications	70	(9.9)	1	68	(10.3)	1
Cerebro-vascular Accidents	51	(7.2)	5	37	(5.6)	2
Heart/Circulatory Diseases	51	(7.2)	6	27	(4.1)	3
Respiratory Diseases	35	(4.9)	10	26	(4.0)	4
Ill-defined Conditions	54	(7.6)	4	21	(3.2)	5
Digestive Diseases				18	(2.7)	6
Intestinal Infections	41	(5.8)	8	18	(2.7)	7
Other Bacterial Diseases				18	(2.7)	8
Endocrine/Metabolic Diseases				16	(2.4)	9
Nervous System Diseases				15	(2.3)	10
Pneumonia and Influenza	64	(9.0)	2			
Malignant Neoplasms	55	(7.7)	3			
Ischemic Heart Disease	43	(6.1)	7			
Acute Myocardial Infarction	41	(5.8)	9			
TOTAL	709			658		

* Dr. Hawley feels that these statistics do not reflect the real situation in Belize. "There is a lack of standardization in disease reporting, death certificate reporting, rapid turnover in personnel with varied backgrounds, etc. One of the principal responsibilities of the Ministry of Health Epidemiologist should be to develop a degree of standardization which would result in data suitable for long-range planning and short-term management."

The shared responsibilities among the three ministries involved in occupational health should be clearly defined. Industrial hygiene and safety should be under the purview of the EHD, and a physician or PH nurse should oversee occupational medicine. Objectives and priorities in occupational health must be evaluated to establish guidelines to protect workers' health.

Organization of the Health Sector

"Emphasis on preventive care, improvement of the environment, rural health centres and health education have proven to be effective in reducing child death and illness among children. Belize's thrust has been more effective than the strategies of some countries that have chosen to put their resources into costly and technologically sophisticated institutions and buildings that benefit a small portion of the population." (A Kayayan, GIS 1984, p. 11.)

On an organizational basis, the Minister of Health and Permanent Secretary nominate a Chief Medical Officer (CMO) who is appointed by the Governor General, to oversee all health responsibilities. In the Public Health Bureau, a principal PHI and two senior PHIs supervise 14 PHIs with responsibilities including premises inspections (PAHO/AID 1982).

District Medical Officers (DMOs) are under the jurisdiction of the CMO. Since Belize does not have any college training beyond the third year (US) level, Belizeans study abroad and many do not return. Many DMO's are young foreign medical doctors (only 12 of 35 government doctors are Belizeans; CDSS 1983, p. 42). Two DMOs are assigned to each district and they are responsible for health services throughout the district. One of the DMOs administers public health programs (MHHC/PAHO 1983). Unfortunately, most doctors do not have the rare talents to administer health programs and provide all the necessary medical services in a district. There are 29 health centers throughout Belize. Some problems exist due to language differences as well as preferred cultural practices interfering with medical treatment.

Belize has seven hospitals, one in each district and one in Belmopan, and Belize City has a private hospital as well. Funds are being secured to build a new hospital in Belize City (MHHC 1984a; GOB 1984b). Maternal and child welfare services are available in each district (GOB 1983g). Outside urban areas, medical services are provided by rural health centers and mobile clinics. The Belize School of Nursing provides local training for nurses and midwives (GOB 1983g).

The EHD now has responsibility for *Aedes* control, rural water supply, water quality control, food and environmental sanitation, occupational health and zoonoses (communicable diseases).

Though there is no organized continuing education program for PHIs, they must complete a three-year training program. PHI duties include control and abatement of nuisances as defined by the *Public Health Ordinance*, 1958, Chapter 87, Section 136: collection of water and food samples; inspection of septic tanks, offensive trades, factories, meats and food samples, and condemnation of unsound food; drainage; rabies control; port health duties; health education; specialized campaigns; pollution control and prevention; keeping of records; reporting promptly and investigation of complaints and any other investigations required by the CMO (PAHO/AID 1982). However, the broad range of responsibilities far exceeds the capacity of any one PHI in a district, and this factor leads to frustration and crisis management.

Qualifications for senior and principal PHI's should be clearly defined and minimum standards should be required. Details of their assignments can be found in the Health Assessment (PAHO/AID 1982). Each district needs at least one more full-time person, and one of the two PHIs in a district should be fully trained (i.e., at least a three-year program).

Problems of Health Personnel

The universal problems facing DMOs, PHIs, health workers, volunteer health and nutrition trainers and counselors are communication, definition of and support for staff responsibilities, and mobility. Many workers cannot fulfill their duties because of vehicle breakdown, supplied vehicle not being matched with needs of the health worker, telephone or two-way radio communication unavailable to attend promptly and adequately to a problem, or lack of financial assistance that should have guaranteed that the worker could fulfill work requirements.

Better management of recurrent expenses and capital outlays would alleviate problems. In the absence of a guaranteed budget to cover program expenses, some innovative solutions might be possible. For example, the telephone systems should be upgraded to cover more villages that are not now being serviced. Remote areas should have two-way radios with open lines to the DMO clinics. Young people in remote villages should be trained in use and simple maintenance of radio equipment. Radio communication could also be expanded to meet goals of other ministries. Small motorcycles would help health and nutrition workers carry out their duties. The MHHC budget for health programs should be guaranteed and then health personnel can be held accountable for providing their services. Responsibilities and salaries must also be based on training and job requirements.

Health legislation is weak, and enforcement is absent. However, PAHO has been helping the CMO to revise the Draft Health Plan that will be submitted to Cabinet this year (C. Harry, pers. comm.).

Finance and Budgeting

All EHD activities are seriously under-funded. Budget allocations represent less than 40% of program needs. The 1982-83 budget for Health was over B$8 million; for 1983-84 it was about B$10 million (MHHC/PAHO 1983). In addition, budget allocations are not always available for expenditure. For example, in 1982 a conservative estimate of funding for the National Malaria Program was B$968,000; however, only B$350,000 was available to be spent. Budget projections that are determined by past allocations and expenditures rather than by projected program goals and needs effectively limit reallocations on the basis of current priorities.

Health and Nutrition Education and Community Participation

The need for community-based health education has been identified by EHD; many projects had previously been implemented by MHHC. The Caribbean Food and Nutrition Institute (CFNI) and the Pan American Health Organization (PAHO) provide technical and financial support for MHHC programs. The following organizations play significant roles in health care and nutrition.

Project Hope is developing a three-year program in health care at the Belize School of Nursing. It is also upgrading district clinic laboratories (MHHC 1984a).

Project Concern International (PCI) has a three-year health program in Toledo district that will reach 8,000 persons in 20 villages. To date, 7,000 people in 14 villages have been served through the PCI programs administered by 14 PCI-trained health workers. Monthly attendance at community meetings (after six months) rose from 25 to 75 villagers per session (MHHC 1984a).

The **Peace Corps** (PCV) has eight volunteers working in the health sector (B. Perrin, pers. comm.); other PCVs indirectly influence rural people in good practices of health and sanitation. The PCV clinical psychologist works at Rockview (the only mental hospital) to develop agricultural skills as part of a rehabilitation program; he also works in five districts to train staff and nurses in mental health and to prevent institutionalization of the mentally handicapped.

PAHO has extensive programs in environmental health, malaria control, diarrhea disease control, and health planning and management.

UNICEF channels funds into health education and community participation activities related to improving infant and maternal health (Breast is Best League), sanitation, and water supply (MHHC 1984a; GIS 1984).

CARE helps to provide potable water in rural Belize, and its food and nutrition programs are nearly synonymous with "CARE" throughout the world. CARE's **REAP**, associated with the MNR and Ministry of Education, assessed rural life and developed agricultural projects in 1976. The program was extended (1979-1982) to all six districts (23 primary schools) and the curriculum was expanded to include nutrition, focusing on homegrown foods and adequate diet composition. REAP is currently administered by the GOB with international assistance. The expansion (55 primary schools in 1984) will eventually cover 65 schools with REAP-trained teachers from the Belize School of Education. Another 35 schools receive REAP information but the programs are informal (CARE 1983).

At least 12 other organizations, including U.S., Canadian, U.K., French and German governments, contribute to health and nutrition cooperative programs (MHHC 1984a).

The National Food and Nutrition Council, a high level policy advisory board, has been in limbo for more than a year. However, a recently organized, but informal, group of health-nutrition professionals meets to keep abreast of current issues and GOB and volunteer activities. Called the Belize Nutrition Communication Network (**BNCN**), this group began its informal meetings in November (1983) and has participants from the Ministry of Health, CARE, PCV, PAHO, Social Development, Ministry of Education, UNICEF, Council of Voluntary Workers, University of the West Indies, BELCAST, the Belize School of Education, Public Health nurses and guests. The annual Food and Nutrition Week (11-17 March 1984) was organized and implemented by BNCN members. Activities were held in all districts and many schools and volunteer groups participated. CFNI initiated the annual event five years ago and the National Food and Nutrition Council had previously been responsible for the programs.

Nutritional Status

CFNI and the National Food and Nutrition Council gathered in a 1982 workshop in Belize to review and evaluate the 1979 Belize nutrition policy (B. Anderson, pers. comm.). Results of the meeting were not available in Belize by April 1984 (G. Dennison, pers. comm.). Various mini-studies for health and nutrition have been undertaken in Belize but their conclusions are not definitive. Community studies, on a house by house basis, show children to be generally healthy; tests of sick children who visit clinics, where many studies are made, show a modest degree of malnutrition and anemia. Children in rural areas have a high incidence of parasites (whipworm, *Trichuris trichiura;* roundworm and hookworm) due to poor eating habits and sanitation. Malaria incidence and infestations of parasites as well as diarrheal diseases contribute to anemia and malnutrition, and dry-season reduction of potable water also contributes to incidence of intestinal diseases that increase malnutrition. Malnutrition models and strategies for improving public health are given in Table III-11.

Table III-11. Malnutrition models and strategies for improving public health. (AID 1984).

(A) MODEL DESCRIPTION	(B) BASIC PROBLEM	(C) PRIMARY CAUSES	(D) STRATEGIC RESPONSES
I. Inadequate availability of food (may be chronic or seasonal; may be nationwide or area specific)	Supply (Production and Imports)	– Low production – Post harvest food loss – Rapid population growth – Inability to import	– Increase food production – Improve production incentives – Reduce food losses – Reduce population growth – Short-term food aid
II. Adequate availability of food, but people unable to procure it (may be chronic or seasonal; may be nationwide or area specific)	Demand (Distribution, Food Price, Consumer Income)	– Inequitable geographic distribution due to poor marketing system, transport, storage – Inequitable economic distribution, due to people lacking purchasing power	– Improve transportation, storage and marketing systems – Increase incomes by employment generation – Stabilize prices of basic staples
III. Adequate availability of food, adequate distribution, and people have purchasing power, but do not consume proper diets	Ignorance and motivation	– Nutritionally inappropriate beliefs and food habits	– Modify food-related behavior through nutrition education and nutrition motivation.
IV. Adequate availability of food, people with power to purchase, distribution equitable, and nutritionally sound beliefs and habits, but nutrient loss in body after ingestion	Malabsorption or poor biological utilization of nutrients	– Poor environmental sanitation – Poor water supply – Poor waste disposal – Prevalence of disease	– Improve health care delivery (medicines, education) – Provide improved water and sanitation

Water Supply Programs and Needs

In general, Belize is able to provide an adequate supply of potable water for the foreseeable future. However, in a national water development scheme, due consideration should be given to water conservation, provision, and intersectoral coordination. For example, large scale tourism development on Ambergris Cay must address the availability of potable water and water conservation.

The urban population of Belize lives in eight centers that are served by public distribution systems operated by WASA (including chlorination facilities). House connections serve 62% of the population in urban areas. The WASA systems also serve nearly 5,000 of the rural population (MHHC 1982).

Rural water supplies fall under the purview of MHHC, MEC and MNR. The MNR is primarily responsible for providing water for livestock and irrigation but occasionally drills wells for private consumption on farms. WASA (MEC) is responsible for all urban water supplies and has provided some communities in Stann Creek and Cayo districts with rudimentary water supply systems. WASA also drills wells and fits them with hand pumps; but in most villages the drilling of wells and hand pump installation and maintenance responsibility of MHHC.

A 1981 review indicated that 458 wells with hand pumps had been drilled servicing 44 persons per pump in

Belize district, 160 in Cayo, 144 in Corozal, 119 in Orange Walk, 190 in Stann Creek and 296 persons/pump in Toledo district. It is estimated that up to 50% of these wells or pumps are not operational at any given time; however, MHHC maintenance crews try to keep them operational.

In 1979 CIDA identified 56 villages as needing a rudimentary water supply. Of these, 40 were chosen as priority areas, but to date only two water systems have been constructed. A joint MHHC-CARE project has provided most villages in Belize and Toledo districts with a drilled well and hand pump. Twenty-two other villages have a rudimentary water supply system.

MHHC has proposed to UNICEF (MHHC 1981, update 1983) a project to provide potable water to 6,500 persons in rural Toledo district. The project would provide 39 additional wells with hand pumps to 13 small villages and a rudimentary water supply system to seven larger villages. The project would also include an extensive health education component focusing on personal health and sanitation, a demonstration project for human waste disposal and environmental sanitation. Toledo's high mortality rate (9.5/1000; versus 5.5/1000 in other districts) demands that action be taken to improve water provisions to that population (MHHC 1981/1983).

Water Agency Development

Provision of potable water, especially in rural areas, should fall under one Rural Water Supply agency that would have two or three excellent technical units. A technical unit would evaluate hydrogeology, utilize appropriate drilling techniques, determine appropriate water systems, and establish norms for hand pump installation including types of casing, pumps, supporting structure and drain-off areas. The technical unit should have a separate engineering section. Another unit should manage water quality and the MHHC should be responsible for establishing regulations and controls to monitor water quality. A third unit would be responsible for implementation of water projects. Coordination of this agency with WASA for the urban supplies could be facilitated by establishing a National Water Council that would have the authority to define water policy, allocate program responsibilities, and oversee their implementation.

The problems of insufficient planning are well illustrated in the Valley of Peace resettlement scheme. A January 1983 report notes that there is only one pit latrine for every 4 households or 16 persons. The one hand-pump well is located in a topographic low spot at the village center. The well serving about 170 persons is surrounded by 10 latrines, one as close as 45 m. The MHHC was not involved in planning this settlement so no provisions were made for health services, sanitation or adequate water supply. In contrast, the MHHC was consulted on the proposal for Haitian resettlement.

Sanitation

The two municipal sewage systems (Belmopan and Belize City) are operated by WASA, the agency responsible for urban sewage disposal. The MHHC approves the design, construction and operation of septic tanks and other individual disposal systems. The *Public Health Ordinance* requires a private owner to provide a proper and sufficient sewage disposal system "approved by the Chief Medical Officer". Improvement in rural sewage disposal appears to be at the expense of urban areas. The existence of an approved system does not mean that it is functioning properly or being used. Some "approved systems" include direct disposal into the sea or adjacent water course.

Belize City will have its new sewage system (funded by CIDA and GOB) completed within three years. However, many people are making connections as sections to the system are completed. Many people interviewed by DeClerque (1982) in relation to another study, are not homeowners. As many as 65% of her respondents who rent said they would not install indoor plumbing in their homes. USAID's housing improvement loan will make low cost loans available to homeowners to make house connections to water and sewer mains as well as permit the installation of indoor facilities. Some legal steps may need to be taken to bring sanitation standards in Belize City to 100% approved sanitation systems.

The problems of water supply and sewerage are closely linked, thus the proposed National Water Council should propose sewerage and sanitation regulations as well. A random sample survey of homes to verify the number, type, functioning, and connection of sanitation services would help in assessment and planning of projects. Public and private systems in rural areas should be evaluated in relation to local topography and soil conditions.

III–E. CONTAMINATION

An amendment to the *Public Health Ordinance* (Gazetted 6 August 1983) empowers the Ministry of Health to make regulations and set penalties for infractions of the law. However, the National Assembly must approve all regulations. Though no specific regulations or guidelines have been proposed, an Environmental Task Force has been appointed to draft a national pollution control policy.

Major Contamination Problems

Water

The Belize River is a highway to some, a source of food to others, and a laundry and bath to many. Its fertile valley has considerable agricultural potential (Jenkin et al. 1976). It is the primary source of water for Belize City, Belmopan and numerous villages on its banks.

The water treatment plant supplying Belize City with potable water is located at Double Run (at Mile Marker 17 on the Northern Highway). The high quality water is well upstream of the contaminating influences of Belize City. Raw water turbidity is low with a range of 5 to 10 FTU (Formazin Turbidity Units) during the dry season and 30-35 FTU after periods of heavy rain. The pH varies annually between 6.5 and 7.7, with the slightly more alkaline values in the dry season. Bacterial testing in the Double Run area shows a total coliform concentration of 3,500 colonies per 100 ml of water tested (Gonzalez 1980). However, all potable water has been treated with chlorine to render any bacteria harmless.

In Belize City, the excessive discharge of organic effluents into water courses causes extremely high counts of bacteria, coliform and yeast/mold, as well as high levels of carbon dioxide. Belmopan is the only urban area fully served by a community sewage system. In district towns, most residents rely on septic tanks and latrines, but the use of buckets and the dumping of faecal matter into drains, rivers, and the sea is a common practice in all other rural and urban areas (except Belmopan). In San Antonio (Toledo district) and other villages of relatively high population density, the use of nearby streams for drinking water, bathing, laundry, and the dumping of sewage is becoming a serious health problem. Projects are being proposed to improve the potable water supply and sanitation systems.

A CIDA-funded project to provide potable water and a modern sewage system for Belize City commenced in 1974. The water treatmen facility has been completed and most houses with plumbing are connected; city dwellers without plumbing rely on public standpipe for potable water. Two sewerage lagoons located south of Belize City have an outlet to a coastal waterway. Scheduled for completion in 1987, the project is designed to permit sewage connections to houses as the mains are completed (Monahan 1983). For homeowners without financial resources to complete connections, USAID's housing improvement loan to homeowners should help Belizeans to install facilities and make connections.

Fish kills are the most serious evidence of industrial pollution in the Belize River; cyanide wastes from the nail and roofing manufacturer are dumped just north of Belize City. Fish kills have also been reported in the New River near Tower Hill sugar factory. Definitive regulations governing manufacture have not yet been set forth by the Ministry of Health.

The wastes from the four cooperative seafood processing plants are dumped directly into the sea or Belize River. In recent years, interest in aquiculture has increased, but there are no controls or guidelines for such concerns as location of ponds and processing plants, treatment of effluents, or the control of diseases.

Though increased production and food processing is expected, these operations need not pollute the environment if regulations are defined and enforced. Industries should be encouraged to regulate their effluents and reduce environmental contamination: the Belize Sugar Industry currently monitors BOD (Biochemical Oxygen Demand) levels in the New River and their research department plans ecological studies relating to their processing of sugar (A. Cawich, pers. comm.).

Effects of fertilizers, pesticides and herbicides on contamination of water have not been studied.

Water Quality Control

Most water resources in Belize are not systematically tested for changes in quality. Water samples should be tested regularly wherever people live or work, especially in areas where foods are grown or processed.

An integrated program that would facilitate testing of water samples to check for water quality and also aid in identification of non-bacterial pollutants should be provided by MHHC. Belize does not have a comprehensive water-testing laboratory nor the technical staff to test for impurities. Though collection of water samples and pollution control are among the duties of the principal Public Health Inspector, he cannot fulfill the requirements of his office if he is understaffed and lacking in physical facilities and funding.

Funding and technical assistance for initiating an integrated water quality monitoring program will most likely have to be provided by an external agency. However, taxation of high pollution risk industries and agribusiness ventures, in addition to fines for infractions of pollution regulations, might be considered as potential sources of revenue to finance such a program. With the inclusion of personnel training, in time the project could be staffed entirely by Belizeans.

Solid Waste

Garbage disposal is an extreme problem of immediate concern (DeClerque 1982). Dumping of solid waste into the sea is common (Fig. III-10). Some of it washes up on beaches of the mainland and the cays. Tourist areas are littered with refuse. Hospital wastes are dumped near the hospital rather than being incinerated.

The GOB can help improve the problems of solid waste disposal by providing trash collections and dumping areas. Once the mechanism is established to clean up the environment of litter and trash, the communities should be encouraged to participate in cleanup activities through educational programs to stimulate improved environment and health. If government money is not available for sanitation, all businesses and property owners should be assessed for the creation of either a municipal or private sanitation operation. Ministry of Health can help with enforcement of sanitation laws if necessary.

III–F. TOURISM

Tourism (including business travel) ranks second to sugar in foreign exchange earnings. Belize has enormous potential for development of a strong tourism sector. There are few countries as close to the United States that have the attractions that are present in Belize. The spectacular barrier reef is the longest in the western hemisphere and second longest in the world. Inside the reef are many cays and areas offering excellent snorkeling opportunities. Seasoned divers rate Belizean waters among the best in the world. The sport fishing potential is unrealized and the waters inside the reef are excellent for sailing, windsurfing and other activities.

Belize's Mayan heritage is exemplified by the large number (over 600) of known archaeological sites (see Appendix A) throughout the country. The Mountain Pine Ridge, the Maya Mountains, and the rain forest of southern Belize offer beautiful and often spectacular scenery. Many rivers that drain the Maya Mountains are suitable for canoeing, birdwatching and camping. Hunting and fishing are also inland attractions.

The peak season for visitors is February through June, the dryer months. Visitors arrive most frequently by land (more than half) from neighboring Mexico and Guatemala.

No record is available to distinguish vacationers from business visitors; all visitors are classified as tourists in this report. The amount of space available to accommodate tourists or businessmen is limited. There are 138 hotels in the country with 1,372 rooms, a third of them in the Belize City area. Hotels in the cays host SCUBA tours and fishing parties. A new 20-room convention center in Belmopan (small by international standards) has just been completed. Existing hotels and tourist services are generally modest and would be considered substandard in the tourist-oriented

Figure III–10. — Sea wall around Belize City showing refuse dumped either into the Caribbean Sea or into sewage canals that empty into the sea. (photo L. Nicolait)

Caribbean. The GOB recently granted three economic concessions to companies to build hotels in Belize.

Most tourism development has occurred in northern Belize on Ambergris Cay (Fig. III-11), Cay Caulker (or Corker), and other nearby cays. Other areas of tourism growth center on Corozal, Dangriga, and Placencia peninsula. Fishing lodges and other tourist accommodations are being built on cays that are privately owned or leased from the GOB. Access to these cays is by boat (or small airplane to Ambergris Cay and Cay Chapel). Though there are some promising areas for tourism development in southern Belize, they are virtually inaccessible (for example, Punta Negra and parts of the southern Maya Mountains).

Several factors make Belize attractive to investors in the tourist industry. First, there are many untouched areas in the country suitable for development. Second, there are no language barriers for travelers from the United States and Canada and their proximity to Belize is advantageous. Third, there is a growing interest among travelers to visit lesser known places of the world. Fourth, visits by Americans and Canadians to Caribbean areas are increasing. Fifth, the barrier reef and inland areas have excellent potential to capture part of the fastest growing segments of the travel industry in the United States-adventure and/or educational tourism. Sixth, the climate is suited for tourist incursions year-round though rains can often prevent access to some of the more remote areas of the country. Seventh, though Belize has a variety of cultures and languages, it is relatively tranquil.

Three economic factors make growth of the tourism industry an attractive prospect. First, like tropical hardwoods, shrimp and lobsters, tourism is generally associated with higher income elasticities. Second, tourism is a service industry and the growth will accelerate local employment opportunities. Third, relative high levels of foreign exchange could be generated for a relatively small public investment. In Mexico, tourism is the second leading foreign exchange earner after petroleum, and while there are constraints to development of this sector in Belize, these barriers are nowhere near as formidable as they are for agriculture, forestry, fisheries, or for that matter, virtually any other aspect of the Belizean economy.

Constraints to Tourism Development

Development of tourism depends upon expansion of knowledge about Belize. It is doubtful that many North Americans know where Belize is located much less its attractions. Though Belize is one of the few countries south of the United States whose national language is English, only the British may be aware of this fact. The name change from British Honduras to Belize (1974) further confuses foreigners. However, the small population of Belize and low demand for service make expansion of tourism difficult. Belize has no facility that can compare in terms of service and accommodations to the established areas of Cancun and Cozumel in Mexico.

Figure III–11. — Tourist area on Ambergris Cay, looking south. Tourists arrive by small plane (airstrip top left) or by boat (bottom left). (photo L. Nicolait)

The status of Belizean roads and road signs is a major obstacle to tourism development. Road access and improvement must precede or parallel tourism development. Many interesting pre-Columbian sites, scenic areas, and fishing areas are nearly inaccessible. Tourism depends not only on interesting environments but also adequate facilities. Water is not available on some cays or coastal areas that might otherwise support the tourist trade.

Mexico's Quintana Roo is an example of how a properly developed area can prosper due to tourism. Belize might not follow the same route, but it must recognize the role of infrastructure to the success of a tourism program.

Recreational Facilities for National Use

Private development capital is invested in recreation facilities and activities principally to accommodate foreign visitors. However, there is an acute need for recreation facilities for use primarily by Belizeans. Most towns have modest sports facilities, but rural picnicing and camping areas are lacking.

Facilities for local use need not be unique or elaborate, but they must be accessible to urban dwellers. All urban centers are near rivers and these offer ideal sites for picnic facilities. Privately owned land along rivers can still be purchased at relatively low prices, hence efforts to acquire some of these lands should be made before increased development drives up prices.

Although many towns are on the coast, the scarcity of beaches and localized water pollution preclude active use of the seashore for recreational purposes. Most Belizeans do not have the means to travel to and enjoy the cays, one of the country's great recreational resources. Therefore, several sand beaches on the mainland should be reserved from private development and held for public recreational use. A program to develop recreational facilities for national use is not likely to be self-supporting and would have to be handled as a social service.

Figure III–12. — Dredging the beach sand at Cay Chapel. Dredging is often a source of conflict to the conservation of natural resources in coastal areas. (photo L. Nicolait)

IV.

Natural Resources

IV–A. COASTAL & MARINE ECOSYSTEMS

Physical Features

Few countries have the extent and diversity of highly productive, tropical coastal and marine ecosystems characteristic of Belize (Fig. IV-1). These include coastal lagoons, mangroves, seagrass beds and coral reefs. Coastal lagoons provide nursery and feeding grounds for many near-shore fish species, act as sinks for terrestrial run-off, supply abundant nutrients to coastal waters and provide critical habitat for many species of Belizean wildlife, such as the manatee *(Trichechus manatus)* and crocodile *(Crocodylus acutus)*.

Mangroves are the principal source of nutrients enriching coastal waters, provide nursery and feeding areas for coastal fish species, function as sediment traps for estuarine waters and act as a physical buffer between marine storms and inland areas. Mangroves (also see p. 93) fringe most of Belize's coastline and can be found inland bordering rivers where salt water influences internal waters. Offshore, many cays are covered with mangroves or have been colonized on the lagoon side, principally by red mangrove *(Rhizophora mangle)*.

Marine grasses bind sediments and provide a stable substrate for benthic organisms (animals and plants living on sea floor). Sea grasses provide food and shelter to organisms that support Belize's second most important commercial fishery, the conch *(Strombus gigas)*.

Together with tropical rainforests, **coral reefs** are commonly described as the richest biological communities on earth (see Rutzler & Macintyre 1982 for IMSWE species lists and Perkins 1983 for other data). Besides signifying a highly productive ecosystem, Belize's coral reefs provide a zone of protection from incoming swell, support the country's most economically important fishery (spiny lobster, *Panulirus argus)* and attract a growing tourist trade to this world-class resource. Belize has the second longest barrier reef in the world, three of the Caribbean Basin's 14 atolls and the Blue Hole in Lighthouse Reef (a collapsed karst dome forming a vertical cave 144 m deep).

Lighthouse Reef (126 km^2) and Glover's Reef (132 km^2) differ considerably from the larger atoll, Turneffe Islands (330 km^2). Glover's and Lighthouse Reefs have patch reefs in the shallow central lagoons and distinct windward and leeward coral zonation patterns. Protected from an easterly swell by Lighthouse Reef, the Turneffe Islands atoll has a different coral composition on its windward side and generally lacks well-defined reef crest and reef flat on its leeward side. There are no living patch reefs in Turneffe lagoon.

The physical and biotic zonation patterns of the barrier reef appear to be similar to those described for other reefs in the Caribbean (see Rutzler & Macintyre 1982). The fore-reef (windward portion of the reef) extends from the reef crest to a depth of 40 m. Within the fore-reef several sub-zones can be distinguished: (i) a relatively deep outer ridge characterized by deep-water corals, sponges and soft corals that grades to a series of coral ridges and sand channels (spur and groove sub-zone) where more high-energy tolerant coral species dominate together with milliporans (fire coral); (ii) leeward of this sub-zone is a buttress zone composed of palmate and finger corals; and (iii) the reef crest is the area of maximum wave energy where only the hardiest corals survive. Behind the fore-reef is a rubble and pavement sub-zone characterized by broken coral and shell fragments that separate labyrinthine patch reefs from the inner lagoon (Fig. IV-2).

The approximately 450 sand and mangrove cays confined inside the barrier reef and atolls range in size from small, ephemeral sand spits to larger, permanent islands capable of sustaining human settlements. Cays typically develop in gaps between stretches of linear reef, on small

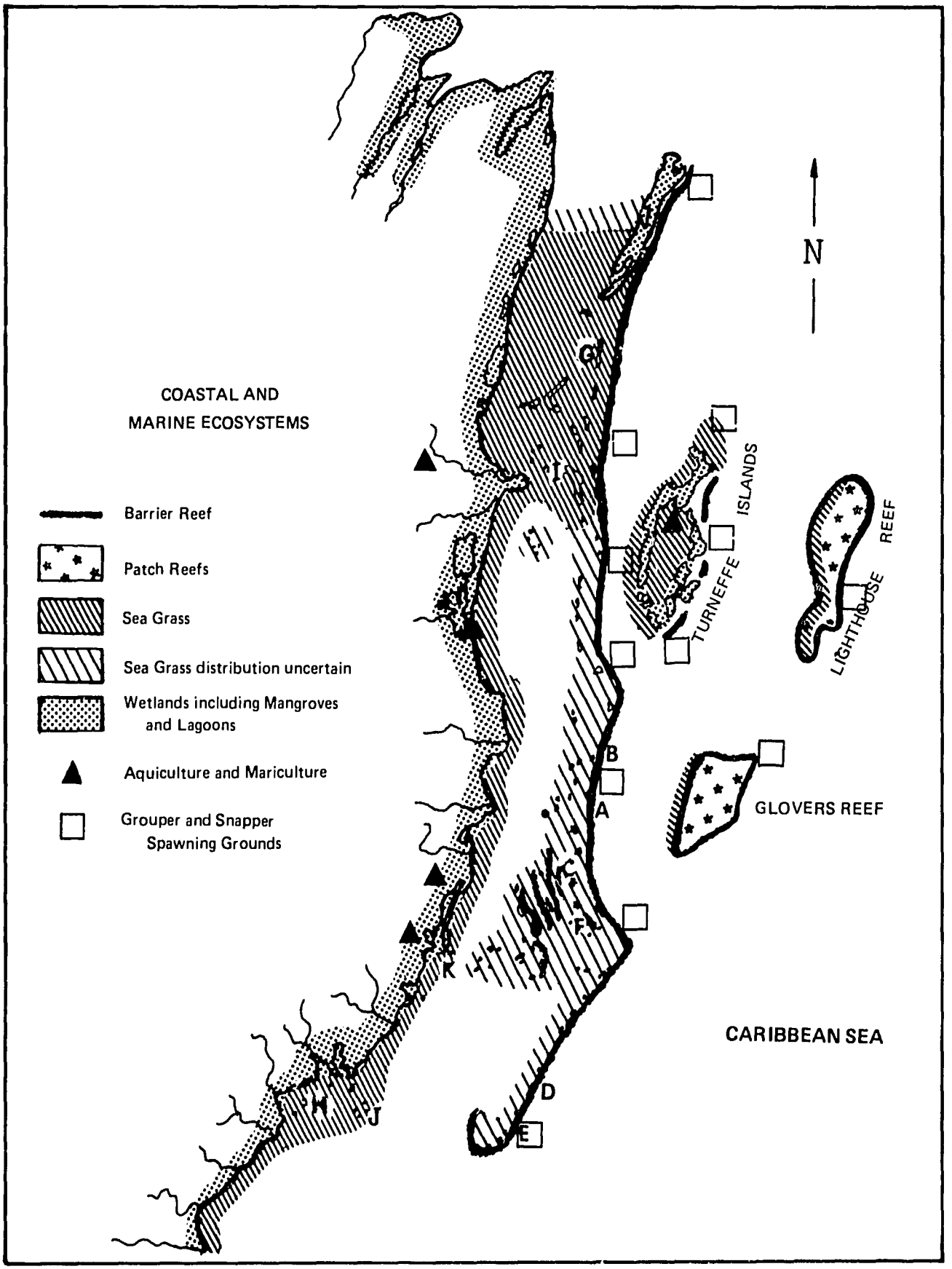


Figure IV–1. — Marine ecosystems of Belize. These sea waters support the export fishing industry as well as the major tourism attraction. Note aquiculture development areas and cay types (see Table IV–1 for characteristics).

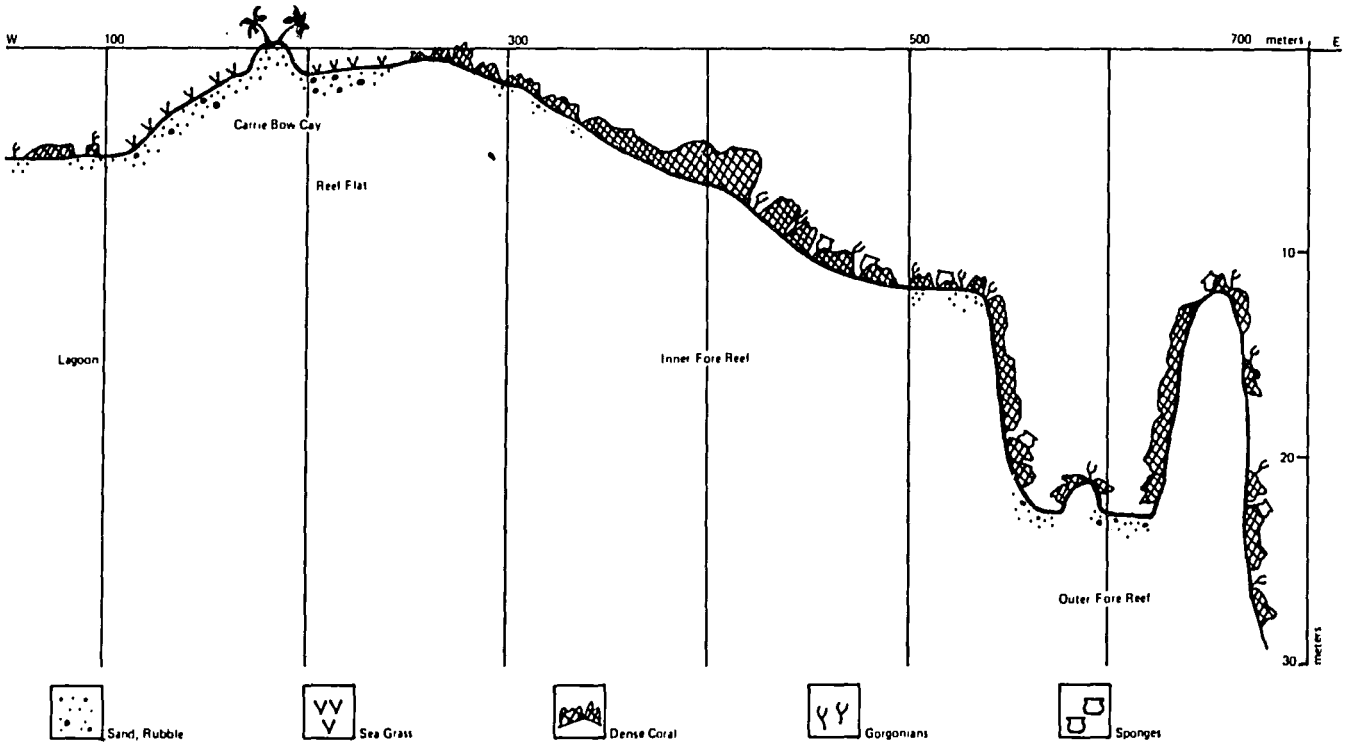


Figure IV–2. — Transect across Belizean barrier reef near Carrie Bow Cay. (Redrawn from Rutzler & Macintyre 1982). Transect is at 16° 48 N, 88° 05 W. The transect is representative of many barrier reef islands, with shallow inland waterways and deep trench to the Caribbean Sea.

arcuate (bow-shaped) reef segments, or at prominent disfigurations on bends in the reef.

While no inventory of mainland coastal vegetation exists, Stoddart et al. (1982a) identify 11 cay types in Belizean waters based on physical location, substrate composition and vegetation type and extent (Table IV-1; Fig. IV-1). Stoddart records 178 species of vascular plants, including 32 non-native species. Much native vegetation on cays either has been eliminated or disturbed for coconut tree plantations. In general, plants on the large mangrove cays are distinct from the sand cays along the reef edge; the former possess many more grasses, sedges and succulents. Factors affecting the occurrence of these species include rain gradient, degree of exposure, degree and interval of recent disturbance (natural or human) and substrate, including substrate movement. Small sand cays are highly vulnerable to human pressure and natural disturbance.

Between the mainland and the barrier reef is an extensive **offshore lagoon** that increases in width and depth from north to south. The offshore lagoon's northern shelf is an extension of the coastal plain. Water depth averages 2-3 m with a maximum of 6 m (Fig. IV-1) over a flat, featureless bottom 20-25 km wide. Bottom sediments consist of a terrigenous (land-derived) band in the nearshore and an offshore mud dominated by foraminiferal tests (James and Ginsburg 1979). South of Belize City, the shelf gradually deepens forming a channel between the mainland and outer shelf platform, reaching a depth at its southern boundary of 65 m in the Gulf of Honduras. Three distinct facies occur on the southern shelf: (i) a nearshore terrigenous zone; (ii) marl varying in composition of terrigenous and carbonate sediments; and (iii) sediments near the barrier reef platform strongly influenced by the (formerly living) coral carbonate compounds of the reef (Pundy et al. 1975). Numerous submerged rhomboid shoals or faroes composed of coral and algal rubble occur on the Placencia shelf.

Offshore water currents are dominated by the southwesterly Caribbean Current, with a velocity of one to three knots. Near the Gulf of Honduras a component of the offshore current appears to veer to the south and west forming a counterclockwise gyre in the gulf. Inshore from the barrier reef is a narrow countercurrent flowing south (Fig. IV-3). Reduced circulation of waters in Chetumal Bay causes it to function as an evaporation basin in the dry season, with salt water penetrating up the New and Hondo Rivers. Salinity patterns on the northern and southern shelves differ during the rainy season. In the north, the shallower water is well mixed and there is no surface fresh water wedge effect (lenses). In the south, a lens of fresh water spreads out from the Punta Gorda area where river discharge is greatest. Surface water temperatures range from 25° C to 29° C. Deeper waters are stratified with a well

Table IV-1. Types of cays in Belizean waters (after Stoddart et al. 1982a). See Fig. IV-1 for locations of the symbols.

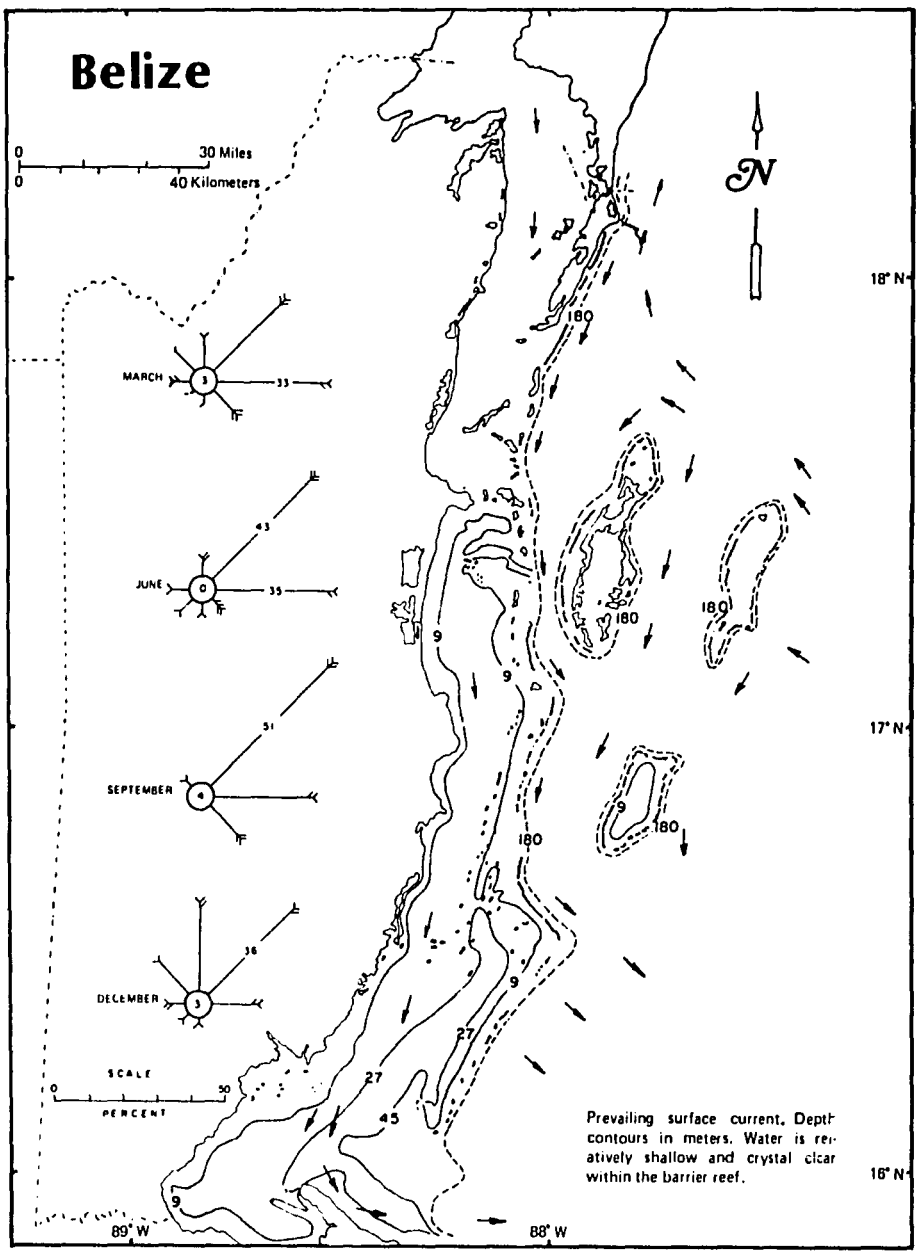
MORPHOLOGICAL TYPES	DESCRIPTION	SYMBOL	EXAMPLES
Unvegetated sand cay	Small, ephemeral islands often forming and reforming following hurricanes	A	Paunch Cay and Curlew Cay
Vegetated sand cay	Larger islands with strand scrub and woodland vegetation	B	Nicolas Cay and Tobacco Cay
Unvegetated shingle cay	Small, ephemeral cays located in exposed situations	C	
Vegetated shingle cay	Small cays located in exposed conditions, often on small patch reef	D	North Spot Cay and Ragged Cay
Sand and shingle cay	Small, stable islands in exposed conditions; vegetation with a windward shingle ridge and leeward sand area	E	Northeast Sapodilla Cays
Mangrove cay	Cays in a lagoon and colonized by *Rhizophora mangle*	F	Jack's Cay
Shelf island	Islands formed through sediment accretion on submerged topographic features in northern part of a lagoon	G	Cay Chapel and Cay Corker
Mangrove cay with dry sand areas	Mangrove islands with sand flats on the windward side; usually in protected areas	H	Wild Cane Cay and French Man's Cay
Mangrove range	Extensive and complex array of mangrove islands separated by partially enclosed bays and lagoons	I	Tobacco Range and Drowned Cays
Moat island	Association of leeward sand area, interior mangrove swamp, lagoon and windward shingle ridge	J	Snake Cays
Coastal barrier island	Barrier beaches or separated headlands	K	Harvest Cay

developed thermocline (boundary between layers of different temperatures) occurring at 50 m (James and Ginsburg 1979). Offshore salinities are typically oceanic (35 ppt). Tidal range (averaging 0.5 m) and its influence on coastal current patterns in Belize are small. However, currents become significant in the channels between reef segments and cays.

Fisheries

Fish and other marketable sea life such as spiny lobster, conch and shrimp constitute a resource that Belize can develop with a comparative advantage over other nations. The barrier reef and associated patch and fringing reef systems support an abundance of marine life (see Appendix B). Lobster is one of the most desirable commodities from the sea and a significant export product. Conch, fish fillets, and whole fish are also exported in substantial quantity.

Some seafoods, particularly lobster, have high income elasticities and therefore can improve the terms of trade for the exporting country. During the period 1978 through 1981 export prices for whole fish rose 50%, fish fillets increased by 80%, lobster by 65%, conch by 125% and shrimp by 90% while the quantity exported of all sea products increased by 35%.



Wind roses for area between Lighthouse Reef and the Bay Islands of Honduras. Wind is given in the direction of the arrow; Length of arrow indicates the % of wind in that direction; Number of feathers indicate wind velocity (see Beaufort Scale for amount of force); and the number in the circle is the % of calm .

Wind Roses

	Direction	%		Direction	%
MARCH	N	9	SEPTEMBER	N	0
	NE	30		NE	51
	E	33		E	30
	SE	10		SE	13
	S	2		S	0
	SW	1		SW	0
	W	4		W	0
	NW	8		NW	2

JUNE	N	5	DECEMBER	N	26
	NE	43		NE	36
	E	35		E	14
	SE	4		SE	0
	S	3		S	1
	SW	5		SW	2
	W	5		W	5
	NW	0		NW	13

Beaufort Scale	Knots	mph	km/hr	
0	1	1	1	
1	1-3	1-3	1-5	
2	4-6	4-7	6-11	
3	7-10	8-12	12-19	
4	11-16	13-18	20-28	
5	17-21	19-24	29-38	
...	...	...	...	
12	64-71	73-82	118-133	(Hurricane)

Figure IV–3. — Water currents and wind currents for Belize. Wind roses shown are for area between Lighthouse Reef and the Bay Islands of Honduras. (Wind roses data by U.S. Naval Oceanographic Office and the Environmental Data Service of the National Oceanic & Atmospheric Administration, Dept. of Commerce).

Table IV-2. Belize fisheries production and exports in 1982, by cooperatives. (Source: Fisheries Unit, MHHC)

COMMODITY	NATIONAL	NORTHERN	CARIBENA	PLACENCIA	SARTENEJA	INDEPEN-DENCE	TOTAL
Lobster							
kg	90,164	90,709	69,182	18,091	9,177	–	277,323
US$	1,636,470	1,646,370	1,255,650	328,350	166,567	–	5,033,407
Conch							
kg	49,545	30,182	11,273	29,318	22,568	–	142,886
US$	231,625	141,100	52,700	137,062	105,506	–	667,993
Shrimp							
kg	–	–	2,705	727	–	–	3,432
US$	–	–	29,750	8,000	–	–	37,750
Fish Fillet							
kg	1,545	2,709	2,500	3,386	–	–	10,140
US$	6,375	11,175	10,321	13,968	–	–	41,839
Whole Fish							
kg	53,523	69,996	7,477	78,864	–	–	209,860
US$	88,312	115,494	12,337	130,125	–	–	346,268
Saltwater Aquarium Fish	–	–	–	–			
kg	–	–	–	–	–	3,784	3,784
US$	–	–	–	–	–	6,244	6,244
Freshwater Fish				–			
kg	–	–	–	–	–	891	891
US$	–	–	–	–	–	1,225	1,225
Freshwater Fillet							
kg	–	–	–	–	–	5,773	5,773
US$	–	–	–	–	–	16,050	16,050
Stone Crab (Claws)							
kg	–	- 670	–	–	–	–	670
US$	–	4,793	–	–	–	–	4,793
TOTAL VALUE (US$)	1,962,782	1,918,932	1,360,758	617,505	272,073	23,519	6,155,569

In 1982 the fishing industry exported almost 655 metric tons of fish products valued at US$6.2 million (Table IV-2). Based on export value, the industry ranks second behind sugar as an earner of foreign exchange. The mainstay of the export industry is spiny lobster *(Panulirus argus)* with 1982 exports of 277 tons valued at US$5 million. Second in terms of economic importance is the queen conch *(Strombus gigas)*, with 143 tons exported in 1982 valued at US$668,000. Conch exports peaked at 567 tons in 1972 and declined to a low of 113 tons in 1981; the 143 tons in 1982 is the first increase in catch in 10 years.

The fishing industry is composed of approximately 800 fishermen in four major, export-oriented cooperatives, plus there are approximately 400 independent fishermen catching fin fish (called scale-fish in Belize) for local markets. The principal fishing grounds are grass beds and reef areas inside the barrier reef and the outer atolls

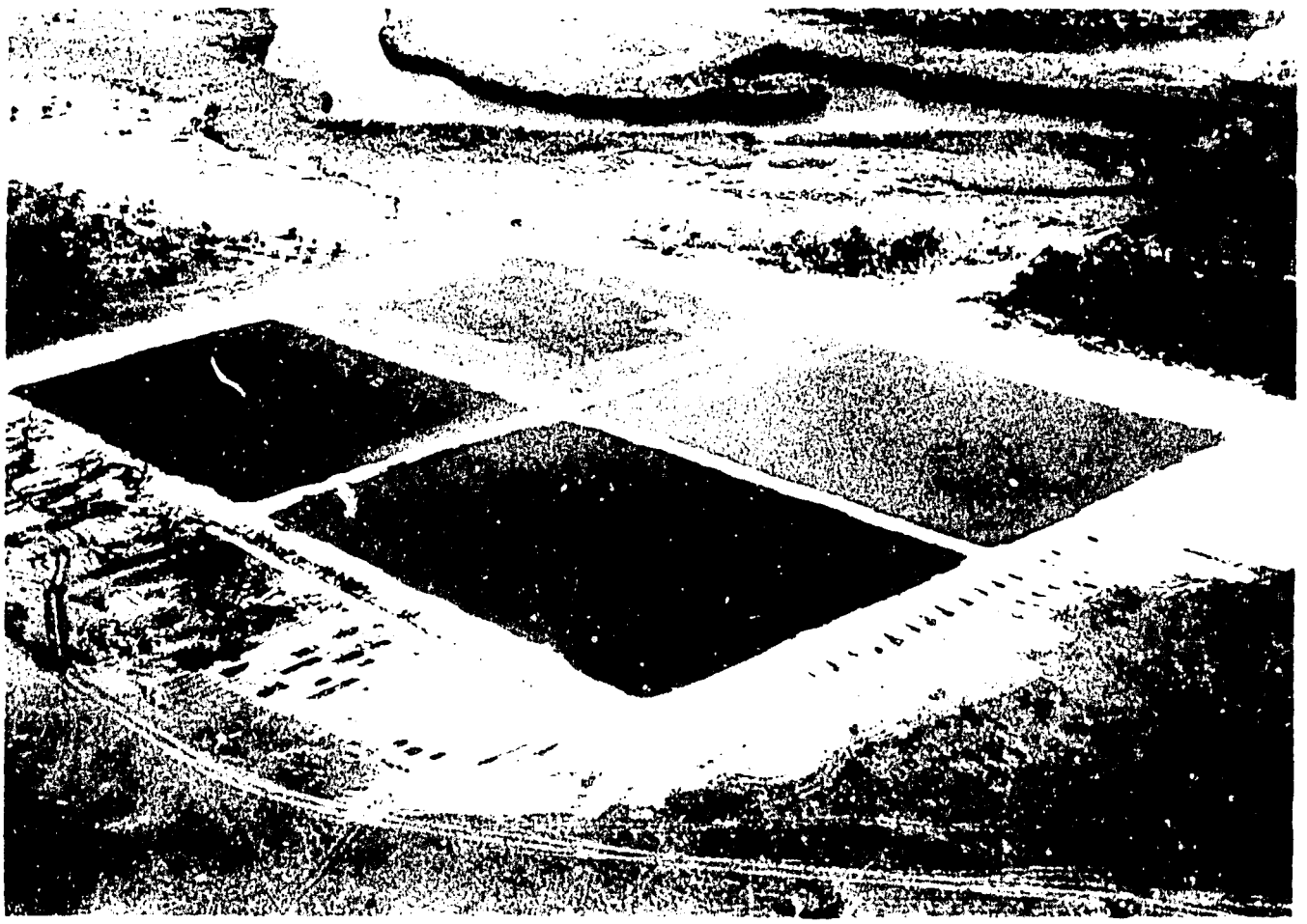


Figure IV–4. — Artificial ponds for rearing shrimp, near Placencia. (photo G. Hartshorn)

(Fig. IV-1). The two principal methods employed for fishing lobster are skin diving with hook-stick and trap fishing. Beach weirs are also used on the shallow water cays in the north. Conch is harvested by divers.

Much of the success of Belize's export fishery is due to the development of fishing cooperatives. The cooperatives secure export markets each year and collect, process and package all products for export. They also provide ice for fishermen's boats, and loans. Fish is an important source of protein in the diet of Belizeans. To ensure a supply of cheap, high quality protein on the local market, GOB controls retail price of fish and requires cooperatives to market a portion of their catch locally; for example, 10% of conch and 5% of lobster. The in-country quota for conch and lobster is currently 13,636 kg/month. However, fin fish constitute a larger amount of seafood available to domestic consumers. Belizeans show a distinct preference for higher quality species such as snapper, mackerel and hogfish, leading to underutilization of lower value species. Hence, a consumer education program is needed to promote use of less popular species like grunt, mullet and shark, in order to ensure a more balanced utilization of the resource.

Deep sea fishing in the waters beyond the barrier reef has not been fully explored. Though fishing cooperatives have experimented with deep water fishing, further development will depend on basic research to determine the extent of the resource. Capital for local fishing cooperatives and individual fishermen is needed to acquire boats and fishing gear. For example, one cooperative is in dire need of a generator to provide ice for short-term storage of catches.

Poaching by aliens has been and remains a problem. The extent to which aliens enter and illegally fish Belizean waters is unknown; however, many local fishermen report that poachers are numerous. Adding to the problem, Belizean fishermen will occasionally sell out-of-season catches of lobster and conch to poachers and to local consumers. As the Sapodilla Cays lie roughly midway between the Belize and Honduras mainlands, Hondurans feel equally justified in harvesting these waters, though this fishing is not condoned by the GOB.

Mariculture and Aquiculture

Mariculture is a new activity in Belize, still in its pilot stage. One company has recently harvested its first year's production of shrimp near Monkey River (Fig. IV-4). The two species of shrimp, *Penaeus stylirostris* and *P. vannamei*, were introduced from Ecuador. Another company will raise

shrimp near Quashie Trap lagoon in southern Belize district. Two other concessions have been approved for similar activities. One company's pilot project, located on Turneffe Islands, will introduce the American lobster *(Homerus americanus)* to Caribbean waters to try to stimulate faster growth. Another company, at Northern Bogue of Turneffe Islands, will raise the local spiny lobster in enclosed submerged pens.

Shrimp ponds with *Macrobrachyum rosenbergii* will also be established. At Burrell Boom on the Belize River west of Belize City, a company commenced farming the Louisiana swamp crayfish *(Procambarus clarkii)* in 1982. The Fisheries Unit favors aquiculture of indigenous (local) species. Since techniques for farming these local species must be determined, exotic (introduced) species will be farmed in "closed" systems to prevent consequent detrimental effects on native species or habitats.

There are four international fisheries projects in Belize. CARE is attempting to diversify Belizean fisheries by encouraging fishing of deep-sea species. Funded by CIDA, the project is beginning a second three year cycle. Another CIDA program provided training in Nova Scotia for Belizean fishermen who studied fishing techniques, engine repair and navigation, and fish processing. The third project, funded by IDRC, is a study of conch population dynamics and the development of effective management strategies. The NYZS has begun a study of the natural history and feeding ecology of the Nassau grouper.

Freshwater Fisheries

Complete catch statistics are not available for freshwater fish. Nevertheless, they are an important supplementary source of protein for rural people. To ensure that villagers have access to fish, it is illegal for commercial fishing to be practiced within a kilometer radius of any settlement.

In 1981, 34,450 kg of freshwater catfish (known locally as baca) were exported. Other freshwater species caught include mullet, bay snook *(Petenia splendida)*, and other cichlids, tarpon *(Megalops atlanticus)* and machaca *(Brycon guatemalensis)*. Several species of mosquito fish *(Gambusia* spp.) present in rivers and lagoons are of economic and health importance because they feed on mosquito larvae. Other river species used only on a subsistence level are freshwater shrimp *(Macrobrachyum* spp.) and freshwater turtle *(Dermatemys mawii)*. See Appendix B.

Fisheries Administration

Fisheries management has evolved into a unique and relatively sophisticated mix of private and public sectors. The primary administrative body is the Fisheries Unit located in the Ministry of Health, Housing and Cooperatives and staffed with 12 employees of which 8 are trained technicians or administrators. Major responsibilities of the unit are the overall management of the fishing industry, promulgation and enforcement of regulations, industry-related research, collection and analysis of statistics, education and extension work, quality control and monitoring of aquiculture projects. There is also a Fisheries Advisory Board composed of 12 members from government, fishing and business communities, that advises government on fisheries matters. Finally, the Belize Fishermen's Cooperative Association represents the interests of the cooperatives and their members.

The draft Fisheries Development Plan for 1983-88 identifies several areas for potential development such as demersal (bottom-dwelling) fish occurring on the outer continental Slope between 110 and 274 m; a pelagic (open ocean) resource consisting of bonito, mackerel and small tuna; and a deep-water crustacean and fin fish complex. Aquiculture is another area identified in the Development Plan as showing potential, particularly with such species as the characid *Brycon guatemalensis*, the freshwater crayfish *Procambarus clarkii* and *P. acutus* and local species of marine shrimp *Penaeus schmitti* and *P. duoranum*.

Of the significant problems identified in the Development Plan, the more serious may be poaching of lobster and conch in southern Belizean waters by Guatemalans and Hondurans. Poachers take lobsters regardless of size, sex, state of maturation or season. The significance of this uncontrolled harvesting on the fishery is not known. Several cooperatives are beginning to notice a shift of members selling to the more lucrative, but illegal market. A 1983 raid on poachers caused one death but the deterrent was short-lived. There is hope that a new "marine wing" of the Belize Defense Force will provide the enforcement of fisheries legislation.

Significant fisheries legislation includes the following regulations: a closed season (designed to protect the species during some critical life phase such as the breeding period or to limit the annual harvest of the resource) for lobster between March 15 and July 14; and a size/weight limit of 9 cm cape length or 113 g (4 oz) tail weight. Berried (with eggs) and soft shell lobsters are protected. The lobster export quota is 270 tons/year.

In response to the continued decline in the conch industry, regulations were passed in 1977 setting minimum sizes of 18 cm shell length and 85 g (3 oz) clean net market weight, and a 3-month closed season from July 1 to September 30.

General regulations require the registration of all fishermen and boats; forbid use of traps outside the barrier reef; a closed season for turtles from June 4 to August 31; prohibit taking underweight turtles or turtles and eggs from the beach; a license is required to harvest coral; forbid poisons for fishing; minimum net mesh size is 3.8 cm for fin fish; and SCUBA may not be used to catch fish, lobster and conch.

An important amendment to the fisheries ordinance was passed in February 1983, giving the Minister of Health,

Housing and Cooperatives the power to designate any area in Belize waters a marine reserve and prohibit people from entering the reserve.

Despite a solid legal basis for sound management, the lack of enforcement capabilities appears to be the principal constraint to an effective fisheries management program in Belize. The Belize Defense Force is working in the enforcement program. The Fisheries Unit has a new boat for fisheries research and demonstration fishing, but enforcement of laws would only be incidental to the objectives of the Unit.

Ports

Until 1980 the country's major port consisted of a lighterage facility in Belize City. The new port facility 1.6 km south of Belize City has a single 65 m pier head at the end of a 762 m long pier. The new port can accommodate ships up to 5.5 m in draft; deeper draft ships must still anchor 2.5 km or more offshore to be served by lighters and barges.

Belize's second important port is at Commerce Bight south of Dangriga. The pier that opened in October 1980 handles mainly citrus exports and fertilizer imports as breakbulk cargo. Other port facilities are privately or municipally owned and administered, and consist of small finger piers and longshore wharves.

Despite the country's recently increased capacity to handle cargo, several constraints remain. The presence of a new port facility in Belize has only partially filled the need for a deep water port. The new facility was not designed for low lighters, hence a second berth had to be constructed. Present delays in completion of cargo handling procedures are breakbulk cargo (2-3 days), lift-on/lift-off (6-12 hours) and roll-on/roll-off (2-6 hours).

Economic factors have reduced shipping to Belize. Either container ships will continue to replace breakbulk cargo or Belize will increasingly depend on Honduran port facilities at Puerto Cortés, especially for transshipment of bananas.

Present shipping patterns are relatively simple. Sugar is shipped by barge from Libertad (site of the Corozal sugar factory),stored in Belize, then lightered to a ship for export. Citrus produce from Commerce Bight is carried by boat directly to export markets. Banana exports are transported by covered barge to Puerto Cortés for reexport.

There is very little coastal trade but occasionally small boats carry cargo and passengers between Belize City and Placencia or San Pedro. Barges can travel up the Belize River from Haulover Creek to the industrial belt located west of the city. Barge traffic is common in Belize due to the shallowness of nearshore waters and limited entry. Access for ocean-going vessels is limited to English Cay and the southern end of the barrier reef near Punta Gorda.

There appear to be few substances shipped through Belizean waters considered hazardous to the marine environment. Fertilizer imports are dropping in part due to decreased local usage and local mixing of fertilizer chemicals. Oil, however, continues to increase as an essential import. All oil enters through the Esso facility located near the new port. Belize has no refinery capacity so it must import refined products. While Esso imports these products it makes them available to other companies operating in the country through various product-exchange arrangements. Most of these are now re-distributed by land transport.

No incidents involving oil spills have been recorded in Belize. Tar balls, however, are becoming increasingly frequent in Placencia and Ambergris Cay. In all likelihood these are the product of dumping of ballast and tanker washing from ships outside Belizean waters. Two fertilizer boats have run aground on the barrier reef, one near San Pedro and one on Lighthouse Reef. The long-term environmental consequences of these wrecks are not known.

The two national ports of Belize are administered by the Belize Port Authority. Created in 1976 under the Ministry of Works, it is responsible for pier construction, port management, dredging and maintenance of lighthouses and navigation aids. In 1980, new regulations made it unlawful to discharge or dump ballast, sewage, garbage, liquids, etc., in Belize territorial waters. Despite these regulations the Port Authority has been hampered by lack of resources for enforcement.

Future development plans for Belize City port include the filling in of wetlands near the Esso storage facility for location of new sugar storage warehouses, dredging a deeper channel to accommodate deep draft sugar vessels, building a second jetty to provide for two-way vessel traffic, enlarging the present pier head to handle more ships and developing 14 ha behind the present port site. These development projects will cost an estimated US$75 million and if funded will occur over the next 10 years.

For the Commerce Bight facility planned improvements include the construction of a new floating jetty to provide roll-on/roll-off capabilities. Dredging plans are being considered for Big Creek to enable ships to enter the river mouth to load bananas. Dredging activity will be contingent on the vigor and growth of the banana industry. Dredging is planned for the port area to increase channel depth to 7.3 m (World Bank 1983).

There is no evidence that environmental considerations are examined prior to initiation of required port maintenance and development activities. Notification of other ministries about proposed activities appears to be an informal procedure.

Natural Disaster Preparedness

The principal factors that make hurricanes so destructive are the initial wave surge preceding the storm and accompanying high winds and rain. Belize is particularly vulnerable to hurricanes because most to the country's urban centers are on the low-lying coastal plain. In Belize City the storm surge associated with Hurricane Hattie was estimated to be 3.7 m above sea level. The damage wrought by hurricanes in Belize appears to have increased since the early 20th Century, due in part to better record keeping as well as growth of the country's coastal towns and cities.

Belize's coral reefs can be severely affected by direct breakage and suffocation by sediment. Hattie caused as much as 80% die-off or disappearance in some areas, with the heaviest loss suffered by rapidly growing, fragile coral species *(Acropora, Porites)*. The effects of hurricanes on sand cays can signify a drastically altered morphology including reduction in size, breakup or disappearance. Stoddart (1963) estimates that Hattie reduced Goff's Cay from 1756 m^2 to 794 m^2. Most vulnerable to storms are the small narrow cays stripped of vegetation and altered by man.

In response to the continued vulnerability of Belize to hurricanes, the GOB has developed an elaborate hurricane plan that identifies a central emergency organization charged with directing and coordinating preparedness and relief activities. Eleven sub-committees have been designated to develop specific preparedness plans addressing such areas as housing, food and water. Procedures have been developed for communications, public information and provision of shelter. When necessary, disaster contingency plans are reviewed and amended.

Control of Coastal and Marine Areas

The coastal area of Belize is predominantly in the hands of private owners. A 1939 law reserved one-chain (20 m) of water frontage as public land. However, much of the land along the coast was privately titled before the law was passed.

The marine continental shelf is public land. Though the majority of the cays is still public land, the figures are misleading because many "public" cays include privately-owned parcels. The largest cay (Ambergris) and some of the more attractive ones (Long and Northeast Cays) are privately owned. It has been GOB policy to refrain from selling offshore cays during the past decade, with a few exceptions for special development schemes. Cay exchanges have been between private owners and buyers.

Foreign speculation in coastal lands has been and may continue to pose a problem. To dampen speculative pressures, a series of ordinances were passed: *Land Tax Ordinance* (1966); *Aliens Landholding Ordinance* (1973); *Land Utilization Ordinance* (1981) and *Land Tax Act* (1982). The 1982 *Act* taxes private land based on unimproved value; thus, land values could come to be determined by foreign pressures. The two areas most vulnerable to this possibility are Placencia and San Pedro.

Belize's marine boundaries are currently defined by a 5 km territorial limit, a legacy of the British era. Recently the GOB signed the Law of the Sea (LOS) Treaty that upon ratification by the Belizean National Assembly will increase jurisdiction to a 20 km limit and a 335 km exclusive economic zone.

Coastal Development

Based on comparisons of the 1970 and 1980 censuses the percentage of Belize's population that lives on the coast grew at a lower rate than the national population. Nevertheless, rural and urban coastal inhabitants in 1980 comprised 43% of the nation's population, with 35% concentrated in Belize City. In any country where a high percentage of the national population lives on or near the coast, there are significant issues that need to be addressed. In Belize these issues include improving basic services to the community, conservative use of natural resources to support settlements, design and implementation of evacuation plans for coastal settlements in case of natural disasters, improvement of human and corporate waste disposal systems, and providing additional housing.

In Belize City, situated on a small peninsula of mangroves, continued urban expansion has greatly modified the landscape. Major development projects include the clearing of mangroves for industrial sites and housing. Other projects that entail large-scale mangrove loss include expansion of the port facility and building the sewage treatment plant on the southern side.

Large-scale dredging operations to open channels near the northern cays result in dumping of debris somewhere else. For example, mangrove areas of Cay Chapel have recently been filled, as well as some at Gallow's Point. The effect of dredging on nearby reefs has not been studied. Currently there is no regular system for issuing dredging permits nor coordination between dredging operators and those concerned with the marine environment. Most areas are being filled for construction of tourist facilities, thus dredging may be a conflict between tourist and fishing industries (Fig. IV-5).

The Maritime Wing of the Belize Defense Force has tentative plans to dredge the mouth of Haulover Creek and build a small groyne (jetty to prevent erosion) in order to keep the mouth clear of silt. This would enable their patrol boats to dock alongside the new naval base. Dredging will no doubt lead to heavy sedimentation along the southern foreshore, where high value properties are on sea frontage.

Several coastal areas are suffering from beach erosion, notably near the mouth of the Sibun River and the Commerce Bight area south of Dangriga. Sand mining for

A

B

Figure IV–5. — Mangroves along coastal lagoon (A) are cut and cleared (B) for development (B, behind Placencia Peninsula). (photos L. Nicolait)

construction purposes occurs in the former area, and the sand is transported by sailing "lighters" to Belize City. There are plans to construct a groyne in Commerce Bight to reduce beach erosion; the groyne in San Pedro has halted beach erosion there.

A growing demand for potable water in the coastal area is also a significant issue. In many villages, especially on cays and sandy peninsulas, rapidly increasing populations have caused water shortages. Drawing down the water table has caused salt water intrusion in some areas and has become particularly acute in San Pedro. With increased water demand and use there is a similar increase in problems of disposal. Contamination of potable water supplies by faecal material has been reported for both San Pedro and Placencia. Ground water contamination, threatens the water supply of the Placencia Fishing Cooperative, the principal employer and economic force in the village.

Belize City, San Pedro, Placencia and other coastal communities use mangrove areas as dumping grounds for wastes. Toxic runoff and leachates may enter coastal waters from these open dumps.

Recommendations

While the development of coastal and marine resources should be fully supported, administrative and legal priorities must be addressed. Legal areas requiring changes are: (i) the complete protection of marine turtles; (ii) a provision for granting the right of public access to Belizean beaches and coastal areas; (iii) further definition of relevant forestry legislation to specify mangroves as a resource requiring a license for harvesting or removal; and (iv) establishing a means to regulate future development of cays now privately owned, effective upon change of ownership.

On an institutional basis the GOB appears weak in effectively managing the country's coastal and marine resources. This is due to a host of factors, principally the lack of human and financial resources within the government to enforce existing legislation; natural resources administrative units that are institutionally misplaced; and the need for a multisectoral approach to coastal administration. Of these factors, there is a lack of sufficient enforcement capabilities over administrative units responsible for fisheries, ports, public lands and tourism. Belize is currently accepting responsibility for protecting the country's sovereign rights (previously held by the U.K.). Establishment of the Belize Defense Force "marine wing" may help resolve the enforcement problems. Members of the BDF marine wing should be versed in existing legislation and associated technicalities.

The Fisheries Unit is under the jurisdiction of MHHC because of the prominence of cooperatives in the fishing industry. However, if the Unit's primary responsibility is to manage the nation's fisheries, the possibility for a compromising situation exists whenever a management decision to preserve a fishery stock adversely affects fishermen.

A multisectoral approach should be taken for coastal area management by including the Fisheries Unit in the MNR along with other agencies responsible for coastal affairs (Forest Dept., mangroves; Petroleum Office, offshore exploration; Lands and Surveys, coastal zone, cays and continental shelf ownership and development). Representatives from the Tourist Board, Dept. of Archaeology, WASA and the Port Authority would complement such a coastal management commission.

Coordination and communication among government agencies responsible for the coastal area would be a primary objective. The organization could review and assess proposed private and government activities, and make recommendations. Such a commission should prepare a management plan for the country's barrier reef.

In recognition of the importance of education in natural resources management, the GOB should expand the present limited curricula in both primary and secondary schools. Emphasis in coastal areas should be on marine resources. The University of the West Indies extension program in Belize could possibly help develop an environmental curriculum, as Jamaica's Mona campus is well known for its high level of competence in marine ecology.

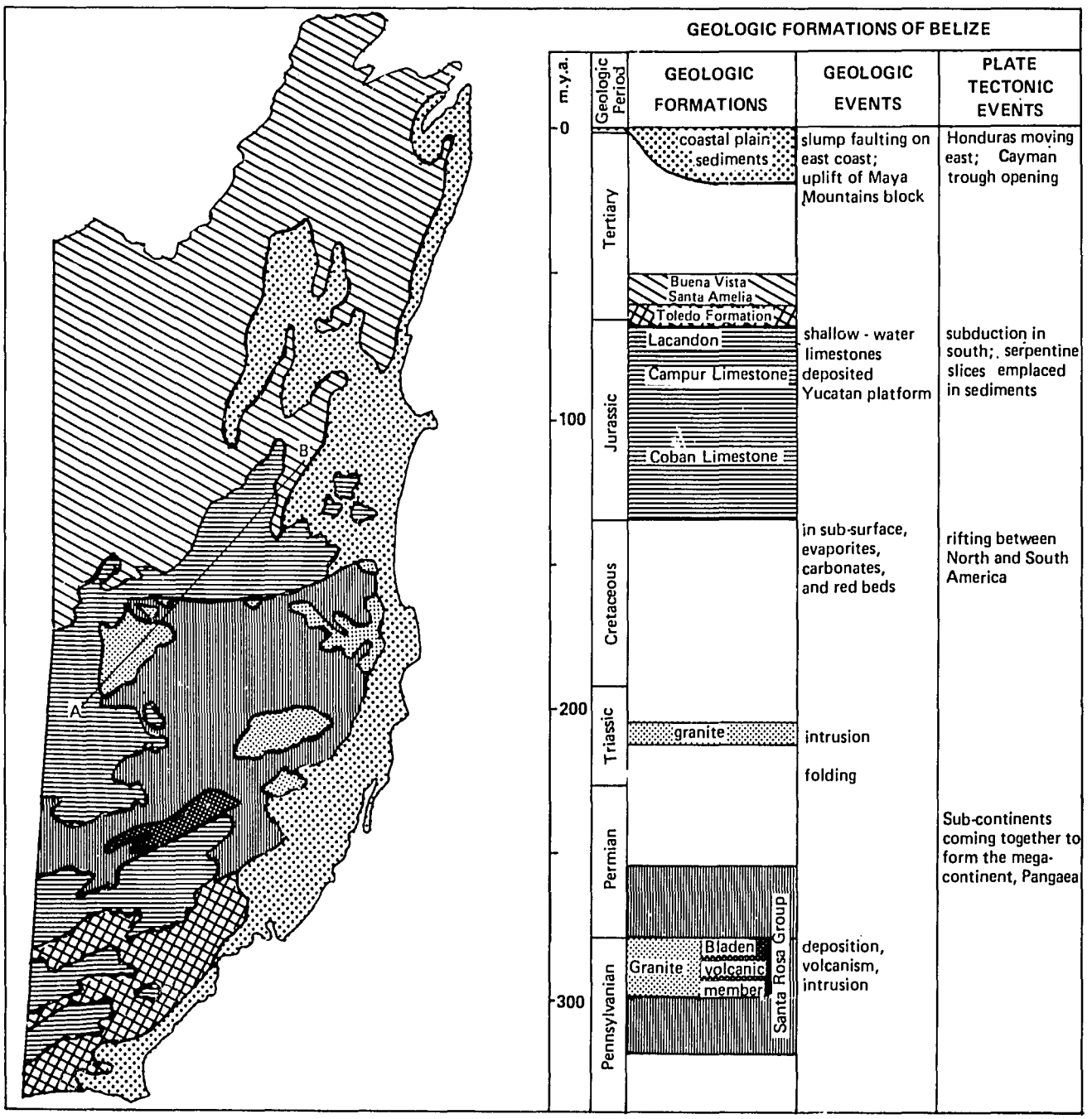
IV–B. GEOLOGY

Belizean geology is largely a study of limestone (Fig. IV-6). A major exception is the Maya Mountains, a large upfaulted block of intrusive rocks and associated metamorphosed sedimentary rocks in south-central Belize. Ancient limestone makes up the bedrock underlying a karst (solution-formed) topography that is typified by numerous sinkholes, caverns and underground streams. Modern limestones are forming offshore in the shelf lagoon and barrier reef. Oil deposits may occur in reefs on ancient limestone, and groundwater reserves exist in ancient and modern limestone.

The northern half of Belize is on the Yucatán Platform, a long stable region with gently dipping beds of limestone, chalk, marl and other sedimentary layers. The southern edge of the Yucatán Platform coincides well with an east-trending broad fold known as La Libertad Arch (Fig. IV-7). South of this arch is the up-faulted Maya Mountains block. Farther south is a major east-trending tectonically active zone that barely includes Belize's southern border: Honduras and southeastern Guatemala are moving eastward relative to the Yucatán Platform. Records from the coastal plain sediments, the savanna southeast of the Maya Mountains, the Sibun Hills, the Vaca Plateau west of the mountains, and alluvial valleys all contribute to the geologic history of Belize.

Maya Mountains

The oldest rocks in Belize are found in the Maya Mountains. Victoria Peak, the highest point in Belize and in



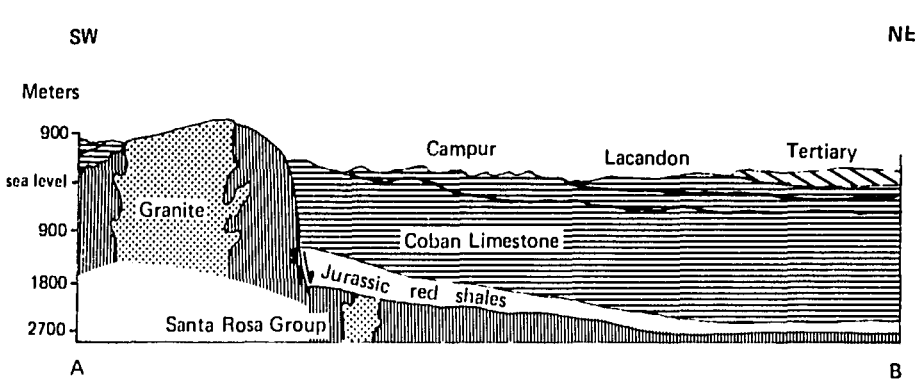


Figure IV–6. — Geologic formations of Belize. Coastal plain sediments and limestones nearly surround the granitic, metamorphic and volcanic rocks of the Maya Mountains. The limestones, especially Campur formation, may prove to be the major aquifers in Belize. (From Baldwin 1979)

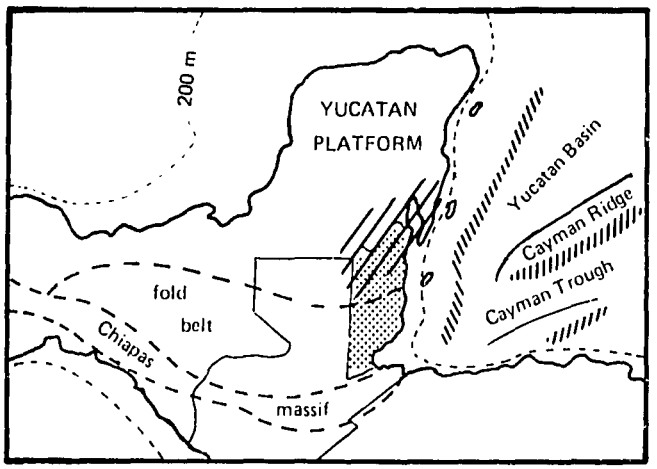


Figure IV–7. — La Libertad Arch. See text for description of formation. (From Baldwin, 1979)

the Cockscomb Range, has a elevation of 1120 m (3675 ft). The mountains are framed on the north by the Northern Boundary Fault and the associated Barton Creek Fault, and on the south by the Southern Boundary Fault. Several lesser faults trending east or northeast cut through the central part of the mountains (Fig. II-2). The rocks consist of metamorphosed sediments with granitic rock intrusions. They are mostly of Paleozoic era and regarded as part of the basement rocks of Central America.

Metamorphosed sediments (metasediments) are assigned by Dixon (1956) to the Maya Series (older) and the Macal Series (younger). However, this terminology was rejected by Bateson and Hall (1971), who assign the metasediments to the Santa Rosa Group of early Pennsylvanian to mid Permian period. The metasediments were deposited as shales and fine-grained sandstones with some limestone and conglomerate. In the southern Maya Mountains, the Santa Rosa Group includes the Bladen volcanic member (Bladen Porphyry of Dixon), that is a thick sequence of rhyolites, pyroclastic rocks and volcanic sediments (Hall and Bateson 1972); these dip northeast beneath and intertongue with the sediments of the Santa Rosa Group.

In northern Mountain Pine Ridge near Hidden Valley Falls, bedding in the metasediments is nearly vertical with tight folds trending east. Just to the south of Hidden Valley Falls along Cooma Cairn fault, the metasediments show a second folding, probably due to drag along the fault. Near Cabbage Haul Fire Lookout, in the foothills west of the savanna, the bedding is also vertical but trends north-northwest.

The Santa Rosa Group has been subjected to low-grade metamorphism with the development of such minerals as talc and white mica from clays of the original shales. This metamorphism was associated with folding, and the rocks have been further altered by thermal metamorphism near contacts with granite intrusions (Bateson 1972).

Radiometric dating suggests the granitic intrusions are 200-400 million years old (Bateson 1972). Bateson's samples were obtained from the Hummingbird Granite (exposed on the highway from Belmopan to Dangriga), the Cockscomb Granite south of Victoria Peak, and the Mountain Pine Ridge area near Augustine (about the age of the Bladen volcanic member). Some representative rocks of 390 million years ago are older than the Santa Rosa Group and may indicate an earlier intrusion. The Mountain Pine Ridge granite is well exposed at Río On, in the beds of Privassion Creek, and the Macal River gorge. Kesler et al. (1974) summarize the chemical and mineral properties of these granites.

Hall and Bateson (1972) infer that sediments of the Santa Rosa Group were deposited in an east-trending trough between the continental platform to the north and a volcanic arc to the south. The Bladen volcanic member is a record of that arc. The sediments were folded sometime after mid Permian (youngest sediments of the Santa Rosa Group) and before early Triassic (age of the younger granites). The region probably remained a land mass from then until the Cretaceous period when it was covered by shallow seas in which the Cretaceous limestone was deposited.

Yucatán Platform

North of the Maya Mountains, the rocks represent shallow water sediments deposited on the Yucatán Platform. Oil test holes in northern Belize show a sequence of red shales and sandstones with some evaporites (Viniegra 1971). These beds are probably of the Jurassic period and do not occur as outcrops in Belize. They are overlain by limestone, dolomite and some evaporites in layers that dip gently north (Fig. IV-6).

Much of Belize's limestone is hard and dense. Some softer chalky limestone is merely the deeply weathered equivalent of harder limestone, but the marls and calcarenites of the Belize River to Orange Walk and Corozal appear to be little weathered. This seems to be generally true for limestones younger than Cretaceous. Soils that mantle the limestone and older rocks are described in Chapter IV-D.

Cretaceous and Tertiary sedimentary rocks apparently continue west into Guatemala where they have been described by Vinson (1962). His descriptions are summarized below, mainly to give a useful nomenclature to rocks that Dixon (1956) described as Cretaceous-Eocene (see Fig. IV-6).

Principal Geologic Formations

The *Coban limestone* is a thick sequence of limestone, dolomite and evaporites deposited during early to

mid Cretaceous (90-130 million years ago). Outcrops of *Coban limestone* have been reported north of the Maya Mountains. The thickness and nature of the formation was revealed from oil-test holes. Viniegra (1971) reports *Coban limestone* to be 1830 m thick beneath Ambergris Cay, thinning to 760 m or less northwest of the Maya Mountains on the flanks of La Libertad Arch. Should oil be found in Belize, it will probably be in the *Coban limestone;* the formation could also be an important groundwater source in central Belize.

The *Campur limestone* is a sequence of gray, brown and tan limestone with thin beds of dolomite, shale and siltstone. Parts of the formation are very porous; when exposed in outcrops, they consistently develop prominent karst topography. North of the Belize River, the *Campur* reaches a thickness of about 610 m where it lies unconformably upon the *Coban limestone.* Between the North Boundary Fault and the Belize River, *Campur* outcrops occur in a belt about 15-30 km wide. To the west of the Maya Mountains it forms the rugged hills of the Vaca Plateau and extends southward in outcrops to just south of where the Moho River enters from Guatemala.

The *Campur limestone* is conspicuously absent east of the Maya Mountains (Fig. IV-6), but isolated small outcrops do occur along the foothills (metasediments) south of Stann Creek to the Sittee River, and as scattered monadnocks in savanna farther south (such as the small hills west of Savannah Forest Station).

A very prominent area of rugged relief on the *Campur* outcrop extend from Caves Branch of the Sibun River east-northeast to Northern Lagoon and east to near Gales Point. This large area is a good example of tower karst—deeply dissected doline karst topography with many caves, sinkholes and underground streams. Near the coast, the rugged hills become buried progressively deeper in the coastal plain sediments and form a series of monadnocks rising 90-150 m above the plain (e.g., the Peccary Hills).

The *Campur* formation will probably prove to be the major aquifer in Belize. The Barton Creek Member (an oil driller's term for a porous marker zone) contained water when penetrated by oil-test holes. The *Campur* may also contain oil in significant quantities if suitable geologic structures and "traps" of oil can be found.

The *Lacandón* formation of the Verapaz Group consists of fragmental limestone up to 400 m thick, including recrystallized calcites and dolomite. Generally massive in appearance, the *Lacandón* occasionally shows bedding planes and some algal beds. Typically, the formation has fine to coarse sand-sized particles of eroded limestone. The formation is light gray, tan or cream. The *Lacandón*, and other formations of the Verapaz Group are of recent Cretaceous period.

In central Guatemala, the *Lacandón* grades southward into a thick terrigenous sequence, the *Sepur* formation. The *Sepur*, which rests unconformably on the *Campur* formation, consists of clay, shale, siltstone, fine-grained sandstone and a few thin limestones; in southern Belize the *Sepur* is probably equivalent in age to the Toledo Beds of Dixon (1956). The Toledo Beds are definitely Eocene and were probably deposited in a subsiding trough south of the Yucatán Platform at the close of the Cretaceous.

The early Eocene Peten Group lies north of the Maya Mountains, consisting of the *Santa Amelia* and *Buena Vista* formations. The *Santa Amelia* consists of dolomites, limestone and marl with some evaporites, up to 200 m thick. The dolomites are cream-colored and granular and are interbedded with reddish evaporite-rich clay and limestone breccia. The *Santa Amelia* is thickest in Belize near the Guatemala border and along the Río Hondo, but thins eastward and probably does not exist east of New River and Crooked Tree Lagoon, being replaced eastward by more dense and fossiliferous limestone of comparable age. West of Booth's River, the *Santa Amelia* is well exposed in several fault scarps, where it has a modest karst topography.

The *Coastal Plain and Belize Shelf* developed in the Quaternary period. Though the Yucatán Platform has been stable, the opening of the Yucatán trough allowed the eastern edge of the platform to slump along faults that trend north-northeast (Fig. IV-7). Slumping of limestone is well displayed in Booth's River escarpment and the Río Bravo escarpment a few miles farther west. East of Booth's River, slumping is represented by the narrow, deep (15 m), New River lagoon and to a lesser degree by the much shallower lagoon at Crooked Tree. Further evidence of slumping exists in the alignment of New River and Progresso and Shipstern lagoons.

Sea level changes that accompanied the formation and melting of continental ice sheets during glacial epochs are recorded in coastal plain sediments, in shelf sediments and in alignments of old reefs in the shallow bay between Ambergris Cay and the mainland. Flores (1952) describes the coastal plain deposits in greater detail.

The coastal plain has low elevation and little relief. Traces of former beach ridges and deposits of detrital materials derived from western uplands are found along the coast of Belize. In general, these coastal deposits north of Belize City contain more limestone fragments than those to the south. Although isolated quartz sand deposits are found at the mouth of major streams north of the Belize River (e.g., New River at Corozal), most of the extensive quartz sand beaches lie south of Belize City.

Minerals

Several economically important minerals are known to occur in Belize, but none has yet been found in commercial quantities. The most important mineral deposits, dolomite and limestone, are certain to increase in economic importance. Commercial quantities of barite (source of barium) and bauxite (source of aluminum) may occur along

the coast. Gold and tin are also known to occur but prospecting has been disappointing.

Small amounts of cassiterite, the principal mineral of tin, have been found in most streams draining the granite intrusives of the Maya Mountains. Cassiterite has been traced to its granitic source but only small quantities were found; attempts to find alluvial deposits concentrated along streams have been unsuccessful. Placer gold has been found in very small amounts in Ceibo Grande River and other streams draining the Bladen Porphyry. Gold is probably associated with quartz veins in the metamorphic rocks surrounding the prophyry.

Dolomite occurs in commercial quantities near St. Margaret's Creek, near Punta Gorda and elsewhere in Toledo district. The dolomites are dense, hard and tough, making excellent road ballast. Limestone quality varies and is found in many places around the Maya Mountains. Hard limestone is an excellent road material, but chalk and soft limestone are not suitable for any construction use. The four major limestone quarries are San Antonio (north), Lester Quarry (Punta Gorda), Gracy Rock and Melinda. New limestone and dolomite quarries will decrease hauling distances from existing quarries. Sites to be considered are near Indian Church, Cedar Crossing, the Yalbac Hills area, near San Ignacio, near Belmopan and at St. Margaret's Creek. At Caves Branch, river gravel is crushed and sorted. More river gravels could be used if crushed to a suitable size. Potential sites for river gravel exploitation are Sibun River near Sibun Camp, North Stann Creek near Middlesex, Sittee River at Kendall, and Swasey Branch near Cowpen. Though the savanna lacks road surfacing materials, quarrying might be feasible in the isolated monadnocks northwest of Mullins River, near Perry Bank, the Sierritas west of Savannah Forest Station, near Medina Bank, and near Hellgate.

Petroleum

Mineral development and management is an administrative responsibility of the recently established Petroleum Office in the MNR. The Petroleum Office will develop and interpret a data base and be responsible for training Belizean petroleum scientists and engineers. The new Petroleum Office does not have environmental guidelines for the activities of prospecting companies.

Foreign oil companies (primarily from the U.S.) have recently increased inland and offshore petroleum exploration in Belize. Since 1955 over 40 test wells have been drilled with about 65% showing oil and only six being classified as dry holes. Many of the wells were drilled primarily to gain structural information. Rao (1982) gives a good summary of the history of oil exploration and petroleum geology in Belize.

Since the geology of Belize is similar to that of high oil producing areas in Guatemala and Mexico, it is possible that Belize has oil. Three petrochemical areas include the *Maya Uplift*, the *Corozal Basin* on the Yucatán Platform, and the *Belize Basin* in the extreme south of the country. The *Maya Uplift* generally separates the two basins and structurally is related to the Cayman Ridge. The *Belize Basin* is an extension of Guatemala's Southern Peten Basin where there have been significant oil discoveries. Drilling activity in the *Belize Basin* has produced numerous "shows" at both surface and subsurface levels. Poor seismic data due to swamps, marshes and estuaries have hindered extensive exploration.

The *Corozal Basin* is the eastern continuation of the North Peten Basin and is believed to be the western continuation of the Yucatán Basin (Rao 1982). Most of the country's drilling activity has taken place in the *Corozal Basin*, with one well showing oil at roughy 183 m, but poor seismic data have prevented extensive exploration. Nevertheless, optimism is high among producers for forthcoming significant discoveries.

Oil exploration may increase in the near future because the GOB is politically stable and has a favorable investment climate attractive to oil explorers and wildcatters (see Chapter II-C). Improved techniques will enable producers to extract hydrocarbons from formations and zones previously uneconomical. Drilling and exploration costs are currently low. Producers can add to their assets through lease acquisitions and/or by developing reserves cheaply, and their position will be strengthened should world oil prices increase as expected.

In addition to the legal considerations of leases, rights and obligations, environmental issues must be addressed. Well-drilling can entail opening roads into forested areas or penetrating the sea floor, as well as polluting the area with crude oil or toxic chemicals. The geology must be carefully studied to avoid contamination of key aquifers.

Creating laws and regulations for petroleum exploration and development in Belize must be preceded by thorough analyses not only to help the national economy but also to protect the environment from irreparable damage. Should commercial quantities of hydrocarbons be found, the movement and processing of crude oil should be carefully assessed to minimize environmental damage.

IV–C. HYDROLOGY

Surface Water Resources

Though Belize is a relatively low country, its river systems and many perennial streams supply most of its water needs (Fig. IV-8). In the well-developed and highly dissected karst regions on the periphery of the Maya Mountains many streams disappear underground and may reappear as springs along major streams or as tributaries to large watercourses.

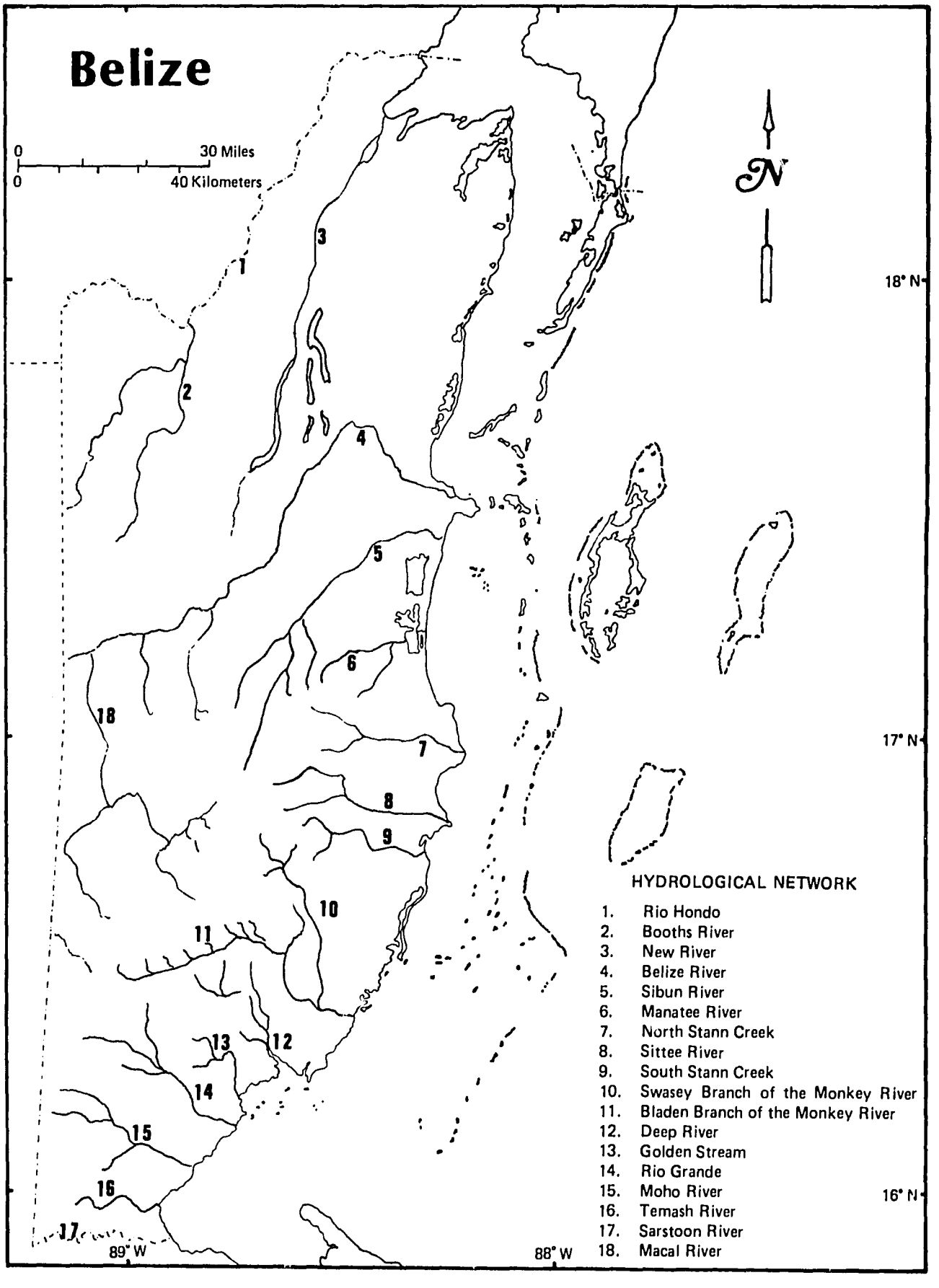


Figure IV–8. — Major river drainage patterns for Belize.

Streams draining southeastern and eastern slopes of the Maya Mountains have a well-developed branching pattern with relatively steep, straight courses in the mountainous areas. On the coastal plain savanna, streams become progressively more sluggish and drainage is less effective. Near the submerging coast, numerous lagoons, mangrove swamps, deep estuaries and river-mouth bars are well-developed.

The drainage pattern is less branched west of the main divide of the Maya Mountains, because many streams drain underground to major rivers through the highly dissected, rugged, limestone Vaca Plateau. No important tributaries enter from the east bank of the Chiquibul River, which must be due to subterranean drainage through porous limestone and highly developed karst topography of the Vaca Plateau. Similarly, no major tributaries feed the Macal River from the west (Vaca Plateau). The Macal River drains a large area of high relief (from 1020 m elevation at Baldy Beacon down to 70 m at Black Rock) and is the most tumultuous river in Belize.

North of the Maya Mountains, the Belize River flows generally northeast in a tortuous course from San Ignacio to about 19 km south-southeast of Crooked Tree, then south and southeast to enter the sea near Belize City. Dixon (1956) postulates that the Belize River formerly flowed north, possibly into the New River. The Belize River carries the largest volume of water, draining about 27% of the country. The River probably receives considerable recharge from springs in the Cretaceous limestones *(Campur limestone)* in the stretch between San Ignacio and Belmopan.

North of the Belize River all rivers drain northeast following faults in the limestone bedrock. Booth's River and New River undoubtedly receive most of their recharge from the underlying Cretaceous limestones. East of Crooked Tree and northeastward to Sarteneja, drainage systems are poorly developed and most drainage is internal (subsurface). This vast area is mostly lower than 15 m above msl, hence freshwater and brackish water lagoons abound.

Stream-gauging in Belize is in its infancy and the network is incomplete (Table IV-3). Information on stream flow in Belize is found in the National Hydrometeorological Service Yearbook 1981-82 (GOB 1982i). Additional stream flow data are needed for Monkey River (Swasey Branch and Bladen Branch), South Stann Creek and New River drainage basins. Such data are essential in planning for flood control, drainage, canals and hydroelectric projects.

Current Usage of Surface Water

Surface water is used exclusively for domestic purposes by an estimated 70% of the population. San Ignacio, Belmopan, Belize City and Dangriga (with combined population of about 56,000) all obtain their municipal water from streams. Many small villages are located near creeks with a reliable water supply, and inhabitants still "dip" their drinking water. Of course, the same streams are used for bathing and laundry. Pollution is not yet a serious problem, although faecal and detergent contamination of potable water is a real risk. Some examples of water quality characteristics are given in Table IV-4.

No information is available on surface water used for irrigation or industry, but the amount is undoubtedly small. A few small industries near Belize City use water from the Belize River. A few farmers probably irrigate during the dry season. Belize City currently uses about 4.2 million liters per day (mld), Belmopan, an estimated 0.8 mld, San Ignacio 1.1 mld, and Dangriga about 0.8 mld; no other data on surface water use are available.

Potential Hydroelectric Sites

Belize is well endowed with potential sites for development of large and small hydroelectric projects. The only functioning hydroplant is on Blue Creek (Orange Walk district), where the Mennonites have built a low stone and concrete dam across the mouth of the Río Brava (Booth's River), impounding a 5 km long reservoir. The 35 KW of electricity generated serves the small Mennonite community west of Blue Creek through several kilometers of light-duty transmission lines. Potential for similar development exists at numerous places, chiefly on the periphery of the Maya Mountains.

Three potential sites for large impoundments are in the northern Maya Mountains. One site in the Cockscomb Basin is near Double Fall on the Swasey Branch, 14 km south of Victoria Peak. Halcrow & Partners (MEC 1982) identified a promising site on the Macal River near Black Rock. There are several potential dam sites on the Macal River upstream from Black Rock, but dams cannot be very high because of cavernous limestones on the Vaca Plateau to the west. Though the Macal River has hydroelectric potential, seasonal discharge varies so much that hydroelectric installation designs must be carefully studied.

Smaller but potentially important sites include the Río On north of Augustine, Privassion Creek near Blancaneaux Lodge, the upper Macal River 5 km south of San Luis, the Sibun River 8 km south of Sibun Camp, and the Sittee River 4 km west of Kendall. In Toledo district, the Río Grande Sink 4 km north of San Miguel, Blue Creek at Blue Creek Village, Aguacate Creek near Aguacate Village, and the Bladen Branch 1.6 km upstream of Chun Bank, should all be considered as potential hydropower sites (see Chapter IV-J).

Practically any small perennial stream with modest gradient should be capable of producing 2 to 10 KW. Small hydroplants could be used to produce power for family farms or small villages in rural areas of the country.

Table IV-3. Stream-flow data for Belizean rivers (GOB 1982i). See Figure IV-7.

STATION (NUMBER)	NATIONAL CATCHMENT AREA (km^2) ABOVE RECORDING STATION	RECORDING PERIOD	MEAN ANNUAL DISCHARGE (m^3/s)
Belize River Watershed = 5,874 km^2 in Belize + 3,238 km^2 in Guatemala			
Double Run (17788401)	5,708	VI 81 – V 82	155.4
Big Falls Ranch (17588602)	4,926	IV 81 – III 82	99.8
Banana Bank (17388805)	4,022	IV 81 – V 82	95.8
Benque Viejo (17189106)	943	VI 81 – II 82	51.8
Cristo Rey (17189108)	1,590	IV 81 – II 82	30.2
Río On (17089009)	70	I 81 – II 82	2.3
Río Frio (17089010)	19	I 81 – II 82	0.1
Sibun River Watershed = 1,222 km^2			
Freetown Sibun (17488403)	1,059	V 81 – IV 82	50.5
Norland Farm (17188604)	749	III 81 – III 82	35.9
North Stann Creek Watershed = 518 km^2			
Middlesex (17088511)	65	VI 81 – V 82	6.9
Melinda (17088312)	256	IV 81 – V 82	15.4
Sittee River Watershed = 474 km^2			
Kendall (16888413)	383	V 81 – IV 82	13.9
Rio Grande Watershed = 772 km^2			
Big Falls South (16388914)	536	V 81 – IV 82	24.0
Moho River Watershed = 927 km^2			
Blue Creek Village (16289015)	168	V 81 – IV 82	7.8
Aguacate Village (16289116)	186	V 81 – IV 82	5.1

Groundwater Resources

Any rock formation or stratum that will yield water in sufficient quantity is called an aquifer. The amount of water an aquifer can hold is determined by its porosity. Unconsolidated materials such as sand and gravel generally are more porous than consolidated rocks, such as sandstone or limestone; however, some consolidated rocks are very porous. Igneous rocks such as granites, or metamorphic rocks such as slates generally have very low porosity.

Water that is free to seek its own level in an aquifer is said to be under water-table conditions. Water that is confined in an aquifer by an overlying impervious stratum is under pressure, providing artesian water when the cap is breached by drilling or a well. If the water is under enough pressure the well will flow like a spring. If the pressure is not great enough to cause the well to flow the water will still rise above the top of the aquifer; thus artesian wells hundreds of meters deep may only have to be pumped a few meters to yield water.

Belize has both water-table aquifers and artesian aquifers. The generally shallow water-table aquifers are utilized for water supplies throughout the country, but few water wells have been drilled deeper than 30 m and very rarely are they artesian. Oil test holes indicate artesian aquifers in Belize are usually deeper than 30 m. Assuming

Table IV-4. Examples of drinking water quality characteristics throughout Belize. Samples were taken in February 1984 and represent point sources, not averaged over the system. Trends--northern districts (Corozal and Orange Walk) experience greater hardness and chloride levels causing more corrosion of pipes and machinery. Bacterial problems are minimal since chlorination is applied. (Source: WASA records, 1984; a/b, PAHO/AID 1982).

District	Cayo	Orange Walk	Corozal	Stann Creek	Toledo	Belize	
City	Belmopan	Orange Walk	Calcutta	Dangriga	Punta Gorda	Belize City	San Pedro
Treatment Facility[a]	C,S,F,Ch	Ch	Ch	C,Ch	Ch	F,S,Ch	-
Water Source[b]	R, RR	W	W	R,W	W	R, RR	W
pH	7.6	7.4	7.2	8.2	7.4	–	7.4
Temp. °C	24	28	15	20	25	27	22
Conductivity (u-mhos/cm)	140	400	700	40	280	280	480
Turbidity (NTU)	1.4	1.5	0.8	0.6	0.2 (FTU)	1.2	1.3
Sulfate (mg/1)	10	450	420	10	10	108	18
Hardness (mg/1)							
Mg	50	100	300	10	30	60	30
Ca	140	400	500	20	170	270	200
Total	190	500	800	30	200	330	230
Chloride (mg/1)	20	85	250	10	35	45	240
Alkalinity (mg/1) Total	150	300	400	70	170	145	225

[a] Treatment: C = Coagulation; S = Sedimentation; F = Filtration; Ch = Chlorination.

[b] Source: R = River; RR = Reservoir; W = Bore hole, well.

that water in artesian aquifers is of suitable quality, an important source of ground water is currently being overlooked.

Groundwater Provinces

For convenience in describing groundwater resources Belize has been divided into seven groundwater provinces (Fig. IV-9). Each province has one or more potential aquifers but the extent to which they may be developed and utilized will have to await further water well drilling and data collection. Very few records (logs) of water wells and almost no water quality data exist. (Logs of 30 shallow wells are on file at Robert Nicolait & Associates Ltd.)

The Coastal Plain and Shelf Province includes Corozal and Orange Walk towns and numerous surrounding villages. The towns of Corozal and Orange Walk are supplied by municipal water systems. Each small village has at least one well. All wells tap the chalks and marls of Eocene or younger age. Almost without exception the wells are characterized by uncertainty of water supply and/or questionable quality.

Several oil-test holes (Tower Hill N° 2, San Pablo N° 1, London N° 3 and Patchacon N° 1) report fresh or clear water flowing to the surface from 500-600 m depths. Unfortunately, no water analyses are available. Potable water was reported from 158 m in the Rancho Dolores N° 1 oil-test about 40 km south of Orange Walk. Clearly, the deeper artesian aquifers underlying Corozal and Orange Walk districts are a possible source of abundant potable water.

The limestone artesian aquifers underlying all of the *Coastal Plain and Shelf Groundwater Province* may prove to be the most important groundwater source in Belize. Little is known of the groundwater resources of the higher elevations west of the escarpments. No records of wells are available for this extensive area and the *Campur limestone* aquifer probably cannot be reached by wells less than 600 m deep. The overlying *Lacandón* formation probably contains beds of limestone that will yield water but quality and depth will not be known until wells are drilled.

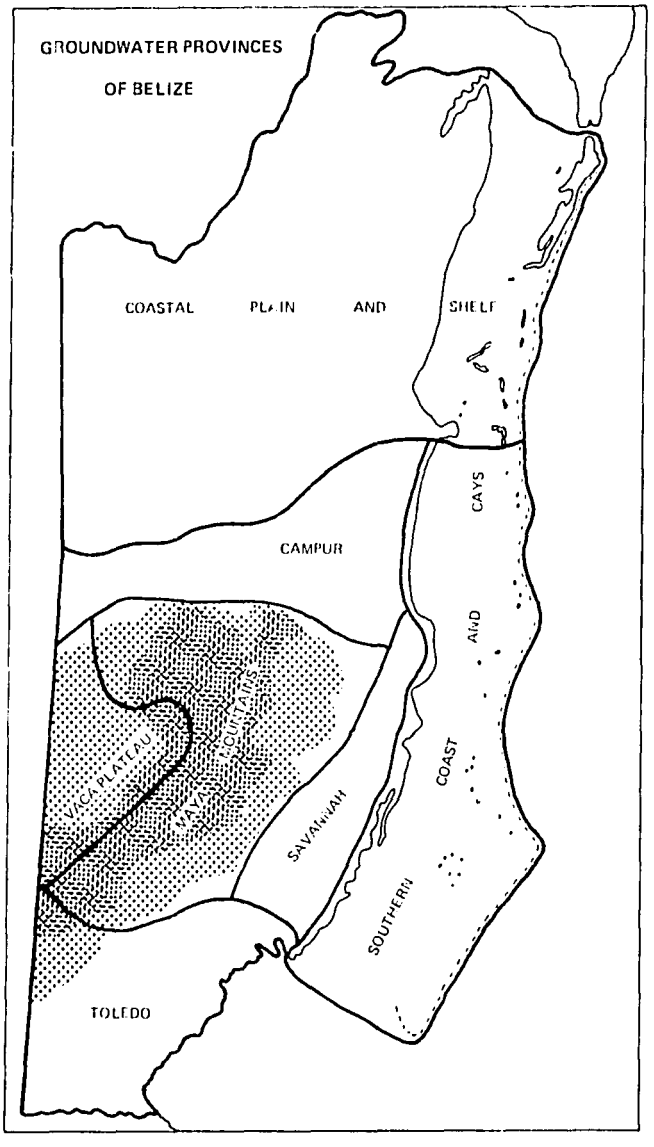


Figure IV–9. — Groundwater provinces of Belize.

Wells drilled to limestone of probable Eocene age at San Felipe report good quality water from 30 m. Flowing wells less than 30 m deep have been reported from San Antonio and Douglas near the Río Hondo, but the Douglas well contained hydrogen sulfide gas and was abandoned; an 18 m well drilled east of town contains good water.

In the extreme northeast near Sarteneja and southwest to near Cowpen, water is obtained from hand-dug wells in a hard, porous, highly fossiliferous limestone of probable Miocene age. The village well at Sarteneja is probably the oldest in Belize; it was apparently dug by the Maya (Fig. IV-10). It is 2 m deep and 1 m in diameter with about 1 m of water; numerous small milpa farms in the area have similar wells. Residents say the village name Sarteneja is Mayan for "water in the rock". The water may be a "perched" aquifer over salt water or it could be a discharge area for the underlying *Campur limestone.*

A similar situation exists on Ambergris Cay. The northern part of the cay is an old reef with very porous, fossiliferous limestone; a miniature karst topography exists with numerous sink holes and natural wells. Fresh water is abundant and some of the natural wells are reported to be more than 10 m deep.

At the southern end of the cay the fishing village of San Pedro obtains its water from shallow, low-yielding wells hand-dug or drilled about 4-5 m deep in coral sand. Water shortages and contamination problems in San Pedro have been caused by overuse associated with tourism development. A possible solution to the water supply problem would be deeper wells, preferably 1-2 km north of town where the limestone is close to the surface. Wells should be cased to the top of the limestone to eliminate possible contamination through the sand.

North of the Belize River, mostly unsuccessful attempts have been made to obtain water from wells less than 30 m deep. Water is contained in thin beds or pockets of sand and gravel that was reworked along old shorelines, so unless a good deposit can be found, chances for abundant shallow water are slim. Closer to the Maya Mountains the underlying *Campur limestone* is nearer to

Figure IV–10. — Maya well at Sarteneja. (photo L. Nicolait)

the surface (with good quality water), hence chances of obtaining water at moderate depths from the limestone are much improved. No water well should be abandoned as a dry hole in this area until the limestone is reached.

The Southern Coast and Cay Province extends in a narrow belt 1-2 km wide along the coast from Belize City to about 15 km south of Monkey River Town. It includes the barrier reef and nearly all of the southern cays. The province lacks significant groundwater resources. The only sizeable town in the province, Dangriga, gets its municipal supply from North Stann Creek.

Although a persistent perched fresh water aquifer exists in the extensive sand beaches along the coast and on the larger cays, the thickness of the fresh water lens floating on salt or brackish water seldom exceeds one meter. Most permanent residents rely on hand-dug wells or collection of rain water except in dry years when they must find alternate sources of fresh water.

Fresh water wells were dug at Mullins River, but the quality and amount of water are unknown. Wells drilled to 18 m at Hopkins did not reach fresh water. The MHHC drilled five wells at Sittee Village to find groundwater in the river valley alluvium; all have fresh water but it tastes strongly of iron, so the water is not used.

On Placencia Peninsula about 30 hand-dug wells 1.5 m deep are the only groundwater supply. These areas rely on rainwater collection and storage for drinking and cooking. Few cays have year-round residents and these generally depend on collected rain water and a few shallow wells. Visiting fishermen and campers to the smaller cays generally report finding fresh water in shallow wells. On the coast between Sittee Village and Monkey River Town a well was drilled in 1964 at Maya Beach to a depth of 24 m without finding water-bearing strata.

If a stratigraphic connection with the recharge area in the Maya Mountain foothills is identified, deep water wells drilled on the cays south of Belize City would find fresh water in the limestone. An adequate supply of fresh water is critical to the development of tourism on the cays.

The Campur Province coincides with the outcrop of *Campur limestone* north of the Maya Mountains and it has good quality groundwater. Springs are common near Benque Viejo and eastward to Belmopan, and wells less than 150 m deep should find plentiful water from the limestone.

Benque Viejo is supplied by a spring while San Ignacio and Belmopan take municipal water from the Belize River. Between Benque Viejo and San Ignacio deep wells are necessary to reach water-bearing zones in the deeply weathered limestone. At Rockview several unsuccessful wells ended in sediments covering the limestone. Wells drilled throughout the broad area east of Belmopan and south of the Belize River should not stop short of the limestone unless ample supplies of water are found.

The Maya Mountains Province has insignificant amounts of groundwater. The metamorphic rocks and dense intrusions will not contain much water. Mountain residents obtain water from permanent streams or rainfall.

The Vaca Plateau Province has no permanent towns or villages though there are about 20 small milpa farms. Presumably water is taken from springs or streams in the Chiquibul drainage basin.

The Savannah Province does not yet have reliable groundwater sources. Wells drilled along the Southern Highway had limited success. Only shallow wells (12-15 m) were drilled at small villages or individual farms where people depend on perennial streams for their water supply. A 29 m well near the school in San Roman Village did not reach water. The small community of Silk Grass north of Freshwater Creek drilled several wells before finding an adequate groundwater supply from "white stone" at a depth of 20 m.

Toledo Province has an abundant supply of groundwater at shallow depths throughout the province. Punta Gorda and provincial villages are supplied by town wells. Groundwater is found in two major aquifers: the *Sepur* formation (Toledo Beds of Dixon, 1956) and the underlying *Campur limestone.* Because the entire province consists of recharge areas of either the *Sepur* or *Campur* outcrops, both aquifers contain abundant groundwater. Yields of water from wells bottomed in the sandstones and siltstones of the *Sepur* can be expected to be less than those finished in the more porous and cavernous limestone and dolomite of the *Campur.*

The area south-southwest of Little Quartz Ridge is well-developed karst terrain where many surface streams disappear into sink holes (e.g., the Dry Columbia); however, deeper drill holes (on the order of 60 m) should find water before the metamorphic rocks are reached. The area near *Savannah Province* and along the coast may prove difficult because the *Sepur* formation is thin in this area and it is not known if limestone extends in the subsurface as far east as the coast. Near the Sarstoon River, the *Sepur* and *Campur* appear to grade into each other to form a complex sequence of alternating limestone and siltstone beds; thus the formation may yield only small amounts of groundwater.

Solid guidelines for drilling into artesian aquifers and strict enforcement of regulations are the only ways to secure continued quality water. The various ministries with responsibilities for well drilling and water supply or potability must work together to ensure that they do not overlook a procedure that could endanger the water supply. A central agency should be responsible for all well-drilling logs.

IV–D. SOILS

Scientific appraisal of the soils of Belize commenced with studies by F. Hardy in 1935. In 1940 C. F. Charter

made soil maps of areas recommended by the Colonial agricultural staff. A comprenhensive study (Wright et al. 1959) describes the general distribution of soils, land use potential and vegetation cover of the whole country. For this BCEP Wright regrouped the soils to conform with the boundaries of the country's principal landform units (Fig. IV-11). The main soil features of each major landform unit are described below (and summarized in Table IV-5).

Principal Landforms

1. Siliceous Soils of the Mountain Pine Ridge

Although the region known as Mountain Pine Ridge is only 3.4% of Belize's land area, its geological history (see p. 11), and unusual soils and pine forests (see p. 90), easily achieve status as a principal landform. Two subunits –upland plateau (1a) and upland ranges (1b)–are differentiated on the basis of physiography and topography.

1a. Mountain Pine Ridge Upland Plateau

This plateau area appears to be a remnant of a much smoother, older island surface that rose above the sea 180 million years ago (middle Cretaceous). Subsequently much of the northern, eastern and southeastern parts of the plateau were eroded into a deeply dissected landscape. Its core area reflects differences in the relative hardness of the underlying Paleozoic rocks. Crystalline limestones west of the plateau probably prevented drainage from the plateau that resulted in an extensive shallow lake. Waters from this impoundment eventually dissolved tunnels through limestone walls (now seen as caves) to discharge into major river systems at lower elevations.

The soils of this map unit (mostly of the Pinol series) show features that are not found elsewhere in Central America; their closest American counterparts probably are the soils of Brazil's Itapeva highlands. Most of these soils have a thick "erosion pavement" of accumulated rock fragments on the soil surface. Over the millennia, underlying rocks have been exposed and deeply weathered to form a soil mantle composed mainly of kaolinitic clay and quartz sand. The downward translocation of clay by illuviation has produced compact subsoil that impedes percolation of water and promotes soil creep (solifluction of quartz sand in the topsoil). A micro-relief of "terracettes" develops concentrically around many high points in the landscape. The thickness of the erosion pavement indicates the degree of erosion. Under the prevailing climatic regime (excess soil moisture for seven months of the year, followed by five months when evapotranspiration often exceeds precipitation for several weeks at a time), the sharp delineation between sandy topsoil and clay subsoil restricts plant formations to those that can tolerate these extreme soil conditions.

In addition to difficult physical conditions, Pinol soils are markedly lacking in plant nutrients, particularly exchangeable calcium and magnesium and available phosphorus. They are low in nitrogen and potassium, especially in the dry season, when the soils are usually baked as hard as brick, and are also deficient in many trace elements (cobalt, copper, molybdenum, boron). Fertilizer mixtures applied to Pinol soils in pasture establishment trials have only brief effects on plant growth, being lost through lateral leaching downslope. Pinol soils are not well-suited to permanent agriculture due to high "input" costs (fertilizers, legume inoculants; pest, disease and weed control; irrigation in the dry season; and erosion control). The present system of land use (systematic regeneration and management of natural pine forests) is comparatively inexpensive and well-adapted to these soils.

Thirty years ago, the forestry road system on the plateau was in danger of destruction from deep gullying of roadside drainage ditches. Damage was controlled by constructing outlets for lateral drains to divert runoff and prevent further erosion. Forest management requires controlled burning of underbrush to improve regeneration of pine seedlings. Since fires of natural origin (mainly lightning strikes during dry period storms) are a feature of the normal environment, controlled burning has produced little acceleration in the normal rate of erosion in these soils.

1b. Mountain Pine Ridge Upland Ranges

This name is given to the highly dissected region lying mainly east and southeast of the plateau. Drainage is to the north, east and southeast in steep, ungraded water-courses marked by many waterfalls in the rainy season. Pinol soils occur on the rounded crests of many ridges supporting scattered pine forest and low oak woodland. The soils of the steep slopes are predominantly lithosols of the Baldy series--exceedingly shallow, rocky soils of very low base status (other than potassium, which is comparatively abundant). The lithosols are highly susceptible to erosion and even under natural conditions develop erosion scars where a fallen tree precipitates a small landslide. These soils should be maintained strictly under protection forest.

2. Siliceous Soils of the Maya Mountains

This principal landform extends from the highest point in Belize (Victoria Peak, 1120 m) down to about 50 m above sea level. Except in the Cockscomb Basin, topography is extreme; steep and very steep slopes comprise 52% of the region. The parent rock is of Paleozoic age and notably deficient in minerals needed by crop plants (calcium, magnesium, phosphorus. as well as many trace elements). High erosion risk and nutrient deficiencies make these soils singularly unsuitable for agriculture. With the possible exception of alluvial soils in the Cockscomb Basin, it appears that the Maya wisely avoided the soils of this region. Changes in vegetation physiognomy suggest a climate transition at about 450-600 m. For purposes of this chapter, an elevation of 530 m is used as the division between upland (2a) and lowland (2b) subunits.

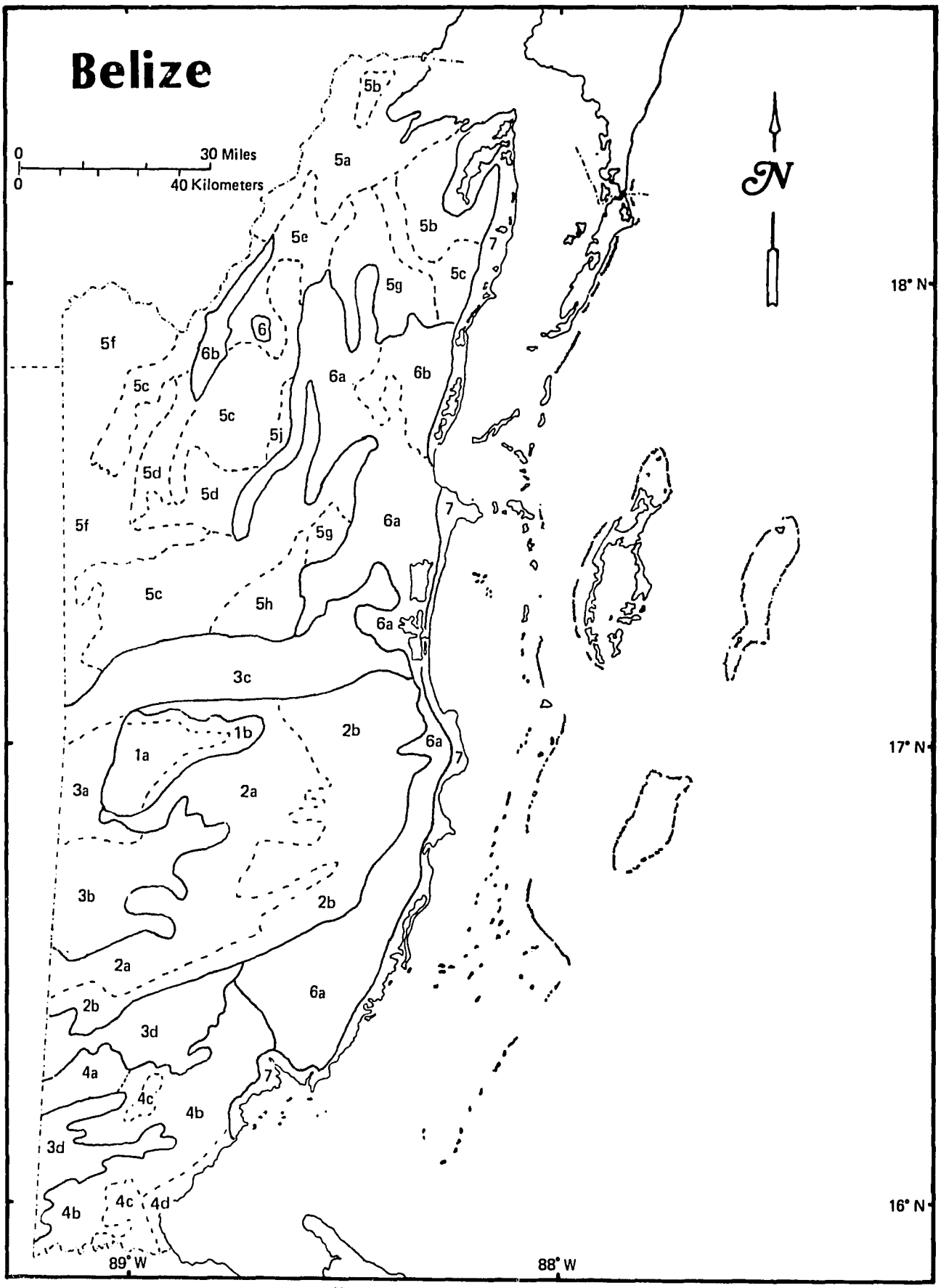


Figure IV–11.— Principal landforms of Belize based on major soil features. See Table IV–5 and text for explanation. (from A.C.S. Wright)

Table IV-5. Soil features of the principal landforms of Belize.

Map Code	Subunit	Area km² (%)	Principal Soil Series	Major Limitations	Recommended Land Use
1.	SILICEOUS SOILS OF THE MOUNTAIN PINE RIDGE (738 km² = 3.4%)				
1a	Upland Plateau	488 (2.3)	Pinol	Droughty; low fertility	Production Forestry
1b	Upland Ranges	250 (1.2)	Baldy	Shallow; low fertility; highly erodible	Protection Forests
2.	SILICEOUS SOILS OF THE MAYA MOUNTAINS (3,260 km² = 15.2%)				
2a	Uplands (steep)	1,846 (8.6)	Raspaculo, Cockscomb, Chapayal, Richardson Peak	Shallow; low fertility; highly erodible	Protection Forests
2a	Uplands (strongly rolling)	(included above)	Curassow, Chiquibul, Palmasito, Granodoro	Shallow; low fertility	Protection Forests
2b	Lowlands (steep)	1,414 (6.6)	Swasey, Tiger	Shallow; low fertility highly erodible	Protection Forests
2b	Lowlands (hilly)	(included above)	Stopper, Curassow, Ossory Sirin, Esperanza, Granadoro	Low fertility; highly erodible	Production Forestry; Permanent Tree Crops
3.	CALCAREOUS SOILS OF KARST LANDSCAPES (3,425 km² = 16.0%)				
3a	Northern Karst Uplands (Vaca Plateau)	426 (2.0)	Tziminkax	Plastic when wet; accessibility	Production Forestry; Permanent Tree Crops
3b	Southern Karst Uplands (Chiquibul)	927 (4.3)	Cabro, Chacalte, Cumbre	Slow internal drainage, accessibility	Production Forestry; Pasture; Agriculture
3c	Northern Karst Foothill Ranges	1,122 (5.2)	Xunantunich, Cuxu, Hummingbird	Stony	Protection Forests; Permanent Tree Crops; Pasture; Milpa Agr.
3d	Southern Karst Foothill Ranges	950 (4.4)	Xpicilha	Droughty; some stoniness	Milpa Agr.; Pasture; Rice
4.	TOLEDO LOWLANDS OF TERTIARY MUDSTONES, SHALES AND SANDSTONES (1,673 km² = 7.8%)				
4a	Toledo Foothills	392 (1.8)	Aguacate, Manfredi, Wetziltot	Low fertility	Milpa Agriculture
4b	Toledo Lowlands	1,059 (4.9)	Temash, Manfredi, Cimin Sanjuanilina, Hiccattee	Poor physical structure; clay pan	Permanent Tree Crops; Rice
4c	Toledo Inland Swamps	162 (0.8)	Caway	Flooding; poor drainage	Some Rice
4d	Toledo Coastal Strip	60 (0.3)	Barranco	Clay pan; lack phosphorus	Permanent Tree Crops
5.	CALCAREOUS SOILS OF THE NORTHERN LOWLANDS (7,433 km² = 34.7%)				
5a	Soils from Coral Rubble, Coralline Limestones and Beach Sands and Gravels	402 (1.9)	Reinate	Stony; shallow; droughty	Permanent Tree Crops; SugarCane; Milpa Agr.
5b	Soils Similar to 5a but with Volcanic Ash Minerals	508 (2.4)	Xaibe	Stony; shallow; phosphorus deficient	SugarCane; Fruit Crops; Vegetables
5c	Soils from hard Miocene Limestone; Cemented Conglomerate	2,222 (10.4)	Puluacax Yaxa	NONE	Intensive Agr.; Milpa Agr.
5d	Soils Similar to 5c but with Volcanic Ash Minerals	255 (1.2)	Chacluum	Phosphorus deficient	Pasture; Mechanized Agr.
5e	Soils from Soft Siliceous Limestone	409 (1.9)	Louisville	NONE	Mechanized Agr. with Pasture Rotation

Table IV–5. – (Continued)

5f	Soils from Calcareous Marl and Gravel	1,566 (7.3)	Jolja	Droughty	Production Forestry
5g	Soils from Hard Siliceous Limestone with Flints	447 (2.1)	(Jobo)	Low fertility; slow internal drainage	Agriculture with Fertilizer & Drainage
5h	Soils from Hard Cretaceous and Shattered Limestone	568 (2.6)	(Jobo)	Plastic clay	Permanent Tree Crops
5j	Soils from Alluvium and Colluvium over Marl or Hard Limestone	1,056 (4.9)	Ramgoat	Flooding	Rice
6.	SILICEOUS SOILS OF THE LOWLAND "PINE RIDGE" (4,010 km^2 = 18.7%)				
6a	Without Limestone Outcrops	3,411 (15.9)	Puletan	Low fertility; clay pan	Aquiculture ponds
6b	With Limestone Outcrops	599 (2.8)	Rockstone, Felipe, Tok	Low fertility; rock outcroppings	Pasture; Production Forestry
7.	LITTORAL COMPLEX OF ORGANIC SOILS AND DUNE SANDS (904 km^2 = 4.2%)				
	Peaty Swamp and Muck Soils	602 (2.8)		Poor drainage	Protection Forests
	Sandy Soils (including cays)	301 (1.4)	Turneffe, Shipstern	Infertile; fragile	Permanent Tree Crops

2a. Uplands of the Maya Mountains

On steep and precipitous slopes where the soil mantle is very thin and outcropping rock is common, the soils are almost entirely lithosols. The remaining area consists of moderately steep or very strongly rolling landforms, with narrow strips of colluvial and alluvial soils in narrow valley bottoms. These relatively fertile alluvial soils total less than 1,600 ha, are widely scattered and often inaccessible, and subject to flash flooding and obliteration by landslides.

The uplands of the Maya Mountains are presently covered in primary forest (including vigorous cohune palms in some areas) that may suggest valuable agricultural soils. However, forest destruction would only result in loss of the accumulated organic matter, making the land worthless for agriculture and prone to accelerated sheet and gully erosion. Fully 90% of the landscape could become unstable if the natural forests are removed. Subsequent erosion debris would inundate the plains below. In a worst case scenario, all bridges on the Southern Highway between Silk Grass and Deep River would be in jeopardy from floods (Fig. IV-12). This critical area must be excluded from agricultural development and administered as a watershed protection forest.

2b. Lowlands of the Maya Mountains

The steep parts of the lowlands of the Maya Mountains require protection from forest exploitation, casual burning and agricultural development (including browsing by cattle). On strongly rolling and moderately steep slopes tall cohune palms give a false impression of good soil fertility, but almost all nutrients in these soils are contained in the accumulated soil organic matter that rapidly disappears after forest clearing. The less steep areas can be used for sustained-yield forest management, but are unsuited to most forms of agriculture except permanent tree crops such as cacao and citrus. Coffee is less suitable because of erosion of the bare soil. On landforms of slightly dissected relief citrus plantations do well when the soils are maintained with a permanent grass cover; cacao and coffee can also be grown successfully. All crops on these soils need phosphate fertilizer almost from the start of farming. Many of the soils are well suited to dairy production and there is no lack of water for livestock or for local electric power production.

Milpa farming should be discouraged on the gently rolling hills. The good yields obtained from the first and second year of milpa farming are misleading for successive cycles. Soil depletion often proceeds at an exponential rate until the infertile and eroded soil is abandoned or used for rough pasture. Soils of this landform require careful attention to farming practices. Uncontrolled settlement should not be permitted in the Maya Mountains.

3. Calcareous Soils of Karst Landscapes

The rugged landscapes of this major landform were formed by long-continuing solution of mainly hard, white, dense crystalline limestones of Cretaceous age, giving rise to such "karstic" features as underground streams and rivers, sinks and solution pits, subterranean caverns and "cenotes" (underground lakes exposed by collapse of a limestone roof). Valley sides are precipitous and outliers of the steep foothill ranges continue onto the lowland plains; often the

outliers form a chain of isolated hills with caves of marine origin, revealing the levels of ancient shorelines.

As with the Maya Mountain landform (2), an elevation of 530 m is used to divide upland and lowland subunits. Because the northern part of this region is significantly drier than the southern, four subunits are described: Northern karst uplands-Vaca plateau (3a); southern karst uplands-Chiquibul plateau (3b); northern karst foothill ranges (3c); and southern karst foothill ranges (3d).

3a. Northern Karst Uplands (Vaca Plateau)

Two-thirds of this subunit is a highly dissected upland plateau with very steep to precipitous slopes. The remaining third is flattish to gently rolling land of upland valleys, usually surrounded by limestone hills ("cockpits"). Occasionally these valley floors interconnect in a chain of valleys. A smaller, strongly rolling area has bouldery or rocky soils from the collapse of part of the valley wall.

Throughout much of this subunit, the limestone has a pinkish cast caused by small amounts of volcanic ash minerals embedded in the limestone. Montmorillonitic clays dominate in these soils, but the presence of metahalloysite derived from the volcanic ash improves friability.

Approximately one-third of this landform subunit has deep, seasonally friable soil of good natural fertility that could be used for agriculture. However, most of these soils occur in isolated patches enclosed by steep limestone hills. Water supply for domestic use and livestock from January to May is also unreliable in this region. Access roads in this landscape are costly, so most of this landform should be kept as "reserved" production forest until it must be released due to population pressure.

3b. Southern Karst Uplands (Chiquibul Plateau)

The southern part of the limestone uplands are mainly distinguishable from the northern part because the limestone lacks the pink cast. Steeper and more precipitous slopes occur west and south of the plateau. The central part of the plateau has moderately steep to strongly rolling landforms and undulating to rolling landforms in about equal proportions.

A fourth of this subunit is well suited to agricultural crops (rice, corn, sorghum and beans), plus another quarter is suitable for pasture. Surface water is scarce during March, April and May, but groundwater supplies will probably prove to be abundant. Since 160 km of new road construction are necessary to open the land to settlement and commerce, it is not expected that this subunit will soon be developed. Nevertheless, the Chiquibul region has considerable forestry potential (Johnson and Chaffey 1973).

3c. Northern Karst Foothill Ranges

A belt of limestone foothills extends around the northern flank of the Mountain Pine Ridge (1a), continues across the northern third of the Hummingbird Highway and approaches the Caribbean coast in the vicinity of Gales Point and Mullins River. In this subunit much of the Cretaceous limestone is unusually fragmented and shattered, and at the lowest elevations the hilly landscape

Figure IV–12. — Road flooded on Southern Highway. (photo G. Hartshorn)

appears to have been carved in ancient tumultuous fan materials. Depth of soil varies widely in this landform, but almost all soils are markedly stony or bouldery.

Most of the original forest was cleared for farming or burned by runaway fires from milpa preparations. Little more than subsistence farming occurred in this landform during the last 50 years; more recently rice has been grown as well as shaded cacao orchards. Most of these soils are not affected by erosion because soil aggregates become trapped by pockets in the uneven topography. The soils have a relatively high level of natural fertility and can withstand milpa farming if allowed a three to five year fallow cycle.

For the 32,822 ha of lithosols on steep slopes, the only rational form of land use is protection forest. The best land use on 28,779 ha of hilly and very strongly rolling land is shaded cacao plantations. On the 50,599 ha of more gentle relief, the better-drained soils can be used for cacao plantations or citrus orchards; the less well-drained soils are best suited for improved pastures. In some areas with stony soil, intensive agriculture will require irrigation during the five dry months. Groundwater supplies have not yet been fully explored and some areas may be deficient. Mechanized farming should be possible on about 30,364 ha in this subunit; elsewhere the soils are too stony or bouldery. The soils and climate are suitable for fruit production (papaya, avocado, etc.).

3d. Southern Karst Foothill Ranges

The southern karst lowlands form the hinterland of much of Toledo district. The limestone ranges are often narrow, with a pronounced WSW-ENE orientation, decreasing in height from west to east and occasionally ending in a chain of isolated hills. About a quarter of this landform is flattish to gently rolling and includes a belt of deep colluvial soil along the foot of steep slopes. All the steep land has outcropping rock; soil usually occurs in pockets and fissures in the rocks. Most of the moderately steep and rolling foothills have outcropping rocks and boulders that prohibit mechanized agriculture. The limestone is uniformly dense and hard, with few impurities. Areas of shattered rock are not common, but along the eastern margin there are a few low hills of rubbly limestone that give rise to stony soils. These areas may represent remnants of tumultuous fan building at the margin of the Tertiary sea; they are of little agricultural importance but are an important source of ballast and surfacing materials for road building.

The soils of this area are relatively fertile (with the exception of available phosphorus), but their agricultural potential is limited by physical and moisture relationships. Most of the soils shrink, developing wide and deep fissures during the dry months (sometimes breaking roots of young trees in plantations of coffee and cacao). When thoroughly moist, the clay swells and percolation of water through the soil is impeded to the point where the soil surface may be flooded during heavy rain.

On most of the soils of this subunit, removal of the natural forest cover does not lead to a decline in soil fertility. Even under repeated milpa cycles the soils remain remarkably fertile for several decades and there are few indications of widespread erosion. That the heavily used milpa soils retain their dark color suggests that soil organic matter may be unusually stable in these highly calcareous soils; nutrients combined in the soil organic matter are not readily oxidized or lost by leaching.

For mechanized production of grains and other annual crops the main problems are effective drainage and the difficulty in cultivating the soil at anything other than optimum moisture conditions. Given the abundance (and erratic nature of) rainfall in this landform, optimum moisture conditions are often so rare as to be a major limitation to mechanized farming. In some years, the Amerindian rice crop (grown by a modified milpa system) gives better yields than rice grown by mechanized farming.

Most soils in this subunit (except on steep land) are good for pasture; however, an adequate supply of water for livestock in the dry season cannot be assured. Where financial and technical resources are available, the best land use on the flattish to gently rolling hills is unquestionably mechanized production of dryland rice for two or three crops followed by a pasture grass fallow lasting two to three years. On steeper slopes (6-25° or 10-40%), pastoral farming or tree crops are more appropriate land uses.

4. Toledo Lowlands of Tertiary Mudstones, Shales and Sandstones

Tertiary mudstones, shales and sandstones are largely restricted to the Toledo district of Belize. Physiography is the primary criterion for differentiating four subunits of this major landform: Toledo foothills (4a); Toledo lowlands (4b); Toledo swamps (4c); and Toledo coastal strip (4d).

4a. Toledo Foothills

Under natural vegetation these soils are of moderate to high fertility, derived from calcareous sandstones and siltstone. When the vegetation is destroyed and the soil organic matter oxidized, soil nutrient status rapidly declines and accelerated sheet erosion removes much of the topsoil, especially on moderately steep and steep slopes. In virgin conditions these soils are highly prized by milpa farmers, but after a few cycles of milpa (in which the corn crop is immediately followed by one or more bean crops), regeneration of natural vegetation slows and the fallow interval between milpas must be increased to seven to nine years. In extreme cases (as occurs on some overpopulated Amerindian reserves) the vegetation degenerates into fern thicket, after which no further milpas are made.

Paradoxically, erosion helps to keep some soils of moderately steep slopes in milpa production. Even as the topsoil material is being lost to erosion, the weathering of

underlying sandstone takes place so rapidly that crop roots can easily tap minerals. This is a common situation in many parts of the humid tropics, but unfortunately this rapid rock-weathering process is not generally widespread in Belize. Too often, the nutrient demands of plants in milpas established after an insufficient fallow period are greater than the nutrient supplying power of the soil weathering system. For example, under light milpa pressure, the moderately erodible Aguacate soils remain moderately fertile for many decades; although ideally, these soils should be used for permanent tree crops (cacao in particular) and semipermanent tree crops (e.g., anatto, *Bixa orellana*). Many fruit trees, such as avocado, mango and annona, also grow well. The steep slopes are highly erodible and should be allowed to return to protection forest.

4b. Toledo Lowlands

The lowland soils derived from this varied assemblage of Tertiary rocks show a range of clay minerals (kaolin, illite, montmorillonite and metahalloysite). They are derived from a mixture of calcareous parent material (limestone), weakly calcareous parent material (sandstone), very weakly calcareous parent material (shale and mudstone) and non-calcareous parent materials; all of these may occur with bedding angles ranging from flat to nearly vertical. This physical and chemical heterogeneity causes a very complex soil pattern with great variation in inherent soil fertility and soil drainage properties.

When the natural plant cover is removed, soil organic matter oxidizes rapidly with a concomitant loss of nutrients. A slower degrading process then commences. In almost all the soils of this subunit, clay-sized particles and silica gels are leached from the topsoil into the upper part of the subsoil. As a result of this clay translocation process, the finer pores of the subsoil become blocked, impeding percolation of water and leading to diminished aeration for roots. In other words, a "clay pan" develops in the upper part of the subsoil.

In many soils of this subunit, the rate of change in the physical condition of the subsoil is such that within five years from the time of original forest clearing, the planting of young citrus or cacao trees (or nutmeg, avocado, etc.) is adversely affected by the increasing lack of subsoil aeration. However, trees planted on soils recently cleared of forest grow well. Except for rice, a second cycle of milpa production is affected by diminished nutrients and deteriorated subsoil aeration. Pastoral farmers are likewise distressed by the speed with which sedges and rushes invade new pastures.

The unusually dynamic condition of most soils of this subunit has a bearing on potential land use. Leaching and illuviation (the accumulation of materials in one layer of soil that have been leached out of another layer) can be minimized by planting permanent or semipermanent tree crops with little delay after clearing the forest. Clearings without burning are preferred in order to minimize loss of nutrients. Rice (unaffected by poor subsoil aeration) can be grown on flattish terrain for one or two years, alternating with two or three years of pasture. Most soils are not well suited to traditional milpa farming, nor to mechanized production of corn or beans.

4c. Toledo Swamps

These swamps are a series of large "ponding" areas where the main rivers (Río Grande, Moho and Temash) discharge surplus water during times of high flood. Much of the topsoil consists of fresh alluvial materials, and the general nutrient content of the soils is fairly high. Limited agriculture is possible around the edges of ponding areas (mainly rice production), but the twin problems of seasonal inundation and the subsequent disposal of surface water cannot be easily overcome.

4d. Toledo Coastal Strip

Between Deep River and Sarstoon River in southern Toledo there is a narrow coastal plain representing an ancient foreshore of dunes and coastal swamps that has been uplifted in probably recent geological time and is being cut back slowly by sea waves. Here is found the only part of the Belizean shoreline with low, but well-defined coastal cliffs. The sandy clays to loamy clay soils are used for coconut and pineapple plantations, as well as milpa production of cassava and other less-demanding subsistence crops. The nutrient supply in these soils is somewhat low under natural forests and decreases steadily under milpa farming. With regular fertilizer applications and improved subsoil drainage, these soils could be used for permanent tree crops such as cashew, citrus, guava and coconuts, possibly in combination with a productive leguminous cover crop like peanuts.

5. Calcareous Soils of the Northern Lowlands

With the sole exception of the ancient Mayan ceremonial center of Xunantunich, no part of this extensive landform exceeds 55 m above present mean sea level. The northern lowlands of Belize have close links geologically, pedologically and botanically with the Yucatan Peninisula. Northern Belize appears to have been a coastal shelf cut in limestones of Cretaceous and Oligocene age. The embayed area is bordered with slightly more elevated Oligocene limestones along the western flank and an abrupt wall of Cretaceous rocks to the south. Materials accumulated on this shelf include coral rubble and calcareous sand in the north, kaolinitic clay mixed with coral sand forming the beds of marl so common in the center, coral sand and marl (enriched with silica in the form of quartz sand and silica gels or soluble silica) producing the silicified limestone beds of the eastern and part of the southern area of the shelf. Different kinds of soil have been formed by solution or weathering of each of these varied marine and delta deposits on the limestone shelf, in addition to soils formed

directly by solution of the basal shelf rock. The resulting soil pattern is quite complex.

Concurrent with the formation of soils (during regression of the sea, or more likely, a slight uplift of the whole coastal area), colluvial and alluvial deposition filled in some of the slight depressions in the plain, giving a further sequence of alluvial and gleyed colluvial soils. Karstic features are not common in this landform. Repeated solution and recrystallization has produced a non-porous surface layer.

Despite low elevation and preponderance of flat land in this principal landform, the heterogeneous sediments permit differentiation of nine subunits. These subunits differ in potential land use and in the emerging farming patterns.

5a. Soils Derived from Coral Rubble, Coralline Limestones and Beach Sands and Gravels

These soils occur in the northernmost part of the country where marine sedimentary influences were strongest. Generally, the soils are well-drained and moderately fertile, but deficient in phosphorus and potassium. Many of the soils in this subunit are too shallow and stony for mechanized farming of arable crops, which would also require irrigation during the lengthy dry season. Most soils are well suited to deep-rooted fruit trees (e.g., lime, mango, avocado) and sugar cane, as well as milpa production of corn, sorghum and beans. Pasture is not a recommended land use.

5b. Soils Similar to 5a but Containing Some Volcanic Ash Minerals

These soils in the Shipstern Lagoon region have a high proportion of andesitic volcanic ash drifted in by sea currents from some distant source. The soils are shallow, stony or gravelly, brown to reddish-brown friable clays over hard limestone. Available phosphorus is exceedingly low; milpa yields are also low. While largely unsuited for pasture and deeply rooted trees, these soils are locally suited to papaya, pineapple, sugar cane and peanut crops. With irrigation, many vegetables could also be grown.

5c. Soils Derived from Hard Miocene Limestone

This subunit occurs patchily throughout the northern plains; and is more extensive in northern Cayo district. The soils derived from partially cemented limestone conglomerates are mainly dull brown plastic clays, fairly deep and well-drained. They are of moderate to high fertility and usually do not dry out severely during the dry season. These soils are well-suited for agriculture ranging from milpa farming to mechanized cultivation of grain crops, beans and sugar cane.

5d. Soils Similar to 5c but Containing Some Volcanic Ash Minerals

These soils are mainly reddish-brown, moderately plastic clays of moderate depth and fertility. Low availability of phosphorus makes them unsuitable for milpa agriculture; however, balanced fertilization permits mechanized production of corn, beans, peanuts and pineapples. They are also well-suited for improved pastures in areas with adequate supplies of water for livestock.

5e. Soils Derived from Soft Siliceous Limestone

These soils are mainly dark brown, deep, sandy clays with a friable topsoil over a somewhat plastic and slow-draining subsoil, hence moisture retention is quite good through the dry season. The moderately fertile soils are well-suited to mechanized growing of sugar cane, pasture, corn, beans, peanuts and tobacco, plus irrigated plantains. A grass fallow period is advisable in an intensive cropping program. They also stand up well under milpa agriculture.

5f. Soils Derived from Calcareous Marl and Gravel

Tertiary limestone soils form the western flank of the northern plain. The gray-brown, somewhat plastic clays are of moderate depth and frequently gravelly on higher ground. Soils tend to dry out during the dry season, and surface water is very scarce. Thus, this subunit has negligible potential for agriculture, including pastoral farming.

5g. Soils Derived from Hard Siliceous Limestone with Flints

Soils are mainly deep, but subsoil drainage is notably slow, causing frequent but brief flooding of flat areas. Gray-brown sandy clay loams comprise most topsoils, over somewhat compact and plastic sandy clay subsoil. Soil fertility is rather low, but there is nevertheless some milpa farming. Improvement in subsoil drainage would make these soils suitable for improved pastures; dry season irrigation, much improved drainage and fertilization would be necessary for mechanized growing of corn, beans, peanuts and other annual crops.

5h. Soils Derived from Hard Cretaceous Limestone and Shattered Limestone

These deep, fairly well-drained soils are dark gray to black, very plastic montmorillonitic clays of relatively high natural fertility. Soils on slopes of moderate relief are well-suited for permanent tree crops such as cacao. Flatter land is suitable for tree crops and pasture.

5j. Soils Derived from Alluvium and Colluvium Overlying Marl or Hard Limestone

The soils are dark gray clays or sandy clays with strongly mottled subsoil. Though soil fertility is moderately high, they are flooded through much of the rainy season. Costly diking and drainage would be required to put these soils into rice production.

6. Siliceous Soils of the Lowland Pine Ridge

The major landform where these soils occur is a lowland plain built up by continuing accumulation of mainly siliceous alluvium often on top of the calcareous coastal shelf. The source of the alluvial material is the acid rocks of the Maya Mountains and upland pine ridge plateau (major landforms 1 & 2). Accumulative processes on the lowlands appear to have been active throughout the Quaternary period, and in many places more than 25 m of alluvium is present over the limestone. In the early stages the transported materials appear to have been deposited in shallow water, and remnant surfaces visible at high points of the present plain suggest that there was sporadic ingression of the sea and some redistribution of the weathered materials.

Because accumulation of alluvium has been going on for a long time, the soils in different localities on the plain show an age sequence. The youngest soils where accumulation of fresh alluvium is still active have the highest fertility. At the other end of the scale, long-continued soil processes of leaching and clay translocation have produced very acid, strongly leached soils notably deficient in nutrients and with a very compact clay pan that greatly restricts the percolation of water through the subsoil. With the passage of time, soil processes have converted the siliceous parent material into soils that are almost pure quartz sand on top of very compact kaolinitic clay (Lietzke and Whiteside 1981). During heavy rains all soil material above the clay pan is flooded and the quartz grains flow (like quicksand) downslope; in the dry season, the whole soil dries out and the clay pan bakes to a brick-like consistency. Few plant species can tolerate such ecological extremes.

Although pine savanna covers only 42% of this major landform, it characterizes the landscape, thus this unit is designated Lowland Pine Ridge. Two subunits are differentiated on the basis of the thickness of the alluvial mantle over the underlying limestone.

6a. Siliceous Soils Without Outcropping Limestone

The majority of soils in this flat subunit are of low or very low nutrient status. The only fertile and moderately fertile soils (13% of subunit) are adjacent to the main river systems, e.g., soils of the Monkey River series account for most of the export banana production in Belize. Apart from a little citrus growing and cattle grazing on the natural grassland, there is no permanent agriculture established on the rest of the soils in this subunit. Because of low natural fertility, they are only rarely used for milpa agriculture. With modest improvement to drainage, the less leached and less illuviated soils can be used for citrus and other tree crops, provided they are regularly supplied with fertilizers, but are proving unsuitable for banana production. They are also suited for pasture. The most strongly leached and illuviated soils require considerable technical and financial aid: They are mainly being used by the Forest Department for reforestation projects.

Most of the latter soils belong to the extensive Puletan soil series (168,729 ha), which are still covered with natural pine forest/grassland savanna vegetation. Some of this area is in extensive pasture, but no permanent agricultural use has been found for this soil, other than one communal mango orchard. Some expensive attempts have been made to use the Puletan soils for vegetable production and fattening cattle on improved pastures, but none has lasted more than a few years. Most fertilizer was lost by vertical or lateral leaching, and the compacted subsoil reconstituted itself almost as fast as the machines broke it up. The Puletan soils are unquestionably problem soils with no possibilities for traditional agriculture. However, they may be suited to shrimp or fish production from artificial ponds, such as the Sennis River and Silver Creek projects.

One feature of this lowland landform is the slow movement of rainwater through and upon the soil along the gently inclined plain from the inland margin to the sea. Flooding of the landscape occurs whenever there is a prolonged period of heavy rain. This flow of "perched" water moves quartz sand grains from high points to low points, a process of solifluction (soil creep) that is slowly leveling the surface of the plain. Small terraces develop as the result of this process.

6b. Siliceous Soils With Outcropping Limestone

This subunit differs from 6a in that soil parent materials are: (i) siliceous sediments influenced by the presence of outcrops of hard limestone; (ii) siliceous sediments thinly deposited over either hard or soft calcareous materials; or (iii) an intimate mixture of quartz sand and calcareous marl. As a consequence, the soils are less acid and better supplied with exchangeable calcium and magnesium than the soils of 6a. The abundance of silica in the ancient geomorphological system is attested to by the common occurrence of flint and chert in these soils.

Soils of the Rockstone series are mainly sandy clay loams, easily worked but very low in available phosphorus and potassium. Rock outcrops and flinty patches make mechanized farming difficult. Peanuts, pineapples, limes and other citrus can be grown, but pasture is becoming more popular in areas with adequate water supplies. Felipe soils are of lower natural fertility and show some subsoil compaction; they are not used much by milperos, but cashew can be grown as a permanent tree crop. Tok soils

have a strongly leached sand topsoil that makes them worthless for milpa production. Pine forest regeneration is good on these soils.

7. Littoral Complex of Organic Soils and Soils from Dune Sands

Though of practically no agricultural importance, the littoral landform occurs along almost the whole length of the mainland coast (ranging in width from a few meters to a maximum of about 1.5 km) and on most of the offshore cays. This landform is a complex of dry land and swampy land, with parts of the latter occurring in the intertidal zone. The soils of both the well-drained sandy areas and adjacent swamps are of comparatively recent origin.

The soils of convex micro-relief are usually derived from coral sand or coral rubble. On some cays these two materials are mixed with quartz sand and sometimes with flinty pebbles. The soils are deep and well-drained, but locally underlain (at 1 m) by cemented calcareous rock ("reef rock"). Where quartz sand is absent the soils are of moderate fertility. Coconuts grow well on these soils. From the old soil maps it is calculated that about 33% of this landform consists of sandy soils, with the remainder peaty swamp and muck soils.

Soils of concave or flat micro-relief have a permanently high water table that may be saline or brackish. The higher (and older) soils are often moderately deep, resting on hard limestone or blue, anaerobic clay. Many mangrove peats on the cays are shallow soils over reef rock. Little agricultural use can be made of these soils; it is exceedingly important that they should NOT be used. They serve as the only breeding grounds for many organisms that are vital to the biological stability of the region.

IV–E. LAND USE

Historical Perspective

The agricultural record in Belize extends back more than 1000 years B.C. The milpa farmers (milpa is a small field fallowed after seasonal crops of corn or beans), who were the backbone of ancient Mayan civilizations, concentrated their agriculture on limestone soils of the rolling and hilly landscapes. When necessary, they supplemented traditional milpa production by more intensive systems of land use such as terracing of foothill slopes and constructing raised beds in valley bottoms where soil fertility could be enhanced by trapping alluvial deposits and adding organic supplements. All evidence suggests that the ancient Maya displayed considerable sophistication in using local soil resources.

Most Maya agricultural activities required cooperation and the conscientious application of existing technology. For the ancient Maya, agriculture was (like most of their other activities) a carefully orchestrated duty, planned months in advance and carried out under expert supervision. It is not surprising that when the ancient Maya no longer felt a duty to maintain permanent chronological records through construction of ceremonial centers (sometime before 1000 A.D.), communal agricultural activities likewise lapsed and the burden of food production returned to the simple level of individual and family milpas.

From the records of the earliest Spanish invaders it is clear that there were comparatively few Amerindian inhabitants in this part of Central America. Early inhabitants are reported as occurring in scattered, small family groups, often as far as 30-50 km apart. They subsisted on a limited range of food crops grown by "primitive" methods, and showed a marked aversion to leaving their village area for amalgamation into larger, more permanent settlements. This diffuse pattern of land use persisted during the ensuing 300 years; the only notable change being the steady decline in numbers of Amerindian inhabitants around the Bay of Honduras and adjacent foothills. In the 1600's, the Spanish systematically rounded up and deported the Manche Chol, native inhabitants of southern Belize (Thompson, 1972). To what extent this diminution in land use was caused by introduced diseases, to Spanish disruption of traditional village life, or to raiders seeking labor for Caribbean sugar plantations, the general result was a migration into the interior away from the coast. By 1900 the number of Amerindian milpa farmers left in Toledo district was reduced to the inhabitants of half a dozen small interior villages.

Meanwhile, from about 1700, non-Amerindian immigrants settled along the Caribbean coast in increasing numbers. They adapted some Amerindian milpa farming techniques and replaced what had once been a highly organized system of milpa farming with a method described as slash-and-burn. Patches of fertile soil around coastal settlements, inland along some of the major river systems, and in the vicinity of semi-permanent logging camps, were used to grow essential food crops; but a large part of the food consumed in the British colony came from overseas in the ships returning for more forest products. This led to the rise of a potent group of importing firms whose business soon became so profitable that they campaigned actively and openly to discourage local agriculture. It was not until about 1870, during a period when the importing elite were suffering from a sharp decline in both incoming and outgoing trade, that serious attempts were made to promote agricultural settlements in selected rural areas. Concurrent with this decline in trade, agriculture was being practiced in the districts of Corozal and Orange Walk, stimulated by refugees from the Yucatecan Caste War. Agricultural production in Belize began only a little more than 100 years ago, almost 200 years behind Caribbean and Central American neighbors.

Almost all early settlement schemes and land development projects failed within a few years; consequently, it took another 50 years to bring about effective agricultural

development in Belize. As a result, most soil resources of Belize have not been seriously degraded. The ancient Maya did little irreparable damage to their environment and the brief scratchings of immigrant colonists that followed caused only ephemeral damage. Of all tropical countries, Belize may have the least depleted soil resources. The challenge is to maintain this positive situation while building intelligently an economy based on agricultural, forestry and fisheries production.

Small family farms, with mixed subsistence and cash-crop production based essentially on slash-and-burn operations, are still common throughout Belize. However, areas of more permanent agriculture are being developed: sugar cane and pasture in the north; mechanized production of beans and small grains in the west; cacao and citrus in the eastern central sector; and rice production in the south. The potential of Belizean soil resources is beginning to be tested, and thousands of hectares of potentially useful agricultural soils await development. This contrasts with other Central American countries whose lands are near saturation with burgeoning human populations. As a result Belize has been a focal point for immigrants and refugees. If not guided and controlled carefully, this wave of land-hungry immigrants (usually lacking in finances and equipment, and coming from a background of lengthy struggle against depleted soil conditions) may initiate undesirable farming practices that will lead to accelerated soil degradation. Until recently, erosion was not a serious problem on the agricultural soils of Belize, but erosion is clearly evident in some foothill regions subjected to slash-and-burn agriculture.

Actual and Potential Land Use

Although only about 2% of Belizean land is currently used for agriculture, the potential for agricultural development is not unlimited. Many soils have moderate to severe limitations (Table IV-5) for modern agriculture. Of the total of about 15,000 km^2 of potentially mechanizable soils, serious limitations include drainage (30%), shallowness or rocky (5%), inherent low fertility (20%) and lack of moisture in the dry season (15%). That leaves about 4,500 km^2 (19% of Belize's land) capable of mechanized agriculture without large financial and technological investments.

Actual and potential land use are considered according to the classification of major landforms in Chapter IV-D. By "potential land use" is meant the maximum sustainable use of the land without causing serious degradation of soil resources (fertility, structure, erosion, etc.) or other deleterious environmental effects.

1. Siliceous Soils of the Mountain Pine Ridge

There is no archaeological or historic evidence of permanent settlements in the Mountain Pine Ridge. The ancient Maya had several east-west trails crossing the uplands, but totally avoided this area for milpa agriculture and settlement. Some recent uses include extensive grazing, but the grasses are extremely low in nutritional quality. The existence of extensive natural pine forests, relatively effective fire control measures, and a substantial access road system clearly indicate that production forestry is the most appropriate land use in the Mountain Pine Ridge.

2. Siliceous Soils of the Maya Mountains

As with the Mountain Pine Ridge there is little evidence of previous agricultural use of this area. The soils are totally unsuited to milpa agriculture, although a few citrus orchards and pastures exist in Stann Creek district. The most recent land use is illegal marijuana cultivation on small patches of alluvium and colluvium on the remote eastern periphery of this landform. Some of the soils could be used for cacao orchards, but most of this landform should be in protection forest. Any thoughts of permitting or promoting slash-and-burn agriculture in this landform should be quickly and categorically rejected. The soils are too infertile and highly erodible.

3. Calcareous Soils of Karst Landscapes

The archaeological record of human use of this landform goes back at least 4,000 years. Where permanent water was available, these lands were preferred by the ancient Maya for permanent settlement, marked by centers surrounded by a zone of terracing and permanent farming. These soils are well suited to milpa production of corn. Milpa farming is still the dominant agricultural practice in this landform, with fallow periods ranging from 5 to 15 years. Two major changes are now occurring. The traditional inhabitants are facing pressure from immigrant farmers seeking land that local Amerindians regard as territory held in reserve for their own future milpa requirements. They are also under some pressure from mechanized farming operations and cattle-ranching activities. However, much of this landform lacks permanent water for livestock and is too rocky for mechanized farming, with the result that the key to increasing real agricultural production in this landform must lie in permanent tree crops, especially on the rolling and hilly terrain.

4. Toledo Lowlands of Tertiary Sediments

The ancient Maya certainly used part of this landform for agriculture, though ceremonial centers were located in the adjoining limestone areas. Modern Amerindians have been farming this area for at least 50 years, and most of the better soils are still used for milpa farming. However, the flatter, less-fertile land is now used (mainly by non-Amerindians) for pasture and mechanized rice production. Marijuana-growing transcends cultural differences throughout this landform. With regard to milpa farmers, this landform may be nearing maximum human carrying capa-

city, as an increasing area of the land is starting to show signs of degradation. The Amerindians use this as an argument to persuade the GOB to open the periphery of the Forest Reserve (e.g., 5000 ha in Columbia River FR) to milpa farmers.

5. Calcareous Soils of the Northern Lowlands

The ancient Maya found many soils in this landform suitable to milpa agriculture; where seasonal flooding was a problem they developed a "flood-warping" technique using raised beds and a system of low dikes. The Mennonites have pioneered intensive, modern agriculture in both the northern and southern parts of this landform and some areas are actively being converted to extensive pastures for beef cattle. The complex nature of soils and water resources in this landform indicates that agriculture should develop through an intricate mixture of permanent tree crops and local centers with mechanized agriculture, rather than by large agribusiness ventures based on a single arable crop. Ideally, it is a place for agroforestry development.

6. Siliceous Soils of the Lowland Pine Ridge

Except for the alluvial terraces of major rivers (Willey and Bullard 1965), the ancient Maya did not farm this landform. Small permanent agricultural settlements have come into existence on soils with above-average fertility. Modern efforts include the establishment of farms for the production of rice, mangoes, vegetables, and fish-pond products, but most have failed due to intractable soil and water problems. Despite extensive native pine forests and the existence of systems for fire control, timber production is scarcely economic on the dominant Puletan soils. There have been many attempts to improve the natural pastures on the Puletan soils by use of fertilizers but these have had only limited success because the low fertility is due as much to adverse physical conditions as to chemical depletion.

Recommendation

The landmark study by Wright et al. (1959) includes a map of potential land-use. While this 30 year-old study provides a general framework for agricultural and forestry considerations, it is not of sufficient detail for present-day development planning, ranging from agribusiness to watershed protection. A new definitive study (preferably at 1:50,000 scale) of land-use capability is critical to development of the lands of Belize.

This classification should not only determine land-use capability by major landforms and life zones, but also include technological assessment of uses of land as well. For example, the Toledo foothills produce acceptable maize yields under milpa agriculture, but are unsuited to annual mechanized corn farming.

A land-use capability classification of the Maya Mountains complex could be used to resolve the increasing conflicts and pressures for land. The area urgently needs clarification and delineation of protection forests, wildlife reserves, production forests, national parks, and areas suited to traditional Amerindian agriculture or modern agriculture. Information on land use classification must be integrated with the development process. Ministries responsible for development, natural resources, demography and culture should all share in land use planning, as well as regulation of land use.

IV–F. AGRICULTURE

Agriculture (including forestry and fisheries) is the largest contributor to the national economy--employing one-third of the work force and accounting for about half of the GDP. Agricultural production is organized either for domestic or export markets (Table IV-6). Items produced for the domestic market include corn, rice, red kidney beans, cattle, pigs, poultry, eggs, vegetables, and small amounts of avocado, breadfruit and other fruits. Export commodities are sugar, citrus, bananas and to a much smaller extent, mangoes, rice and honey (Fig. IV-13).

Farm size ranges from small, scattered milpa plots organized basically for subsistence, to large holdings characterized by absentee landlords. Small subsistence plots are operated by milperos (Mayan and Kekchí Indians), primarily in Toledo district. The Indians rotate their milpas through a fallow period of 5-15 years. While milpa production may be high on a per hectare basis, these plots are usually in areas lacking roads, distribution points, or even commercial markets. Milpa farmers contribute over 50% of the rice produced for the local market.

Farm Size and Status

The Belizean milpa farmer (Fig. IV-14), usually Amerindian, leases his plot of land from the GOB or private landholders. He plants and harvests crops of corn, beans and rice while the soil shows good results. When the crop production decreases, he must find another plot that looks promising. The milpero's uniqueness is their relationship with the land, tailoring the milpa size to needs and ability to farm. Milperos are not resistant to improved agricultural practices, but they are hesitant to accept financial risks. Techniques that require special skills, fertilizers, pesticides or credit are not readily accepted. Marketing skills are lacking. Drying and storage facilities are crucial to the development of the economics of milpa farmers.

Small farmers (as distinct from milpa farmers) use permanent fields to produce much of the food for national consumption, as well as sugar cane (about 60%) and some citrus for export. Primarily located in Corozal, Orange Walk, and Stann Creek districts, small farmers (with holdings of 2-20 ha) comprise the largest single group within the agricultural sector.

Table IV-6. Agriculture statistics from 1982. The percent change from the 1981 statistic is in parentheses.

COMMODITY	AREA or INDIVIDUALS	NUMBER OF FARMERS	PRODUCTION (metric tons)	VALUE B$
Sugar cane	25,101 ha (+ 2%)	4,083	960,709 (+ 9%)	67,500,000 (-23%)*
Citrus	4,453 ha (ND)	360	69,132 (+ 7%)	14,100,000 (+ 8%)*
Rice	3,320 ha (-16%)	ND	7,955 (-27%)	9,790,000 (ND)
Maize	10,931 ha (-4%)	ND	21,364 (0)	8,460,000 (-25%)
Bananas	648 ha (+ 3%)	29	10,004 (-5%)	4,200,000 (-2%)*
Beans	2,834 ha (-7%)	ND	1,773 (+ 3%)	3,600,000 (-5%)
Honey	ca. 10,000 hives	495	200 (-7%)	340,000 (-32%)*
Cacao	486 ha (0)	1	17.7 (+ 329%)	72,000 (+ 300%)
Sorghum	1,660 ha (ND)	ND	ND	ND
Mangoes	405 ha (0)	1	ND	ND
Beef[1]	6,000 (-6%)	1,386	909 (-9%)	ND
Pork[1]	5,733 (+ 9%)	2,893	151 (-9%)	ND
Poultry[1]	1,788,800 (+ 17%)	ND	2,755 (+ 16%)	ND

[1]Does not include animals slaughtered for home use; an estimated 60% of pigs and 17% of chickens slaughtered are unrecorded.

ND = No Data

* Export value only. Does not include value of domestic sales.

Farms in the 20-200 ha range are owned and operated for the most part by Mennonites, who supply the domestic market with eggs, poultry, fresh milk, cheese and vegetables. Mennonite farmers are perhaps the most productive; they commonly pool resources to purchase equipment, machinery and supplies necessary for farm operation and maintenance. This utilizes capital resources and equipment efficiently and economically and most importantly reduces individual capital requirements while spreading risk.

Large landholdings–mostly corporate-owned–include about 60% of the country's productive agricultural land (Nuñes 1980). Most are owned by absentee landlords and many have not been brought into production. Some are held for speculative purposes and others are farmed marginally or occasionally rented to small farmers. The large farms produce sugar, citrus, bananas and mangoes, mainly for export.

Only 10-15% of land suitable for agriculture (see p. 81) is being utilized. Agriculture development is the top priority of the GOB, not only to increase production of export commodities, but to substitute local for imported food. Specific GOB projects include land acquisition for resettlement, improving credit access for small and medium sized farmers, development of access roads, establishing buying centers in areas of major production and projects to increase production of crops inadequate to meet local demand.

Constraints to Agricultural Development

Major constraints to agricultural development include lack of infrastructure, difficulty in obtaining credit and capital items for small and mid-sized farmers, and contemporary attitudes about farming. Infrastructural problems are severe. Many areas suitable for agriculture are not utilized because of inaccessibility, especially in the southern third of the country. The Southern Highway is a gravel road occasionally impassable because of flooding (see Fig. IV-12, p. 75). Lack of cold storage facilities and refrigerated transport cause much produce to spoil or lose quality before it reaches markets. The Belize Marketing Board (BMB) has had limited success and consistently requires GOB subsidies due to high spoilage rates, unsuccessful attempts to re-market produce and management and administrative problems (World Bank 1983).

Historically, it has been difficult for small farmers to secure loans because of small equity holdings and expensive equipment. The small GOB agricultural mechanization project attempts to provide machinery and maintenance on a cost or rental basis. Most available credit goes to

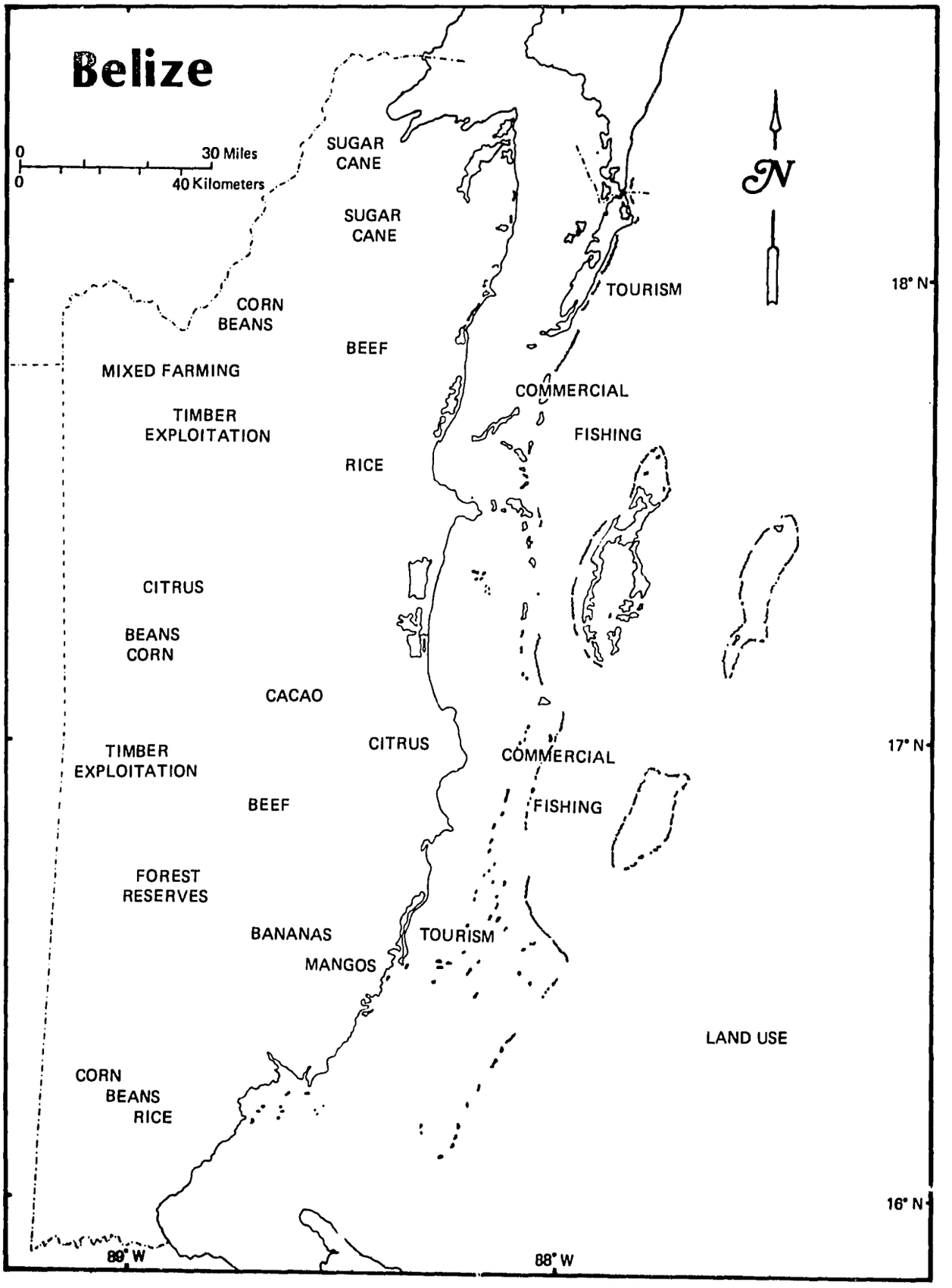


Figure IV–13. — Major land use in Belize.

larger-scale farms producing exports; sugar, bananas and citrus receive 75% of the agricultural credit.

Though the potential for agriculture in Belize is good, accelerated development will not take place without radical change. Infrastructure needs drastic improvement. Research and new crop management are needed. Large amounts of capital are required. Emphasis should be on export crops with high income elasticities.

Major Agricultural Crops

Sugar

Sugar is the largest contributor to the Belizean economy accounting for 59% of domestic exports and 20% of GNP. The two sugar refineries are owned and operated by Belize Sugar Industry (BSI), a subsidiary of Tate & Lyle of the U.K. Of 117,000 tons of 1982-83 sugar exports, 36% went to the European Economic Community (EEC). Production estimates for 1983-84 are only 106,000 tons (H. Fuller, pers. comm). Slightly more than half of the country's active cropland is devoted to sugar cane (Table IV-6), but 45% of these farmers have less than 2.4 ha each of sugar cane. Farmer's income is 65% of the net value of sugar sold; BSI receives the other 35%.

The Cane Farmers Association (CFA) and the Belize Sugar Board (BSB), a statutory body under the Ministry of Trade & Industry, offer extension services to farmers. BSI is involved in on-going research into variety selection, plant protection, testing against smut and rust, froghopper prevention, and intensive versus extensive cultivation. Improvements at Tower Hill, through the financial assistance of the CDC, have increased sugar cane capacity by about 5,000 tons (H. Fuller, pers. comm.). Tate and Lyle is discussing with the GOB the possibility of eventual control of BSI by Belizean interests (H. Fuller, pers. comm.).

Citrus

Citrus, second to sugar as an agricultural export earner, generates about 10% of exports. Most commercial production is in Stann Creek valley with some groves in Cayo district. Of some 360 citrus growers, 90% farm less than 8 ha, while the two processing companies own 36% of the groves. Two processing plants, one locally owned and one foreign, process fruit into orange and grapefruit

Figure IV–14. — Milpa with farmer's home garden and clearing. (photo G. Hartshorn)

concentrates. Currently the capacity of these two plants is sufficient to handle production, but if the industry is expanded, one plant would have to be modernized and storage capacity in the other increased.

Grapefruit (28% of the citrus groves) accounts for 40% of total citrus production. However, market prospects for grapefruit are not promising and replacing those groves with oranges will burden the group (older farmers with small groves) most in need of assistance.

The Citrus Growers Association is encouraging improved management to increase yields. Average fruit yields are 15-25 tons/ha (175-250 boxes per acre). The Commonwealth Development Corporation (CDC) has granted a loan of US$3.2 million for the rehabilitation of derelict citrus groves.

The major constraint to the industry is the never-ending dispute between growers and processors over prices to be paid for fruit. The dispute surfaces every season and a price has to be negotiated before harvesting commences. Fruit losses can be heavy during times of prolonged negotiation. Another constraint is shipping problems that plague all export oriented agro-industries in Belize.

Bananas

The banana industry in Belize is hindered by low production (Table IV-6), shortage of farm management talent, high shipping costs, and lack of credit available to the small farmer. The Banana Control Board (BCB), a statutory body, has taken over the majority of the leases of tenant farmers and now manages 90% of the plantations at Cowpen. Thus the banana industry is almost entirely subsidized by the GOB; BCB's operational losses were more than B$2 million in 1981-82. To ease this drain on GOB financial resources, lots will be sold to farmers currently employed by BCB who have demonstrated management capability, with BCB retaining control over export functions.

The GOB has estimated that a minimum of 1,600 ha should be in production to make the industry economically sound. Some expansion is underway with 50 ha at Bladen-Trio already established (partially financed by CDB), as well as other privately-financed plantations not yet in production. Two elements in favor of developing this industry are availability of land suited to banana cultivation (World Bank 1983) and a protected market in the U.K. Exports are made through Fyffes, a marketing subsidiary of United Fruit, which also provides technical assistance to BCB. Currently, exports are barged to Honduras and transshipped through Puerto Cortés. A constraint to expansion is the vulnerability of plantations to hurricane damage. Hurricanes Fifi (1974) and Greta (1978) caused heavy damage in the plantations at Cowpen.

Cacao

Although cacao is believed to be native to Belize, commercial production has been recently initiated by Hummingbird Hershey Ltd. (HHL) in the Sibun River valley. Plantations are being expanded using some 35 hybrids and local varieties. A GOB project (B$2 million through DFC) is underway to involve small farmers in cacao production, primarily in Toledo, Stann Creek and Cayo districts. The project is being coordinated by HHL, who supplies farmers with seedlings, technical assistance, and a market. Two to four hectares of cacao are recommended for a small farmer. Preliminary projections for 1990 are production of 10,000 tons of cacao beans grown by 600–1000 farmers, with Hershey producing 25%, large farmers 25% and small farmers 50% (N. Wade, pers. comm.).

USAID is also supporting expansion of cacao plantations through an "Accelerated Cacao Production" project to start in 1984 funded through an OPG to Pan American Development Foundation (PADF) and VITA (Volunteer International Technical Assistance).

Rice

Belize produces all the rice needed for domestic consumption, with about half the production from milpa farming. Until 1982 rice farming showed healthy growth with increases in area and yields due to mechanization (subsidized equipment leased from GOB) and improved varieties. In Toledo district –the principal growing area– 200 ha less were planted in 1982 after GOB removed subsidies for machinery rental. More significantly, rice cultivation at Big Falls Ranch Ltd., the country's largest single producer and only exporter, decreased from 1800 ha in 1981 to 1100 ha in 1982. Consequently, rice exports dropped from 1,200 tons in 1981 to only 136 tons a year later. Big Falls Ranch, Ltd. is in receivership and, unless its financial problems are resolved, the future of rice as an export commodity is uncertain.

A recent feasibility study by OPIC and a U.S. investor resulted in an offer to purchase Big Falls Ranch, an offer the GOB is seriously considering.

Cattle and Swine

Belize's suitability for livestock production has been studied in depth (e.g., AID loan No. 505–T–003) and the consensus is that development potential is high. In 1978 (the most recent cattle census) agricultural land in 1,386 cattle operations totaled about 100,000 ha, of which 45% was in pasture. About 76% of the total herd (48,747 head) was on 375 farms larger than 40 ha. Large cattle operations in Belize are animal-based, while small producers are mainly involved in crops with livestock as a complimentary activity.

The USAID project (US$3,250,000 of grants and loans over five years) is designed to address production inefficiencies, expand product markets and encourage the full participation of Belize's small and medium livestock producers. The project has six components: Swine improvement; pasture improvement; dairy industry development; improved veterinary laboratory services; pork and beef processing; and government policy analysis and formulation.

Pigs are traditionally a small-farmer enterprise involving small numbers of free-ranging hardy animals scavenging for food. A substantial proportion of the country's pork comes from milpa farmers in Toledo district. This USAID project has a specific subcomponent to bring improved breeds of pigs for pen-rearing in Toledo Indian communities.

Poor pasture management and insufficient forage in the dry season are major constraints to development of beef and dairy cattle programs. This USAID project will focus on improving existing pastures and management rather than encouraging expansion of cattle farms. With respect to the nascent dairy industry, the USAID project will fund a market demand study and upgrade milk processing facilities of the Macal Cooperative.

USAID project assistance to pork and beef processing is oriented to substitution of about 1,000-1,500 tons of processed pork imported annually. USAID support for agriculture policy analysis and formulation will greatly increase the MNR's capability in these important areas.

Pests and Diseases Affecting Crops

The most important agricultural pests, by virtue of losses incurred or the effort expended to control them are: sugar cane froghopper *(Aeneolamia postica jugata);* Mexican fruitfly *(Anastepha ludens);* armyworm *(Spodoptera frugiperda);* earworm *(Heliothis zea);* weevil *(Sittophilus zeamais);* chinchbug *(Normidea pictiventris);* bean beetle *(Epilachna borealis);* and grain weevil *(Acanthoscelidus obtectus).* These pests are responsible for losses of at least 10% in the crops that were grown on 96% of the cultivated area, excluding pastures.

Effective control programs are available for commercial sugar cane and citrus pests. However, the level of control achieved by most small farmers is poor due to their lack of knowledge about pesticide use and timing of treatment. There is also a dearth of information on pest densities and losses in grain crops, a large portion of which are grown by Mennonite farmers. These farmers, however, obtain moderate control, particularly of grain pests. Other farmers obtain little control and sustain severe losses.

Fruit crops sustain diseases, namely premature fruit drop in citrus caused by the fungus *Colletotrichum gloesporoides,* black sigatoka in bananas caused by the fungus *Mycosphaerella fijiensis* var. *diformis,* and anthracnosis in mangoes.

Side effects from continuous use of some pesticides include the development of secondary pests and insect resistance. Though these have not been noted in Belize, documentation of either pest resistance or secondary pests would be difficult because no baseline data have been taken for the organisms, except for the froghopper. DDT is still used in small amounts to control mosquitos.

The herbicide paraquat is used in weed control in bananas and sugar cane in Belize. It is also used by drug enforcement personnel to eliminate illegal marijuana fields. However, paraquat use must be strictly controlled to prevent accidental exposure. Training in use should be provided, and toxic effects of the herbicide should be clearly defined.

Legislation is needed to regulate the importation, handling, storing and use of pesticides along the lines of the Health Department's *Antibiotic Ordinance* that regulates medicines. The monitoring of pesticide residues on food and in human tissues should be conducted and actions taken if the levels are considered high or dangerous. Alternative methods of pest control should be studied, and then actions should be encouraged that will integrate pest control with agricultural methods (see below).

Integrated Pest Control

Although the plan to allocate land to individual farmers and encourage them to develop orchards and permanent crops may be a sound agricultural development strategy, a shift away from milpa farming will create other problems requiring new policy and management decisions. One potential problem will be an increase in agricultural pests, especially in areas planted with monocultures. This tendency is illustrated by the increasing problems of pests and diseases in the sugar cane growing region of northern Belize and the citrus orchards of Stann Creek valley.

Efforts should be made to incorporate pest control technology with agricultural development. Experience has shown that an integrated approach to pest control is the most promising answer. By using a combination of biological, agronomic and chemical means to keep pest populations at levels that are not economically harmful, environmental hazards due to abuse of toxic chemicals and the resultant pest resistance to pesticides will be prevented. Successful implementation of this integrated pest control program depends on crop management planning as it involves intercropping, spacing and timing of crops.

Belize Institute of Agricultural Science (BIAS)

Belize does not have sufficient technical expertise and institutional capabilities to carry on the research and project monitoring necessary for the management of an integrated pest control program. However, the newly chartered BIAS, a research and development-oriented society

of Belizean agriculturalists, could develop the technical advisory capacity to supervise and coordinate such a program. It is especially important to Belize that community involvement of this type be stimulated and supported.

BIAS chose its acronym because it plans to be biased toward rational development and research in agriculture. Most farming problems affect small farmers; large farms have trained agricultural technicians to regulate fertility, pest and chemical control, and seeds/animal sources and quality. BIAS membership is limited to professionals in agronomy or agriculture-related fields.

Agricultural research in Belize is almost nonexistent. Except for crop management in the monocultures for export, little research is conducted to improve production for the domestic market. The Belize School of Agriculture at Central Farm should be the fundamental training institute in Belize, but it falls short on expertise, financial aid and guidelines to help the agriculture sector.

The GOB, while directing the country to produce its own food and reduce imports, does not have guidelines to direct the farmers who should supply the domestic market on an annual basis. Especially important is the capital and research for farmers to dry and store their crops. Cottage industries for the small farmer and his family are natural complements to areas where all-year production is impossible. Though BIAS is just beginning to address these and other problems facing farmers, the organization will need outside expertise to formulate reasonable solutions, bolster their organization, and attract the Belizean talent that is typically drawn away from home. BIAS will also need financial aid to carry out research projects.

V–G. FORESTS AND FORESTRY

Flora

Belize is estimated to have roughly 4,000 species of native flowering plants (Angiosperms) of which 2,500 are dicots (Dwyer and Spellman 1981) and 1,500 are monocots (Spellman et al. 1975). The latter include approximately 250 species of orchids (B. Adams, pers. comm.). Approximately 700 species of native trees (Appendix F) are reported for Belize, representing 331 genera in 87 plant families.

The Belize flora are most closely allied to the Yucatan Peninsula, where Standley (1930) suggests 17% of the regional flora consist of endemic species. The absence of high mountains and natural barriers makes it unlikely that Belize has many endemic species (those species known to occur only within the country). Nevertheless, the presence of two tropical life zones (see p. 91) in this subtropical region and Belize's proximity to western Caribbean islands provide some floristic surprises. The Cyrillaceae genus *Purdiaea (= Schizocardia)* has ten species in Cuba, one in Colombia and one in Belize *(P. belizensis). Cameraria latifolia* (Apocynaceae) is the only one of four species in the genus to occur outside the West Indies. Standley and Record (1936) report a Belize collection of *Christiana africana* (Tiliaceae), otherwise known only from the Guianas, Brazil and west Africa.

No systematic treatment of the Belize flora has been completed or is in progress. The existing literature merely lists species known from collections in major herbaria (Bartlett 1935; Standley and Record 1936; Lundell 1940; Spellman et al. 1975; Dwyer and Spellman 1981). The multi-volume Flora of Guatemala (Field Museum of Natural History, Chicago) includes Belize in its geographic coverage, hence it is the most useful floristic reference. B. Adams (pers. comm.) is preparing a book on the orchids of Belize.

Historical Perspective

Belize is unique in tropical America in that the country's geopolitical identity is directly related to its forest resources. Settlement of Belize in the mid-Seventeenth Century was for cutting logwood (*Haematoxylon campechianum*, Caesalpiniaceae). Although exploitation of logwood for dye continued until early in this century, by the mid-1700's mahogany *(Swietenia macrophylla*, Meliaceae) superseded logwood as Belize's principal export. The dominance of mahogany exploitation was the principal justification for the British colonial presence in Belize. For nearly three centuries the local economy depended on exported logs and imported food.

Despite the widespread use of limestone soils by the Maya more than a millennium ago and the more recent selective logging of logwood and mahogany (Fig. IV-15), Belize has extensive forests. The large-scale abandonment of farms associated with the decline of the Maya civilization permitted forest regeneration that has attained what plant ecologists consider to be "climax" status. Nevertheless, a distinctive vegetation association is still recognizable around Maya ruins (Lambert and Arnason 1978). Centuries of selective logging for large trees of only a few species had minimal effect on forest structure and composition. Only in areas of traditional slash-and-burn agriculture (southern Toledo and western Cayo districts) and the northern sugar cane region has the country suffered significant deforestation.

Before describing the major types of forest, some explanation of local terminology is necessary for the reader unfamiliar with Belize. Forest is usually called "bush" with modifiers such as high, medium or low. More idiosyncratic is the use of "ridge" to mean a strip of well-developed forest with a continuous canopy. "Broken ridge" is a more open forest, whereas "cohune ridge" is forest dominated by *Orbignya cohune* (Palmae). The use of "ridge" to describe forest types has no relation with topography; for example, "pine ridge" also occurs on the flat coastal plain.

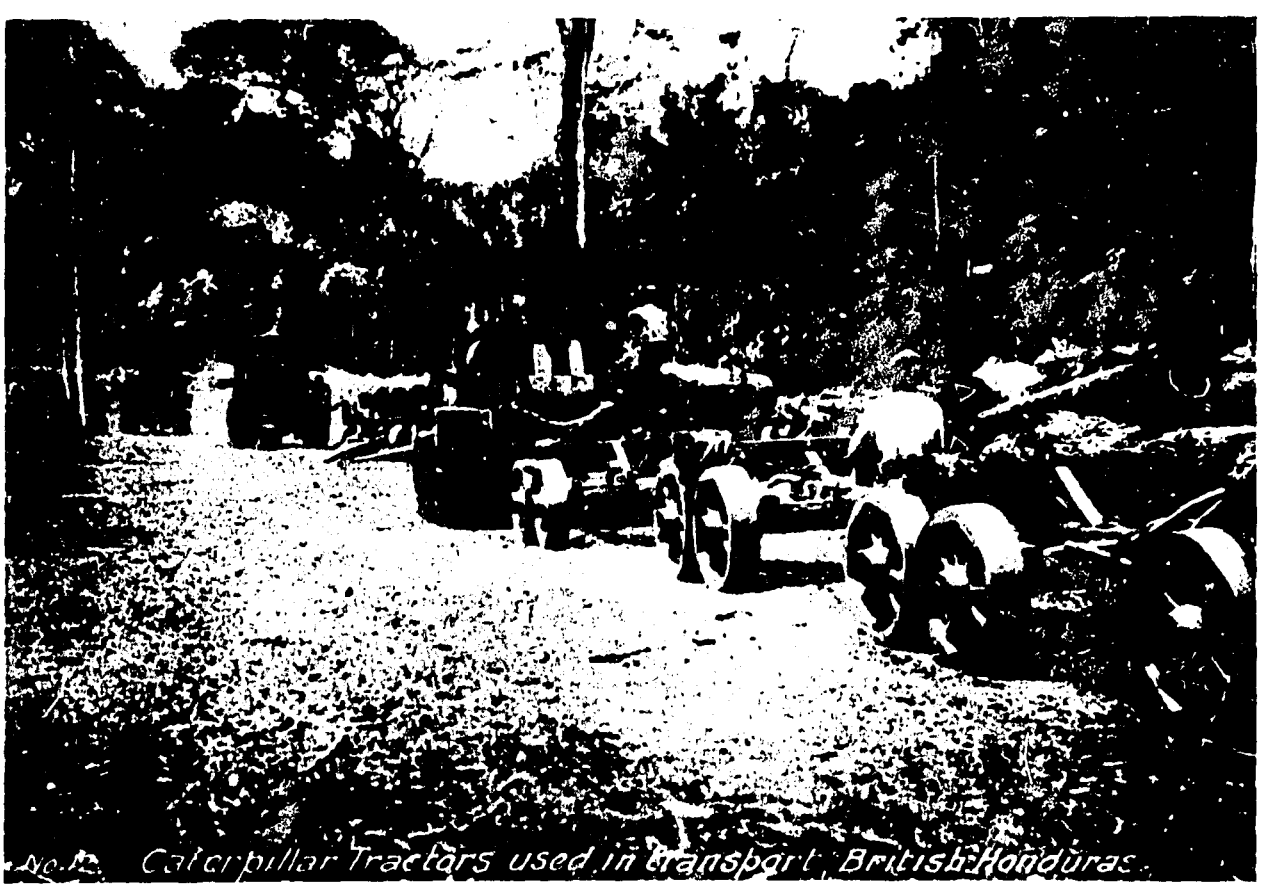


Figure IV–15.—Mahogany loggers in British Honduras (possibly in the 1930's; from postcards of J. Waight collection)

The older literature describing forest types in Belize generally uses the Spanish terminology that adds the suffix "al" to the local name of a common or characteristic species. Some examples are "caobal" with an abundance of mahogany, "tintal" is a grove of logwood trees and "ramonal" is dominated by breadnut trees (*Brosimum alicastrum*, Moraceae).

Ecological Life Zones

The early descriptions of forest types of Belize lack a theoretical framework to facilitate comparisons between types or to understand Belize's forests in a regional context. In their definitive study of the country's land, Wright et al. (1959) attempt to provide the theoretical underpinning for their vegetation descriptions by using the Holdridge Life Zone System (Holdridge 1947). Unfortunately, the Wright et al. (1959, Fig. VIII) map of environmental zones preceded the differentiation of tropical and subtropical latitudinal regions (Holdridge 1967) and is based on erroneous extrapolations of rainfall data (Walker 1973).

During preparation of the forestry sector report for this CEP, an effort was made to revise the life zone map of Belize. Because of severely limited time in the field, the life zone boundaries shown on the revised map (Fig. IV-16) should be considered as first approximations. Nevertheless, correct terminology is used and valid ecological comparisons can be made. The following descriptions are based on the six major ecological life zones of Belize; minor transitions have not been mapped. Reference is made to the substantial literature published on Belizean forests, but the descriptions are not repeated here. Bartlett (1935), Beard (1944, 1955), Burdon (1932), Hummel (1925), Lundell (1945), Standley and Record (1936), D. Stevenson (1928), N. Stevenson (1942, 1945) and Wright et al. (1959) offer good descriptions of the principal forest types of Belize.

Subtropical Moist Forest Life Zone

Covering the northern lowlands of Belize, this life zone extends south along the lower, western part of Mountain Pine Ridge, far up the Macal River valley and onto the Vaca Plateau. Average annual rainfall is between 1300 and 2000 mm. This life zone covers all of major landform N° 5 and parts of N°s 3 and 6 (see Chapter IV-D). Inclusion of pine forest and heterogeneous broadleaved forest in the same life zone may seem incongruous, but these disparate forest types are edaphic associations that are recognized in the hierarchical Life Zone System.

The ***Subtropical moist forests*** of northern and western Belize are similar to the vast broadleaved forests covering Guatemala's northern Petén (Holdridge et al. 1950) and much of Mexico's Yucatán peninsula (Pennington and Sarukhán 1968). These forests are variously described as deciduous seasonal forest (Beard 1944), medium-high semi-deciduous forest (Pennington and Sarukhán 1968), and broadleaf forest rich in lime-loving species (Wright et al. 1959). The latter differentiate 14 associations within the broadleaved forest of this life zone.

Characteristic tree species of ***Subtropical moist forest*** include *Swietenia macrophylla* (mahogany, caoba), *Manilkara zapota* (sapote, sapodilla), *Brosimum alicastrum* (breadnut, ramón), *Pouteria izabalensis* (silly young, silión), *Pimenta dioica* (allspice), *Manilkara chicle* (chiquibul, chicle), *Drypetes brownii* (bullhoof), *Pseudolmedia spuria* (cherry), *Dialium guianense* (iron wood), *Calophyllum brasiliense* (santa maría), *Orbignya cohune* (cohune, corozo) and *Terminalia amazonia* (nargusta).

Two major areas of *Pinus caribaea* are mapped as ***Subtropical moist forest*** Life Zone: the extensive pine savanna north of the Western Highway and the lower, western part of the Mountain Pine Ridge. The latter has been inventoried (Johnson and Chaffey 1973) and has been the location of considerable ecological research by Martin Kellman and colleagues (Kellman 1976; 1979; Kellman and Hudson 1982; Kellman and Miyanishi 1982). Particularly noteworthy is Kellman's finding that some broadleaved tree species accumulate nutrients in the infertile soil of the pine savanna. These enriched patches may facilitate invasion of the open pine by other broadleaved species typical of more fertile soils.

Subtropical Lower Montane Moist Forest Life Zone

In the Mountain Pine Ridge at 650-700 m elevation there is a noticeable floristic change from the basal ***Subtropical*** belt to the altitudinal ***Lower Montane*** belt. Some *Quercus* spp. (oak), *Pinus oocarpa* (pine) and *Podocarpus guatemalensis* (cypress) are representative of this altitudinal belt. ***Subtropical Lower Montane moist forest*** appears to occur on the higher parts of the Vaca Plateau, as well as along the upper western slopes of the Maya Mountains. This life zone may be due to a modest rain-shadow effect south of the Mountain Pine Ridge and west of the Maya Mountains crest.

Subtropical Lower Montane Wet Forest Life Zone

The windward ranges of the Mountain Pine Ridge and the Maya Mountains are appreciably wetter (>2000 mm of average annual rainfall) than the preceding life zone. Mountain Pine Ridge high points such as Cooma Cairn, Baldy Beacon and Baldy Sibun are ***Subtropical Lower Montane wet forest*** with *Pinus oocarpa*. In the upper Maya Mountains, *Euterpe macrospadix* (mountain cabbage palm) and the tree ferns *Alsophila mysuroides* and *Hemitelia multiflora* are characteristic of this wet life zone.

Subtropical Wet Forest Life Zone

This life zone occurs below about 600 m on the windward side of the Maya Mountains. Average annual rainfall is

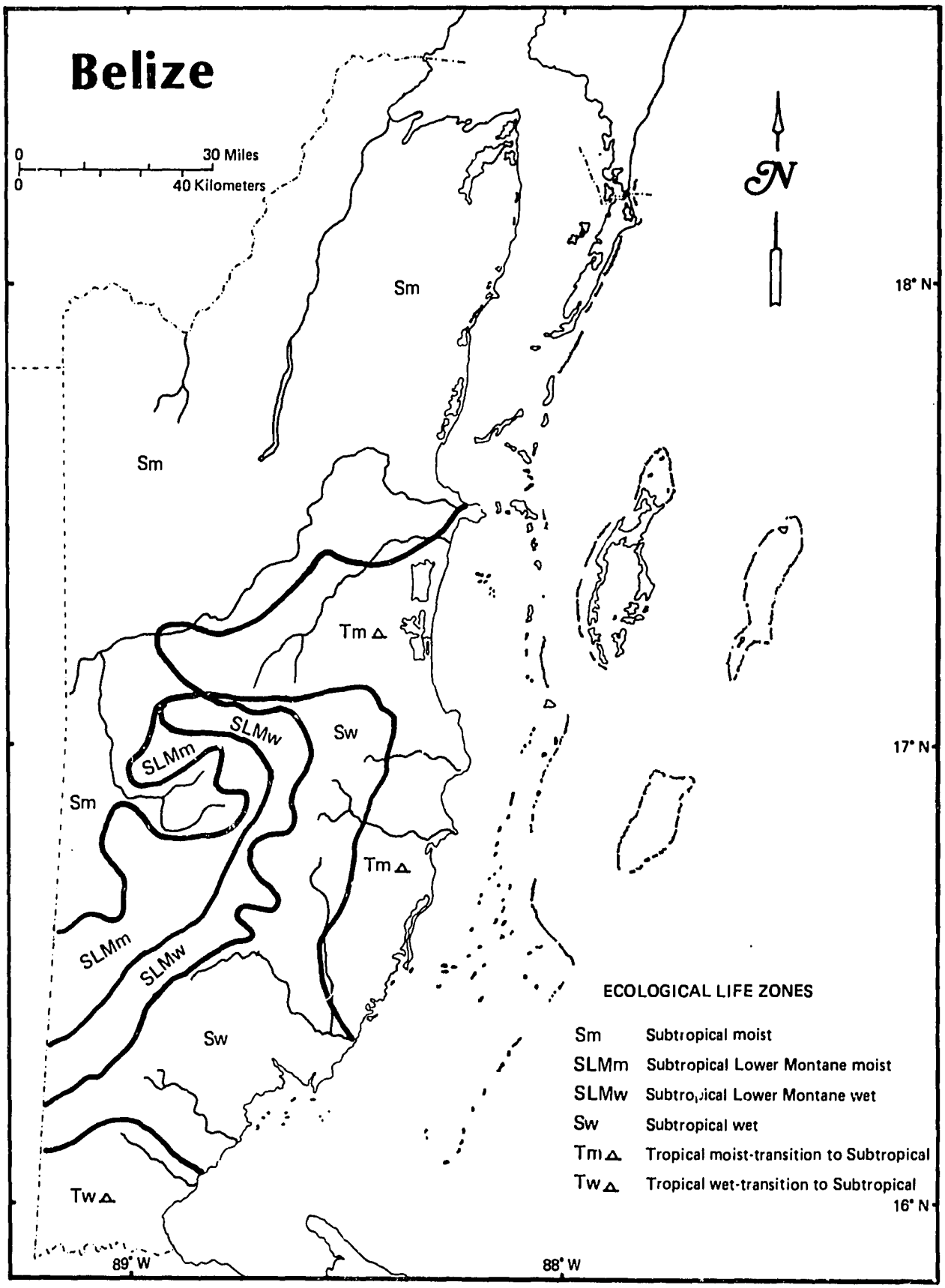


Figure IV–16.— Ecological Life Zones of Belize. These areas are determined on the basis of latitudinal region, altitudinal belt, humidity, evapotranspiration, and precipitation. On the ground the life zones can be recognized by the type of natural vegetation that occurs there. (G. Hartshorn unpubl. data)

Figure IV–17.— Broadleaved forest of the Subtropical wet forest life zone, north of Punta Gorda. (photo G. Hartshorn)

between 2500 and 4000 mm. Upper Stann Creek valley, the Cockscomb Basin and much of Toledo district are in this life zone that extends to the coast (Fig. IV-17) between Monkey River Town and Punta Gorda. Some characteristic tree species in this life zone include *Virola koschnyi* (banak), *Symphonia globulifera* (waika swivelstick), *Schizolobium parahybum* (quamwood), *Vochysia hondurensis* (yemeri), *Simarouba amara* (negrito), *Calophyllum brasiliense* (santa maría) and *Dalbergia stevensonii* (rosewood).

Tropical Moist Forest Life Zone, Transition to Subtropical

This transition zone between ***Subtropical moist*** and ***Subtropical wet forest*** Life Zones has average annual rainfall of 2000-2700 mm. It occurs generally south of the Western Highway in a lowland arc around the northern and northeastern foothills of the Maya Mountains, extending along the coast to about Monkey River Town. Forest types on the coastal plain fringe are a mosaic determined by soil type, drainage and fire. Because of frequent fires *Pinus caribaea* is a conspicuous component of this transitional life zone. Only on the broad floodplains of Maya Mountain rivers is broadleaved forest characteristic. Elsewhere, low soil fertility and impeded drainage produce a range of forest types from mixed pine-broadleaved forest to sparse pine savanna (Johnson and Chaffey 1974).

North of Dangriga, extensive lagoons and marshes occur on the flat coastal plain. The palm *Paurotis wrightii* (palmetto) is quite common on these seasonally flooded and frequently burned flatlands (Anderson and Fralish 1975). Other common tree species in this transitional life zone include *Byrsonima crassifolia* (craboo), *Curatella americana* (yaha), *Metopium brownii* (black poisonwood), *Spondias mombin* (hogplum) and *Crescentia cujete* (calabash).

Farther west where drainage is better on the low hills, a more heterogeneous broadleaved forest occurs on the karst terrain. Although species composition is similar to the drier ***Subtropical moist forest*** Life Zone to the west, trees are taller in this transitional life zone. Furley and Newey (1979) describe the complex mosaic of plant communities occurring on karst terrain near Belmopan.

Tropical Wet Forest Life Zone, Transition to Subtropical

The wettest area of Belize is in southern Toledo district, where average annual rainfall is 4000-4600 mm. The impressive height of trees is a distinctive feature of this transitional life zone: some *Ceiba pentandra* (cotton tree) reach 50 m and even the *Rhizophora mangle* (red mangrove) along the lower Temash River are quite tall. Extentensive swamp forest is dominated by *Pterocarpus officinalis* (caway), while *Manicaria saccifera* (comfray palm) dominates the freshwater palm swamp. This transitional life zone has an interesting floristic representation of species typical of tropical areas much farther south, such as *Pterygota excelsa* (L.R. Holdridge, pers. comm.).

Mangroves

Mangroves are a common coastal feature of many tropical and subtropical life zones. Although mangroves occupy most of Belize's coastal fringe as an apparent single edaphic-hydric association, life zone differences occur. Mangroves in ***Subtropical*** moist ***forest*** Life Zone along the northern coast are shorter than in the wetter life zones to the south. The tallest mangroves occur in the ***Tropical wet forest*** Life Zone–***transition to Subtropical***–in southern Toledo district.

Wright et al. (1959) recognize three major types of mangrove forest: (i) a *Conocarpus erectus* (buttonwood)-*R. mangle-Laguncularia racemosa* (white mangrove) association on land periodically inundated with sea water; (ii) permanently inundated *R. mangle;* and (iii) *R. mangle-L. racemosa* with occasional *Avicennia germinans* (black mangrove) where salt water infrequently intrudes. Mangroves may form a simple narrow coastal fringe, a concentric ring around small mainland lagoons, or colonize the lagoon side of offshore cays (see Fig. IV-5).

Forest Lands and Reserves

According to the most recent (1981) government information, 21,323 km^2 (8,233 mi^2, 93%) of the country is officially classified as "forest land" (O. Rosado, pers. comm.). By definition, only urban areas and agribusiness operations (e.g., sugar cane) are excluded from the official "forest land" category. Although 74% of "forest land" is classified as closed broadleaved forest, only 33% of this forest type is listed as forest reserves (Table IV-7). The "forest land" classification ignores milpa and small farm agriculture, so the official statistics do not show the considerable deforestation (see p. 98) of western Cayo and southern Toledo districts. In contrast to closed forest, 65% of the "forest land" classified as pine forest is in forest reserves. It may appear strange for open areas and grassland (Table IV-7) to be officially recognized as "forest land", but these areas are included because a few pines have survived repetitive fires.

The *Forests Ordinance* (Henriques 1960, Chapter 15) gives the GOB power to declare forest reserves (FR). Based on colonial tradition, FRs are considered as lands for permanent forestry. Fifteen FRs have legal status (Table IV-8), covering 6,367 km^2 (28%) of the country. Despite the prominence and public awareness of the Mountain Pine Ridge FR, 83% of the total land in FRs is broadleaved forest (Table IV-7). Approximately 22% of the land in FRs is unofficially recognized as protection forest, "which cannot be utilized except for selective fellings of minor impor-

Table IV-7. Official forest land in km^2 (%) in Belize by type, status and ownership. (Recalculated from FAO 1978).

Forest Land Category	Permanent Forest Reserve	Unreserved State Land	Private Land	Total
Closed Forest (Broadleaved)	5,286 (83)	4,367 (67)	6,159 (73)	15,812 (74)
Open Forest (Woodland & Pine)	642 (10)	210 (3.2)	134 (1.6)	986 (4.6)
Mangrove and Swamp	26 (0.4)	974 (15)	1,408 (17)	2,408 (11)
Open and Grassland	414 (6.5)	1,006 (15)	696 (8.3)	2,116 (10)
TOTAL	6,368 (100)	6,557 (100)	8,397 (100)	21,322 (100)

tance". An additional 2,116 km² of FRs are considered inaccessible, thus reducing the accessible and productive area in FRs to 1,735 km² (FAO 1978, Appendix 5).

Despite 6,557 km² of unreserved state forest land and 8,397 km² of privately-owned forest land, the FRs are under increasing agricultural pressure. The former Maskall FR was released for agriculture and the Freshwater Creek FR has been opened to sugar cane farming, even though its legal status has not been changed. As happened with Freshwater Creek FR, 2,429 ha of steep terrain in the Mountain Pine Ridge FR was converted to private agriculture (A. Carty, pers. comm.). Several other FRs such as Columbia River, Machaca, Maya Mountains, have lost forest to slash-and-burn agriculturalists. Unfortunately, the Forest Department does not have the political support to protect the country's forest patrimony.

Forest Production

The exploitation of forest resources such as logwood, mahogany, chicle, pine, etc., provided the economic base for colonial settlement and development over nearly three centuries. Logwood and mahogany exploitation was so lucrative that the British crowned in Belize a "king of the Mosquito coast" to maintain political control of the Caribbean coast of Central America (Gibbs 1883).

By the 1950's mahogany volume had declined and the mature pine had been exploited, hence it is not surprising that the infamous Downie (1959) report recommended a 50% cut in the colonial forestry budget. Downie may have been influenced by the early waves of nationalism and independence sweeping the British colonial empire. Why should a colonial power faced with a growing independence movement invest in forest management to produce timber 20-50 years in the future? The shock of the Downie-inspired budget cut devastated and demoralized the Forest Department. Fire protection of pine forests and an active plantation establishment program suffered greatly. Some long-term observers of the forestry scene in Belize believe that the Forest Department is still in decline. However, increasing foreign assistance appears to be enabling the Forest Department to move forward again.

The Forest Department is concentrating forestry activities in the principal forest lands with exploitable or productive potential (Table IV-9). The Cockscomb Basin is unreserved state land leased to the Minter Naval Store Co. for exploitation of secondary hardwoods, principally *Virola koschnyi* (banak). The Belize Estate and Produce Co. (BEC) owns 2,538 km² (980 mi²) on the northern plain that is the country's richest reserve of mahogany (Fig. IV-18). Active timber concessions are also operative in the Mountain Pine Ridge and Chiquibul FRs.

Over the past six years, total timber production has shown a modest increase (Table IV-10), but 1982 forestry exports earned only B$3,800,000, equivalent to 2% of foreign earnings. Approximately 40 sawmills exist in the country, with three (Belize Timber Ltd., Barrow Lumber

Table IV–8. Legally established Forest Reserves of Belize. See Fig. IV-16 for location of Forest Reserves on Land Ownership map. (Source: Forest Department, 1984)

Map Number	Forest Reserve	Administrative Division	Area (km²)	Area (mi²)
1	Freshwater Creek	Northern	300	116
2	Mountain Pine Ridge	Western	515	199
3	Chiquibul	Western	1,849	714
4	Sibun	Southern	430	166
5	Manatee	Southern	459	177
6	Grants' Work	Southern	39	15
7	Silk Grass	Southern	29	11
8	Commerce Bight	Southern	12	5
9	Deep River	Southern	591	228
10	Swasey Bladen	Southern	62	24
11	Mango Creek	Southern	267	103
12	Sittee	Southern	381	147
13	Maya Mountains	Southern	927	358
14	Machaca	Toledo	23	9
15	Columbia River	Toledo	417	161
	TOTAL		6,301	2,433

Co., and BEC) accounting for almost two-thirds of production. The many small sawmills providing sawn wood for the local market are inefficient and produce poorly-dimensioned lumber. Government price controls on lumber are a disincentive to upgrading sawmills and producing better quality lumber. Because of the poorer quality of local lumber, demand exists in Belize City for imported lumber. Except for the few sawmills oriented to exports, the Belize sawmilling industry is characterized as hopelessly antiquated and sawmills are in need of replacement (Fellows 1976).

The Forest Department and the GOB believe that forestry can contribute much more to the national economy. Forestry development in Belize has been thoroughly studied by several international organizations (Melhuish 1973; Bassili 1976; Fellows 1976; FAO 1978; Berl-Cawthron 1982). These reports generally concur that the annual cut of timber is only about 5% of the potential annual cut on a sustained-yield basis. However, that potential will only be possible if the forest reserves are protected from slash-and-burn agriculture, local wood processing facilities are improved, effective forest management plans are implemented and the technical and administrative capabilities of the Forest Department are strengthened.

Forest Management

The management of Belize's forests is strongly rooted in colonial forestry principles developed in more than a century of practice throughout the British Empire. Due to the economic preeminence of timber exploitation in tropical colonies, the British became leaders in tropical silviculture, wood products, and forest soils. British expertise in tropical forestry still plays an important role in Belize forestry with research activities of the Commonwealth Forestry Institute (Oxford) and technical and personnel assistance to the Forest Department from the Overseas Development Administration (ODA).

The Forest Department (FD) is a dependency of the MNR. Current staffing is six professionals with provisions for a seventh, three forest technicians, 11 rangers and two conservation officers (who function as rangers) and 20 forest guards (O. Rosado, pers. comm.). The FD is decentralized with only two senior staff (who are two of the six professionals) in Belmopan (Chief Forest Officer and Principal Forest Officer). The other four professionals include one western and three southern district officers, two of which are the Forest Research Officer (with country-wide responsibility) and District Forest Officer for Utilization, both based at Melinda (O. Rosado, pers. comm.).

Table IV-9. Estimated exploitable area (km^2) and volumes (m^3) in productive forests of Belize. (Recalculated from FAO 1978)

	Area	Primary (Mahogany & Cedar)	Secondary Hardwoods	Pine	TOTAL
Cockscomb Basin	410	24,600	1,410,400	–	1,435,000
Columbia River & Maya Mountains	1,340	80,700	8,142,300	–	8,223,000
Chiquibul	1,850	80,800	3,434,600	–	3,515,400
Belize Estate	2,430	444,000	4,148,700	–	4,592,700
Mountain Pine Ridge	515	–	10,600	205,800	216,400
Other Forest Reserves	2,614	ND	3,647,800	454,300	4,102,100
Other Private or Government	4,850	ND	4,672,500	140,000	4,812,500
TOTAL	14,009	630,100	25,466,900	800,100	26,897,100

ND = No Data

A legacy of the British foresters is species-specific minimum cutting limits that are rigidly enforced by the FD. Minimum dbh (diameter at breast height) cutting limits range from 73 cm for *Enterolobium cyclocarpum* (tubroos, guanacaste), 63 cm for *Swietenia macrophylla* (mahogany) and *Cedrela mexicana* (Spanish cedar) down to 34 cm for *Pinus caribaea* and 29 cm for *Zanthoxylum kellermannii* (prickly yellow). Contrary to FD regulations, some landowners cut mahogany as small as 49 cm dbh. Minimum cutting limits are designed to leave some reproductive individuals as seed sources.

In the 1940's, the colonial FD established plantation programs near the Machaca forest station in Toledo district, Savannah forest station near Mango Creek and somewhat later at the Melinda forest station in the Stann Creek valley. The first plantations were of *Pinus caribaea*, followed by *Swietenia macrophylla* and *Cedrela mexicana*. Some *Tectona grandis* (teak) was also planted. Plantation establishment virtually ceased following the drastic budget cut recommended by Downie (1959). Modest plantings of *Gmelina arborea* (melina) begun in 1962 now cover about 1,000 ha near Mayflower. There are also about 2,000 ha of pine and 500 ha of mahogany plantations. Some of the mahogany and melina plantations at the former Salamanca forest station were cut down by Indian milperos.

Fire is an integral component of most pine ecosystems; *Pinus caribaea* is more fire-resistant than the higher-elevation *P. oocarpa*. While wildfires can destroy many pine trees, controlled burning is beneficial to established pines by suppressing competing vegetation. After the old-growth pine was exploited in the 1950's and wildfires stimulated abundant pine regeneration, the FD began an aggressive program of fire control to protect young pines. The establishment of extensive, fine stands of 20-30 year-old pine on the southern coastal plain and Mountain Pine Ridge (Fig. IV-19) is testimony to the successful FD program in fire protection. This continues to be done with limited staff and equipment to fight wildfires.

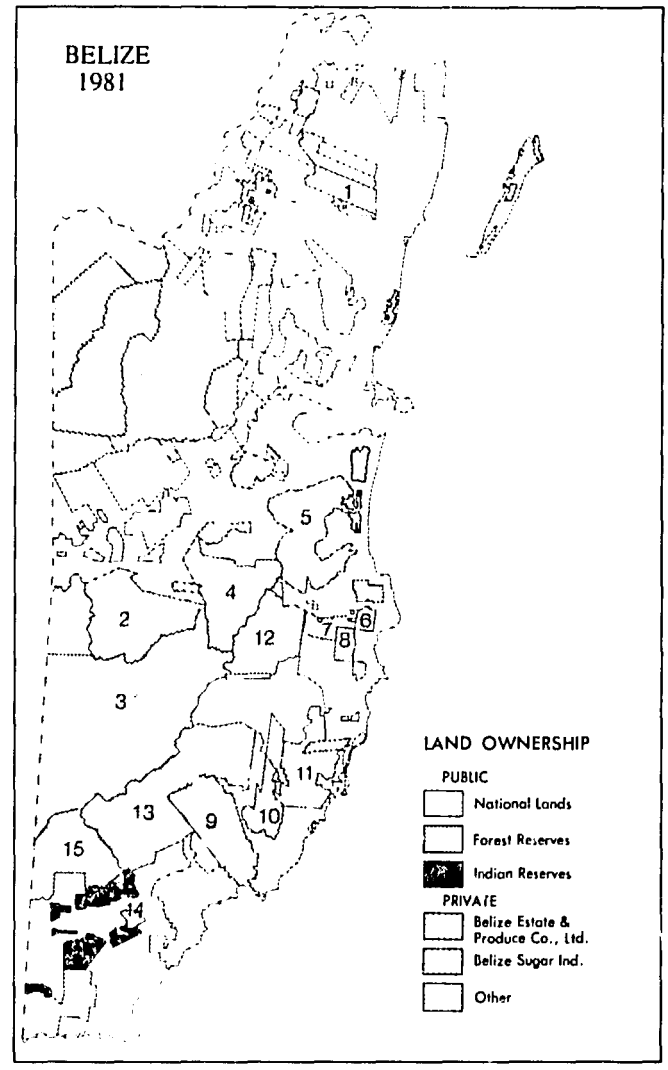


Figure IV–18.—Land ownership including private and public lands. Forest reserves are numbered; see Table IV–8 for names of Forest Reserves. (map by W. Davidson)

Table IV-10. Recent timber production (m^3) statistics for Belize. (Data provided by O. Rosado)

	1977	1978	1979	1980	1981	1982
Mahogany and Cedar	9,571	13,662	13,441	15,148	14,220	17,215
Pine	4,307	2,943	3,797	2,151	4,123	5,850
2° Hardwoods	13,895	15,514	17,855	23,957	19,697	18,750
Rosewood	504	258	3,509	2,541	357	458
Ziricote	5	126	18	36	38	55
Logwood	–	–	–	–	–	132
TOTALS	28,282	32,503	38,620	43,833	38,435	42,460

Figure IV–19.— Well-developed secondary pine forest in the Mountain Pine Ridge. (photo G. Hartshorn)

Pest problems are relatively minor on Belize forests and plantations. Dwarf mistletoe *(Arceuthobium globosum)* is becoming a significant problem on Belize pines (A. Carty, pers. comm.), weakening young trees and increasing their susceptibility to other diseases and pests. The true mistletoes *(Psittacanthus* sp.) and bark beetles *(Dendroctonus* spp.) are insignificant in Belize. The mahogany shoot-borer *(Hypsipyla grandella)* attacks mahogany and *Cedrela mexicana* (Spanish cedar) juveniles, but damage has not been severe because few plantations have been established in the past two decades. Wood-boring long-horn beetles (Cerambycidae) attack freshly felled logs of several secondary hardwood species such as *Virola koschnyi* (banak).

As is typical of many forested developing countries, the principal task of the Belize FD is regulating timber exploitation through licensing and concessions as well as collecting royalties. All trees in Belize belong to the state but royalties (or stumpage) vary according to species (e.g. B$21/m^3 for mahogany) and are 50% less on private land. Over the years concessionaires frequently felled more trees than they could remove from the forest, so the FD limits the number of trees to be felled before removal. FD rangers now check concessions (for minimum cutting size) and release only 25–50 trees at a time; when the marked trees are satisfactorily extracted, another set is released.

The FD has put little effort into mahogany management for sustained yield production and none into secondary hardwoods. This is perhaps understandable given the severe budgetary limitations beginning in 1960 and the immensity of the national forest resource base. The lack of information on silviculture of important native species (e.g., mahogany), natural forest management and productivity, and identification of native species is a characteristic of most developing countries.

Despite centuries of mahogany exploitation, Belize still has a large reserve of mahogany. The richest mahogany forests are the private Belize Estate and Produce Co. (BEC) lands in northwest Belize. The FD should encourage management of broadleaved forests for secondary hardwoods on lands suitable only for production forestry. The principal constraint to sustained yield management in forest reserves is that concessions are relatively short-term; the longest is 10 years to Minter Naval Stores Co. in the Cockscomb Basin. Short-term concessions offer no incentives for the concessionaire to become involved in forest management. Rather, the emphasis is on exploita-

tion. The FD should grant longer-term concessions in key production forests such as the Chiquibul FR and the Cockscomb Basin, with the crucial *proviso* that a forest management plan be implemented with sustained yield principles. Because of budgetary limitations in the FD, Belize will only realize the considerable productive potential of the vast forests if private industry becomes actively involved in forest management.

Deforestation

Deforestation is not a major issue in Belize. Unfortunately, no data exist on how much forest remains nor on the rate of deforestation; the official classification of "forest land" (see p. 93) is useless in determining how much forest is in Belize. Except in forest reserves, virtually all roadsides have been deforested for a few to several hundred meters. This has caused some local alarm, particularly where immigrants practice slash-and-burn agriculture with little regard for topography (see p. 33). However, aerial reconnaissance indicates few clearings remote from roads--and these are probably clandestine marijuana patches.

Extensively deforested areas are few in Belize: Mennonite farming communities in the north and west; sugar cane lands in the north; and traditional Indian areas of milpa farming in the west and the south. In a detailed study of the Belize River valley (3,170 km^2), 46% of the area is mapped as forest, while 6% is cleared land and 14% is used for milpa farming; the remainder is other vegetation types such as thicket and savanna (Jenkin et al. 1976).

Despite the extensive forests of Belize, the pressure for agricultural land is increasing. Forest reserves are gradually being decreased as small farmers, milperos and even agribusiness operations usurp forest land. The FD must determine what Crown Lands are to be maintained as production forests and protection forests and then vigorously protect the national forest patrimony.

IV–H. WILDLANDS CONSERVATION

Conservation of Belize wildlands focuses on major sea-bird rookeries (Fig. IV-20). In 1928, the colonial administration established Half-Moon Cay as a Crown Reserve. In 1977, seven tiny mangrove cays were established as Crown Reserves to protect rookeries, with administration entrusted to the Belize Audubon Society (BAS). The colonial government also created 15 forest reserves (see Table IV-8) covering almost 20% of Belize, but they are (or were) for timber exploitation rather than wildlife conservation.

The *National Parks System Act* (No. 5, 1981), passed shortly after Belizean Independence, provides the legal basis for establishing national parks, natural monuments and wildlife reserves. Administrative responsibility is assigned to the Forest Department, but it is understaffed, short of funds and lacking expertise in wildlands conservation. Consequently, the impetus for promoting conservation has fallen on the BAS, an established private group that actively promotes conservation of Belize wildlife and wildlands.

Status of Conservation Units

Half-Moon Cay in Lighthouse Reef, 100 km offshore, supports Belize's famous nesting colony of *Sula sula* (Red-footed Booby). Part of it was made a Crown Reserve in 1928 and the Red-footed Booby added to the list of protected wildlife in 1950. The GOB purchased the private lands on the cay in 1981; half the costs (US$7,000) were paid by the BAS with help from CATIE, WWF/US, RARE, The Nature Conservancy, ICBP/US, ICBP/Pan Am, and the National Audubon Society/US. With the passage of enabling legislation in 1981-1982, Half-Moon Cay became Belize's first Natural Monument (Weyer 1982), with the BAS helping to care for it until the National Parks Department is established and can carry the responsibility. The cay is approximately 18 ha, half in coconut, half in low *Cordia sebestena* (ziricote) forest, the latter is where boobies and *Fregata magnificens* (Magnificent Frigatebird) nest. Half-Moon Cay Natural Monument includes an area of coral reef and inner lagoon extending 7 km from the cay.

At the suggestion of the BAS, **Guanacaste Park** was established in 1973 as a "crown reserve for use as a national park". This park centers on a large *Enterolobium cyclocarpum* (guanacaste or tubroos) tree that supports an epiphyte colony of about 35 species of orchids, bromeliads, ferns, cacti, strangler figs and others. With only 21 ha, Guanacaste Park does not meet international size specifications for national parks. Given its proximity to Belmopan, Guanacaste Park could be a city park or a botanical garden. At the request of the MNR, Guanacaste Park is managed by the BAS, but vandalism and theft make maintenance difficult and milpa farmers have also used the park. Regardless of designation, Guanacaste Park needs effective protection.

In 1968 the MNR designated 3,644 ha of the upper valley of the **Río Grande** as a wildlife sanctuary and natural reserve. One of the purposes in establishing this reserve was to protect the upper Río Grande watershed by preventing Indian milpas that caused erosion and silting of the river. However, Indians belonging to a rice cooperative organized under the Cooperatives Department began farming in the upper valley reserve. The area, now abandoned and eroded, is an illustration of the need for cooperation between divisions of Government and for a comprehensive Conservation Strategy for the development of Belize's natural resources.

In response to a 1977 BAS request, the MNR established **Crown Reserve Bird Sanctuaries** (on seven small cays) that were waterbird rookeries for such species as *Ajaia ajaja* (Roseate Spoonbill), *Mycteria americana* (Wood Stork), *Eudocimus albus* (White Ibis or Coco), *Casmerodius albus* (Great Egret), *Egretta thula* (Snowy Egret), *Anhinga anhinga* (Anhinga), *Phalacrocorax olivaceus* (Cormorant or Shag), and *Cochlearius cochlearius* (Boat-billed Heron or

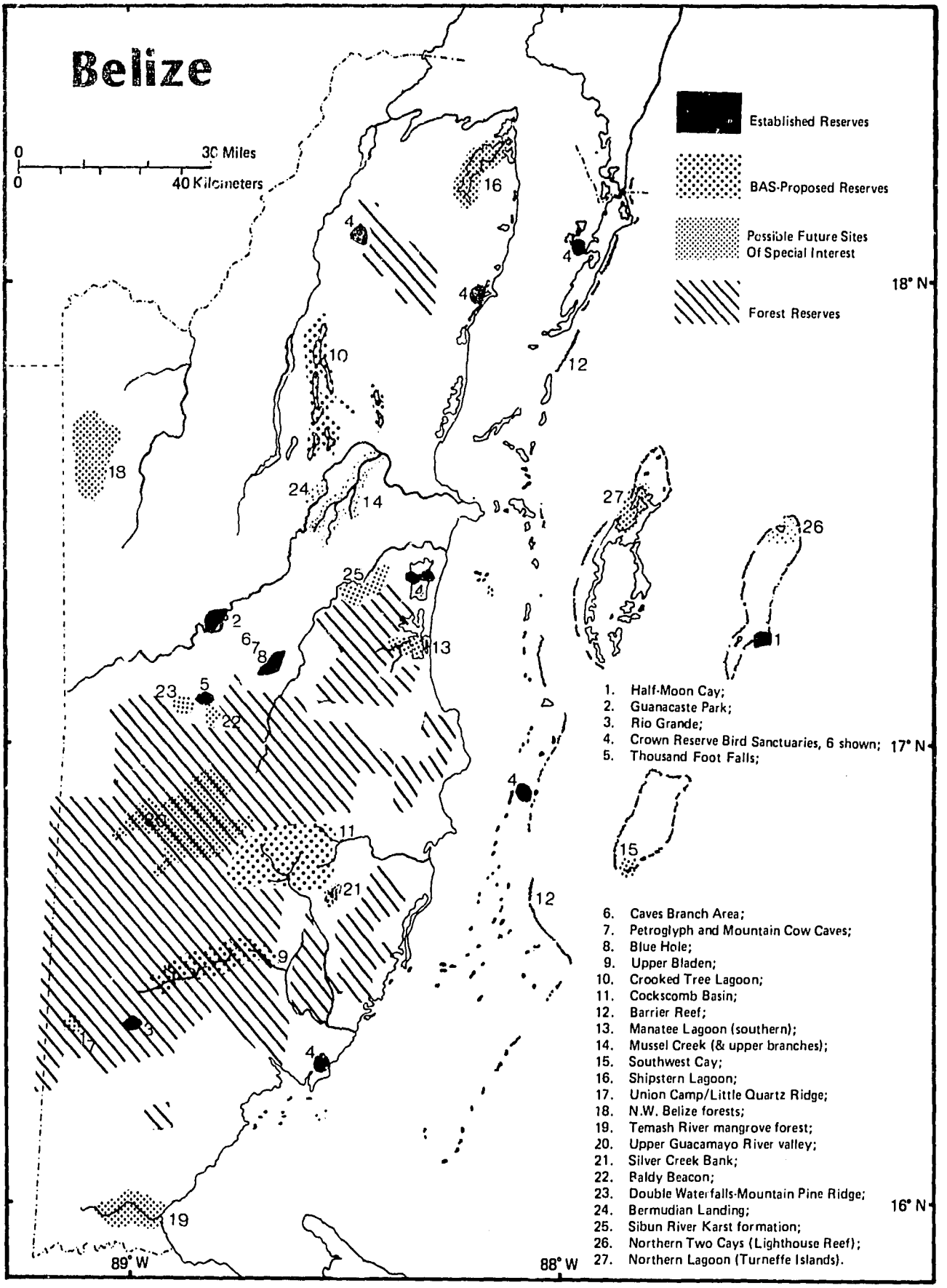


Figure IV–20.— Present reserves, areas under consideration for reserve status and possible sites to be given reserve status. Areas in Forest Reserves are shown for comparison.

Cooper). These cays were given into the care of the BAS until the GOB could set up a National Parks Department. The BAS asked local people to act as unpaid wardens on some of the cays; other cays were neglected because of expensive access. Birds on three of the reserved cays have been wiped out; hunters and fishermen killed most nesting birds on two cays, but a few birds returned to nest in 1983; the status of one cay is unknown; and only one cay has been left undisturbed. The BAS discovered that signs and radio discussions are ineffective; it is necessary to fund on-cay wardens who can call by radio for police intervention, since designating reserve areas on land or sea cannot guarantee protection.

In addition, several small areas of outstanding scenic beauty are being protected by the GOB but their status is unclear. These are the **Thousand Foot Falls** on The Mountain Pine Ridge, and the **Caves Branch** area near the Hummingbird Highway. In the latter area, the GOB has title to 233 ha that includes Blue Hole, St. Herman's Cave, Mountain Cow Cave and Petroglyph Cave. The extensive **Petroglyph and Mountain Cow Caves** are spectacular and could in the future become tourist attractions. **Blue Hole** was formed by the roof of an underground river collapsing; within about 45 m the river wells out of the ground and then returns underground. The river flows through Petroglyph Cave, St. Herman's Cave, and into the Blue Hole, then flows under the Hummingbird Highway to eventually join Caves Branch a few kilometers downstream. The area should be established as a Natural Monument. Blue Hole is accessible to tourists, but some repairs to the access structure must be made at the site.

Proposed Wildlands Reserves Under Consideration by GOB

The BAS had proposed to the MNR the creation of three large wildlife reserves: Upper Bladen, Crooked Tree Lagoon and Cockscomb Basin (Fig. IV-20). The **Upper Bladen** area centers on Bladen Branch of the Monkey River, which collects water from a series of almost parallel creeks draining the main divide of the Maya Mountains in western Toledo district. With a drainage area of approximately 350 km^2, the proposed reserve is an area of spectacular beauty and includes Richardson Peak, the second highest peak in Belize. The lower watershed along Bladen Branch is probably *Subtropical wet forest*, while higher areas include *Subtropical Lower Montane wet forest*, with cloud elfin forest on the higher peaks. The upper watershed is rugged wilderness undisturbed by man. Members of the few expeditions to the Upper Bladen report numerous tapirs and some spider monkeys. The proposed reserve includes not only the Maya Mountain Divide but a portion of the upper northwestern slope. The ICBP-listed endangered Ocellated Turkey is particularly abundant on the northwest side of the Divide and on the high plateau around Richardson Peak, but does not range south of the Divide. This reserve would give these unique birds a home remote from domestic poultry. A disease decimating Ocellated Turkeys in other areas of Belize is thought to be transmitted by poultry.

The proposed **Crooked Tree Lagoon** waterbird reserve boundaries should extend 100 m above high water mark of six lagoons: Revenge Lagoon, Crooked Tree Lagoon, Western Lagoon, Spanish Creek Lagoon, Southern Lagoon (in this complex) and the smaller Poorhaul Creek Lagoon; together with their joint outflow into Black Creek; Black Creek to its junction with the Belize River; and nearby Mexico Lagoon and Jones Lagoon that are of similar type but drain separately. This extensive complex of shallow lagoons is critical to migratory and resident waterbirds during the height of the dry season. Thousands of birds congregate on these lagoons in March, April and May. Black Creek is bordered with forested swamps along much of its route, thus the shores are a haven for wildlife and wintering migrants. Wildwings Foundation, Inc., (a private, U.S. bird conservation group), has offered financial and administrative assistance to BAS to develop this reserve for conservation, wildlife protection, and natural history tourism, subject to GOB approval and that of the people of Crooked Tree Village. The reserve would be open to tourism, fishing (Crooked Tree men operate a large fishery when low water concentrates the fish) and licensed cattle grazing for the late dry season when Western Lagoon goes dry.

On invitation from the BAS, the Animal Research and Conservation Center of the New York Zoological Society is conducting a long-term jaguar study (Fig. IV-21) in **Cockscomb Basin**. The Animal Research group is evaluating the area as a proposed jaguar reserve, not only to maintain a viable population but also as a tourist attraction similar to the famous Treetops in Kenya. Cockscomb Basin is roughly 220 km^2, bordered on the north by Cockscomb Range including Victoria Peak. This highest point in the country has an interesting elfin forest that supports a number of bird species found nowhere else in Belize. Cockscomb Basin is bordered on the west by the main divide and on the south by an unnamed range lying between the basin and the valley of Trio Branch. The nearly enclosed Basin supports a high jaguar population; early radio-tracking results indicate that the animals do not stray into nearby agricultural lands. The Cockscomb Basin land is not suitable for agriculture, the soil is derived from acid rocks that are highly erodable if cleared of forest. Within the Basin are two sites identified as having potential for hydroelectric dams; this would be compatible with a jaguar reserve since the watershed should be kept in forest to minimize erosion. If the Cockscomb Basin is not used for hydroelectric power, selective logging could be practiced as it does not interfere with jaguar; in fact, forest openings favor some jaguar prey species.

Belize's Barrier Reef, Proposed World Heritage Site

Belize's spectacular **Barrier Reef** (see Fig. IV-22) is certainly the most important of the country's ecosystems in need of proper protection and management. Coral reefs, sand cays and mangrove cays should be evaluated for biological diversity, tourism potential, and fisheries production in order to establish appropriate conservation units. Over-

Figure IV–21.— Jaguars are not endangered nor of low populations in Belize. A major jaguar study by NYZS should clarify the jaguar status and needs in Belize. (photo L. Nicolait)

Figure IV–22.— View of the Barrier Reef from Ambergris Cay looking south. Note how close the reef is to the island. (photo L. Nicolait)

fishing, chemical dumping, unregulated dredging and uncontrolled development must be prevented. The BAS has suggested that the GOB join the World Heritage Convention and propose Belize's barrier reef, cays, inner lagoons, coastal edge and the three outer atolls as a World Heritage Site. UNESCO's World Heritage Program can help protect the barrier reef. International publicity would be generated to call attention to the reef and possibly stimulate scientific and educational tourism. The World Heritage Program supports specialists who can help by developing programs to conserve the resources while moderate development occurs. The program's local people from Belize would work with and arrange for conservation measures with the international specialists who advise, rather than direct, the program.

Other Potential Areas for Wildlife Conservation

In each of the major ecosystems of Belize (see p. 90) adequate and representative areas should be established to preserve viable populations of the fauna and flora. If areas large enough to support healthy populations of the larger animals are preserved, the smaller species should also be able to exist successfully in those reserves.

The southern half of the **Southern** or **Manatee Lagoon** (Figs. IV-20, IV-23) that lies near the coast between Belize City and Dangriga, and the lower stretches of the Manatee River are favorite areas for manatees. This appears to be the best potential reserve for this endangered species. A number of Belize City boatmen take tourists to Gales Point to see the manatees; the distinctive Burdon Canal and waterbirds nesting on Bird Cay (a BAS rookery reserve) add interest to the trip.

Mussel Creek and its upper branches would be an excellent reserve for black howler monkeys, tapir, Morelet's crocodiles and a number of rare waterbirds such as Black-collared (Fishing) Hawk, Gray-headed Kite, Crane Hawk, Wood Storks (their last nesting area might be somewhere in this water complex), Agami Heron, Boat-billed Heron, Sungrebe, and at least five species of rails. The Mussel Creek reserve should include Cook's Lagoon, Mucklehany Lagoon, and Cox's Lagoon. As at Crooked Tree, a reserve boundary 60-100 m above normal high

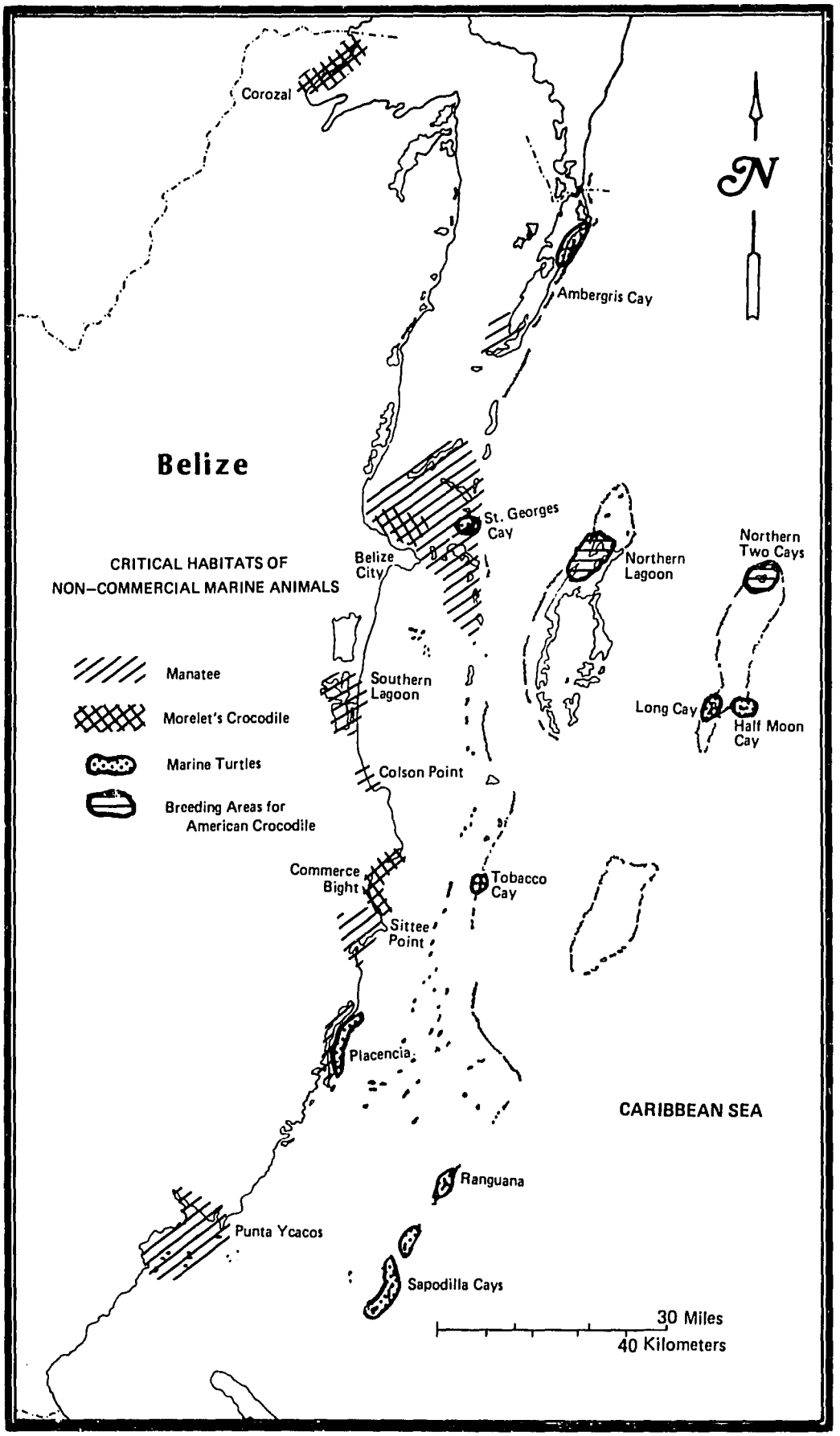


Figure IV–23.— Critical habitats of non-commercial marine animals.

water mark would preserve enough forest edge to protect wildlife. Mussel Creek is bordered by forested swamp, or occasionally by marsh.

A large colony of Noddy Terns nests in the coconut trees on the southern half of the two islands that make up **Southwest Cay** in Glover's Reef. This nesting area belongs to the GOB (acquired in 1968; B. Ozaeta, pers. comm.). Noddies are terns with the crown of the head white instead of black, and the rest of the bird is brown, not white. This is the only nesting colony of Noddy Terns on any cay in Belizean waters, hence it should be protected.

The large Wood Stork rookery on a mangrove cay in **Shipstern Lagoon** was destroyed by Corozal fishermen even though the fishermen of Sarteneja tried to protect it. It may be too late for Wood Storks to reestablish populations in Mussel Creek. Shipstern Lagoon is also the main breeding area for White-winged Doves, and Great Egrets formerly nested here. Shipstern Cay is a small round mangrove cay at the mouth of the lagoon that supports a large colony of White Ibis and about 12 nesting pairs of *Egretta rufescens* (**Reddish Egret**); the latter are rare in the Caribbean.

Some of the best forest in Belize occur just south of **Union Camp** and west of **Little Quartz Ridge**. Among interesting plant species are endemic orchids and a large cycad. The Slate-colored Solitaire was recorded here by the Royal Air Force Ornithological Society's Expedition to Belize in 1981. This bird, not found elsewhere in Belize, is an indicator that other montane species may be found in the area.

Because of less rainfall and a longer dry season, the **forests of northwestern Belize** differ from those to the south. Grison *(Gallictis vittata)* are common here, but scarce to the south. These forests would make an excellent reserve for *Agriocharis ocellata* (Ocellated Turkey), *Crax rubra* (Great Curassow or Curasso), *Penelope purpurascens* (Crested Guan or Guam), *Spizaetus tyrannus* and *S. ornatus* (Black and Ornate Hawk-eagles), *Columba speciosa* (Scaled Pigeon), the forest parrots and *Momotus momota* (Blue-crowned Motmot).

The finest mangrove forest in the country lies along **the Temash River** from its mouth to approximately 33 km upstream. *Nyctibius griseus* (Common Potoo) nest in the mangroves, and large troops of howler monkeys live in the firm-ground forest on the sand bars at the river mouth.

Probably the least disturbed *Pinus caribaea* forest in Belize is in the **Upper Guacamayo River** valley. A reserve here should include an area (possibly along the Brunton Trail) that supports *Pinus oocarpa*. The reserve would be superb for wildlife: Raspaculo Creek and the Guacamayo River have high populations of otter and Morelet's crocodile. This mountainous region supports a high concentration of the rare *Sarcoramphus papa* (King Vulture or King John Crow). Up to ten King Vultures at a time came to a bait station on the edge of the Guacamayo bluff in a King Vulture Study conducted two years ago (J. Clinton-Eitniear, pers. comm.). This is the only known range in Belize of *Harpyhaliaetus solitarius* (Solitary Eagle), *Ara macao* (Scarlet Macaw), and where the rare *Spizastur melanoleucus* (Black-and-white Hawk-Eagle) nested two years ago. Deer and puma are abundant, and spider monkeys occur along the Raspaculo. This area in the Chiquibul and Mountain Pine Ridge Forest Reserves should receive complete protection for wildlife; loggers should not be allowed to hunt for game as they do elsewhere in the forest reserves.

The fine stand of tall pines at the old **Silver Creek Bank** Fire Lookout (directly west of Riversdale) should be protected. Possibly this area could be included in the proposed Cockscomb Basin Jaguar Reserve, or it could be defined as a small reserve or natural monument.

Baldy Beacon is a radio station for the army where unique geological features of the earliest rock were uplifted above the sea. Interesting orchids, butterflies and other plant and animal species are found on the exposed granite and in the grass and ravines. The area should be incorporated in the proposed Mountain Pine Ridge National Park.

The **double waterfall** side by side on Headly's property at the edge of the Mountain Pine Ridge is a most unusual site. If the property becomes available, it should be purchased by the GOB.

Bermudian Landing has an interesting group of black howler monkeys living in the village. The monkeys do not disturb commercial fruit trees, are not inordinately curious, and they laze in riparian figs and the trees in villagers' yards. The villagers realize that the monkeys attract tourists. There are legal problems associated with designating the village as a historical monument, but villagers might want some recognition to attract tourist trade.

The **karst formation** south of the Sibun River between Gracy Rock and the Mile 33 Road has a characteristic honeycomb physiography. There are flat-bottomed holes supporting good forest surrounded by bare, white cliffs, while ridgetops are covered with low scrub.

The two areas that contain the largest number of breeding American crocodile *(Crocodylus acutus)* populations in Belize are **Northern Two Cays** in Lighthouse Reef and **Northern Lagoon** (Vincent's Lagoon) in Turneffe Islands. Both areas should be reserved for this endangered species, (one of the largest crocodiles in the world), because there is currently heavy hunting pressure on the species and reserve status will afford some protection.

Institutional Capability to Plan and Manage Conservation Units

Little effort was made under the British Colonial administration to develop a national parks program and to train future government officials in park planning and

management. However, one of the first acts of the newly independent government in September 1981 was to pass the *National Parks System Act* (N° 5, November 1981). Obviously the GOB was indicating the need for protection of important ecological and genetic resources.

Unfortunately, economic limitations and a multiplicity of other equally legitimate needs have delayed the GOB's action to create an adequate agency to administer park and reserve development envisioned in Act N°5; nor has funding been available for training government personnel in park planning and management. All proposals for conservation units come under the jurisdiction of the Forest Department in the MNR. But the Forest Department is understaffed, underfinanced, undertrained and admittedly in no position to take on this added responsibility.

Evaluate Existing and Potential Wildlife Reserves

The total area of Belize is small, but it encompasses a considerable area of undisturbed or little disturbed wilderness. It has good to excellent populations of many wildlife species that are endangered in neighboring countries. All five wild cats (jaguar, puma, ocelot, jaguarundi and margay) are common, as is Baird's tapir. A number of rare birds, such as Ocellated Turkey, American Sungrebe and Boat-billed Heron are quite common. Solitary Eagles, Orange-breasted Falcons and Agami Herons still live in Belize's wilder areas.

Belize's barrier reef and three coral atolls should be set aside as a marine reserve (similar to Belize's forest reserves) so that rational development of fisheries, tourism and scientific research will be possible. UNESCO's designation of the barrier reef as a World Heritage Site would provide Belize with international recognition of the area, some funding for technical assistance, especially to fill the professional gaps in biological reserve management, and possibly funds for training Belizeans in World Heritage Site management.

IV–I. TERRESTRIAL WILDLIFE

Belize lies in what is known in zoogeography as nuclear Central America. During the Cretaceous period when the Maya Mountains and the cordillera from Chiapas, Mexico to Nicaragua formed an isolated island complex, a number of endemic species evolved from the basic neotropical stock. These species still form a major part of the Belizean fauna. Roughly two million years ago, Central America became a land bridge between North America and South America. The formation of a land bridge allowed reciprocal migration of animal species that had evolved into substantially different regional faunas. As a result, the Central American fauna is one of the most varied on earth.

Belize's modern fauna belongs to the Caribbean lowland assemblage. The animals of the drier northern half of the country are strongly Yucatecan (sometimes called Campechean) in character; the fauna of the wetter, southern half is allied to that of Petén, southeast Chiapas, and eastern Guatemala. A few montane species occur in the Maya Mountains, living at considerably lower elevations than they do in the Cordilleras. Despite few montane species, the Belizean avifauna of approximately 533 species for an area of 22,963 km^2 is quite large. Belize's nearness to North America is a factor, contributing an unusually high proportion of wintering and transient species.

Since the collapse of the Mayan civilization, Belize has been an underpopulated country in a world largely overpopulated. Much of the country is still in forest (reestablished in the last 1,000 years) with large numbers of howler monkeys, brocket deer, otter, jaguar, ocelot, margay, jaguarundi, puma and tapir. Most of these species are under such heavy human pressure (e.g., deforestation, agriculture, hydroelectric dams, hunting, etc.) in other countries that they are on the CITES Appendices I and II as seriously endangered or in need of careful monitoring. With care and effort, viable populations of these species can be maintained in Belize. Checklists of fish, mammal, bird and reptile species of Belize are in Appendices B, C, D, and E.

Laws Concerning Wildlife

Legal protection of wildlife is based on a 1944 ordinance (No. 5, Chapter 127), followed by subsidiary legislation in 1945 (Vol. III, p. 1626) and recently updated in the 1982 *Wildlife Protection Act.* The 1944 attempt was marred by lack of knowledge of the wildlife species occurring in Belize, the use of common names not recognizable to the Belizean population, and, primarily, by little attempt at enforcement, except in regard to the procurement of licenses. Wildlife protection and management has always been, and still is, severely hampered because the Forest Department (responsible for wildlife protection) is limited in personnel, vehicles and equipment, and has no personnel trained in wildlife management or conservation.

The new *Wildlife Protection Act* is a great improvement over the earlier ordinance; it is simplified, contains the correct scientific and English names of the animals concerned, and includes, so far as possible, common Creole and Spanish names. The 1982 law allows licensed hunting of the game animals used by Belizeans, while protecting those animals listed in the CITES agreements plus those obviously in need of local protection. The law prohibits hunting of immature wildlife and females accompanied by young; it also includes a seven year moratorium on dealing for profit in any other wildlife species. This moratorium allows time to analyze the wildlife situation. Local licensed hunters may only sell meat of permitted game species within 25 km of the kill.

Country people and city "sportsmen" pay little attention to the new regulations, because enforcement is practically nonexistent. However, the Forest Department,

backed by the Ministry of Natural Resources (MNR), has done a commendable job of stopping the large-scale export of animals to the pet trade. No large shipments of parrots, macaws, toucans, snakes, or lizards have left Belize in recent years despite considerable foreign pressure for illicit trade in wildlife. The smallness of Belize has made it easier to enforce export regulations, and the GOB Customs Department has been cooperating to prevent abuse of the law.

In 1972 the Forest Department and the MNR passed an ordinance limiting sale of hides of all wild animals, with the plan that all buying and selling of hides would be phased out by 1974. With some extensions and exceptions, legal sale of hides has been stopped. Although illegal trade in crocodile hides continues (primarily of the America crocodile, *Crocodylus acutus*), the beleagered mainland populations of *Crocodylus moreleti* (Morelet's crocodile) are already showing an increase. Jaguars are apparently on the increase, though no previous population estimates are known. When Belizean hide dealers ceased trading, Mexican buyers moved in to continue illegal hide purchases; smuggling along the border or by sea is difficult to control.

Sea turtles were included in the 1981 draft of the *Wildlife Protection Act*, but these protective provisions were omitted because sea turtles were under the jurisdiction of the 1977 *Fisheries Ordinance*. Whereas the *Wildlife Protection Act* would have given complete protection to all marine turtles in Belizean waters, the *Fisheries Ordinance* allows restricted exploitation of sea turtles according to season and size.

Wildlife as Sources of Food

Wild mammal species whose meat is commonly sold in local markets include white-tailed and brocket deer, paca and agouti (both sold as gibnut), white-lipped and collared peccaries, and nine-banded armadillo. Although not sold in markets, coati, raccoon, and opossum are hunted for home consumption. Tapir meat is popular in Garífuna communities, while coastal people eat manatee meat.

Of bird species, tinamous are universally preferred. Very popular are the fat young of Wood Storks and Roseate Spoonbills just prior to fledging. Other birds taken for food include Herons, Egrets, White Ibis, ducks, large forest hawks, Chachalaca, Crested Guan, Great Curassow, Ocellated Turkey, Limpkin, large pigeons, Scarlet Macaw, Keel-billed Toucan and Lineated and Pale-billed Woodpeckers. The larger parrots are taken as food only by Maya Indians.

All sea turtle species are taken for food, but the green turtle is preferred. Of the larger freshwater turtles taken, the hickety *(Dermatemys mawii)* is most common in the markets. Gravid female iguanas are a prized food. Rural people also eat the leopard frog *(Rana pipiens)* and large river shrimp. Toledo district forests have been so depleted of wildlife that local Indians are paying B$1.10/kg (B$0.50/lb) for freshwater snails.

Wildlife Pests

It is impossible to arbitrarily rank the importance of pest species. "Riceys" (several species of finches) that are such a problem to small rice farmers do not bother cattlemen. Brown rats *(Rattus norvegicus)* that plague Belize City do not occur in rural areas. Rats and mice are major pests, but their predators (snakes, hawks, owls) are killed on sight.

Invertebrate pests (insects, ants and the like) are of great economic importance to agriculture and health. Belize suffers from biting flies of many species, particularly in coastal areas. Mosquitoes transmit malaria and the control of mosquitoes is difficult and costly.

Fruit-eating bats (family Phyllostomidae) damage mangoes, guavas, papayas, and bananas (when hung to ripen). But insect-eating bats are extremely important to man, especially in the control of nocturnal pest insects, including mosquitoes. Nectar-drinking bats *(Glossophaga)* are essential to plant pollination. Vampire bats *(Desmodus rotundus)* attack sick or weak animals and cause blood loss; *Desmodus* can carry rabies to man and domestic animals and equine encephalitis to horses, but Belize's vampire bats, while having transmitted rabies to domestic animals (K. Stafford, pers. comm.), have not infected humans with rabies. *Diphylla ecaudata*, the vampire bat that attacks birds, causes loss of poultry in some areas, particularly in Toledo district, but is not a widespread species.

In areas with large coati populations, the coati is probably the most important pest of Indians' corn. The raccoon is a pest when corn is being dried (A. Choc, pers. comm.).

The gray fox is falsely accused by Creole farmers of killing poultry because of confusion in the public mind with the red fox of children's stories. It kills mice, small rats, lizards and grasshoppers, but does not bother poultry.

Weasels and opossums are important predators on domestic poultry. Several reports of fox-caused massacres in chicken houses are obviously the work of weasels that bite off the head, drink the blood, and go into killing frenzies, sometimes beheading 20 to 30 birds in a night. Oddly, farmers think that weasels are too small to have done the damage.

All wild cats can be pests. Even the shy margay is known to attack chickens. The common jaguarundi (called a halari) is a competent predator; Indians in the southeast complain it is almost impossible to raise chickens because of it. Ocelots generally do not come within close range of farm animals and are seldom pests. There are numerous reports that pumas attack dogs and cattle. At times they undoubtedly do, but how frequently? There is also confusion between jaguar and puma killings. Some individual jaguars can be serious pests, killing cattle, sheep, hogs and dogs. However, many ranchers insist jaguars do no harm. Two American ranchers report seeing jaguars crossing

or near their pastures repeatedly with no loss of livestock. Other ranchers have reported serious losses to jaguar, but say that once the killer is shot, other jaguars in the vicinity do not bother them. Because jaguars are common in Belize, conflicts are to be expected as new cattle ranches are established. The Belize Audubon Society (BAS) asked for assistance from the New York Zoological Society's Animal Research and Conservation Center to learn more about the habits of the jaguar and to advise GOB on handling the jaguar/cattle problem.

Pocket gophers (called "moles" in Belize) are larger and more destructive than true moles which do not exist in Belize. They eat roots of bananas, plantain, corn, sugar cane, papayas and other fruit crops. Cotton rats are abundant native rats that are active day and night and have enormous appetites. The brown rat *(Rattus norvegicus)* lives only in coastal towns and is common in Belize City. It is hoped that the new sewage system will cut their numbers. So far as is known, they have not invaded rice plantations as they have in many other countries. The black rat *(Rattus rattus)* is widespread in towns, on farms where foodstuffs of any kind can be found, and pastures and fields; it also infests the cays. The common house mouse is also widespread. Native mice and rat species (family Cricetidae) are not important disease vectors nor are they as destructive as introduced rats and mice. However, several species of climbing rats attack corn stored in Indian open storage piles and are as destructive as house mice.

Whistling-Ducks feed on recently sown paddy rice, but the practice of seed treatment with insecticides and fungicides has decimated their population. This is unfortunate as they were an important source of meat for rural people. The Blue-winged Teal is the only northern duck that winters in Belize in large numbers, feeding in flooded paddies; the Teal might pull up young rice sprouts, but does not eat them, nor bother ripening rice on dry land.

Amazon parrots, especially the Red-lored Parrot *(Amazona autumnalis)* attack Indians' corn, ripping the shuck off the ear from the top down and eating the grain. To prevent this, Indians bend the stalk after the ears are full but before they ripen so that the ears hang upside down. Parrots are unable to tear the tough husk from the bottom of the ear and seem never to learn to turn upside down themselves to rip upwards. These parrots also attack fruits, especially mangoes, guavas, and oranges. They flock from considerable distances to orchards of ripening fruit and must be shot to save the crop. Most species of parrots have maintained fair populations. Parakeets sometimes descend on ripening rice or sorghum crops in considerable numbers. However, their populations have declined considerably in the last 15 years.

Montezuma Oropendulas damage oranges, inserting the long sharp bill into the fruit to suck juice before the fruit ripens. A small flock may initiate the devastation of an orchard because insects and fungus attack the punctured fruit.

Avian seedeaters (family Fringillidae) are major pests of subsistence rice growers. In commercial rice farms such as Big Falls the rice approaching maturity is attacked by large flocks of Indigo Buntings and lesser numbers of Blue Grosbeaks that are migrating north. They lay over in Belize for days or weeks, feeding heavily for their next flight.

Endangered Species

Even though Belize has a low population density and extensive areas of forest, several wildlife species are endangered or threatened with extinction. As mentioned earlier (p. 104), Belize's fauna is representative of the southern Mexico-Central America region. Cat species are categorized as endangered throughout their ranges, yet jaguars appear to have robust populations in Belize. Other widespread species such as the Jabiru Stork have a declining population in Belize. Brief explanatory comments are given below for each Belizean species listed by CITES (Convention on International Trade in Endangered Species).

Mammals

Alouatta pigra (black howler monkey) The sylvan yellow fever epidemic of 1955-57 in Central America killed all but a few small populations along the lower stretches of large rivers. Locally known as "baboons", by 1978 there were almost pre-epidemic populations in eastern Belize and southern Toledo district. However, populations are low in western Belize, where they are hunted for food by Guatemalan and Salvadoran immigrants.

Ateles geoffroyi (black spider monkey) Spider monkey populations survived the yellow fever epidemic only near the mouths of Monkey River, Sittee River and Río Hondo. This small surviving population was further reduced by the local pet trade. Fortunately, populations from northern Petén have recently spread into Belize along the forested western edge north of the Belize River and, with protection, should increase.

Lutra longicaudus (Central American river otter) Despite continuing illegal sales of hides to Mexican buyers, otters are fairly common in both lowland and Maya Mountain streams.

Felis concolor (puma or mountain lion) is common in Belize, particularly in savanna and semi-open areas.

Felis pardalis (ocelot) is fairly common in forested areas.

Felis wiedii (margay) is fairly common in hardwood forests.

Felis yagouaroundi fessata (jaguarundi) This subspecies is common and widely distributed except in savanna in Belize.

Panthera onca goldmani (jaguar) is common in Belize forests. Their territories are small, with dense populations, probably due to abundant prey (A. Rabinowitz, pers. comm.).

Stenella plagiodon (Brainville's spotted dolphin) is fairly common in deep water outside the barrier reef.

Steno bredanensis (rough-toothed dolphin) is a mid-ocean species recorded only once in Belize when a herd was stranded on the bar at the mouth of the Sibun River in 1982.

Tursiops truncatus (Atlantic bottle-nosed dolphin) is common and regularly seen inside the barrier reef.

Trichechus manatus (manatee) Belize is said to have the largest population of manatees of any country, with the possible exception of the United States. They have been protected in Belize for many years, but their meat is sold occasionally on the cays. Honduran and Guatemalan (and Belizean) fishermen illegally take manatees from Belizean coastal waters for sale in their markets.

Tapirus bairdii (Baird's tapir) Generally rare elsewhere in its range, Baird's tapir is common and lives near water. Only Garífuna have traditionally eaten tapir meat, but not being hunters, they are supplied by Creoles. Mayans who raise cattle kill tapirs because they mistakenly fear that tapirs will destroy their young livestock.

Tayassu tajacu (white-collared peccary) The peccary is still common in low areas as well as in the Mountain Pine Ridge hardwood forests.

Mazama americana (red brocket deer) is fairly common in hardwood forests. Locally known as "antelope", it is also a game species.

Birds

Harpia harpyja (Harpy Eagle) is rare. There have been five sightings in 15 years in undisturbed lowland forest. The Harpy Eagle is thought to breed in the southern part of the Chiquibul Forest and in the wilderness along the main divide of the Maya Mountains in Stann Creek and Toledo districts. Since the area is being colonized by Indians, survival of the Harpy Eagle will depend on establishment and protection of a reserve such as proposed for the Upper Bladen wilderness.

Falco peregrinus (Peregrine Falcon) Though these migratory falcons winter in Belize in small numbers, they aren't hunted and their winter habitat has not been disturbed.

Reptiles

Crocodylus acutus (American crocodile) is widely distributed along the entire coastline and the cays, where there are sheltered mangroves along rivers and lagoons away from populated areas.

Crocodylus moreleti (Morelet's crocodile) is a smaller crocodile species that lives in inland lagoons, rivers, streams and even the upper streams of the Maya Mountains. Since 1974 when commerce in hides became illegal, the population has been rebuilding. However, according to Abercrombie et al. (1980) the population consists mostly of juveniles with less than 10% breeding adults.

Dermatemys mawii (Central American river turtle) This turtle is an important food throughout its range from Veracruz, Mexico, along the coast of Belize and eastern Guatemala. The turtle is rare in Guatemala and Mexico. Though fairly common in Belize, it is the only living representative of the Dermatemyidae, a turtle family known from as early as the Cretaceous (del Toro et al. 1979).

Chelonia mydas (green turtle), *Eretmochelys imbricata* (hawksbill), and *Caretta caretta* (loggerhead) occur in Belizean waters and in the 19th Century they were all exported in large numbers. Their numbers are greatly reduced but a few turtles still nest in the southern cays, especially Ranguana, Pompion, Silk and Sapodilla Cays (Perkins 1983). About 1200 kg of meat is still sold annually for local consumption and eggs are taken for food, though the latter is illegal. Making tortoise shell jewelry is not prohibited by law; such jewelry is available in tourist shops though it is illegal for tourists to take it out of the country. Mounted hawksbill yearlings (taken illegally) are regularly sold to tourists. These turtles should have full protection or at least there should be a moratorium on the taking of turtles.

Iguana iguana (common iguana) Except for a few inaccessible mountain streams, riversides are searched during the nest season for gravid females and their eggs. The female iguana population is severely reduced.

Species with Dangerously Low Populations

The following bird species are not listed as endangered species by the International Council for Bird Preservation (ICBP). However, the reduction of their numbers appears to be related to habitat destruction, hunting or other human pressures and practices.

Egretta rufescens (Reddish Egret) Ten to 12 pairs nest at Shipstern Cay in the north and perhaps the same number at Cayos Pajaros behind Ambergris Cay. These are the only known populations. Both cays are vulnerable to destruction of breeding habitat as cay use by humans increases.

Agamia agami (Agami or Chestnut-bellied Heron) is a shy heron living along forested streams; it is known only from Spanish Creek, Black Creek, Mussel Creek and Labouring Creek. The proposed Crooked Tree Lagoon Reserve, which includes all of Black Creek, should help preserve this rare species.

Mycteria americana (Wood Stork) There were large populations of wood storks in Belize, but they have been greatly reduced in the last 10 years. A number of wood storks can be seen at Crooked Tree Lagoon in the dry season, including year-old birds. These may be from an unidentified colony in Belize or they may be migrants from Mexico.

Jabiru mycteria (Jabiru Stork) There are only 9-12 breeding pairs in Belize. The surviving young about balance those being killed each year.

Eudocimus albus (White Ibis), *Casmerodius albus* (Great Egret) and other egrets and herons occur in fair numbers but habitat destruction and hunting pressures have eliminated half of their breeding territories. These birds promote turnover of plankton, the base of the fish food chain.

Ajaia ajaja (Roseate Spoonbill) nested on Cayo Rosario and occasionally on Cayos Pajaros 15 to 20 years ago. These populations were destroyed by local fishermen from Ambergris Cay. Though there are no known breeding areas in Belize, as many as 30 spoonbills (possibly migrants) can be seen at Big Falls, Crooked Tree Lagoon and sometimes in the mangrove bays of Ambergris Cay.

Dendrocygna autumnalis (Whistling-Duck or Black-bellied Whistling-Duck) was an important meat source that was often sold at the market. Due to extensive poisoning--the nocturnal ducks flock to eat seed rice coated with insecticides and fungicides--the populations are now very small. They have, however, shown a large increase in 1983/84.

Cairina moschata (Muscovy Duck) Though protected, this duck is a favorite food when found. Populations are low but the species may escape local extinction because it does not usually flock. Pairs are well dispersed in remote forested streams.

Cathartes burrovianus (Lesser Yellow-headed Vulture) Though being studied only recently by the Vulture Study Group of the ICBP Birds of Prey Group, recent censuses indicate an unprecedented low population (1983) throughout eastern Mexico and Belize.

Chondrohierax uncinatus (Hook-billed Kite), *Harpagus bidentatus* (Double-toothed Kite), *Leptodon cayanensis* (Gray-headed Kite), *Geranospiza caerulescens* (Crane Hawk), *Accipiter bicolor* (Bicolored Hawk), and *Falco deiroleucus* (Orange-breasted Falcon) are rare in Belize. These birds are shot by hunters usually out of curiosity.

Spizastur melanoleucus (Black-and-white Hawk-Eagle) is known only in the Mountain Pine Ridge. In 1981 a pair nested in the Upper Guacamayo Valley and previously a pair nested near the 1,000 Foot Falls. Both areas are located on boundaries between pine and hardwood forest.

Spizaetus tyrannus (Black or Tyrant Hawk-eagle) occurs in lowland hardwood forests where it is seen more often than other hawk-eagles. Formerly common along the Hummingbird Highway, it is no longer seen there due to extensive deforestation and hunting.

Spizaetus ornatus (Ornate Hawk-eagle) is the rarest of the three hawk-eagles in Belize, known only from the upper Sibun River gorge.

Harpyhaliaetus solitarius (Solitary Eagle) has been seen in the Mountain Pine Ridge. Immature birds have been seen in two different years so this species is apparently breeding there.

Agriocharis ocellata (Ocellated Turkey) The range of this species is from eastern Chiapas and southern Quintana Roo in Mexico, northern Petén in Guatemala, and northern and western Belize, southeast to the divide of the Maya Mountains. Despite legal protection, it is heavily hunted throughout its range. In areas of milpa farming north of the Belize River around Saturday Creek, Valley of Peace, and forests to the north, reduced populations of the wild turkey seems to be a result of diseases spread by poultry, rather than due to hunting.

Pardirallus maculatus (Spotted Rail), *Amaurolimnas concolor* (Uniform Crake), and *Laterallus jamaicensis* (Black Rail) are rare. Little is known about the conservation of these birds, but Spotted Rails have been reported from two sites in 1982-83 so their numbers may be increasing.

Heliornis fulica (Sungrebe or American Finfoot) Though rare in many surrounding countries, it is common in the lowland rivers and creeks of Belize. Even with farms and fishing camps in their breeding areas, this bird's populations seem to be stable.

Eurypyga helias (Sunbittern) is known from one unsubstantiated record.

Anous stolidus (Brown Noddy) and *Anous minutus* (Black Noddy) These birds were reported nesting at Southern Cay in Glover's Reef in 1864 (Salvin 1864). Brown Noddies have been sighted there regularly, but no sightings of Black Noddies have been made in recent years. Protection should be given to Southern Cay as it is the only noddy breeding ground in Belize.

Columba leucocephala (White-crowned Pigeon) Once common, a few birds nest on Long Cay in Lighthouse Reef and possibly elsewhere off the coast. This pigeon is a favorite game bird, although protected by law.

Ara macao (Scarlet Macaw), once common, has been reduced to 10 breeding pairs in the Chiquibul Forest near Millionario.

Amazona ochracephala (Yellow-headed Parrot) is the best talking parrot species in the New World. Though the

Forest Department and Ministry of Natural Resources have halted commercial sales of this species, a great demand fuels the black market trade for these parrots and jeopardizes reproductive success.

Monitoring Endangered Species Status

Belize's endangered animal and plant species should be monitored to gather basic natural history information and accurately determine present status, threats, and management possibilities.

IV–J. ENERGY

Imported Energy

Virtually all of the energy consumed in Belize is produced from imported petroleum products. Belize imports between 600,000 and 900,000 barrels (MEC 1982) of oil products, costing B$55 to B$85 million (MEC 1982). Most petroleum-supplied energy is used for transportation or heavy construction equipment (Table IV-11). Approximately 29 million liters of gasoline were imported in 1980 (GOB 1981b). Most of this was used for fueling automobiles that have large-displacement, fuel inefficient engines.

Table IV-11. Sector distribution (%) of petroleum product imports.

Transportation	55–60
Electricity Production	20–32
Aviation & Bunker Storage	8–12
General Domestic Use	8–9
Miscellaneous	6–7

Fiscal incentives favoring the importation of light weight, small-engine, fuel efficient vehicles could reduce national gasoline consumption by one-third, equivalent to a savings of B$4.5 million annually (RN&A 1983).

Electricity

The Belize Electricity Board (BEB) is the statutory body charged by the GOB with the responsibility of providing the country with electricity. The BEB operates diesel generating plants at Corozal, Orange Walk, Belize City/Ladyville, Belmopan, Dangriga and Punta Gorda. The BEB also transmits electricity to some surrounding areas. A 6.6 KV transmission line carries electricity from Corozal south to San Narciso; another 6.6 KV line extends electricity from Orange Walk west to Yo Creek and south to Tower Hill. The Belize City/Ladyville complex serves the surrounding area by a 22 KV line. A second 22 KV line connects Belmopan to Santa Elena, serving Roaring Creek Village and three other settlements. Voltage is reduced at Santa Elena to 6.6 KV and extended to Benque Viejo.

Abnormally high transmission line losses have largely offset a 1978-82 production increase from 76 to 85 million KWH per year. Available electricity has therefore remained nearly constant at 70 million KWH per year. It has been suggested that this levelling of available electricity has contributed to economic stagnation (MEC 1982; World Bank 1983). Diesel generators can be efficient, reliable and economical, but only by keeping the generators and all connecting equipment in excellent condition will there be high efficiency resulting in lower diesel consumption.

Current potential rated capacity of BEB generators is 23-40 MW (BEB 1983; MEC 1982); however, only about 12 MW is available for consumption. The electrical supply situation for BEB customers is critical, particularly in the Belize City area.

Inadequate plant facilities and limited transmission lines have forced many potential BEB customers to invest in private generating plants. Nearly all private systems operate only part time. Generators at the sugar refineries run at full capacity only during production months. Many community generators produce electricity only a few hours a day; however, sporadic operation and relative inefficiency of private generation facilities create a high cost per KWH.

The major failure of the BEB is the inability to devise a program to meet the growing demand for electricity. Inefficient operation and maintenance of equipment may result from managerial and technical inadequacies. There is little evidence that studies made by outside agencies have been given more than cursory attention (BEB 1983).

A comprehensive United Nations Energy Project study determined national electrical needs and predicted future requirements for the purpose of developing an overall strategy for electrical production (MEC 1982). The report's forecast of unrestricted electrical consumption of 286 million KWH in 1995 is based on extrapolations from dubious statistical data and is at considerable variance with other predictions (Lewis 1981).

Demand for electricity continues to increase as long as the supply is not restricted. Belize should be prepared to address its energy problem in an intelligent and organized manner in order to correct inadequacies of BEB service. Belize's dependence on numerous small private generating systems and the BEB's inability to provide reliable electrical service have so far not been resolved by the ministry responsible for energy (MEC).

Provision of Electricity

Availability of electricity differs widely between districts (GOB 1982c, Bulletin 3). In Belize district, 78% of the population has electricity available; but only 19% of the population in Toledo district has electricity.

Available electricity is highly biased toward urban centers. Although the number of households is comparable between urban and rural areas (14,800 vs. 13,300), electrical service to urban homes is three times greater (87% vs 29%) than in rural areas. Electrical service to scattered rural communities is difficult when the majority of communities have fewer than 70 families.

The non-urban population (76,000) is scattered over an area the size of the state of Massachusetts. One-third (24,000) live in widely-separated communities of less than 400 and another 1500 live in communities of less than 50 people. Statistics show that 42% of Belize's population is without electricity.

Adding to the problem of providing electricity to a widely dispersed, essentially rural population is the low power requirements of the country. It is estimated that present demand for electricity, public and private, is only 80-85 million KWH per year without interruption (Lewis 1981, MEC 1982). The need is for small amounts of power efficiently distributed over a relatively large area.

Development of Electricity-Producing Strategies

Belize's electrical energy requirements are not well defined. The critical issue in energy production is not the availability of energy *resources* but the manner in which these resources should be employed. The Belize Electricity Board (BEB) needs to formulate an overall energy strategy to satisfy current and future urban and rural electrical energy requirements. Electrical generating and distribution is largely the responsibility of the BEB; however, the inefficiency and expense of the BEB's product, as well as disruptions in service, may be the motivation for private generation of electricity.

Belize requires a multifaceted approach for supplying electricity to its citizens. In northern urban areas emphasis should be on improving existing facilities to provide reliable power. Present service is inadequate in these areas because of deteriorated equipment. A systematic replacement of worn out generators and an improvement of existing transmission lines to eliminate abnormally high line losses would be reasonable initial measures. Tying together the northern part of the country with a new, high voltage grid is contingent on negotiated purchase of electricity from Mexico. It should be subject to thorough economic and technical analyses. Providing a reliable and economical supply of electricity should be the first priority.

In rural areas, particularly in southern districts, emphasis should be on providing electricity to the population that is currently without service (42%). Installation of a number of moderate size, high efficiency electrical generating facilities (both hydro and diesel) could supply clustered communities such as in western Cayo district and Toledo district. Smaller, more dispersed communities would have to rely on small generating facilities, possibly hydro, diesel or solar.

Belize has been purchasing small amounts of electricity from Mexico to provide power to the border town of Santa Elena. However, a proposal was made by the Comisión Federal de Electricidad de México to sell Belize up to 20 MW of electricity during a five year build-up period from their thermal power plant at Xul-Ha (MEC 1982). This proposal would entail the construction of a 115 KV transmission line to convey electricity from the border to the Belize City/Ladyville complex. If the BEB accepts the Mexican proposal, the power boost of Mexican electricity should help alleviate the current electricity crisis in the Belize City/Ladyville complex. The necessary construction of efficient transmission lines to the northern communities should provide the infrastructure for eventual conversion to hydroelectric or other electric generation in Belize.

The Belize City/Ladyville complex suffers power failures due to malfunctioning equipment. Peak load demands for this complex indicate an increase during the next 15 years from present value of 8-10 MW to 15-35 MW (Lewis 1981; BEB 1982, 1983). The Mexican electricity would certainly benefit the complex, but some supplementary local generation would still be necessary. New equipment will have to be installed to meet increasing electricity needs over 20 MW, and ultimately to replace the proposed Mexican supply of power.

Though buying electricity from Mexico would only benefit the populations of the Belize City/Ladyville complex in the near future, it could help to initiate the eventual overhaul of Belize's energy program.

Other development strategies for supplying Belizeans with electricity include hydroelectric generation, solar energy, and biomass conversion especially of wood, bagasse and energy cane. Belize has sufficient water, solar and biomass resources (Alexander 1982) to provide all of its electrical energy requirements for the foreseeable future.

Generation of power by using falling water is a clean, efficient way of using a renewable resource. Few areas in Belize have been studied for their suitability as electric generating sites (Grover 1981), but the possibility of generating electricity and providing potable water, too, should not be overlooked. It takes little more than water in a stream on a hillside to obtain hydroelectric power. The Mennonites in Blue Creek use a shallow impoundment to generate their electricity.

Though the base data on environment, streamflow, meteorology, geology, topography, and engineering would all necessarily precede installation of a generating plant,

these data are not currently available. Some potential sites have been identified (see p. 66) and inexpensive studies could be completed for the smallest sites that would be suitable for "off-the-shelf" generators. See Chapters IV-C and IV-D for other possible and larger hydroelectrical generating sites.

Solar energy, with special emphasis on the generation of electrical energy by using photovoltaic cells (a metal and semiconductor, when struck by sunlight, react to convert light energy to electricity) is also a clean and efficient use of a renewable resource. In areas of high incidence of solar radiation, harnessing solar energy is practical. Still, the initial expense of installing solar energy devices can be too expensive to serve those who would receive the most benefit.

Compared to conventional systems, i.e., hydroelectricity and diesel generation, photovoltaic systems are elegantly simple in operation and require little maintenance. The systems are increasingly used in third world areas (ARCO 1982), especially to provide water pumping systems for villages and simple lighting (PTA 1982).

The major drawbacks to securing photovoltaic systems in Belize are funds to provide the systems to the rural poor.

Use of wind generating devices on the cays and coastal areas can produce enough energy to light homes and run small appliances.

Combustion of biomass to generate electrical energy is possible when the resources such as wood, bagasse or energy cane can be economically produced, especially on lands that are not needed or suited to produce food crops.

Saw mill residues can be burned for energy, but in Belize they would produce only enough energy to run the small sawmills. Thermal energy from bagasse (sugar cane residue after the sugar is removed) is a viable technology wherever sugar cane is produced. Indeed, bagasse has been used modestly this way in Belize for some time. The use of bagasse from the two major sugar mills in Belize could produce approximately 10–16 million KWH with an installed peak output of 4 MW during the six months of sugar processing (MEC 1982). This use of bagasse for production of electricity could theoretically reduce diesel imports by B$4 million/year.

Though bagasse could be used to produce electricity and the option seems attractive, no proposals have been made by GOB or the sugar industry, perhaps due in part to the poor state of the industry.

Energy cane, developed in 1977 in Puerto Rico by the U.S. Department of Energy, is a hybrid grass with an incredible growth potential (CEER-UPR 1982). Energy cane accumulates biomass rather than sucrose (sugar cane), and it can be harvested throughout the year. The plants can be grown near areas of high electrical consumption and the technology has been developed to grow, harvest and convert the energy cane to electricity. If two thirds of the area now devoted to sugar cane (25,000 ha) were planted with energy cane (at 12% efficiency, an electricity generating plant could produce 660 million KWH/year), this would be more than twice the projected country demand for electricity in the year 2000 (Alexander 1982 a,b; UPR 1982).

V.

Institutional and Legal Aspects of Environmental Issues

V–A. INSTITUTIONS RESPONSIBLE FOR NATURAL RESOURCES CONSERVATION AND DEVELOPMENT

Government Organization

Since independence on 21 September 1981, Belize is a constitutional monarchy with The Queen of the British Commonwealth as titular head of state, represented in Belize by a Governor-General, whom the monarch appoints after consultation with the Prime Minister of Belize. The Constitution of Belize is the supreme law of the land. The Governor-General must act in accordance with the advice of Cabinet in almost all instances. Only in certain constitutionally prescribed circumstances may the Governor-General act on his own judgement. For instance, the Governor-General is constitutionally required to appoint as Prime Minister "a member of the House of Representatives who is the leader of the political party which commands the support of the majority of the members of that House" [Section 37(2), Belize Constitution]. However, if no party controls the House, the Governor-General may appoint the member of the House of Representatives who "appears to him likely to command the support of the majority".

The Cabinet

The Cabinet directs policy of the GOB. It consists of the Prime Minister and such number of Ministers of Government as may be created by the National Assembly to be responsible for any business or department of government. The Ministers are appointed by the Governor-General on the advice of the Prime Minister from among members of the House of Representatives and the Senate, excluding the Speaker of the House and President of the Senate. The Cabinet is collectively responsible to the National Assembly for all actions of its Ministers in the execution of their duties.

Because Ministers are appointed on the advice of the Prime Minister, the latter's influence in policy decisions made by the Cabinet cannot be overstated. The Prime Minister presides at all Cabinet meetings; in his absence, a minister of his choosing presides.

The National Assembly

Belize has a bicameral legislature, with an elected House of Representatives and an appointed Senate. There are eight senators, five of whom are appointed by the Governor-General on the advice of the Prime Minister, two on the advice of the leader of the opposition, and one on the advice of the Belize Advisory Council. Currently there is a ninth senator because the appointed senators elected a non-member as their president. This practice is constitutionally allowed for both President of the Senate and Speaker of the House, but neither is entitled to vote. There are currently 18 elected representatives, plus the non-member Speaker for a total of 19. The constitutional maximum number of representatives is 29 with the requirement that each representative be elected by a constituency of at least 2,000 but not more than 3,000 registered voters; that is, when there are more than 3,000 voters, the district limits are shifted to distribute the voters to add a new representative.

The House is clearly the stronger body in the National Assembly. Though the Senate or other government bodies may originate legislation, the House must concur before it can become law. Legislation introduced in the House, on the other hand, can be presented to the Governor-General for assent without the Senate's approval if passed by the House in two successive sessions.

The Belize Advisory Council has at least six persons, four or more appointed by the Governor-General on the advice of the Prime Minister after consultation with the opposition leader, and at least two appointed on the advice

of the Prime Minister with the concurrence of the opposition leader. The Council functions to advise the Governor-General on the exercise of the royal prerogative of mercy and the removal of judges from the Supreme Court or Court of Appeal. The Belize Advisory Council also acts as an appellate in disciplinary matters relating to public service.

Ministries of Government

Virtually every one of the ten GOB Ministries conducts some program involving environmental regulation and/or natural resource management: no single Ministry is responsible for environmental regulation and/or conservation in Belize. Thus, ministerial coordination of environmental activities is cumbersome and confusing. Rarely is there adequate opportunity to evaluate environmental consequences.

Theoretically, each ministry has a development coordinating committee that reports to the Permanent Secretary. Permanent Secretaries collectively form a Central Coordinating Committee whose function is to provide interagency coordination of development activities. This committee, in turn, reports to the Cabinet Development Committee, the body responsible for approving and implementing national development plans. But development projects are often underway before necessary reviews are completed. The review process is aggravated by shortages of qualified government personnel, funding for the projects and conflicts of interest within and between ministries.

In the following synopsis of each ministerial portfolio, only environmentally-related subjects are mentioned. It should be noted that the number of ministries and the responsibilities of each ministry can be altered by the Governor-General at the request of the Prime Minister.

The *Ministry of Finance and Defense* oversees aid programs, banking, investments, culture, natural disaster response as well as the Development Finance Corporation and the Reconstruction and Development Corporation.

The *Ministry of Home and Foreign Affairs and Attorney General* covers aliens, district administration, general election to House of Representatives, information and population, laws and legal affairs.

The *Ministry of Local Government* oversees local elections, local government and town boundaries.

The *Ministry of Works* (MW) is responsible for bridges, the port authority, ports and harbors, public works, reclamation and drainage and roads.

The *Ministry of Natural Resources* (MNR) covers agriculture, livestock, forestry, geology, land settlement and survey, marketing, security of tenure, and veterinary and animal health.

The *Ministry of Energy and Communications* (MEC) is responsible for electricity, telecommunications, meteorology, water and sewage, and traffic.

The *Ministry of Health, Housing and Cooperatives* (MHHC) oversees building, drugs, fisheries, quarantine, credit unions, and agricultural and fishing cooperatives.

The *Ministry of Labor, Social Services and Community Development* carries the responsibility for children, community development, labor and factories, liquor licensing, public assistance, trades, workers and social development.

The *Ministry of Education and Economic Development* administers the census, education and scholarship, libraries and museums, vocational training and youth.

The *Ministry of Trade and Industry* (MTI) covers archaeology, the Citrus Growers' Association, consumer protection, development incentives and investments, export marketing, the Sugar Control Board, supplies and price control, and tourism.

Quasi Public Agencies

There are a number of quasi public agencies involved in the exploitation and conservation of the country's natural resources. The *Belize Marketing Board* (BMB) acts as a commodities market for such products as rice, corn, red kidney beans, and imported milk. The BMB is supposed to stimulate agricultural production by providing markets, storage and milling facilities, as well as insulating small producers from world market fluctuations. The BMB is a serious economic drain on the GOB as a result of its subsidies, but its role as a market advisor could be extended to help small and medium producers.

The *Belize Sugar Board* (BSB) is a statutory body that carries out research for and extension services to the sugar industry. With only four extension officers, the program seems barely adequate. New regulatory programs (e.g., pesticide controls and use requirements) will require an increase in staff.

The *Banana Control Board* (BCB), another statutory body, employs small farmers, trains them in management techniques and centralizes banana exports. It is an economic drain because it is subsidized by GOB and the training program has been inadequate.

The embryonic nature of the *Belize Tourist Board* (BTB) reflects the state of the tourism industry. Currently with a staff of six persons, BTB will have to expand its staff and operations to keep pace with the anticipated expansion of tourism. The BTB should undertake a comprehensive training and promotion program if tourism development is given high priority.

The *Belize Electricity Board* (BEB) is a GOB-controlled statutory body providing unreliable and expensive electric service. Blackouts occur in Belize City on virtually a daily basis. Creation of a National Energy Plan should help solve the essential problems of management, maintenance, inefficiency, and dependence on imported fuel. The BEB will probably continue to drain financial resources from the GOB.

The *Belize Telecommunications Authority* (BTA) has recently expanded and improved services. The comparatively good financial performance of the BTA contrasts with other quasi public bodies.

The aforementioned bodies as well as private trade organizations, influence political decisions in Belize. Cooperatives and agricultural associations, especially in the fishing, sugar, and citrus industries, influence policy affecting their industries.

Non-Governmental and International Organizations

Domestic Private Groups

Belize has many voluntary organizations or civic groups (per capita) actively involved in social causes. Though civic groups are beginning to address environmental problems in their urban areas, there is still little community involvement in environmental affairs. However, USAID funds through a PVO grant are being made available to help finance some of these groups.

The *Belize Audubon Society* (BAS) has been a major force behind GOB conservation legislation. It directs and assists in financing (especially from international conservation organizations) conservation projects and calls international attention to conservation issues in Belize. With about 150 members, the BAS maintains close ties with government.

International Conservation Organizations

A number of conservation-oriented foreign groups have assisted the BAS in its efforts to protect Half-Moon Cay, including the World Wildlife Fund (WWF/US), the New York Zoological Society (NYZS), the U.S. National Audubon Society, the Rare Animal Relief Effort (RARE), the U.S. Nature Conservancy, the Tropical Agronomy Teaching and Research Center (CATIE), the International Council for Bird Preservation (ICBP), and the Fauna Preservation Society. A research grant from WWF (Wild Wings) is helping with support of one BAS member to provide the base data necessary to establish Crooked Tree Lagoon as a reserve.

NYZS and CATIE have played a broad role in conservation issues in Belize. The NYZS has recently completed a study assessing the barrier reef ecosystem (Perkins 1983), has provided orienting and explanatory signs for Half-Moon Cay, is carrying out a major study of jaguars in the Maya Mountains, and is working with BAS to promote the designation of Cockscomb Basin as a reserve for jaguars, and the establishment of Bladen Branch nature reserve.

Other wildlife related research has been undertaken by WWF/US and NYZS--crocodiles; and the Smithsonian institution--ongoing research on Carrie Bow Cay focusing on shallow water marine ecosystems, and initiating a mangrove research program.

In 1981, representatives of NYZS and BAS initiated efforts to encourage the GOB to request: (i) that UNESCO designate Belize's barrier reef as a World Heritage Site under the Convention concerning the Protection of World Cultural and Natural Heritage; and (ii) that the IUCN and CATIE assist Belize in preparing a National Conservation Strategy. It is hoped that both important goals will be realized. Although there was some initial confusion as to whether or not Belize is a signatory of the Heritage Convention, the reef is now a candidate for World Heritage status, a designation that would make available international heritage funds for Belizean management of the barrier reef.

The GOB has requested assistance from IUCN for the preparation of its country conservation strategy, and IUCN has responded by hosting several meetings and preparing a report outlining a "pragmatic" approach to development of the strategy. Support for IUCN's efforts has come from UNEP, USAID and WWF/US. The MNR has allotted one middle-level Forest Department official to work half-time on the strategy. In order to succeed, the country conservation strategy will have to obtain support from higher levels of government. Outside financial assistance will be necessary to see that the conservation strategy is implemented and enforced.

Technical Assistance Organizations

The Cooperative for American Relief Everywhere (CARE) had a program to improve rural water systems during the 1970's and continues to run a rural education and agricultural program (REAP) that is so successful it is being expanded to include students from urban areas. The primary aspects of REAP are sound land management and conservation. CARE is working with the GOB and fishing cooperatives to encourage conservation on the barrier reef, utilization of non-traditional fish species and fishing areas, and increasing fish-processing capabilities.

Since the 1960's the U.S. Peace Corps (PC) has been involved in Belize and currently has about 80 volunteers –the highest ratio of PCVs per capita in the world. PCVs assist GOB and outside agencies in education, rural development, health, social services and technical services. Though PCVs do not work directly in natural resources management, they advocate conservation and sanitation, provide expertise in plant protection, grain storage, health

planning, livestock management, alternate energy and archaeology. Local PC officials say they could provide the GOB with qualified volunteers in ecology and resource management, wildlife protection, natural monuments, pollution control and water quality control.

Some of the other organizations providing technical assistance in Belize are the Pan American Health Organization (PAHO)--malaria eradication program; Heifer Project International, Partners of the Americas, the Mid-West Universities Consortium, the Universities of Wisconsin and Michigan, the Kalamazoo Foundation, World Vision, the United Church Ministries--the Belize Feedstuffs Project; and Britain's Voluntary Service Overseas (VSO)–volunteers to work in GOB ministries. See p. 42.

Development Assistance Organizations

Almost all public capital investment projects in Belize are undertaken with grants and loans provided by multilateral and some bilateral development assistance agencies. At present, some 50 projects, with committed international funds of about US$66 million, are in operation or recently completed in Belize. The GOB also has a priority list of nearly 50 more candidate projects, with funding secured for about half of these proposals. More than half of these projects are designed to improve or construct basic economic infrastructure, especially roads, bridges, airports, highways, harbors and electricity production. About 40% of international assistance goes to support activities in the agricultural and rural sectors; another 10% supports social service, social infrastructure (water supply, sewage) and educational projects.

Great Britain continues to provide nearly 40% of all foreign assistance to Belize. In addition to USAID, other sources of funding have been growing in recent years, especially from the Caribbean Development Bank, the European Development Fund, the Canadian International Development Agency and the United Nations Development Program. The World Bank has recently begun to provide loans to Belize, but Belize remains ineligible for membership in and assistance from the Organization of American States and the Inter-American Development Bank because of the continuing dispute with Guatemala.

Although a large number of projects capitalized by international development assistance agencies involve the clearing, moving, exploitation or conversion of soil, minerals, water, vegetation and animal life, none of these major development projects (except perhaps water and sewer projects) can be categorized exclusively as an environmental or conservation project. Given the relatively short-term economic development focus of most agencies, this is to be expected. On the other hand, most major international development assistance agencies operating in Belize have begun to evaluate projects from an environmental perspective and to take steps to minimize adverse consequences.

In general, the relatively small scale of development projects in Belize has the advantage of reducing the chances that large ecological catastrophes will ensue from activities generated by the influx of international capital. For example, although livestock programs are liable to receive increased support from international donors seeking to help Belize diversify its economy and increase exports, cattle ranching operations that seem large by Belizean standards are likely to be much smaller than in other countries and the adverse environmental repercussions will probably be easier to contain.

Ironically, the relative smallness of development projects in Belize could also result in less attention being paid to environmental assessment by international donors, particularly multilateral banks. This is because environmental assessment procedures of the banks tend to be highly centralized in the hands of one office or a few officials in the central headquarters. With these individuals or teams called upon to review large numbers of projects in many countries, proposed Belizean projects may receive less attention because they will tend to be among the smallest in dollar terms. This may also increase the need for GOB to develop its own capacity to undertake environmental assessments of development projects, a need which the bilateral agencies, or agencies such as UNEP and UNDP have more flexibility to address than do the international lending institutions.

Some of the major projects funded or proposed by international donors that either have an environmental component or potential environmental consequences are detailed below.

USAID opened its bilateral mission in Belize in early 1983; prior to that time USAID assistance was provided to Belize through its Regional Development Office/Caribbean regional program. USAID's overall country development strategy has focused to date on providing short-term economic stabilization assistance and identifying long-term projects that will lead to diversification of the economy away from dependence on basic imported commodities, and encourage sustainable economic development. With passage of the Caribbean Basin Initiative, Belize has received US$10 million of the US$350 million total package, much of which is targeted to help improve the country's foreign exchange outlook, increase liquidity in the domestic banking system, and make more funds available for private sector development. The large projects (budgeted from the above-mentioned US$10 million and USAID's 1983-1984 Development Program) include a US$4.6 million cash transfer loan to the GOB, a US$5 million loan to the Central Bank of Belize for establishment of a Commercial Bank Discount Fund (CBDF) to stimulate private sector investments, US$2 million for housing improvement, US$3.3 million for livestock improvement, and a US$6.0 million grant to finance rural access roads and bridges. USAID also provides support for private voluntary organizations (PVOs) to operate community-based development activities through the Belize National Development Foundation (inaugurated March 1984).

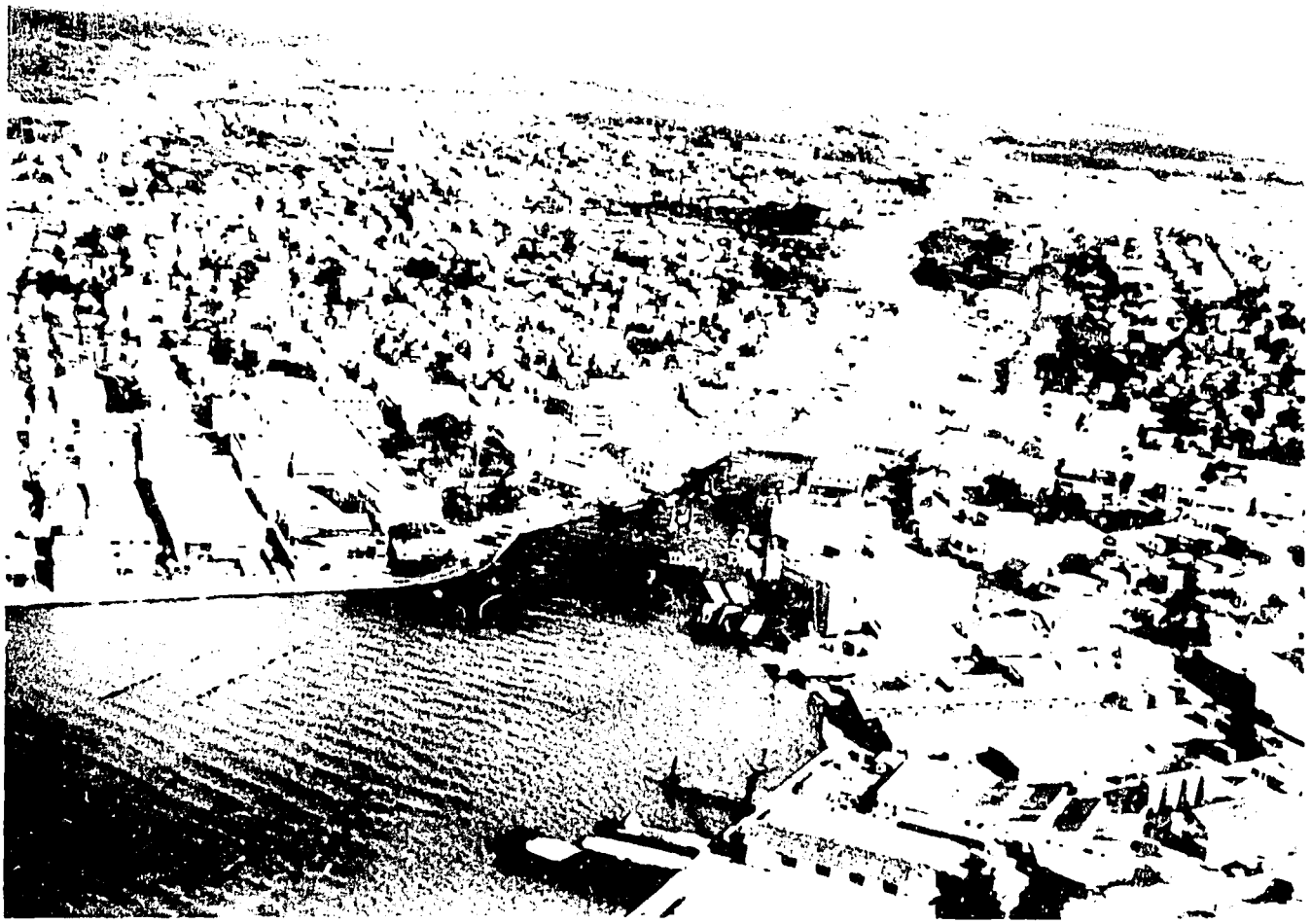


Figure V–1 — Aerial view of Belize City with Haulover Creek, center to top right. (photo G. Hartshorn)

While the 1983 USAID cash transfer loan has no direct environmental repercussions, the CBDF project could stimulate projects with possible negative environmental effects; however, the GOB and USAID might then provide environmental assessment expertise and training. The intent of the CBDF project is to increase productive private-sector development, especially food production and exports. The USAID loan enables the Central Bank to establish a fund allowing commercial banks to provide discount loans for farming, manufacturing and processing projects (for example, fishing, timber, bricks, cattle, canning, edible oils, and aquiculture).

One of the four covenants agreed to under terms of the CBDF part of the loan approved in March 1983, is that the borrower must prove to USAID's satisfaction that a proposed project will not damage the environment. Although the covenant is somewhat broad and vague, the AID mission director has indicated his intention to examine proposed projects and, when necessary, call upon environmental consultants to assess potential environmental problems as well as recommend project improvements.

Potential problems that were reviewed as part of AID's required initial environmental examination of the CBDF project include soil infertility, erosion, cultivation of steep hillsides, pesticide abuse, destruction of mangrove forests and deforestation. A major concern is the management of pesticides in Belize; the potential exists for increased human and agricultural exposure. Training is essential and must precede pesticide use; chlorinated hydrocarbon pesticides must be disallowed for project funding.

Belize is establishing procedures for monitoring systems that will certify that pesticide residues in plant and animal imports do not exceed U.S. standards. Since the GOB has little expertise, no money, and no testing laboratories or equipment, it will need substantial technical and financial assistance to satisfy U.S. import certification requirements. Because USAID wants to help Belize become agriculturally and economically stable, and since pesticide monitoring will primarily satisfy U.S. requirements, AID should try to sustain those costs.

The Canadian International Development Agency (CIDA) has been supporting a long-term program (since 1974) to upgrade the water supply and sewage system of Belize City (Fig. V-1). To date, CIDA has contributed over US$40 million for this project and nearly half of this amount has been in the form of outright grants or a no-

interest loan. CIDA has also been active, albeit on a much smaller monetary scale, in supporting a project to stabilize and diversify the Belizean fishing industry. The project focuses on conservation of dwindling lobster and conch populations along the barrier reef, research, and cooperation with CARE's projects.

The British Overseas Development Administration **(ODA)** allocated B$12 million in loans and grants for support of the newly independent GOB in 1981, to be disbursed in annual amounts of B$3 million. ODA helps with highway, bridge and water supply construction as part of an extensive Belize/UK Infrastructure Development Program. In addition, the first World Bank loan agreement with Belize was signed in the spring of 1983, providing about US$5.3 million for construction of roads and improvement of drainage along the Southern Highway.

For the most part, USAID, CIDA, and ODA projects do not involve clearing of forest for new roads, thus the chances of serious environmental consequences are low. However, international donors should evaluate their projects to reduce negative secondary environmental effects. Road improvements lead to spontaneous settlements, deforestation, and erosion problems. Quarrying and stone crushing operations that provide materials for road construction are necessary, but care must be taken to not endanger the natural surroundings. Ultimately the improvements made through financial aid to the GOB are the responsibility of the GOB.

Two regional multilateral banks have provided increasing amounts of development assistance to Belize in recent years: the Caribbean Development Bank **(CDB)** (with large contributions from the U.S.) has provided about one quarter of foreign project assistance in Belize; and the European Development Fund **(EDF)** now accounts for about one tenth. CDB provides funds for the banana industry, electricity production, the Development Finance Corporation, dredging Belize City's harbor, construction of the Belmopan Hotel, rice marketing, and secondary road construction. Although environmental assessments were not done for these projects, no serious environmental consequences have been identified. Some concern has been raised about the consequences of CDB's interest in doubling Belize's cattle herd as rapidly as possible. Since USAID and the World Bank are also supporting an enlarged cattle industry, the U.S. Government should ensure that long-term sustainability and the environmental consequences of cattle projects are considered. Most EDF funds support small farmers, education and television broadcasting, as well as construction of a veterinary laboratory, an apron at the international airport, and schools.

Within the United Nations system, UNICEF and UNDP have been particularly active in Belize. UNICEF's programs at the village level include community development and water supply and sanitation. UNDP focuses on enhancing development through the Belize Public Investment Project. It has posted foreign financial consultants in the Ministry of Finance to set up the Belize Investment Center. UNDP's key recommendation is to establish a development office that would be responsible for preparing guidelines and evaluating and coordinating all potential development activities.

Environmental Education

Belize is blessed with an abundance of unspoiled land and most of its people have not seen nor felt the effects of environmental deterioration. Local people are being made aware of the effects of poor sanitation including faecal and solid waste disposal, the need for potable water and the importance of natural resources such as soil, water, wildlife, fisheries and forests. However, most Belizeans are unaware of the effects of uncontrolled exploitation of the country's natural resources.

Various ministries involved in natural resources conservation or exploitation should have stimulating programs that will help inform Belizeans about their rights and responsibilities for use of the environment. Well-intentioned environmental legislation (see p. 119) needs to be explained to the public, and public voluntary organizations should be encouraged and financially aided to effect necessary environmental action.

The Belize Audubon Society has made a commendable beginning, bringing environmental education programs to primary schools by slide-illustrated talks and to the general public by radio programs. These efforts should be intensified and increased; environmental education programs should be introduced into the curriculum for primary schools of Belize. Rare Animal Relief Effort (RARE) has received funding from USAID to stimulate environmental education programs in Central America and the Spanish-speaking Caribbean Community, including Belize. For example, in cooperation with ASCONA in Costa Rica, RARE developed a Resource Management Education Program that is being successfully incorporated into the curriculum of primary schools that reach some 25,000 students in Costa Rica. In addition to the prepared environmental education program, the Costa Rica program includes in-service and curriculum guide training for teachers. This type of effort is needed in Belize and RARE has made preliminary inquiries with the Fisheries Unit and Ministry of Education to pursue a modest environmental program focusing on marine resources.

Since the Government Information Service (GIS) is responsible for communication between the GOB and the public, it is the logical route to inform Belizeans about their environment. GIS has video and 16 mm equipment that it can take to all districts (GIS carries generators) to show a variety of films including those on agriculture, health and the environment; it has a small technical staff, access to Radio Belize and publishes the *New Belize* magazine. GIS could call on established voluntary and service organizations to help prepare topics and thereby involve these groups in the planning and generation of enthusiasm for their contributions to improved environmental quality.

A nationwide environmental awareness campaign should be designed and implemented, perhaps to be initiated for the next international "Earth Day". Precise goals should be formulated and creative presentations should help stimulate an interested audience. Also, donor agencies may show interest in supporting such a campaign that is educationally broad and relevant to the national environment. Programs such as National Geographic, BBC Nova, and Prudential, for example, would help stimulate an appreciation for nature and natural history. These are vital starting points.

Building Environmental Safeguards into Development Plans

Belize is a small country with a small population. The nature and quality of Belize's resources–land, marine and people–make it necessary to promote a spirit of involvement in the country's future environment. Both community and government programs will be necessary to fulfill this need. Cultural identity can then be maintained while quality of life is improved, and the natural resources will be rationally developed.

Since much of the capital for development of natural resources and infrastructure is in the form of foreign aid, foreign investments, loans or grants, guidelines to aid in development must be clearly defined. In addition to laws concerning development responsibilities, all development programs should define their needs for human and natural resources. In particular, requirements for successful commercial ventures need to be defined. Financial aid in scholarships should be provided by investors to ensure competent labor and management.

Agricultural and marine producers and processors should

--employ capable managers and technicians who have skills and understand their duties;

–train employees using chemicals, both toxic and benign, in their use, abuse, disposal and general management;

–provide training for all employees in the identification of environmental problems and encourage them to present solutions through seminars, short courses and in-service training;

–be aware of all aspects of the resource they are producing or processing.

Especially pertinent are the uses of substances that are non-renewable: What is the quantity, how fast will it be used up, and is there a substitute or another source when the resource is used up? Will soils cleared of forest be able to support other land uses? Relating to fisheries or forests where certain species are preferred over others: Will removal of selected species lead to the demise of other important members of the ecological community? In wildlife, by removing certain species through hunting or trapping, will this alter the composition of the community? Will forest removal in preparation for agriculture destroy habitat for species that cannot be "transferred"?

Sound business management requires responsibility in the conservation of the resource necessary to its survival. The GOB should not allow commercial development without assessing the resources and their rational use. Environmental conservation is everyone's responsibility.

Insofar as it is difficult to demand that new investors be responsible for research necessary to conserve resources they want to develop, some cooperative plan must be arranged. This could take the form of the industry pairing with a university graduate program to oversee research along with development. Ongoing research would be invaluable to future planning and production in Belize. The support of such a research program would be less expensive than the losses due to mismanagment of the resource. It is an avenue, also, to slow the emigration of talented and trained personnel from Belize. Foreign lending organizations such as AID, CIDA, and EDF, already aid in the financing of such educational programs and could probably be encouraged to increase their levels of support.

Ideally, environmental protection and economic development should be presented as having a common goal –the rational use of Belize's resources. Many external organizations realize this and could aid in the designing and implementing of an appropriate curriculum for Belizean businesses and for government employees. However, it is important to recognize the political, social, and economic forces behind the development drive in Belize and plan a well balanced program.

V–B. LEGISLATION RELATING TO NATURAL RESOURCES

Laws of Protection

There are a number of laws in Belize to guide as well as regulate activities involving natural resources. The *Wildlife Protection Act* (1981, No. 4) is administered by the MNR to provide for the conservation, restoration and development of wildlife. The act protects from hunting some 30 animal species and all but six species of birds (see Chapter IV-H). Licenses are required to hunt other species. The act contemplates enforcement by game rangers who are appointed by the Minister as members of the public service. Offenses are punishable by fine and repeat offenders are subject to imprisonment. The act provides for civil enforcement; up to half of any fine levied is paid to the person who supplies information leading to conviction.

Although provisions of the *Wildlife Protection Act* were effected by Statutory Enactment (1982, No. 3) the

MNR has not developed implementing regulations; regulations pertaining to laws are subject to National Assembly veto.

The *National Parks System Act* (1981, No. 5), administered by the MNR, provides for the preservation and protection of important natural and cultural features and regulates the scientific, educational and recreational use of such features. The Minister of Natural Resources may order the creation of national parks, nature reserves, wildlife sanctuaries and natural monuments. The act was brought into effect by Statutory Enactment No. 4 (1982), and Half-Moon Cay (a Crown reserve since 1928) was reserved as a Natural Monument by Statutory Enactment No. 30 (1982). No other orders have been issued under the authority of the act, nor have any procedural or substantive regulations been adopted.

Conservation units are to be administered by persons appointed by the Public Service Commission. Park officers will enforce the laws and fines and penalties assessed for offenses. As with the *Wildlife Protection Act*, this act provides for civil enforcement.

The *Land Utilization Ordinance* (1981, No. 16), also administered by the MNR, applies only to lands outside cities and towns and requires that GOB approval be obtained before any parcel of land is subdivided (see below). The Minister of Natural Resources is empowered to make regulations to designate and protect watersheds, to prevent soil erosion, and control the type of development allowed in designated areas. The Minister is also authorized to enforce the law and set fines. However, regulations must be defined and adopted to implement this law. Land use capability analysis should be considered in the development of regulations.

The *Land Tax* system (revised 1982) is also administered by the MNR. Land taxes are now based upon unimproved value of land to avoid taxes functioning as a disincentive to development.

The *Ancient Monuments and Antiquity Act* (No. 22, 1971) is administered by the MTI to preserve Belizean cultural heritage and artifacts of archaeological and historical significance. The act declares that all objects over 100 years old are antiquities and, as such, their ownership is vested in the Crown. Thus, it is not possible to privately own any such item; their purchase and sale are illegal. Export of antiquities is prohibited.

The National Assembly recently amended the *Public Health Ordinance*, giving the MHHC authority to regulate pollution. The revised Ordinance is a catch-all for control over effluents. It also authorizes regulations to prevent, control, or reduce contamination of the air, soil or water. This seemingly broad grant of authority is touted as all the authority necessary to resolve all pollution problems in Belize, especially in conjunction with the Minister's authority to levy fines or order closure of any offending entity. However, because the amendment is so broad and general, it is difficult to know precisely what activities are proscribed.

Not until the Minister of Health promulgates extensive regulations detailing the standards and criteria to be enforced under this act will it be known what constitutes pollution. Jamaican pollution control programs are being studied as an appropriate model for such regulations. At the same time, there is a strong reluctance on the part of the GOB to promulgate regulatory programs that are beyond existing enforcement capabilities. Until some implementation of the *Public Health Ordinance* occurs it remains to be seen if it is a panacea.

Environmental legislation is a prime example of the gaps in environmental and conservation law. The intent and *raw* legislative authority to protect natural resources in Belize are impressive. However, these recent laws lack procedural standards for implementation. As such, the potentially awesome conservation powers remain a shell of what they might be. Each instance of their application remains an incipient rule-making process without the continuity, administrative certainty, and ease of application that could result if standards were defined.

The newly created Environmental Task Force has the responsibility to draft regulations concerning pollution. After this procedure is completed, a statutory body will define regulations and oversee their enforcement (W. Miller, pers. comm.).

This situation pervades the important *Development Incentives Ordinance* (1960, 1973) as well. Foreign investors and joint ventures with Belizean citizens may receive development concessions exempting their enterprise from duties on the import of raw materials and the normal income taxes attendant to their operation. The situation becomes doubly attractive when, as with the United States, the expenses of the operation remain deductible from the taxes paid in the country of origin. Even though this program has been used for numerous developments, it lacks standards and conditions for the granting of developments and concessions. Without such standards, the consideration of each new application is an *ad hoc* application of the raw legislation. Experience with this program is extensive enough to publish standards and criteria to avoid administrative caprice as well as initiating decisions for each new development. This would allow administrators more time for attention to enforcement.

Laws that Regulate Natural Resource Exploitation

A number of laws regulate exploitation of various natural resources in Belize. The *Crown Lands Ordinance* (Chapter 110, revised 1958) regulates the manner in which the public can obtain freeholds or leaseholds to lands owned by government. Interestingly, the ordinance originally allowed title transfer of Crown lands to the mean high water mark. However, 1939 legislation reserved to govern-

ment *from all future grants* the title to all lands within one chain (about 20 m) landward of the mean high water mark, to be held in trust for the people. The ordinance also reserves to the Crown all mineral rights in Crown lands.

The *Forests Ordinance* (Chapter 115, revised 1958) contains authority for the administrative creation of forest reserves within which logging is strictly controlled by a permit system. The government is entitled to royalties for all lumber taken, and violators of this ordinance are subject to criminal and civil penalties.

The taking of minerals, except petroleum, is regulated by the *Minerals Ordinance* (Chapter 125, revised 1958). The GOB owns all minerals *under public lands* and mineral rights are reserved from all future grants of Crown Lands. The *Minerals Ordinance* provides for licenses and royalties for the taking of minerals, and prohibits the pollution of any river, stream or watercourse, and establishing fines. However, there are no pollution-oriented regulations.

The *Petroleum Ordinance* (1938, Chapter 126, revised 1958) is considered one of the most liberal petroleum licensing programs in the world (Rao 1982). All petroleum reserves are vested in the government, but 20 year leases are provided for in the event of a discovery. The ordinance has no provision for controlling the pollution of water from drilling or production operations.

The *Fisheries Ordinance* (Chapter 133, revised 1958) applies to all rivers and territorial waters, precludes the taking of fish by the use of poisons or explosives, and establishes authority to regulate net sizes. The regulatory authority under this ordinance has been implemented to establish seasons for various species, minimum sizes, and preclude fishing with traps or other devices constructed of net or wire within 550 m of the barrier reef.

There is also a *Plant Protection Ordinance* (Chapter 124, 1953) to prevent and control plant diseases and pests. The ordinance allows for quarantine of infected nurseries and delegates regulatory authority.

Since obtaining independence from Great Britain (1981), Belize has been sorting out and clarifying its participation in a number of international treaties, agreements and conventions. The government is now a party to the Convention on International Trade in Endangered Species of Wild Animals and Plants (CITES) and is cooperating at the international level to reduce such trade, particularly of crocodile skins, tortoise shells, manatee meat, and exotic species. As part of the attempt to achieve World Heritage status for the barrier reef, Belize has become party to the Convention Concerning the Protection of World Culture and Natural Heritage.

Legal Gaps and Proposed Laws

With the flurry of legislation over environmental activity in the last two years, there are now few major gaps in the legislative authority to protect Belize's natural resources. However, no specific laws deal with air pollution, solid waste, hazardous waste, dredge-and-fill, or the protection of wetlands. Due to a lack of major industrial activities in Belize and the relatively small, scattered population, these problems are either non-existent or of isolated local importance at this time. Presumably, the GOB will need to develop specific legislation in these areas as a response to incipient problems.

The MNR is developing a comprehensive set of pesticide regulations (see USIDCA/AID 1983). The proposals focus on the sale and use of certain types of pesticides and outline procedures for ensuring safe use. They also provide for testing plant and meat products to ensure that they do not contain high levels of pesticides (see V–A). However, procedures for spraying and alleviating problems of secondary exposure are not addressed. While there are no examples of widespread exposure of human populations as a result of spraying practices, the government still is ill-equipped to resolve the effect that aerial pesticide spraying may have on other economic activities. For example, drifting spray from sugar cane fields has killed nearby honey-bees. The response in the past has been for agricultural officials to ask sugar cane growers to spray from a lower altitude and to inform beekeepers in advance. Some simple regulations on spraying procedures might alleviate this kind of problem in the future.

There are few legal gaps in environmental legislation, but regulatory laws in most cases do not exist. The *Wildlife Protection Act*, the *National Parks System Act*, the recent anti-pollution amendments to the *Public Health Ordinance* and the *Development Incentives Ordinance* all remain broadly-worded laws. The broad legislation, delegation of enforcement authority to Ministries, and lack of standardized regulations and enforcement personnel all diminish the effect of a sound body of environmental laws.

There is sentiment in the Ministries against developing regulations without the resources to enforce them. However, it will become apparent that enforcement is essential to the effectiveness of the laws. Ministerial discretion will be tested in instances where government or civil enforcement are demanded for infractions against environmental laws. Conflicts will only be minimized when people are aware of the rational use of natural resources. The National Assembly should consider open forums to discuss and review standard regulations. In this way, those who will be affected by the new regulations would have an opportunity to be involved in their preparation.

People are basically law-abiding; in new situations rules eliminate some of the questions of what is correct or legal. International investors prefer to design projects to comply with environmental requirements rather than risk construction or production delays or future government intervention.

"Passive" enforcement of conservation laws comes from community involvement in the drafting and adopting of standards. An administrator could work with a community to identify problems, regulate against abuse and educate the people about the value of a pleasant and productive environment. Peace Corps volunteers play a major role in underdeveloped countries to fill this important communicative role. There is no question that for the foreseeable future, the GOB will have to rely on private and non-governmental bodies--businesses, cooperatives, quasi governmental boards, international organizations, and local citizen groups--to police their own activities and those of other organizations. The use of civil enforcement of the *Wildlife Protection Act* and the *National Parks System Act* indicate a governmental awareness of this fact; this type of enforcement could be expanded to cover other legislation.

V–C. BARRIERS TO EFFECTIVE IMPLEMENTATION OF ENVIRONMENTAL LEGISLATION

Jurisdictional Conflicts

Fisheries–Although Belize has been self-governing since 1964, the division of responsibilities among Ministries is not clearly defined. This uncertainty affects the degree to which the GOB can deal with natural resources management and environmental problems. The Fisheries Unit, for example, has been shifted in recent years from the old Ministry of Agriculture to the Ministry of Trade and Industry and finally to its present home in the Ministry of Health, Housing and Cooperatives. The reassignments were apparently little related to the best fit. In one instance, jurisdiction was shifted along with a particular Minister whose interests included fisheries management. When that Minister left government, the unit was moved to MHHC on grounds that the fishing industry is largely organized through cooperatives.

The Fisheries Unit is currently under the Cooperatives Department of the MHHC despite the fact that one of its essential regulatory functions is to stop overfishing by barrier reef fishermen. Fisheries should be elevated to Department status and included along with Agriculture and Forestry in the MNR. But the MNR is already overwhelmed with existing responsibilities.

Water–In some instances, the lines of authority between Ministries are poorly drawn, leading to duplication or absence of effort. Three Ministries actively sponsor rural water supply programs: the MNR supplies water for irrigation and livestock, and also provides drinking water in some areas; WASA of the MEC constructs hand pump wells and provides rudimentary water supply systems to areas in Stann Creek and Cayo districts; and the MHHC provides hand pump wells in Corozal, Orange Walk, and Belize districts through the Public Health Service (PHS) of the Medical Department (see Chapters III–D and IV–C).

Although WASA and PHS conduct physical and chemical testing of wells, only the latter has an education program and encourages community participation in water conservation, quality and sanitation. The consolidation of programs relating to water quality would make better use of the limited number of trained health personnel.

Barrier Reef–A major jurisdictional problem concerns the barrier reef. Though no single Ministry has responsibility for safeguarding the reef, almost every Ministry has a stake in its use or development. Belize should have a separate regulatory authority to oversee and coordinate activities on the reef; this will be essential if this exceptional natural resource is declared a World Heritage Site by UNESCO.

Agriculture–Significant conflicts occur between the environmental/conservation responsibilities assigned to a particular ministry and its other primary responsibilities. The MNR, with jurisdiction over agriculture and forestry, is primarily a development-oriented agency. In accordance with declared GOB policies, its primary objective is as a catalyst for non-government development of agricultural and forestry resources. The MNR continues to make land available to Belizeans and foreigners for productive use; it is seeking to maximize Belizean self-sufficiency in foodstuffs; and it is straining to reverse the general decline in forest production that has continued for a number of years. At the same time, the MNR is charged with controlling haphazard clearing of forests; overseeing soil and water conservation efforts; halting cultivating of steep slopes; planning a program for national parks and protecting wildlife; and ensuring that forest development programs include protection of watersheds.

These goals, especially in the long term, need not conflict. In fact, the 1980-1983 Economic Development Plan (GOB 1980c) for agriculture states: "Poor husbandry in many cases limits as well as increases cost of production." (p. 11). The MNR wants to increase the value of crops and timber by processing them locally before export. Some of the pressures to maximize current production of raw materials may be reduced through better resource management techniques. Nevertheless, officials in both the Agriculture and Forest Departments readily admit that they have virtually no time, budgets, nor manpower to ensure that long-term resource management strategies are being implemented along with their development projects.

Pollution–Problems may also arise from the fact that pollution control is vested in the MHHC. Though pollution control is usually delegated to health agencies, an MNR multisectoral commission could be more effective at pollution control. In Belize the major catalyst for pollution regulations has been the health implications of cyanide discharged into the Belize River from a nail factory. Yet, even before pollution standards are adopted to implement newly passed legislation, it is apparent that the MHHC will have difficulty meeting its anti-pollution responsibilities.

Most of the MHHC's budget goes to rudimentary health concerns, particularly to the eradication of malaria.

The Ministry's anti-malaria campaign has intensified as a result of a 30% annual increase in reported malaria cases –1,540 in 1980, about 3,800 in 1982, and about 4,500 in 1983. Consequently, more than half of the PHS's share of the MHHC budget went to support mosquito eradication. Since it is not likely that the MHHC budget or manpower will be substantially increased to enforce the new pollution regulations, little enforcement will occur except for emergencies.

The MHHC is ill-suited to resolve clashes between economic interests that frequently arise even when pollution is not causing direct public health threats–especially as Belize expands processing operations. However, basic food processing industries not only pollute the water, they also can affect downstream fishing industries.

Implementation and enforcement of new pollution regulations will be the responsibility of the Chief Medical Officer (CMO). It is important that the PHS staff be trained to assess health consequences of and solutions to pollution problems.

Constraints to Developing the Public Service and Implementation of Environmental Regulations

Constraints that make it difficult for private Belizean industries to prosper (without heavy export emphasis), and per capita expense for basic infrastructure, also hinder the development of an effective public service in Belize. A country of 150,000 people without large monetary infusions from saleable commodities or services must generate revenues broad enough to support an effective bureaucracy. However, keeping peace, securing national boundaries, conducting foreign affairs, safeguarding public health, and providing the basic fiscal and physical infrastructure for the economy are costly.

Still, the GOB did inherit a reasonably well-trained and experienced core of government employees from its colonial days, and there is general consensus that at upper levels Belizean officials are highly professional and hard working. It is not so much a lack of talent or leadership in government; it is lack of depth. Senior and middle-level officials in each ministry have few trained employees to administer and develop programs and enforce regulations.

The GOB has difficulty attracting young, well-trained talent. Formerly, individuals who joined government service looked to advancement within the British Commonwealth system; however, the prospects are now limited to Belize. Many professionals trained outside Belize who would qualify for the public service do not return to Belize, or they return to work in private industry.

The problem is compounded by Belize's severe fiscal constraints on public spending. Virtually no new positions are opening within the bureaucracy and this situation is not likely to change in the near future. At first glance, this moratorium may not seem problematical, since in sheer numbers the bureaucracy grew from about 2,800 in 1976 to over 4,000 in 1982 (about 10% of the Belizean work force). But these numbers do not reflect major increases in technical capability within the public service.

Permanent Secretaries, department heads, and a handful of officers are overwhelmed as they try to provide basic ministerial services. The list of duties for key officers far exceeds reasonable expectations and secondary activities are given only perfunctory attention or dealt with on a crisis intervention or rotating basis. A good example is found by looking at the responsibilities of the public health inspectors (PHIs) (see p. 41). In such circumstances, it is highly unlikely that the country's 14 PHIs will be able to ensure that recently adopted pollution control legislation will be effectively implemented. However, the new Environmental Task Force may be able to fill this gap.

Thus, while legislation dealing with such issues as wildlife, pollution, land use, and marine conservation has been expanded recently, there has been virtually no concurrent expansion of government personnel able to implement or enforce the law.

Fiscal Issues

The 1983/84 operating budget for Belize's ministries was estimated at about B$176 million or about B$1,200/capita. The proposed budget for 1984/85 is B$180.33 million (GOB 1984b). Projected deficit for fiscal year 1983/84 is B$11.3 million for the following reasons: (i) the significant reduction in projected revenue was due to the decline in the volume of taxable imports; (ii) there were substantial increases in the level of debt servicing on behalf of statutory boards; and (iii) the reduction in volume in business activities caused a reduction in tax revenues.

At the behest of the Central Bank, the GOB has been keeping a tight rein on increases in government spending. Consequently, the operating budget of most ministries has grown only to cover wage increases. Budgetary expansions for new personnel or to purchase equipment, goods and services have been rare. This stark fiscal reality must temper any analysis of the government's ability to implement and enforce recently adopted laws and regulations designed to protect Belize's natural resources and environment. Currently no major government officials are fully assigned to conservation or environmental protection programs. There is no record of large expenditures for goods or services (such as monitoring equipment and employment of professionals) to carry out conservation or environmental protection programs. While the GOB receives no direct external funds to meet its current operating budget, much of its assets are generated by transfers from abroad. In fact, the country's capital expenditure budget for 1982-83 totaled about B$105 million, 83% of which came from external support. Every large government project currently underway or proposed by the GOB is or will be dependent upon foreign funds, with limited domestic contributions. Most government development projects

provide infrastructure and are described in Chapter V–A. The GOB should encourage foreign assistance by identifying and qualifying conservation projects that will improve the quality of life as well as aid economic development.

Few potential private investors are likely to be deterred in their desire to undertake a project in Belize if they are asked to comply with clear, concise and standardized regulations and procedures; these should actually make them more comfortable as they will know there are no hidden dangers to ownership. Some international assistance agencies such as USAID and World Bank provide technical evaluations of potential development projects.

Cultural change is affected from within the culture. Certain types of legislation will help improve health and sanitation if education helps define the positive aspects of the law. Additionally, government programs to improve health and sanitation do not change the culture; such changes are only improvements in the quality of life. Once an improvement is accepted by a group as beneficial, reverting to less agreeable living conditions is unlikely, especially if the government continues to support the improvements.

Marijuana is a major unquantified export from Belize to the United States. Drug production and transshipment are lucrative businesses. Though an increasing number of Belizeans and foreigners earn their livelihood in these pursuits, the U.S. Drug Enforcement Agency is trying to reduce trafficking by U.S. citizens, as well as identifying and destroying marijuana fields with paraquat. The GOB has been cooperating with the USDEA to reduce marijuana production and export.

Environmental Data Base

It is difficult to obtain reliable and timely information on natural resources or environment-related issues in Belize. The inaccuracy or absence of base line data coupled with inadequate data processing and retrieval systems cannot be overstated. Though it is not easy to correct long standing problems, the primary steps should be to train data processing personnel, data collectors, and technical reviewers who will help assure that the processed data is correct and up to date. Environment and natural resources access files should be open and available at Belmopan.

Since the GOB would be financially unable to provide such an improvement program, assistance should be sought from outside agencies. Without the ability to store and retrieve data, the effectiveness of all GOB programs is seriously limited.

VI.

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VII.

Appendices

APPENDIX A: ARCHAEOLOGICAL SITES IN BELIZE

This checklist of Belizean archaeological sites was prepared by the Department of Archaeology in Belmopan. Due to the problems of unauthorized digging for artifacts, only minimum information is given for each site. Special thanks are due to Winnel Branche, Acting Archaeological Commissioner, for making this list available for use in the BCEP.

Site Name	District	Interesting Aspects
Actun Polbilche	Belize	Cave with wooden artifacts.
Altun Ha	"	Major ceremonial center and coastal site. Important Mayan distribution center for exotic goods, obsidian, shells and jade. Noted for largest carved jade (head) found in Mesoamerica.
Colha	"	Large ceremonial pyramids and flint factories. Manufacturing center for Mayan stone tools.
Rancho Dolores	"	Settlement area.
Church Yard	"	Settlement area.
Tiger Bay Cave	"	Cave site, noted for long wooden spear.
Big Falls	"	Settlement area.
Manatee Cave	"	Cave Site, noted for Mayan carved manatee bones.
Batty Cave	"	Cave site near settlement area.
Cedar Bank	"	Minor ceremonial center.
Jebonche	"	Minor ceremonial center.
Mackenzie Run	"	Colonial battle grounds.
Little Fall	"	Colonial battle grounds.
Skeeter Site	"	Settlement area and flint quarries
Bailey's Place	"	Settlement area.
Darby Pat Cave	"	Cave with Mayan artifacts.
Darby Pat Annex	"	Cave with Mayan artifacts.
Hell Shelter Cave	"	Cave with Mayan artifacts.
Manatee	"	Colonial battle grounds.
Hector Creek	"	Minor ceremonial center.
Boom	"	Settlement area.
Burrel Boom	"	Colonial battle grounds.
New Boston	"	Settlement area.
Jonesville	"	Settlement area.
Davis Bank	"	Colonial battle grounds.
Sand Hill	"	Archaic lithic site 9000-4000 B.C.
Chichawate	Belize	Minor ceremonial center.
Haulover	"	Colonial fortifications.
Airport	"	Colonial battle grounds.
Watson Island	"	Industrial site.
Almond Hill	"	Settlement area.
Mile 11, N. Highway	"	Settlement area.
Ladyville	"	Archaic lithic site.
Yarborough Cemetery	"	Colonial site.
Robinson Point	"	Maya coastal site on cay.
Spanish Cay	"	Maya coastal site on cay.
Goff Cay	"	Colonial graveyard.
Sergeant's Cay	"	Settlement area.
St. George's Cay	"	Colonial graveyard.
Hicks Cay	"	Colonial graveyard.
Yacal Che'	"	Minor ceremonial center.
Xunantunich	Cayo	Major Mayan ceremonial center with 3 contiguous plazas surrounded by structures: the tallest is 42 m with a stucco frieze of astronomical significance.
Caracol	"	Belize's largest ceremonial center with 21 stelae inscribed with important genealogical and historical information.
Cahal Pech	"	Large Mayan ceremonial center noted for vast quantities of jade and obsidian.
El Pilar	"	Large Mayan ceremonial center with complex architecture.
San Antonio	"	Large Mayan ceremonial center with 9 uncarved stelae.
Yaxox, Barton Ramie, Baking Pot & Floral Park	"	Ceremonial centers associated with Belize River valley settements.
Tzimin Kex	"	Major Mayan ceremonial center with nearby raised courts built on hill tops.
Hatzcap Ceel	"	Large ceremonial plaza with ball courts, vaulted burial chambers, 2 carved alters end 6 uncarved stelae.
Cahal Cunil	"	Residential site with scattered plazas.
Minanha	"	Ceremonial center with adjoining plazas.
Las Ruinas	"	Ceremonial center associated with settlement area.
La Mula	"	Major ceremonial center.
Actuncan	"	Minor ceremonial center associated with settlement area.
Macal Tipu	"	Maya settlement area in the Post Classic period. Spanish colonial church.
Pedregal	"	Minor ceremonial center and settlement area.

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Round Hole	Cayo	Minor ceremonial center and settlement area.
Camp Six	"	Major ceremonial center, agricultural terraces.
Benque Viejo	"	Minor ceremonial center.
El Guacamayo	"	Major ceremonial center with vaulted burial chambers.
Macaw Bank	"	Minor ceremonial center and settlement area.
Nohoch Ek	"	Minor ceremonial center.
Melhado Site	"	Minor ceremonial center.
Bullet Tree Falls—A	"	Settlement area.
Bullet Tree Falls—B	"	Minor ceremonial center.
Bullet Tree Falls—C	"	Minor ceremonial center with plazuela groups.
Buena Vista	"	Minor ceremonial center with settlement area.
Chial	"	Settlement area.
San Lorenzo	"	Settlement area.
Helina	"	Settlement area.
Caller Creek	"	Settlement area.
La Clarissa	"	Settlement area.
Santiago	"	Settlement area.
Branch Mouth	"	Settlement area.
El Infierno	"	Major ceremonial center.
Ubico	"	Maya agricultural terraces and settlement area.
San Pastor	"	Minor ceremonial center and agricultural terraces.
Monkey Trail	"	Minor ceremonial center.
Maria Camp	"	Minor ceremonial center.
Caledonia	"	Minor ceremonial center with multiple burials.
Hermitage	"	Minor ceremonial center.
Christo Rey	"	Settlement area.
Pilgrimage Valley	"	Settlement area.
Spanish Lookout	"	Settlement area.
Duck Run	"	Settlement area.
Carmelita	"	Settlement area and paleontological finds.
Cool Shade	"	Settlement area.
Barton Creek	"	Settlement area.
Mount Hope	"	Settlement area, minor ceremonial center.
Ontario	"	Minor ceremonial center.
Blackman Eddy	"	Settlement area.
Society Hall	"	Settlement area.
Yalbac	"	Minor ceremonial center.
Warrie Head	"	Minor ceremonial center.
Camalote	"	Minor ceremonial center.
Ponce's	"	Minor ceremonial center.
Happy Home	"	Minor ceremonial center.
Valley of Peace	"	Settlement area.
Young Bank	"	Settlement area.
Young Gal	"	Settlement area.
Caves Branch	"	Settlement area.
Deep Valley	"	Settlement area.
Roaring Creek	"	Settlement area.
Mount Pleasant	"	Settlement area.
Belmopan	"	Settlement area.
Actun Tzimin	"	Cave with ancient Mayan artifacts.
Vampire Cave	"	Cave with ancient Mayan artifacts.
Daylight Cave	"	Cave with ancient Mayan artifacts.
Darknight Cave	"	Cave with ancient Mayan artifacts.
	"	
Glenn Wood Cave	"	Cave with ancient Mayan artifacts.
Dry Creek	"	Cave with ancient Mayan artifacts.
St. Margaret	"	Cave with ancient Mayan wooden artifacts.
Caves Branch Cave	"	Caves with ancient Mayan artifacts.
Chanona Cave	"	Cave with ancient Mayan artifacts.
St. Hermans	"	Cave with ancient Mayan artifacts.
Pot Hunters	"	Cave with ancient Mayan artifacts.
Petroglyph	"	Cave with ancient Mayan petroglyphs.
Edinburgh	Cayo	Cave with ancient Mayan artifacts.
Sa'atabe 1, 2, 3	"	Cave with ancient Mayan artifacts.
Chichan Chen 1,2	"	Cave with ancient Mayan artifacts.
Waterfall	"	Cave with ancient Mayan artifacts.
Foot Print	"	Cave with ancient Mayan artifacts and fossilized foot prints.
Pancho Caranza	"	Cave with ancient Mayan terraces and walls.
Barton Creek	"	Cave with ancient Mayan artifacts.
Rio Privacion	"	Cave with ancient Mayan artifacts.
Jonas Cave 1,2	"	Caves with ancient Mayan artifacts.
San Antonio	"	A series of caves with artifacts.
Vaca Falls	"	A series of caves with artifacts.
Blancaneaux	"	Cave with Mayan burial chambers.
Banana Bank	"	Settlement area and minor ceremonial center.
Beaver Dam Creek	"	Ceremonial center.
Sibun	"	Minor ceremonial center.
Hershey	"	Minor ceremonial center.
Married Woman Point	"	Minor ceremonial center and settlement area.
Belize Groves	"	Settlement area.
Young Girl Run	"	Settlement area.
Spanish Lookout South	"	Settlement area.
Oxmultun Kakab	"	Settlement area.
San Ignacio Sur	"	Settlement area.
Succotz	"	Settlement area; cave with artifacts.
Succotz Hill	"	Minor ceremonial center.
Cebada	"	Cave with Mayan artifacts.
Naranjo Cave 1,2,3,4,	"	Cave with Mayan artifacts.
Zapote Cave	"	Cave with Mayan artifacts.
Green Howard	"	Cave with Mayan artifacts.
Haystack Cave	"	Cave with Mayan artifacts.
Haystack Hill 1,2	"	Cave with Mayan artifacts.
Actun Balam	"	Cave with painted pottery vases.
San Pastor	"	Cave with Mayan burial chambers.
Balanza	"	Cave with Mayan burial chambers.
Las Cuevas	"	Cave with major ceremonial center.
Casconil	"	Cave with artifacts.
Rio Frio A,B,C,D,E	"	Caves with burial chambers.
Retiro Cave	"	Cave with ancient Mayan artifacts.
Starkey Hill	"	Cave with ancient Mayan artifacts.
Uchen Kimin	"	Cave with ancient Mayan artifacts.
Uchen Tzub	"	Cave with ancient Mayan artifacts.
Blister Cave	"	Cave with ancient Mayan artifacts.
Actun Chapat	"	Cave with exotic pottery painted in polychrome style.
Eduardo Quiroz	"	Cave with exotic polychrome pottery.
Cerros	Corozal	Major Mayan ceremonial center occupied solely in Preclassic period. Important distribution center for exotic jade, obsidian, and marine shells.
Aventyra	"	Major Mayan ceremonial center, mass production of double mouth jars for distribution.
Santa Rita	"	Large Post Classic center with cultural connection to basin of Mexico. Traditionally regarded as location of Old Chetumal, capital of Chetumal province. Mixteca-Puebla style murals.
Patchchacan	"	Plazuela groups in a settlement area. Social stratification evidence.

Caledonia	Corozal	Minor ceremonial center reported by J.E.S. Thompson. Enormous platform (88,000 m^2), one of the largest structures in northern Belize.
Chan Chen	"	Minor Early Classic ceremonial center (300-450 A.D.) and Post Classic occupational (900-1250 A.D.). Round temple platform.
Louisville	"	Minor center with large round terraces on top of a rectangular base.
Pucte	"	Settlement area, low-lying house mounds.
Xaibe	"	Settlement area.
Yo Chen	"	Settlement area and house mounds.
Puebo Nuevo	"	Minor ceremonial center with standing masonry walls.
Saltillo	"	Settlement area.
Chunox	"	Settlement area.
Copper Bank	"	Industrial site; sugar mill.
San Andres	"	?
Ranchito	"	Settlement area.
San Antonio/Corozal	"	Minor center.
Sajomal	"	Isolated finds, settlement area.
Santa Elena	"	Isolated finds, settlement area.
Xaman Kiwik	"	Minor ceremonial center.
Consejo	"	Settlement area.
Warrie Bight	"	Chultun and settlement area.
San Francisco	"	Industrial site; 18th Century sugar mill
Shipstern	"	Minor ceremonial center with standing walled structures along coastline.
Sarteneja	"	Minor ceremonial center with plazuela groups. Numerous prehistoric wells and cenotes.
	Orange Walk	
El Pozito		Major ceremonial center.
Cuello	"	Major ceremonial center with Mayan artifacts dating to 2,500 B.C.
Lamanai (Indian Church)	"	Major ceremonial center with longest occupational history in Belize spanning 3,000 years; Mayan artifacts, 17th Century Spanish church, a 19th Century sugar mill.
Nohmul	"	Major ceremonial center with fine pottery paintings and round structures indicative of Mexican influence.
San Felipe	"	Major ceremonial center.
Carolina	"	Minor ceremonial center.
La Milpa	"	Major ceremonial center.
Mun Diego	"	Major ceremonial center.
Blue Creek	"	Major ceremonial center.
Haltunbal	"	Major ceremonial center.
San Estevan	"	Major ceremonial center.
Kakabish	"	Major ceremonial center.
Shipyard	"	Major ceremonial center.
Back Landing	"	Major ceremonial center.
Kaxil Vinic	"	Major ceremonial center.
Naranjal	"	Cave site and settlement area.
Hoyuk	"	Settlement area, village site.
Rosita	"	Settlement area, plazuela groups.
Tres Leguas	"	Minor ceremonial center.
Blue Creek (Dos Bocas)	"	Cave with Mayan artifacts.
Yalbac	"	Minor ceremonial center.
Corozalito	"	Minor ceremonial center.
August Pine Ridge	"	Minor ceremonial center.
Gentle Work	"	Minor ceremonial center.
Camp 1	"	Small center with adjoining plazas.
San Antonio	"	Settlement area with ancient
(Albion Island)	"	raised agricultural fields.
San Lorenzo	"	Small ceremonial complex.
San Roman	"	House mounds, plazuela groups and large cenote.
Guinea grass	"	Settlement area.
Orange Walk	"	Settlement area (Mayan and colonial English fortifications).
Pull Trouser Swamp	Orange Walk	Settlement area with raised agricultural fields and canals.
Gold Button Creek	"	Settlement area.
Fireburn	"	Settlement area and colonial battle grounds.
Yo Creek	"	Minor ceremonial center and settlement area.
Koke'al	"	Minor ceremonial center.
Yo Tumben	"	Minor ceremonial center.
Douglas	"	Settlement area, village site.
Kates Lagoon	"	Settlement area, village site.
Honey Camp	"	Minor ceremonial center.
El Cacao	"	Minor ceremonial center.
Narrows Landing	"	Small house mounds, isolated artifacts.
Wamil	"	Minor ceremonial area.
Sierra de Agua	"	Settlement area.
Betson Bank	"	Settlement area.
Hill Bank	"	Settlement area.
Tower Hill II, III, IV	"	Settlement areas.
Ann Gabourel	"	Minor ceremonial center.
Indian Hill	"	Minor ceremonial center.
Zacharia	"	Settlement area.
Corozallto	"	Settlement area.
Blue Creek (Rommel)	"	Cave with artifacts.
London	"	Minor ceremonial center.
Alabama	Stann Creek	Settlement area.
Pierce Ruins	"	Minor ceremonial center.
Alta Vista	"	Minor ceremonial center.
Placentia Cay	"	Settlement area.
Placentia Lagoon 2, 3	"	House mounds.
Regalia	"	?
Kendal	"	Major ceremonial center with faced masonry.
Pomona	"	Minor ceremonial center.
Canada Hill	"	Isolated find.
Lynam	"	Settlement area.
Maintzunun	"	Minor ceremonial center.
Mayflower 1	"	Stelee platform.
Mayflower 2	"	?
Bailey's Place	"	Minor ceremonial center.
Olive Jar Site	"	Colonial battle grounds.
So. Placentia Village	"	Settlement area and battle grounds.
Traffic Islands	"	Settlement area.
Indian Hill II	"	Settlement area.
Placentia Lagoon	"	Industrial area.
Airstrip Rum Point	"	Isolated finds.
Rum Point Resort	"	Colonial battle grounds.
Harvest Cay	"	Colonial battle grounds.
Drunken Cay	"	Colonial battle grounds.
False Cay	"	Settlement area.
Lagoon Village site	"	Settlement area.
Rollerhome	"	Settlement area.
Santa Maria Creek Mouth	"	Isolated finds.
Maya Beach Airstrip	"	Isolated finds.
Suzanne's	"	Isolated finds.
Pedro Rubio	"	Settlement area.
Indian Hill I	"	Settlement area.
Watson Island	"	Settlement area.
Kakalche	"	Settlement area.
Lubaantun	Toledo	Major Mayan ceremonial center with 2 ball courts. "Stepped perpendicular" type architecture. Walls are unplastered. Home of famous crystal skull.
Blue Creek	"	Minor ceremonial center.
San Antonio South	"	Minor ceremonial center.
Nim Li Punit	"	Major ceremonial center similar in architecture to Lubaantun. Many carved stelae, the tallest is 10 m. Believed to be capital city of Lubaantun.
Pusilha	"	Large ceremonial center near Machaca, River with Mayan stone bridge. Many carved stone sculptures and stelae.
Xnaheb Hase Ehel	"	Ceremonial center near Nim Li Punit.

Santa Cruz	Toledo	Large ceremonial center with ball court.
Uxbentun	"	Minor ceremonial center with non-domestic and residential structures. Abundant carved figurines.
San Pedro South	"	Hamlet site of several plazuela groups on closely adjacent knolls.
San Antonio East	"	Minor ceremonial center with surrounding settlements.
Hinchazones	"	Hamlet site with minor ceremonial center.
Lower Rio Grande	"	Settlement area.
Stuart Cay	"	Settlement area.
Sand Creek	"	Minor ceremonial center.
San Jose	"	Minor ceremonial center with plazuela groups.
Santa Cruz North	"	Minor ceremonial center with masonry walls. Some evidence of colonial architecture.
Santa Cruz East	"	Minor ceremonial center.
San Antonio South	"	Minor ceremonial center.
Blue Creek	"	Minor ceremonial center.
Cadenas	"	Settlement area and cave with artifacts.
Big Falls	"	Settlement area with plazuela groups.
Seven Hills	"	Minor ceremonial center. Many eccentric flints.
Pork and Doughboy Point		Part of site submerged under sea. Materials suggest settlement area.
Wild Cane Cay	"	Hamlet or settlement area. Exotic materials: jade; obsidian; plumbate pottery; indicate coastal trade route.
Frenchman Cay	"	Settlement area. Coastal trade link with Lubaantun.
Moho Cay	"	Settlement area and ancient Mayan fishing station.
Otoxha	"	Limestone cave with Mayan pottery vessels, associated with settlement area.
Esperanza Camp	"	Settlement area.
Edwards Central	"	Settlement area.
San Antonio West	"	Minor ceremonial center.
Rio Blanco	"	Minor ceremonial center.
Jalacte Creek	"	Minor ceremonial center.
Laguna	"	Limestone cave with Late Classic pottery.
Jacinto Creek	"	Settlement area.
Big Hill	"	Settlement area.
Joe Taylor Creek	"	Settlement area.
Golden Stream	"	Minor ceremonial center.
Quebrada de Oro	"	Minor ceremonial center.
Gurkha	"	Cave with Mayan artifacts.
Ochochpec	"	Cave with Mayan artifacts.
Cave C	"	Cave with Mayan artifacts.
Hanover	"	Cave with Mayan artifacts.
Hawiiah	"	Minor ceremonial center.
Seven Hills Sugar Mill	"	Industrial site, 18th Century.
Bladen Branch Shelter	"	Cave with Mayan artifacts.
Crique Antonio	"	Cave with Mayan artifacts.
Hokeb Ha	"	Cave with many polychrome vases.
Actun Kiyon	"	Cave with artifacts.
Lundberg	"	Cave with artifacts.
Santa Theresa	"	Caves with artifacts.
Irish Guard	"	Minor ceremonial center.
Esperanza	"	Settlement area.
Crique Lagarto	"	Settlement area.
Monkey River	"	Settlement area.
Hucho Ha	"	Settlement area.

APPENDIX B: FISHES OF BELIZE FRESHWATER FISH SPECIES

This checklist of freshwater fish species was prepared by Janet Gibson for the BCEP. The principal source document "Preliminary key to the freshwater fishes of Belize" is by Thomerson and Greenfield (unpubl. manuscript). W. Bussing assisted with revisions.

Anguillidae
Anguilla rostrata – American eel

Ariidae
Several species

Atherinidae
Melaniris sp. – Freshwater silverside
Melaniris sp. – Mangrove silverside

Centropomidae

Centropomus spp.

Characidae
Astyanax fasciatus – Mexican tetra, billum
Brycon guatemalensis – Machaca
Hyphessobrycon compressus – Billum
Hyphessobrycon milleri – Billum

Cichlidae
Cichlasoma affine (not confirmed)
Cichlasoma aureum
Cichlasoma friedrichsthali
Cichlasoma godmani
Cichlasoma hyorhynchum
Cichlasoma intermedium
Cichlasoma maculicanda
Cichlasoma melanurum
Cichlasoma octofasciatum
Cichlasoma robertsoni
Cichlasoma salvini
Cichlasoma spilurum
Cichlasoma synspilum
Cichlasoma uropthalmus
Petenia splendida – Bay snook

Clupeidae
Dorosoma anale – Silver shad
Dorosoma petenense – Threadfin shad

Cyprinodontidae
Garmanella pulchra – Orange flagfish
Rivulus tenuis
Rivulus marmoratus

Eleotridae
Dormitator maculatus – Mudfish
Eleotris amblyopsis
Gobiomoris dormitator – Bigmouth sleeper

Engraulidae
Anchoviella sp. – Anchovy

Gerreidae
Diapterus sp.
Eucinostomus melanopterus
Eugerres brasilianus
Eugerres plumieri
Gerris cinereus

Gobiidae
Awaous taiasica – River goby
Evorthodus lyricus – Lyre goby
Gobionellus schufeldti – Freshwater goby
Gobionellus stigmaticus – Marked goby
Gobiosoma spes – Speckled goby
Lophigobius cyprinoides – Crested goby

Ictaluridae
Ictalurus furcatus – Blue catfish

Lutjanidae
Lutjanus griseus – Grey snapper

Megalopidae
Tarpon atlanticus – Tarpon

Mugilidae
Agonostomus monticola – Mountain mullet

Pimelodidae
Rhamdia guatemalensis
Rhamdia hypselurus
Rhamdia motaguensis

Poeciliidae
Belonesox belizanus – Alligator fish
Carlhubbsia (?) sp.
Gambusia luma – Mosquito fish
Gambusia sexradiata
Gambusia yucatana
Poecilia gracilis – Blue molly
Poecilia mexicana – Mexican molly
Xiphophoris helleri – Swordtail
Xiphophoris maculata – Platyfish, moonfish

Pomadasyidae
Pomadaysis crocro – River grunt

Soleidae
Achirus maculatus – Hog choker

Sygnathidae
Oostethus lineatus – Opossum pipefish

Synbranchidae
Synbranchus marmoratus – Mud eel

COMMERCIAL FISH SPECIES

This checklist was prepared by Janet Gibson for the BCEP based on the work of David Greenfield and the FAO (1978) Species identification Sheets for Fishery Purposes, Western Central Atlantic Fishing Area 31.

Albulidae
Albula vulpes – Bonefish

Balistidae
Balistes capriscus – Grey triggerfish
Balistes vetula – Queer triggerfish

Carangidae
Alectis ciliaris – Pompano
Caranx bartholomaei – Yellow jack
Caranx fusus – Blue runner
Caranx hippos – Crevalle jack
Caranx latus – Horse-eye jack
Caranx ruber – Bar jack
Chloroscombrus chrysurus – Atlantic bumper
Decapterus macarellus – Mackerel scad
Decapterus punctatus – Round scad
Elagatis bipinnulatus – Rainbow runner
Hemicaranx amblyrhynchus – Bluntnose jack
Oligoplites saurus – Atlantic leather jack
Selar crumenophthalmus – Bigeye scad
Selene setapinnis – Atlantic moonfish
Selene spixii – Full moonfish
Selene vomer – Atlantic lookdown
Seriola dumerili – Greater amberjack
Seriola rivoliana – Almaco jack
Seriola zonata – Banded nidderfish
Trachinotus carolinus – Florida pompano
Trachinotus falcatus – Permit
Trachinotus goodei – Palometa pompano
Trachurus lathami – Rough scad

Centropomidae
Centropomus ensiferus – Swordspine snook
Centropomus parallelus – Fat snook
Centropomus pectinatus – Tarpon snook
Centropomus poeyi – Mexican snook
Centropomus undecimalis – Common snook

Clupeidae
Chirocentrodon bleekerianus – Dogtooth herring
Harengula clupeola -- False herring
Harengula jaguana – Scaled herring
Jenkinsia lamprotaenia – Dwarf herring
Opisthonema oglinum – Atlantic thread herring
Sardinella aurita – Round sardinella
Sardinella brasiliensis – Brazilian sardinella

Elopidae
Elops saurus – Ladyfish

Engraulidae
Anchoa hepsetus – Striped anchovy
Cetengraulis edentulus – Atlantic anchovy

Gerreidae
Diapterus olisthostomus – Irish mojarra
Diapterus rhombeus – Caitipa mojarra
Eucinostomus argenteus – Silver mojarra
Eucinostomus gula – Jenny mojarra
Eucinostomus melanopterus – Flagfin mojarra
Eugerres plumieri – Striped mojarra
Gerres cinereus – Yellowfin mojarra

Istiophoridae
Istiophorus albicans – Atlantic sailfish
Makaira nigricans – Blue marlin
Tetrapturus albidus – White marlin

Labridae
Bodianus pulchellus – Spotfin hogfish
Bodianus rufus – Spanish hogfish
Lachnolaimus maximus – Hogfish

Lutjanidae
Etelis oculatus – Queen snapper
Lutjanus analis – Mutton snapper
Lutjanus apodus – Schoolmaster snapper
Lutjanus buccanella – Blackfin snapper
Lutjanus cyanopterus – Cubera snapper
Lutjanus griseus – Grey snapper
Lutjanus jocu – Dog snapper
Lutjanus mahogoni – Mahogany snapper
Lutjanus purpureus – Red snapper
Lutjanus synagris – Lane snapper
Lutjanus vivanus – Silk snapper
Ocyurus chrysurus – Yellow tail snapper
Pristipomoides aquilonaris – Wenchman snapper
Pristipomoides macrophthalmus – Cardinal snapper
Rhomboplites aurorubens – Vermillion snapper

Megalopidae
Tarpon atlanticus – Tarpon

Mugilidae
Agonostomus monticola – Mountain mullet
Joturus pichardi – Bobo mullet
Mugil cephalus – Striped mullet
Mugil curema – White mullet
Mugil trichodon – Fantail mullet

Pomadasyidae
Anisotremus surinamensis – Black margate
Anisotremus virginicus – Porkfish
Conodon nobilis – Barred grunt
Haemulon aurolineatum – Tomate grunt
Haemulon bonariense – Black grunt
Haemulon carbonarium – Caesar grunt
Haemulon chrysargyreum – Small mouth grunt
Haemulon flavolineatum – French grunt
Haemulon melanurum – Cottonwick grunt
Haemulon parrai – Sailor's grunt
Haemulon plumieri – White grunt
Haemulon sciurus – Blue striped grunt
Haemulon striatum – Striped grunt
Pomadasys corvinaeformis – Roughneck grunt
Pomadasys crocro – Bum grunt

Priacanthidae
Priacanthus arenatus – Atlantic bigeye
Priacanthus cruentatus – Glasseye

Rachycentridae
Rachycentron canadus – Cobia

Scombridae
Acanthocybium solandi – Wahoo
Euthynnus alletteratus – Little tunny
Katsuwonus pelamis – Skipjack tuna
Scomberomorus cavalla – King mackerel
Scomberomorus maculatus – Spanish mackerel
Scomberomorus regalis – Cero
Thunnus obesus – Bigeye tuna

Serranidae
Cephalopholis cruentata – Grasby seabass
Cephalopholis fulva – Coney seabass
Epinephelus adscensionis – Rock hind
Epinephelus guttatus – Red hind
Epinephelus itajara – Jewfish
Epinephelus mystacinus – Misty grouper
Epinephelus niveatus – Snowy grouper
Epinephelus striatus – Nassau grouper
Mycteroperca interstitialis – Yellow monk grouper
Mycteroperca venenosa – Yellowfin grouper

Sparidae
Archosargus probatocephalus – Sheepshead
Archosargus rhomboidalis – Western Atlantic seabream
Calamus bajonado – Porgy
Calamus calamus – Saucer eye porgy
Calamus pennatula – Pluma porgy
Pagrus pagrus – Common seabream

Sphyraenidae
Sphyraena barracuda – Great barracuda

Sharks

Carcharhinidae
Carcharhinus acronotus – Blacknose shark
Carcharhinus falciformis – Silky shark
Carcharhinus leucas – Bull shark
Carcharhinus limbatus – Blacktip shark
Carcharhinus maou – Oceanic whitetip shark
Carcharhinus obscurus – Dusky shark
Carcharhinus perezi – Caribbean rey shark
Carcharhinus plumbeus – Sandbar shark
Galeocerdo cuvieri – Tiger shark
Negaprion brevirostris – Lemon sherk

Gingylmostomatidae
Ginglymostoma cirratum – Nurse shark

Lamnidae
Isurus oxyrinchus – Shootfin mako

Sphyrnidae
Sphyrna lewini – Scalloped hammerhead
Sphyrna tiburo – Bonnethead

Lobster

Panulirus argus – Spiny lobster
Panulirus guttatus – Spotted spiny lobster
Panulirus laevicauda – Smoothtail spiny lobster

Shrimp

Penaeus aztecus – Brown shrimp
Penaeus duorarum – Pink shrimp
Penaeus schmitti – White shrimp

Crabs

Callinectes sapidus – Blue crab
Cardisoma guanhumi – Blue land crab
Menippe mercenaria – Stone crab

Bivalves

Argopecter irradians – Atlantic bay scallop
Crassostrea rhizophorae – Mangrove oyster
Pecter ziczac – Zigzag scallop

Gastropods

Strombus gigas – Queen conch

Sea Turtles

Caretta caretta – Loggerhead turtle
Chelonia mydas – Green turtle
Eretmochelys imbricata – Hawksbill turtle

MARINE FAMILIES

Acanthuridae	surgeon fish
Albulidae	bone fish
Alopiidae	thresher sharks
Antennariidae	frog fish
Apogonidae	cardinal fish
Ariidae	marine catfish
Atherinidae	silversides
Aulostomidae	trumpet fish
Balistidae	triggerfish
Batrachoidae	toad fish
Belonidae	needlefish
Blenniidae	combtooth blennies
Bothidae	left-eye flounder
Brotulidae	brotulas
Callionymidae	dragonets
Carangidae	jacks, pompano
Carapidae	pearl fish
Carcharhinidae	requiem sharks
Centropomidae	snooks
Chaenopsidae	Chaenopsid blennies
Chaetodontidae	butterfly fish
Cirrhitidae	hawk fish
Clinidae	scaled blennies
Clupeidae	herring
Congridae	conger eels
Coryphaenidae	dolphins
Cynoglossidae	tongue fish
Dactyloscopidae	sand stargazers
Dasyatidae	stingrays
Diodontidae	porcupine fish
Echeneidae	remoras
Eleotridae	sleepers
Elopidae	ladyfish
Engraulidae	anchovies
Ephippidae	spade fish
Exocoetidae	flying fish
Gerreidae	mojarras
Gobiesocidae	cling fish
Gobiidae	gobies
Gremmidae	bassiets
Grammistidae	soap fish
Hemiramphidae	half beaks
Holocentridae	squirrel fish
Istiophoridae	marlin, sailfish
Kyphosidae	sea chubs, rudder fish
Labridae	wrasses
Lamnidae	mackerel sharks
Lutjanidae	snappers
Malacanthidae	tile fish
Megalopidae	tarpon
Microdesmidae	worm fish
Mobulidae	manta rays
Monacanthidae	file fish
Moringuidae	spaghetti fish
Mugilidae	mullet
Mullidae	goatfish
Muraenidae	moray eels
Myliobatidae	eagle rays
Ogcocephalidae	bat fish
Ophidiidae	cusk eels
Opichthyidae	snake eels

Opistognathidae	jaw fish
Orectolobidae	nurse sharks
Ostraciontidae	trunk fish
Pempheridae	sweepers
Pleuronectidae	right-eye flounders
Poecilidae	killer-fish
Polynemidae	threadfins
Pomacanthidae	angelfish
Pomacentridae	damselfish
Pomadasyidae	grunts
Priacanthidae	big eyes
Pristidae	sawfish
Rachycentridae	cobia
Rhinobatidae	guitarfish
Scaridae	parrot fish
Sciaenidae	croakers, drums
Scombridae	tuna, mackerel
Scorpaenidae	scorpion fish
Soleidae	soles
Sparidae	porgies
Sphyraenidae	barracuda
Sphyrnidae	hammerhead sharks
Synbranchidae	synbranchid eels
Syngnathidae	sea bass
Synodontidae	lizard fish
Tetraodontidae	puffers
Trichiuridae	cutlass fish
Triglidae	sea robbins
Tripterygiidae	3–fin blennies
Urolophidae	
Xenocongridae	false eels

APPENDIX C: BIRDS OF BELIZE

This checklist of bird species was prepared by Dora Weyer for the BCEP. Unconfirmed or expected species are in brackets. Species breeding in Belize are indicated by the letter 'B'; winter residents are signified by 'W'; while 'T' indicates migratory transients and 'A' accidental occurrences. F. G. Stiles assisted with nomenclatural corrections and additions.

Tinamidae (Tinamous)
Crypturellus boucardi – Slaty-breasted Tinamou, B
Crypturellus cimmamomeus – Thicket Tinamou, B
Crypturellus soui – Little Tinamou, B.
Tinamus major – Great Tinamou, B

Podicipedidae (Grebes)
Podilymbus podiceps – Pied-billed Grebe, WB
Tachybaptus dominicus – Least Grebe, B

Procellariidae (Shearwaters, Petrels)
Puffinus griseus – Sooty Shearwater, A

Phaethontidae (Tropicbirds)
Phaethon lepturus – White-tailed Tropicbird, A

Pelecanidae (Pelicans)
Pelecanus ery .hrorhynchus – White Pelican, T
Pelecanus occidentalis – Brown Pelican, B

Sulidae (Boobies)
Sula dactylatra – Masked Booby, A
Sula leucogaster – Brown Booby, B
Sula sula – Red-footed Booby, B

Phalacrocoracidae (Cormorants)
Phalacrocorax auritus – Double-crested Cormorant, B
Phalacrocorax olivaceus – Neotropic Cormorant, B

Anhingidae (Anhingas)
Anhinga anhinga – Anhinga, B

Frogatidae (Frigatebirds)
Fregata magnificens – Magnificent Frigatebird, B

Ardeidae (Herons and Egrets)
Agamia agami – Chestnut-bellied Heron, B
Ardea herodias – Great Blue Heron, WB
Botaurus lentiginosus – American Bittern, W
Botaurus pinnatus – Pinnated Bittern, B
Bubulcus ibis – Cattle Egret, WB
Butorides virescens – Green Heron, WB
Casmerodius albus – Great Egret, WB
Cochlearius cochlearius – Boat-billed Heron, B
Egretta caerulea – Little Blue Heron, WB
Egretta rufescens – Reddish Egret, B
Egretta thula – Snowy Egret, WB
Egretta tricolor – Tricolored Heron, WB
Ixobrychus exilis – Least Bittern, B
Nycticorax nycticorax – Black-crowned Night-Heron, WB
Nycticorax violacea – Yellow-crowned Night-Heron, WB
Tigrisoma mexicanum – Bare-throated Tiger-Heron, B

Ciconiidae (Storks)
Jabiru mycteria – Jabiru Stork, B
Mycteria americana – Wood Stork, B

Threskiornithidae (Ibises and Spoonbills)
Ajaia ajaja – Roseate Spoonbill, B?
Eudocimus albus – White Ibis, B
Plegadis falcinellus – Glossy Ibis, B?

Phoenicopteridae (Flamingos)
Phoenicopterus ruber – American Flamingo, A

Anatidae (Ducks and Geese)
Anas acuta – Northern Pintail, W
Anas americana – American Wigeon, W
Anas carolinensis – Green-winged Teal, W
Anas clypeata – Northern Shoveler, W
Anas cyanoptera – Cinnamon Teal, T
Anas discors – Blue-winged Teal, W
Anas platyrhynchos – Mallard, A
Anser albifrons – White-fronted Goose, A
Aythya affinis – Lesser Scaup, T
Aythya collaris – Ring-necked Duck, A
Cairina moschata – Muscovy, B
Chen caerulescens – Blue Goose, A
Dendrocygna autumnalis – Black-bellied Whistling-Duck, B
Oxyura dominica – Masked Duck, B?

Cathartidae (American Vultures)
Cathartes aura – Turkey Vulture, B
Cathartes burrovianus – Lesser Yellow-headed Vulture, B
Coragyps atratus – Black Vulture, B
Sarcoramphus papa – King Vulture, B

Pandionidae (Ospreys)
Pandion haliaetus – Osprey, B

Accipitridae (Kites, Hawks and Eagles)
Accipiter bicolor – Bicolored Hawk, B
Accipiter cooperii – Cooper's Hawk, T
Accipiter striatus – Sharp-shinned Hawk, T
Busarellus nigricollis – Black-collared Hawk, B
Buteo albicaudatus – White-tailed Hawk, B
Buteo brachyurus – Short-tailed Hawk, B?
Buteo jamaicensis –Red-tailed Hawk, B
Buteo magnirostris – Roadside Hawk, B
Buteo nitidus – Gray Hawk, B
Buteo platypterus – Broad-winged Hawk, T
Buteo swainsoni – Swainson's Hawk, W
Buteogallus anthracinus – Common Black Hawk, B
Buteogallus urubitinga – Great Black Hawk, B
Chondrohierax uncinatus – Hook-billed Kite, B
Circus cyaneus – Northern Harrier, W
Elanoides forficatus – Swallow-tailed Kite, B
Elanus leucurus –White-tailed Kite, B
Geranospiza caerulescens – Crane Hawk, B
Harpagus bidentatus – Double-toothed Kite, B
Harpia harpyja – Harpy Eagle, B
Harphyaliaetus solitarius – Solitary Eagle, B
Ictinia plumbea – Plumbeous Kite, B
Leptodon cayanensis – Gray-headed Kite, B
Leucopternis albicollis – White Hawk, B

Rostrhamus sociabilis – Snail Kite, B
Spizaetus ornatus – Ornate Hawk-Eagle, B
Spizaetus tyrannus – Black Hawk-Eagle, B
Spizastur melanoleucus – Black-and-white Hawk-Eagle, B

Falconidae (Falcons and Caracaras)
Falco columbarius – Merlin, T
Falco deiroleucus – Orange-breasted Falcon, B
Falco femoralis – Aplomado Falcon, WB
Falco peregrinus – Peregrine Falcon, W
Falco rufigularis – Bat Falcon, B
Falco sparverius – American Kestrel, W
Herpetotheres cachinnans – Laughing Falcon, B
Micrastur ruficollis – Barred Forest-Falcon, B
Micrastur semitorquatus – Collared Forest-Falcon, B
[*Polyborus plancus* – Crested Caracara]

Cracidae (Chachalacas, Guans, Curassows)
Crax rubra – Great Curassow, B
Ortalis vetula – Plain Chachalaca, B
Penelope purpurascens – Crested Guan, B

Phasianidae (Quails)
Colinus nigrogularis – Black-throated Bobwhite, B
[*Dactylortyx thoracicus* – Singing Quail]
Odontophorus guttatus – Spotted Wood-Quail, B

Meleagrididae (Turkeys)
Agriocharis ocellata – Ocellated Turkey, B

Aramidae (Limpkins)
Aramus guarauna – Limpkin

Rallidae (Rails, Gallinules, Coots)
Amaurolimnas concolor – Uniform Crake, B
Aramides axillaris – Rufous-necked Wood-Rail, B
Aramides cajanea – Gray-necked Wood-Rail, B
Fulica americana – American Coot, W
Gallinula chloropus – Common Gallinule, WB
Laterallus jamaicensis – Black Rail, B
Laterallus ruber – Ruddy Crake, B
Pardirallus maculatus – Spotted Rail, B
Porphyrula martinica – Purple Gallinule, B?
Porzana carolina – Sora Rail, W
Porzana flaviventer – Yellow-breasted Crake, B
Rallus longirostris – Clapper Rail, B

Heliornithidae (Finfoots)
Heliornis fulica – Sungrebe, B

Jacanidae (Jacanas)
Jacana spinosa – Northern Jacana, B

Haematopodidae (Oystercatchers)
Haematopus palliatus – American Oystercatcher

Charadriidae (Plovers)
[*Charadrius collaris* – Collared Plover]
Charadrius semipalmatus – Semipalmated Plover, WT
Charadrius vociferus – Killdeer, W
Charadrius wilsonia – Wilson's Plover, B
Pluvialis dominica – American Golden Plover, T
Pluvialis squatarola – Black-bellied Plover, WT

Scolopacidae (Sandpipers, Snipe and Allies)
Actitis macularia – Spotted Sandpiper, W
Arenaria interpres – Ruddy Turnstone, W
Bartramia longicauda – Upland Sandpiper, T
Calidris alba – Sanderling, T
Calidris alpina – Dunlin, T
Calidris bairdii – Baird's Sandpiper, T
Calidris canutus – Red Knot, T
Calidris fuscicollis – White-rumped Sandpiper, T
Calidris himantopus – Stilt Sandpiper
Calidris mauri – Western Sandpiper, WT
Calidris melanotos – Pectoral Sandpiper, WT
Calidris minutilla – Least Sandpiper, WT
Calidris pusilla – Semipalmated Sandpiper, T
Catoptrophorus semipalmatus – Willet, T
Gallinago gallinago – Common Snipe, W
Limnodromus griseus – Short-billed Dowitcher, T
Limnodromus scolopaceus – Long-billed Dowitcher, T
Limosa fedoa – Marbled Godwit, T
Limosa haemastica – Hudsonian Godwit, T
Numenius americanus – Long-billed Curlew, T
Numenius phaeopus – Whimbrel, T
Tringa flavipes – Lesser Yellowlegs, W
Tringa melanoleuca – Greater Yellowlegs, W
Tringa solitaria – Solitary Sandpiper, W
Tryngites rubruficollis – Buff-breasted Sandpiper, T

Recurvirostridae (Stilts, Avocets)
Himantopus mexicanus – Black-necked Stilt, WB
Recurvirostra americana – American Avocet, T

Stercorariidae (Jaegers, Skuas)
Catharacta skua – Great Skua, A
Stercorarius parasiticus – Parasitic Jaeger, A

Laridae (Gulls, Terns)
Anous minutus – Black Noddy
Anous stolidus – Brown Noddy, B
Chlidonias niger – Black Tern, T
Gelochelidon nilotica – Gull-billed Tern, T
Hydroprogne caspia – Caspian Tern, B
Larus argentatus – Herring Gull, W
Larus atricilla – Laughing Gull, B
Larus delawarensis – Ring-billed Gull, W
Larus philadelphia – Bonaparte's Gull, A
Larus pipixcan – Franklin's Gull, A
Sterna anaethetus – Bridled Tern, B
Sterna antillarum – Least Tern, B
Sterna dougallii – Roseate Tern, B
Sterna forsteri – Forster's Tern, W
Sterna fuscata – Sooty Tern, B
Sterna hirundo – Common Tern, T
Sterna maximas – Royal Tern B?
Ste na sandvicensis – Sandwich Tern, B

Rynchopidae (Skimmers)
Rynchops niger – Black Skimmer

Columbidae (Pigeons, Doves)
Claravis pretiosa – Blue Ground-Dove, B
Columba cayennensis – Pale-vented Pigeon, B
Columba flavirostris – Red-billed Pigeon, B
Columba leucocephala – White-crowned Pigeon, B
Columba nigrirostris – Short-billed Pigeon, B
Columba speciosa – Scaled Pigeon, B
Columbina minuta – Plain-breasted Ground-Dove, B
Columbina passerina – Common Ground-Dove, B
Columbina talpacoti – Ruddy Ground-Dove, B
Geotrygon montana – Ruddy Quail-Dove, B
Leptotila cassinii – Gray-chested Dove, B
Leptotila jamaicensis – Caribbean Dove, B
Leptotila plumbiceps – Gray-headed Dove, B
Leptotila verreauxi – White-tipped Dove, B
Zenaida asiatica – White-winged Dove, B
Zenaida macroura – Mourning Dove, W

Psittacidae (Macaws, Parrots, Parakeets)
Amazona albifrons – White-fronted Parrot, B
Amazona autumnalis – Red-lored Parrot, B
Amazona farinosa – Blue-crowned Parrot, B
Amazona ochrocephala – Yellow-headed Parrot, B
Amazona xantholora – Yellow-lored Parrot, B
Ara macao – Scarlet Macaw, B
Aratinga astec – Aztec Parakeet, B
Pionopsitta haematotis – Brown-hooded Parrot, B
Pionus senilis – White-crowned Parrot, B

Cuculidae (Cuckoos, Anis)
Coccyzus americanus – Yellow-billed Cuckoo, W
Coccyzus erythropthalmus – Black-billed Cuckoo, W
Coccyzus minor – Mangrove Cuckoo, B
[*Crotophaga ani* – Smooth-billed Ani]
Crotophaga sulcirostris – Groove-billed Ani, B
Dromococcyx phasianellus – Pheasant Cuckoo, B
Piaya cayana – Squirrel Cuckoo, B
Tapera naevia – Striped Cuckoo, B

Tytonidae (Barn owls)
Tyto alba – Barn Owl, B

Strigidae (True owls)
Asio stygius – Stygian Owl, B
Bubo virginianus – Great Horned Owl

Ciccaba nigrolineata – Black-and-white Owl, B
Ciccaba virgata – Mottled Wood-Owl, B
Glaucidium brasilianum – Ferruginous Pygmy-Owl, B
Glaucidium minutissimum – Least Pygmy-Owl, B
Otus guatemalae – Vermiculated Screech-Owl, B
Pulsatrix perspicillata – Spectacled Owl, B
[*Rhinoptynx clamator* – Striped Owl]
Speotyto cunicularia – Burrowing Owl, W

Nyctibiidae (Potoos)
Nyctibius grandis – Great Potoo, B
Nyctibius griseus – Common Potoo, B

Caprimulgidae (Nightjars)
Caprimulgus salvini – Tawny-collared Nightjar, B
Caprimulgus vociferus – Whip-poor-will, B
Chordeiles acutipennis – Lesser Nighthawk, T
Chordeiles minor – Common Nighthawk, B
Nyctidromus albicollis – Pauraque, B
Otophanes yucatanicus – Yucatan Poorwill, B

Apodidae (Swifts)
Aeronautes saxatalis – White-throated Swift, B
Chaetura pelagica – Chimney Swift, T
Chaetura vauxi – Vaux's Swift, B
Cypseloides cryptus – White-chinned Swift, B
Panyptila cayennensis – Lesser Swallow-tailed Swift, B
Streptoprocne zonaris – White-collared Swift, B

Trochilidae (Hummingbirds)
Abeillia abeillei – Emerald-chinned Hummingbird, W
Amazilia candida – White-bellied Emerald, B
Amazilia cyanocephala – Azure-crowned Hummingbird, B
Amazilia rutila – Cinnamon Hummingbird, B
Amazilia tzacatl – Rufous-tailed Hummingbird, B
Amazilia viridifrons – Green-fronted Hummingbird
Amazilia yucatanensis – Fawn-breasted Hummingbird, B
Anthracothorax prevostii – Green-breasted Mango, B
Archilochus colubris – Ruby-throated Hummingbird, B
Campylopterus curvipennis – Wedge-tailed Sabrewing, B
Campylopterus hemileucurus – Violet Sabrewing, B
Chlorostilbon canivetii – Fork-tailed Emerald, B
Colibri delphinae – Brown Violet-ear, B
Eupherusa eximia – Stripe-tailed Hummingbird, B?
Florisuga mellivora – White-necked Jacobin, B
Heliothryx barroti – Purple-crowned Fairy, B
Lophornis helenae – Black-crested Coquette
Phaeochroa cuvierii – Scaly-breasted Hummingbird, B
Phaethornis longuemareus – Little Hermit, B
Phaethornis superciliosus – Long-tailed Hermit, B
Thalurania colombica – Crowned Woodnymph, B
Threnetes ruckeri – Band-tailed Barbthroat, B

Trogonidae (Trogons)
Trogon collaris – Collared Trogon, B
Trogon massena – Slaty-tailed Trogon, B
Trogon melanocephalus – Black-headed Trogon, B
Trogon violaceus – Violaceous Trogon, B

Alcedinidae (Kingfishers)
Ceryle alcyon – Belted Kingfisher, W
Ceryle torquata – Ringed Kingfisher, B
Chloroceryle aenea – Pygmy Kingfisher, B
Chloroceryle amazona – Amazon Kingfisher, B
Chloroceryle americana – Green Kingfisher, B

Momotidae (Motmots)
Electron carinatum – Keel-billed Motmot, B
Hylomanes momotula – Tody Motmot, B
Momotus momota – Blue-crowned Motmot, B

Galbulidae (Jacamars)
Galbula ruficauda – Rufous-tailed Jacamar, B

Bucconidae (Puffbirds)
Malacoptila panamensis – White-whiskered Puffbird, B
Notharchus macrorhynchos – White-necked Purffbird, B

Ramphastidae (Toucans)
Aulacorhynchus prasinus – Emerald Toucanet, B
Pteroglossus torquatus – Collared Aracari, B
Ramphastos sulfuratus – Keel-billed Toucan, B

Picidae (Woodpeckers)
Campephilus guatemalensis – Pale-billed Woodpecker, B
Celeus castaneus – Chestnut-colored Woodpecker, B
Dryocopus lineatus – Lineated Woodpecker, B
Melanerpes aurifrons – Golden-fronted Woodpecker, B
Melanerpes formicivorus – Acorn Woodpecker, B
Melanerpes pucherani – Black-cheeked Woodpecker, B
Melanerpes pygmaeus – Red-vented Woodpecker, B
Picoides scalaris – Ladder-backed Woodpecker, B
Piculus rubiginosus – Golden-olive Woodpecker, B
Sphyrapicus varius – Yellow-bellied Sapsucker, W
Veniliornis fumigatus – Smoky-brown Woodpecker, B

Dendrocolaptidae (Woodcreepers)
Dendrocincla anabatina – Tawny-winged Woodcreeper, B
Dendrocincla homochroa – Ruddy Woodcreeper, B
Dendrocolaptes certhia – Barred Woodcreeper, B
Glyphorhynchus spirurus – Wedge-billed Woodcreeper, B
Lepidocolaptes souleyetii – Streak-headed Woodcreeper, B
Sittasomus griseicapillus – Olivaceous Woodcreeper, B
Xiphocolaptes promeropirhynchus – Strong-billed Woodcreeper, B
Xiphorhynchus flavigaster – Ivory-billed Woodcreeper, B

Furnariidae (Ovenbirds and Allies)
Automolus ochrolaemus – Buff-throated Foliage-gleaner, B
Sclerurus guatemalensis – Scaly-throated Leaftosser, B
Synallaxis erythrothorax – Rufous-breasted Spinetail, B
Xenops minutus – Plain Xenops, B

Formicariidae (Antbirds)
Cercomacra tyrannina – Dusky Antbird, B
Dysithamnus mentalis – Plain Antvireo, B
Formicarius analis – Black-faced Antthrush, B
Gymnocichla nudiceps – Bare-crowned Antbird, B
Microrhopias quixensis – Dot-winged Antwren, B
Taraba major – Great Antshrike, B
Thamnistes anabatinus – Russet Antshrike, B
Thamnophilus doliatus – Barred Antshrike, B
Thamnophilus punctatus – Slaty Antshrike, B

Pipridae (Manakins)
Manacus candei – White-collared Manakin, B
Pipra mentalis – Red-capped Manakin, B
Schiffornis turdinus – Thrushlike Manakin, B

Cotingidae (Cotingas)
Cotinga amabilis – Lovely Cotinga, B
Laniocera rufescens – Speckled Mourner, B
Lipaugus unirufus – Rufous Piha, B
Pachyramphus cinnamomeus – Cinnamon Becard, B
Pachyramphus major – Gray-collared Becard, B
Pachyramphus polychopterus – White-winged Becard, B
Platypsaris aglaiae – Rose-throated Becard, B
Tityra inquisitor – Black-crowned Tityra, B
Tityra semifasciata – Masked Tityra, B

Tyrannidae (Tyrant flycatchers)
Attila spadiceus – Bright-rumped Attila, B
Camptostoma imberbe – Northern Beardless Tyrannulet, B
Contopus borealis – Olive-sided Flycatcher, WT
Contopus cinereus – Tropical Pewee, B
Contopus pertinax – Greater Pewee, B
Contopus sordidulus – Western Wodd-Pewee, W
Contopus virens – Eastern Wood-Pewee, W
Elaenia flavogaster – Yellow-bellied Elaenia, B
Elaenia martinica – Caribbean Elaenia, B?
Empidonax albigularis – White-throated Flycatcher, B
Empidonax alnorum – Alder Flycatcher, W
Empidonax flaviventris – Yellow-bellied Flycatcher, W
Empidonax minimus – Least Flycatcher, W
Empidonax traillii – Willow Flycatcher, W
Empidonax virescens – Acadian Flycatcher, W
Legatus leucophaius – Piratic Flycatcher, B
Leptopogon amaurocephalus – Sepia-capped Flycatcher, B
Megarhynchus pitangua – Boat-billed Flycatcher, B
Mionectes oleaginea – Ochre-bellied Flycatcher, B
Myiarchus crinitus – Great Crested Flycatcher, T
Myiarchus tuberculifer – Dusky-capped Flycatcher, B
Myiarchus tyrannulus – Brown-crested Flycatcher, B
Myiarchus yucatanensis – Yucatan Flycatcher, B
Myiobius sulphureipygius – Sulphur-rumped Flycatcher, B
Myiodynastes luteiventris – Sulphur-bellied Flycatcher, B

Myiodynastes maculatus – Streaked Flycatcher, B
Myiopagis viridicata – Greenish Elaenia, B
Myiozetetes similis – Social Flycatcher, B
Oncostoma cinereigulare – Northern Bentbill, B
Onychorhynchus mexicanus – Northern Royal-Flycatcher, B
Ornithion semiflavum – Yellow-bellied Tyrannulet, B
Pitangus sulphuratus – Great Kiskadee, B
Platyrinchus cancrominus – Stub-tailed Spadebill, B
Pyrocephalus rubinus – Vermilion Flycatcher, B
Rhynchocyclus brevirostris – Eye-ringed Flatbill, B
Rhytipterna holerythra – Rufous Mourner, B
Sayornis nigricans – Black Phoebe, B
Sayornis phoebe – Eastern Phoebe, A
Terenotriccus erythrurus – Ruddy-tailed Flycatcher, B
Todirostrum cinereum – Common Tody-Flycatcher, B
Todirostrum sylvia – Slate-headed Tody-Flycatcher, B
Tolmomyias sulphurescens – Yellow-olive Flycatcher, B
Tyrannus forficatus – Scissor-tailed Flycatcher, T
Tyrannus melancholicus – Tropical Kingbird, B
Tyrannus savana – Fork-tailed Flycatcher, B
Tyrannus tyrannus – Eastern Kingbird, T
Tyrannus vociferans – Cassin's Kingbird, A
Zimmerius vilissimus – Paltry Tyrannulet, B

Hirundinidae (Martins, Swallows)
Hirundo rustica – Barn Swallow, WT
Petrochelidon fulva – Cave Swallow
Petrochelidon pyrrhonota – Cliff Swallow, A
Progne chalybea – Gray-breasted Martin, B
Progne subis – Purple Martin, T
Riparia riparia – Bank Swallow, T
Stelgidopteryx serripennis – Northern Rough-winged Swallow BW
Tachycineta albilinea – Mangrove Swallow, B
Tachycineta bicolor – Tree Swallow, WT

Corvidae (Jays)
Cissilopha yucatanica – Yucatan Jay, B
Cyanocorax yncas – Green Jay, B
Psilorhinus morio – Brown Jay, B

Troglodytidae (Wrens)
Campylorhynchus zonatus – Band-backed Wren, B
Cistothorus platensis – Short-billed Marsh Wren, B
Henicorhina leucosticta – White-breasted Wood-Wren, B
Microcerculus philomela – Nightingale Wren, B
Thryothorus albinucha – White-browed Wren, B
Thryothorus maculipectus – Spot-breasted Wren, B
Thryothorus modestus – Plain Wren, B
Troglodytes musculus – Southern House Wren, B
Uropsila leucogastra – White-bellied Wren, B

Mimidae (Catbirds, Mockingbirds)
Dumetella carolinensis – Gray Catbird, Q
Melanoptila glabrirostris – Black Catbird, B
Mimus gilvus – Tropical Mockingbird, B

Turdidae (Thrushes, Solitaires, Bluebirds)
Catharus fuscescens – Veery, T
Catharus minimus – Gray-cheeked Thrush, T
Catharus ustulatus – Swainson's Thrush, WT
Hylocichla mustelina – Wood Thrush, W
Myadestes obscurus – Brown-backed Solitaire, B?
Myadestes unicolor – Slate-colored Solitaire, B
Sialia sialis – Eastern Bluebird, B
Turdus assimilis – White-throated Robin B
Turdus grayi – Clay-colored Robin, B

Sylviidae (Gnatcatchers, Gnatwrens)
Polioptila caerulea – Blue-gray Gnatcatcher, B
Polioptila plumbea – Tropical Gnatcatcher, B
Ramphocaenus melanurus – Long-billed Gnatwren, B

Bombycillidae (Waxwings)
Bombycilla cedrorum – Cedar Waxwing, T

Cyclarhidae (Peppershrikes)
Cyclarhis gujanensis – Rufous-browed Peppershrike, B

Vireolaniidae (Shrike-vireos)
Vireolanius pulchellus – Green Shrike-Vireo, B

Vireonidae (Vireos)
Hylophilus decurtatus – Lesser Greenlet, B
Hylophilus ochraceiceps – Tawny-crowned Greenlet, B
Vireo altiloquus – Black-whiskered Vireo, T
Vireo flavifrons – Yellow-throated Vireo, W
Vireo flavoviridis – Yellow-green Vireo, B
Vireo griseus – White-eyed Vireo, W
Vireo huttoni – Hutton's Vireo, B
Vireo magister – Yucatan Vireo, B
Vireo olivaceus – Red-eyed Vireo, W
Vireo pallens – Mangrove Vireo, B
Vireo philadelphicus – Philadelphia Vireo, W
Vireo solitarius – Solitary Vireo, B

Coerebidae (Bananaquits)
Coereba flaveola – Bananaquit, B

Parulidae (Wood warblers)
Basileuterus culicivorus – Golden-crowned Warbler, B
Basileuterus rufifrons – Rufous-capped Warbler, B
Dendroica caerulescens – Black-throated Blue Warbler, W
Dendroica castanea – Bay-breasted Warbler, T
Dendroica cerulea – Cerulean Warbler, T
Dendroica coronata – Yellow-rumped Warbler, W
Dendroica discolor – Prairie Warbler, W
Dendroica dominica – Yellow-throated Warbler, W
Dendroica erithachorides – Mangrove Warbler, B
Dendroica fusca – Blackburnian Warbler, T
Dendroica graciae – Grace's Warbler, B
Dendroica magnolia – Magnolia Warbler, W
Dendroica palmarum – Palm Warbler, W
Dendroica pensylvanica – Chestnut-sided Warbler, T
Dendroica petechia – Yellow Warbler, B
Dendroica pinus – Pine Warbler, A
Dendroica tigrina – Cape May Warbler, T
Dendroica virens – Black-throated Green Warbler, W
Granatellus sallaei – Gray-throated Chat, B
Geothlypis poliocephala – Gray-crowned Yellowthroat, B
Geothlypis trichas – Common Yellowthroat, W
Helmitheros vermivorus – Worm-eating Warbler, W
Icteria virens – Yellow-breasted Chat, W
Limnothlypis swainsoni – Swainson's Warbler, W
Mniotilta varia – Black-and-white Warbler, W
Oporornis agilis – Connecticut Warbler, T
Oporornis formosus – Kentucky Warbler, W
Oporornis philadelphia – Mourning Warbler, T
Parula americana – Northern Parula, W
Parula pitiayumi – Tropical Parula, B?
Protonotaria citrea – Prothonotary Warbler, T
Seiurus aurocapillus – Ovenbird, W
Seiurus motacilla – Louisiana Waterthrush, W
Seiurus noveboracensis – Northern Waterthrush, W
Setophaga ruticilla – American Redstart, W
Vermivora celata – Orange-crowned Warbler, W
Vermivora chrysoptera – Golden-winged Warbler, T
Vermivora peregrina – Tennessee Warbler, W
Vermivora pinus – Blue-winged Warbler, W
Vermivora ruficapilla – Nashville Warbler, T
Wilsonia canadensis – Canada Warbler, T
Wilsonia citrina – Hooded Warbler, W
Wilsonia pusilla – Wilson's Warbler, W

Icteridae (Orioles, Meadowlarks, Blackbirds)
Agelaius phoeniceus – Red-winged Blackbird, B
Amblycercus holosericeus – Yellow-billed Cacique, B
Cassidix mexicanus – Great-tailed Grackle, B
Dives dives – Melodious Blackbird, B
Dolichonyx oryzivorus – Bobolink, T
Gymnostinops montezuma – Montezuma Oropendola, B
Icterus chrysater – Yellow-backed Oriole, B
Icterus cucullatus – Hooded Oriole, B
Icterus galbula – Northern Oriole, W
Icterus gularis – Black-throated Oriole, B
Icterus mesomelas – Yellow-tailed Oriole, B
Icterus prosthemelas – Black-cowled Oriole, B
Icterus spurius – Orchard Oriole, W
Molothrus aeneus – Bronzed Cowbird, B
Scaphidura oryzivora – Giant Cowbird, B
Sturnella magna – Eastern Meadowlark, B
Zarhynchus wagleri – Chestnut-headed Oropendola, B

Thraupidae (Tanagers)
Chlorophanes spiza – Green Honeycreeper, B
Chlorospingus ophthalmicus – Common Bush-Tanager, B

Cyanerpes cyaneus – Red-legged Honeycreeper, B
Cyanerpes lucidus – Shining Honeycreeper, B
Eucometis penicillata – Gray-headed Tanager, B
Euphonia affinis – Scrub Euphonia, B?
Euphonia elegantissima – Blue-hooded Euphonia, A
Euphonia gouldi – Olive-backed Euphonia, B
Euphonia hirundinacea – Yellow-throated Euphonia, B
Euphonia minuta – White-vented Euphonia, B?
Habia fuscicauda – Red-throated Ant-Tanager, B
Habia rubica – Red-crowned Ant-Tanager, B
Lanio aurantius – Black-throated Shrike-Tanager, B
Phlogothraupis sanguinolenta – Crimson-collared Tanager, B
Piranga erythrocephala – Red-headed Tanager, A
Piranga flava – Hepatic Tanager, B
Piranga leucoptera – White-winged Tanager, B
Piranga ludoviciana – Western Tanager, T
Piranga olivacea – Scarlet Tanager, T
Piranga roseogularis – Rose-throated Tanager
Piranga rubra – Summer Tanager, W
Ramphocelus passerinii – Scarlet-rumped Tanager, B
Tangara larvata – Golden-hooded Tanager, B
Tangara lavinia – Rufous-winged Tanager, B?
Thraupis abbas – Yellow-winged Tanager, B

Emberizidae (Grosbeaks, Buntings, Sparrows, Finches)
Aimophila botterii – Botteri's Sparrow, B
Aimophila rufescens – Rusty Sparrow, B
Ammodramus savannarum – Grasshopper Sparrow, B
Arremon aurantiirostris – Orange-billed Sparrow, B
Arremonops chloronotus – Green-backed Sparrow, B
Arremonops rufivirgatus – Olive Sparrow, B
Calamospiza melanocorys – Lark Bunting, A
Cardinalis cardinalis – Common Cardinal, B
Caryothraustes poliogaster – Black-faced Grosbeak, B
Chondestes grammacus – Lark Sparrow, A
Cyanocompsa cyanoides – Blue-black Grosbeak, B
Cyanocompsa parellina – Blue Bunting, B
Melospiza lincolnii – Lincoln's Sparrow, T
Oryzoborus funereus – Thick-billed Seed-Finch, B
Passerculus sandwichensis – Savannah Sparrow, W
Passerina caerulea – Blue Grosbeak, WT
Passerina ciris – Painted Bunting, T
Passerina cyanea – Indigo Bunting, WT
Pheucticus ludovicianus – Rose-breasted Grosbeak, WT
Saltator atriceps – Black-headed Saltator, B
Saltator caerulescens – Grayish Saltator, B
Saltator maximus – Buff-throated Saltator, B
Sicalis luteola – Grassland Yellow-Finch
Spiza americana – Dickcissel, T
Spizella passerina – Chipping Sparrow, B
Sporophila aurita – Variable Seedeater, B
Sporophila torqueola – White-collared Seedeater, B
Tiaris olivacea – Yellow-faced Grassquit, A
Volatinia jacarina – Blue-black Grassquit, B

Fringillidae (Siskins, Crossbills, Finches)
Carduelis notata – Black-headed Siskin, B
Loxia curvirostra – Red Crossbill, B?

Ploceidae (Weaver finches)
Passer domesticus – House Sparrow

APPENDIX D: MAMMALS OF BELIZE

This checklist was prepared by Dora Weyer for the BCEP. Additions and corrections have been made by D. Wilson, F. Bonaccorso and T. McCarthy. Unconfirmed or expected species are preceded by an asterisk. Creole common names are given in quotation marks.

MARSUPALIA (Marsupials)
Didelphidae (Opossums)
Caluromys derbianus – Wooly opossum
Chironectes minimus – Water opossum, "yapok"
Didelphis marsupialis – Southern opossum, "white-eared opossum"
Didelphis virginiana – Virginia opossum, "black-eared opossum"
Marmosa alstoni – Alston's opossum
**Marmosa canescens* – Grayish mouse opossum
Marmosa mexicana – Mexican mouse opossum
Marmosa robinsoni – South American mouse opossum
Philander opossum – Gray four-eyed opossum, "Four-eyes"

EDENTATA (Sloths, Anteaters, Armadillos)
Myrmecophagidae (Anteaters)
Cyclopes didactylus – Two-toed anteater, "Pygmy silky"
Myrmecophaga tridactyla – Giant anteater
Tamandua mexicana – Tamandua, "Antsbear"

Dasypodidae (Armadillos)
Cabassous centralis – Eleven-banded armadillo
Dasypus novemcinctus – Nine-banded armadillo, "Dilly or hamadilly"

INSECTIVORA (Insectivores)
Soricidae (Shrews)
Cryptotis nigrescens – Blackish small-eared shrew
Cryptotis parva – Least shrew

CHIROPTERA (Bats)
Emballonuridae (Sac-winged bats)
Balantiopteryx io – Thomas' sac-winged bat
Centronycteris maximiliani – Thomas' bat
Diclidurus albus – Northern ghost bat
Peropteryx kappleri – Greater dog-like bat
Peropteryx macrotis – Lesser dog-like bat
Rhynchonycteris naso – Brazilian long-nosed bat
Saccopteryx bilineata – Greater white-lined bat

Noctilionidae (Bulldog or fish-eating bats)
Noctilio leporinus – Greater bulldog bat

Mormoopidae (Leaf-chinned or mustached bats)
Mormoops megalophylla – Peter's ghost-faced bat
Pteronotus davyi – Davy's naked-backed bat
**Pteronotus gymnonotus* – Big naked-backed bat
Pteronotus parnellii – Parnell's mustached bat
Pteronotus personatus – Wagner's mustached bat

Phyllostomidae (Leaf-nosed bats)
Anoura geoffroyi – Geoffroy's tail-less bat
Artibeus cinereus – Gervais' fruit-eating bat
Artibeus hartii – Little fruit-eating bat
Artibeus jamaicensis – Jamaican fruit-eating bat
Artibeus lituratus – Big fruit-eating bat
Artibeus phaeotis – Pygmy fruit-eating bat
Artibeus toltecus – Lowland fruit-eating bat
Carollia brevicauda – Silky short-tailed bat
Carollia castanea – Allen's short-tailed bat
Carollia perspicillata – Seba's short-tailed bat
Carollia subrufa – Hahn's short-tailed bat
Centurio senex – Wrinkle-faced bat
**Chiroderma salvini* – Salvin's white-lined bat
Chiroderma villosum – Shaggy-haired bat
**Choeroniscus guldmani* – Goldman's bat
Chrotopterus auritus – Peter's false vampire bat
Desmodus rotundus – Vampire bat
Desmodus youngi – White-winged vampire bat
Diphylla ecaudata – Hairy-legged vampire bat
Enchisthenes hartii – Little fruit bat
Glossaphaga commissarisi – Commissaris' long-tongued bat
Glossaphaga soricina – Pallas' long-tongued bat
Hylonycteris underwoodi – Underwood's long-tongued bat
Lonchorhina aurita – Tome's long-eared bat
Macrophyllum macrophyllum – Long-legged bat
Macrotus waterhousii – Waterhouse's leaf-nosed bat
Micronycteris brachyotis – Dobson's large-eared bat
Micronycteris megalotis – Brasilian large-eared bat
Micronycteris schmidtorum – Schmidt's large-eared bat
Micronycteris sylvestris – Large-eared forest bat
Mimon cozumelae – Spear-nosed bat

Mimon crenulatum – Striped spear-nosed bat
Phylloderma stenops – Northern spear-nosed bat
**Phyllostomus discolor* – Pale spear-nosed bat
Sturnira lilium – Yellow-shouldered bat
Sturnira ludovici – Anthony's bat
Tonatia bidens – Spix's round-eared bat
Tonatia braziliense – Pygmy round-eared bat
Tonatia evotis – Davis' round-eared bat
Tonatia silvicola – D'Orbigny's round-eared bat
Trachops cirrhosus – Fringe-lipped bat
Uroderma bilobatum – Tent-making bat
Vampyrassa pusilla – Little yellow-eared bat
Vampyrodes caraccioloi – San Pablo bat
Vampyrops helleri – Heller's broad-nosed bat
Vampyrum spectrum – Linnaeus' false vampire bat

Natalidae (Funnel-eared bats)
Natalus stramineus – Mexican funnel-eared bat

Thyropteridae (Disc-winged bats)
Thyroptera tricolor – Spix's disc-winged bat

Vespertilionidae (Vespertilionid bats)
Antrozous dubiaquercus – Van Gelder's bat
Eptesicus furinalis – Argentine brown bat
**Eptesicus fuscus* – Big brown bat
Lasiurus borealis – Red bat
Lasiurus ega – Southern yellow bat
Lasiurus intermedius – Northern yellow bat
Myotis albescens – Silver-tipper myotis
Myotis elegans – Elegant myotis
Myotis keaysi – Hairy-legged myotis
**Myotis nigricans* – Black myotis
Pipistrellus subflavus – Eastern pipistrelle
Rhogeessa tumida – Central American yellow bat

Molossidae (Free-tailed bats)
Eumops auripendulus – Shew's mastiff bat
Eumops bonariensis – Dwarf mastiff bat
Eumops glaucinus – Wagner's mastiff bat
Eumops underwoodi – Underwood's mastiff bat
Molossops malagai – Mexican dog-faced bat
Molossus ater – Black mastiff bat
Molossus molossus – Pallas' mastiff bat
Molossus pretiosus – Miller's mastiff bat
Molossus sinaloae – Allen's mastiff bat
Nyctinomops laticaudata – Broad-tailed bat
Promops centralis – Thomas' mastiff bat
Tadarida brasiliensis – Brazilian free-tailed bat

PRIMATES
Cebidae (New World Monkeys)
Alouatta pigra – Lawrence's howler monkey
Ateles geoffroyi – Geoffroy's spider monkey

CARNIVORA (Carnivores)
Canidae (Coyotes, Wolves, Foxes, Dogs)
**Canis latrans* – Coyote
Urocyon cinereoargenteus – Gray fox

Procyonidae (Raccoons and Allies)
Bassariscus sumichrasti – Cacomistle
Nasua narica – Coati, "Quash"
Potos flavus – Kinkajou, "Night walker"
Procyon lotor – Raccoon, "Coon"

Mustelidae (Mustelids)
**Conepatus mesoleucus* – Hog-nosed skunk
Conepatus semistriatus – Striped hog-nosed skunk, "Polecat"
Eira barbara – Tayra, "Bush dog"
Gallictis vittata – Grison, "Bush dog"
Lutra longicaudus – Southern river otter, "Water dog"
Mustela frenata – Long-tailed weasel
Spilogale putorius – Spotted skunk

Felidae (Cats and Allies)
Felis concolor – Mountain lion, puma, "Red tiger"
Felis pardalis – Ocelot, "Tigrita"
Felis wiedii – Margay, "Tigrillito"
Felis yagouaroundi – Jaguarundi,
Panthera onca – Jaguar, "Tiger"

CETACEA (Whales, Porpoises)
Delphinidae (Porpoises, Dolphins)
Stenella longirostrus – Spinner dolphin
Stenella plagiodon – Blainville's spotted dolphin
Steno bredanensis – Rough-toothed dolphin
Tursiops truncatus – Atlantic bottle-nosed dolphin

SIRENIA (Manatees, Dugongs, Sea Cows)
Trichechidae (Manatees)
Trichechus manatus – Caribbean manatee, "Sea cow"

PERISSODACTYLA (Perissodactyls)
Tapiridae (Tapirs)
Tapirus bairdii – Baird's tapir, "Mountain cow"

ARTIODACTYLA (Artiodactyls)
Tayassuidae (Peccaries)
Dicotyles tajacu – Collared peccary, "Pecari"
Tayassu pecari – White-lipped peccary, "Warri"

Cervidae (Cervids)
Mazama americana – Red brocket deer, "Antelope"
Odocoileus virginiana – White-tailed deer, "Deer"

RODENTIA (Rodents)
Sciuridae (Squirrels)
Glaucomys volans – Southern flying squirrel
Sciurus deppei – Deppe's squirrel
Sciurus variegatoides – Variegated squirrel
Sciurus yucatanensis – Yucatan squirrel

Geomyidae (Pocket gophers)
Orthogeomys hispidus – Hispid pocket gopher, "Mole"

Heteromyidae (Pocket mice)
Heteromys desmarestianus – Desmarest's spiny pocket mouse

Cricetidae (New World Rats and Mice)
Nyctomys sumichrasti – Sumichrast's vesper rat
Oryzomys alfaroi – Alfaro's rice rat
Oryzomys fulvescens – Pygmy rice rat
Oryzomys melanotis – Black-eared rice rat
Oryzomys palustris – Marsh rice rat
Otonyctomys hatti – Yucatan vesper rat
Ototylomys phyllotis – Big-eared climbing rat
Reithrodontomys gracilis – Slender harvest mouse
Sigmodon hispidus – Hispid cotton rat
Tylomys nudicaudus – Peters' climbing rat

Muridae (Old World Rats and Mice)
Mus musculus – House mouse
Rattus norvegicus – Norway rat, "Charlie Price"
Rattus rattus – Brown rat, "Reef rat"

Erethizontidae (New World Porcupines)
Coendou mexicanus – Mexican porcupine, "Porcupine"

Dasyproctidae (Cavimorphs)
Agouti paca – Paca or spotted cavy, "Gibnut"
Dasyprocta punctata – Agouti, "Indian rabbit"

LAGOMORPHA (Rabbits and Hares)
Leporidae (Rabbits)
Sylvilagus braziliensis – Forest rabbit
Sylvilagus floridanus – Eastern cottontail

APPENDIX E: REPTILES OF BELIZE

This checklist of reptile species is based on a published list by Henderson and Hoevers (1975). Some additions have been made by D. Weyer. R. McDiarmid, D. Robinson and J. Savage assisted with nomenclatural corrections. Creole names are given in quotes.

SAURIA (Lizards)

Gekkonidae (Geckos)

Aristelliger georgeensis
Coleonyx elegans – Banded gecko, "escorpion"
Phyllodactylus insularis
Phyllodactylus tuberculosus – Leaf-fingered gecko, "escorpion"
Sphaerodactylus glaucus
Thecadactylus rapicaudus – Turnip-tailed gecko, "escorpion"

Xantusiidae (Night lizards)

Lepidophyma flavimaculatum

Scincidae (Skinks)

Eumeces schwartzei
Eumeces sumichrasti
Mabuya unimarginata – "Snake waiting boy"
Sphenomorphus cherriei – "Galliwasp"

Iguanidae (Iguanids)

Anolis allisoni
Anolis biporcatus
Anolis capito
Anolis carolinensis – American anole
Anolis humilis
Anolis lemurinus
Anolis limifrons
Anolis nannodes
Anolis pentaprion
Anolis sagrei
Anolis sericeus
Anolis tropidonotus
Basiliscus vittatus – Striped basilisk, "cock malakka", "Jesus Christ lizard"
Corytophanes cristatus – Helmeted basilisk, "old man"
Corytophanes hernandesi – Helmeted basilisk "old man"
Ctenosaura similis – Scaly-tailed iguana, "wish-willy"
Iguana iguana – Iguana
Laomanctus longipes – Casque-headed iguana
Laomanctus serratua
Sceloporus chrysostictus – Scaly lizard
Sceloporus lundelli
Sceloporus teapensis

Teiidae (Teiids)

Ameiva festiva
Ameiva undulata
Cnemidophorus angusticeps
Cnemidophorus cozumela

Anguidae (Anguids)

Celestus rozellae – "Galliwasp"

SERPENTES (Snakes)

Leptotyphlopidae (Worm snakes)

Leptotyphlops goudotii

Boidae (Boas)

Boa constrictor – "Wowla"

Colubridae (Colubrids)

Adelphicos quadrivirgatus
Amastridium veliferum
Clelia clelia – "Mussurana"
Clelia scytalina
Coluber constrictor – American black snake
Coniophanes bipunctatus – Two-spotted snake
Coniophanes fissidens
Coniophanes imperialis – Black-striped snake
Coniophanes schmidti
Conophis lineatus – "Guarda camino"
Dendrophidion nuchalis
Dipsas brevifacies – Snail-eating snake
Drymarchon corais – Black-trailed indigo, "blacktail"
Drymobius margaritiferus – Speckled racer, "green snake" "guinea hen snake"
Elaphe flavirufa – Corn snake, rat snake
Ficimia publia – Hook-nosed snake, "barber pole"
Imantodes cenchoa – Blunt-headed tree snake
Lampropeltis triangulum – Tropical kingsnake, "bead and coral"
Leptodeira frenata – Cat-eyed snake, "cohune tommygoff"
Leptodeira septentrionalis – Cat-eyed snake, "cohune tommygoff"
Leptophis ahaetulla – Green tree snake, "green tommygoff"
Leptophis mexicanus – Green-headed tree snake, "green head"
Masticophis mentovarius – Tropical whip snake
Mastigodryas melanolomus – Dryan snake
Ninia diademata – "Coral, bead and coral"
Ninia sebae – Red coffee snake, "bead and coral"
Oxybelis aeneus – Gray vine snake, "tie-tie snake"
Oxybelis fulgidus – Green vine snake
Oxyrhopus petola – Red-banded snake, "bead and coral"
Pliocercus elapoides – "Bead and coral"
Pseustes poecilonotus – "Puffer"
Scaphiodontophis annulatus – Shovel-toothed snake, "double snake"
Sibon nebulata
Sibon sanniola
Spilotes pullatus – Monkey snake, "bocatura clapansaya"
Stenorrhina freminvillei
Tantilla canula – Black-headed snake
Tantilla schistosa – Black-headed snake
Thamnophis marcianus – Central American garter snake, "Pine Ridge tommygoff"
Thamnophis proximus – Central American ribbon snake
Tretanorhinus nigroluteus – "Water snake"
Tropidodipsas sartorii – "Bead and coral"
Xenodon rabdocephalus

Micruridae (Coral snakes - poisonous)

Micrurus diastema – "Bead and coral"
Micrurus hippocrepis – "Bead and coral"
Micrurus nigrocinctus

Crotalidae (American pit vipers - poisonous)

Agkistrodon bilineatus – Mexican water mocassin, "cantil"
Bothrops asper – Fer-de-lance, "yellow-jawed tommygoff"
Bothrops nasutus – Hog-nosed viper
Bothrops nummifer – Jumping viper, "jumping tommygoff"
Bothrops schlegeli – Eyelash or horned palm viper
Crotalus durissus – Central American rattlesnake, "cascabel"

CROCODYLIA (Crocodiles)

Crocodylidae (Crocodiles)

Crocodylus acutus – American crocodile, "alligator"
Crocodylus moreleti – Morelet's crocodile, "alligator"

TESTUDINES (Turtles)

Dermatemyidae

Dermatemys mawii – Central American river turtle, "hickety"

Kinosternidae (Mud and musk turtles)

Claudius angustatus
Kinosternon acutum – Mud turtle
Kinosternon leucostomum – Mud turtle
Kinosternon scorpioides – Mud turtle
Staurotypus triporcatus – "Loggerhead"

Emydidae (Terrapins)

Pseudemys scripta – Ornate terrapin, "bokatura"
Rhinoclemmys areolata – Black-bellied turtle, "black belly"

Chelydridae (Snapping turtles)

Chelydra serpentina – Central American snapping turtle

Cheloniidae (Sea turtles)

Caretta caretta – Loggerhead turtle
Chelonia mydas – Green turtle, "carey"
Dermochelys coriacea – Leatherback turtle, "trunkback"
Eretmochelys imbricata – Hawksbill turtle

APPENDIX F: TREE SPECIES OF BELIZE

This checklist was prepared by G. Hartshorn based on published lists (Spellman et al. 1975; Dwyer and Spellman 1981), the multivolume Flora of Guatemala and augmented by field observations. Introduced species are indicated by an asterisk. For purposes of this checklist a tree is defined as having a minimum height of 5 m or a minimum diameter at breast height (dbh) of 10 cm.

Acanthaceae
Bravaisia grandiflora Donn. Sm.

Actinidiaceae
Saurauia belizensis Lundell – Wild orange

Anacardiaceae
Anacardium occidentale L. – Cashew
Astronium graveolens Jacq. – Glassy wood, palo mulato
**Mangifera indica* L. – Mango
Metopium brownei (Jacq.) Urb. – Black poison wood
Mosquitoxylum jamaicense Krug & Urb. – Bastard mahogany
Rhus striata R. & P.
Spondias mombin L. – Hog plum, jobo
Spondias purpurea L. – Hog plum
Spondias radlkoferi Donn. Sm.
Tapirira macrophylla Lundell – Southern wild mahogany

Annonaceae
Anaxagorea guatemalensis Standl.
Annona cherimola Miller – Cherimoya
Annona glabra L. – Bobwood
Annona primogenia Standl. & Steyerm.
Annona purpurea Moc. & Sesse – Oop
Annona reticulata L. – Custard apple, bullock's heart
Annona scleroderma Safford
Cymbopetalum mayanum Lundell
Cymbopetalum penduliflorum (Dun.) Baill.
Desmopsis microcarpa Fries
Desmopsis schippii Standl.
Desmopsis stenopetala (Donn. Sm.) Fries
Guatteria amplifolia Triana & Planch.
Guatteria gaumeri Greenm.
Malmea depressa (Baill.) Fries – Lance wood, wild soursop
Oxandra proctori Lundell
Rollinia jimenezii Safford
Sapranthus campechianus (HBK) Standl. – Sufricaya
Stenanona costaricensis Fries
Unonopsis pittieri Safford
Xylopia frutescens Aubl. – Polewood

Apocynaceae
Aspidosperma megalocarpon Muell. –Arg. – Mylady
Aspidosperma stegomeris Woods. – White mylady
Cameraria latifolia L. – Savanna white poison wood
Couma macrocarpa Barb. – Rodr. – Cow tree, barca
Lacmellea standleyi (Woods.) Monach. – Prickly vaca
Malouetia guatemalensis (Muell. – Arg.) Standl.
Plumeria obtusa L. – Zopilote
Plumeria rubra L. – Spanish jasmine
Stemmadenia donnell-smithii (Rose) Woods. – Cojotón
Tabernaemontana amygdalifolia Jacq.
Tabernaemontana arborea Rose – Cojón de caballo
Tabernaemontana chrysocarpa Blake – Cojón de perro
Thevetia ahouai (L.) DC – Cojon de mico
Thevetia gaumeri Hemsl.
**Thevetia peruviana* (Pers.) Woods.

Aquifoliaceae
Ilex belizensis Lundell – San Juan macho
Ilex gentlei Lundell
Ilex guianensis (Aubl.) Kuntze – Cassada, bird berry

Araliaceae
Dendropanax arboreus (L.) Decne. & Planch. – White gombolimbo
Dendropanax stenodontus (Standl.) A. C. Smith
Didymopanax morototoni (Aubl.) Decne. & Planch. – Mountain trumpet
Oreopanax lachnocephalus Standl.
Oreopanax liebmannii Marchal – Yaxyulup
Oreopanax xalapensis (HBK.) Decne. & Planch.

Avicenniaceae
Avicennia germinans L. Black mangrove

Bignoniaceae
Amphitecna breedlovei Gentry – Wild calabash
Amphitecna latifolia (Miller) Gentry – River calabash
Crescentia cujete L. – Calabash
Crescentia linearifolia Miers
Godmania aesculifolia (HBK.) Standl.
Jacaranda copaia (Aubl.) D. Don
Parmentiera aculeata (HBK.) Seem. – Cow okra
**Spathodea campanulata* Beauv. – African tulip tree
Tabebuia guayacan (Seem.) Hemsl. – Yellow mayflower
Tabebuia ochracea (Cham.) Standl. – Cortéz
Tabebuia rosea (Bertol.) DC. – Mayflower

Bixaceae
Bixa orellana L. – Annatto, atta

Bombacaceae
Bernoullia flammea Oliver – Mapola
Ceiba aesculifolia (HBK.) Britt. & Baker
Ceiba pentandra (L.) Gaertn. – Ceiba, cotton tree
Ochroma lagopus Sw. – Balsa, polak
Pachira aquatica Aubl. – Provision tree
Pseudobombax septenatum (Jacq.) Dugand – Mapola
Quararibea funebris (Llave) Vischer – Batidos
Quararibea guatemalensis (Donn. Sm.) Standl. & Steyerm.
Quararibea schippii Millsp. – Batidos

Boraginaceae
Bourreria mollis Standl. – Black fiddle wood
Bourreria oxyphyllaria Standl. – Wild craboo
Cordia alliodora (R. & P.) Oken – Salmwood
Cordia bicolor A. DC.
Cordia dentata Poir.
Cordia diversifolia Pavon – Chischis
Cordia gerascanthus L.
Cordia sebestena L. – (Ziricote)
Cordia stellifera I. M. Johnst.
Ehretia tinifolia L.

Burseraceae
Bursera simaruba (L.) Sarg. – Red gombolimbo
Protium copal (Schlecht. & Cham.) Engl. – Copal
Protium multiramiflorum Lundell – Copal colorado
Protium panamense (Rose) Johnst.
Protium schippii Lundell – Copal macho
Tetragastris panamensis (Engl.) Kuntze – Carbón

Caesalpiniaceae
Bauhinia divaricata L. – Cowfoot
Caesalpinia exostemma DC.
Caesalpinia gaumeri Greenm. – Warree wood
Caesalpinia recordii Britt. & Rose – Bastard Billy Webb
Caesalpinia violacea (Mill.) Standl. – Brasiletto
Cassia emarginata L. – Barba jolote
**Cassia fistula* L.
Cassia fruticosa Miller
Cassia grandis L. – Stinking toe
Cassia spectabilis DC. – Pisabed
Cynometra retusa Britt. & Rose
**Delonix regia* (Bojer) Raf.
Dialium guianense (Aubl.) Steud. – Ironwood, tamarindo
Haematoxylon campechianum L. – Logwood
Hymenaea courbaril L. – Locust
Poeppigia procera Presl.
Schizolobium parahybum (Vell.) Blake – Quamwood
Swartzia cubensis (Britt. & Rose) Standl. – Bastard rosewood
Swartzia myrtifolia J. E. Smith
Swartzia ochnacea A. DC.
**Tamarindus indica* L. – Tamarind
Zollernia tango Standl. – Tango

Capparidaceae
Capparis baducca L.
Capparis calciphila Standl. & Steyerm.

Capparis cynophallophora L.
Capparis quiriguensis Standl.
Crataeva tapia L. – Walka bead, yuy
Forchhammeria trifoliata Radlk. – Bastard dogwood

Caricaceae
Carica papaya L. – Papaya, pawpaw
Jacaratia dolichaula (Donn. Sm.) Johnst.

Casuarinaceae
**Casuarina equisetifolia* L.

Celastraceae
Crossopetalum eucymosus (Loes. & Pitt.) Lundell – Limoncillo
Maytenus belizensis Standl.
Maytenus guatemalensis Lundell
Maytenus schippii Lundell
Rhacoma lanceifolia Lundell
Wimmeria bartlettii Lundell
Zinowiewia costaricensis Lundell
Zinowiewia pallida Lundell

Chrysobalanaceae
Chrysobalanus icaco L. – Coco plum
Couepia polyandra (HBK.) Rose – Baboon cap
Hirtella americana L. – Pigeon plum, wild coco plum
Hirtella guatemalensis Standl. – Achotillo, icaco macho
Hirtella racemosa Lam. – Wild pigeon plum
Hirtella triandra Sw. – Wild coco plum
Licania hypoleuca Benth. – Pigeon plum
Licania platypus (Hemsl.) Fritsch – Monkey apple
Licania sparsipilis Blake – Bastard pigeon plum

Clethraceae
Clethra macrophylla Mart. & Gal.
Clethra mexicana DC.

Clusiaceae
Clusia flava Jacq. – Matapalo
Clusia lundellii Standl. – Matapalo
Clusia massoniana Lundell
Clusia quadrangula Bart.
Clusia rosea Jacq.
Clusia salvinii Donn. Sm.
Clusia suborbicularis Lundell – Chunup

Cochlospermaceae
Cochlospermum vitifolium Willd. – Wild cotton

Combretaceae
Bucida buceras L. – Bullet tree
Conocarpus erecta L. – Buttonwood
Laguncularia racemosa (L.) Gaertn. – White mangrove
Terminalia amazonia (Gmel.) Exell – Nargusta
**Terminalia catappa* L. – Almond

Compositae
Baccharis trinervis (Lam) Pers.
Clibadium arboreum Donn. Sm.
Eupatorium albicaule Sch. –Bip. – Old woman's walking stick
Eupatorium araliaefolium Less.
Eupatorium pittieri Klatt
Liabum deamii Robins. & Bart.
Piptocarpha chontalensis Baker
Podachaenium eminens (Lag.) Sch. –Bip.
Verbesina lanata Robins. & Greenm.
Vernonia leiocarpa DC.
Vernonia patens HBK.

Cyrillaceae
Cyrilla racemiflora L.
Purdiaea belizensis (Smith & Standl.) Thomas

Dichapetalaceae
Dichapetalum donnell-smithii Engler – Auselín

Dilleniaceae
Curatella americana L. – Yaha

Ebenaceae
Diospyros albens Presl.
Diospyros bumelioides Standl.
Diospyros cuneata Standl.
Diospyros digyna Jacq.
Diospyros nicaraguensis Standl. – Silión
Diospyros schippii Standl.
Diospyros yucatenensis Lundell

Elaeocarpaceae
Muntingia calabura L.
Sloanea guapilensis Standl.
Sloanea tuerckheimii Donn. Sm. – Wild atta, wild akee

Ericaceae
Befaria mexicana Benth.
Leucothoe mexicana (Hemsl.) Small
Leucothoe pinetorum Standl. & L. Wms.

Erythroxylaceae
Erythroxlyon areolatum L. – Redwood
Erythroxlyon tabascense Britt.

Euphorbiaceae
Acalypha lancetillae Standl.
Adelia barbinervis Schlecht. & Cham.
Alchornea latifolia Sw. – Fiddle wood
Amanoa potomophila Croiz. – Swamp Icaco
Bernardia interrupta (Schlecht.) Muell. –Arg. – Walka ribbon
Cleidion oblongifolium (Standl.) Croiz.
Croton pyramidalis Donn. Sm.
Croton schiedeanus Schlecht. – Wild cinnamon
Drypetes brownii Standl. – Male bullhoof
Drypetes lateriflora (Sw.) Krug. & Urb.
Gymnanthes lucida Sw. – False lignum vitae
Hieronyma oblonga (Tul.) Muell. –Arg. – Redwood
Hippomane mancinella L. – Manchineel
Jatropha curcas L.
Jatropha gaumeri Greenm. – Wild physic nut
Mabea occidentalis Benth.
Margaritaria nobilis Lf. – Clawberry, ramón macho
Pera arborea Mutis
Pera barbellata Standl.
Phyllanthus acidus (L.) Skeels – Wild plum
Phyllanthus longipes Steyerm.
Sapium macrocarpon Muell. –Arg.
Sapium mammosum Lundell
Sapium nitidum (Monach.) Lundell – Leche maría
Sapium schippii Croiz.
Sebastiana adenophora Pax & Hoffm.
Sebastiana confusa Lundell – White poison wood
Sebastiana longicuspis Standl. – Ridge white poison wood
Stillingia zelayensis (HBK.) Muell. –Arg.

Fabaceae
Acosmium panamense (Benth.) Yakoul. – Billy Webb
Andira inermis HBK. – Cabbage bark
Ateleia cubensis Griseb. – Tuxche
Dalbergia cubilquitensis (Donn. Sm.) Pitt.
Dalbergia laevigata Standl.
Dalbergia stevensonii Standl. – Rosewood
Diphysa carthagenensis Jacq. – Wild ruda
Diphysa robinioides Benth.
Erythrina berteroana Urb. – Pito
Erythrina folkersii Kruk. & Mold. – Coral tree
Erythrina fusca Lour.
Erythrina standleyana Kruk. – Coama wood
Gliricidia sepium (Jacq.) Steud. – Madre cacao
Lonchocarpus amarus Standl. – Bitter wood
Lonchocarpus castilloi Standl. – Black cabbage bark
Lonchocarpus guatemalensis Benth. – Dogwood, turtle bone
Lonchocarpus hondurensis Benth. – Waterside turtle bone
Lonchocarpus latifolius (Willd.) HBK. – Water wood
Lonchocarpus lineatus Pitt. – Water wood
Lonchocarpus minimiflorus Donn. Sm.
Lonchocarpus pentaphyllus (Poir.) DC.
Lonchocarpus rugosus Benth. – Black cabbage bark
Lonchocarpus xuul Lundell
Muellera frutescens (Aubl.) Standl.
Myroxylon balsamum (L.) Harms – Balsam of Peru
Ormosia isthmensis Standl. – Hormigo
Ormosia macrocalyx Ducke
Ormosia schippii Pierce
Ormosia toledoana Standl. – Hormiga.
Piscidia piscipula (L.) Sarg. – Dogwood, may bush
Platymiscium yucatanum Standl. – Granadillo

Pterocarpus hayesii Hemsl.
Pterocarpus officinalis Jacq. – Swamp kaway, palo de sangre
Vatairea lundellii (Standl.) Killip – Bitter wood

Fagaceae
Quercus anglohondurensis Mull. – Oak
Quercus currugata Hook. – Oak
Quercus hondurensis Trel. – Oak
Quercus insignis Mart. & Gal. – Oak
Quercus oleoides Schlecht. & Cham. – Oak
Quercus peduncularis (Trel.) Mull. – Oak
Quercus purulhana Trel. – Oak
Quercus sapotaefolia Liebm. – Oak

Flacourtiaceae
Bartholomaea sessiliflora (Standl.) Standl. & Steyerm.
Casearia arborea (L. Rich.) Urb.
Casearia bartlettii Lundell
Casearia commersoniana Camb.
Casearia corymbosa HBK. – Paletillo
Casearia sylvestris Sw. – Wild sage
Casearia tremula (Griseb.) Wright
Hasseltiopsis dioica (Benth.) Sleum.
Homelium racemosum Jacq.
Laetia procera (Poep.) Eich. – Drunken bayman wood, palacio
Laetia thamnia L.
Lindackeria laurina Presl.
Pleuranthodendron lindenii (Turcz.) Sleum.
Prockia crucis L.
Xylosma anisophylla Standl.
Xylosma chloranthum Donn. Sm.
Xylosma flexuosum (HBK.) Hemsl.
Xylosma oligandrum Donn. Sm.
Zuelania guidonia (SW.) Britt. & Millsp. – Water wood

Guttiferae
Calophyllum brasiliense Camb. – Santa maría
Mammea americana L. – Mammee apple
Marila verapazensis Donn. Sm.
Rheedia edulis Triana & Planch.
Rheedia intermedia Pitt. – Waika plum
Symphonia globulifera Lf. – Waika chewstick
Tovomita nicaraguensis (Oerst.) L. Wms.
Vismia baccifera (L). Triana & Planch. – Yellow sangre
Vismia camparaguey Sprague & Riley – Old William
Vismia mexicana Schlecht.

Hippocrateaceae
Hemiangium excelsum (HBK.) A. C. Sm.

Icacinaceae
Calatola laevigata Standl.

Lacistemaceae
Lacistema aggregatum (Berg.) Rusby – Palo mulato

Lauraceae
Beilschmiedea hondurensis Kosterm.
Licaria campechiana (Standl.) Kosterm.
Licaria capitata (Cham. & Schlecht.) Kosterm.
Licaria caudata (Lundell) Kosterm.
Licaria coriacea (Lundell) Kosterm.
Licaria peckii (Johnst.) Kosterm. – Timbersweet
Nectandra ambigens (Blake) Allen – Timbersweet
Nectandra coriacea (Sw.) Grisab.
Nectandra lundellii Allen
Nectandra membranacea (Sw.) Griseb.
Nectandra salicifolia (Kunth) Nees
Nectandra sanguinea Rottb. – ' aurel, timbersweet
Ocotea bernoulliana Mez
Ocotea cernua (Nees) Mez – Aguacatillo
Ocotea eucuneata Lundell
Ocotea lenticellata Lundell
Persea americana Mill. – Pear, butter pear
Phoebe areolata Lundell
Phoebe gentlei (Lundell) Standl. – Timbersweet, wild pear
Phoebe longicaudata Lundell – Aguacatillo, white laurel
Phoebe mayana Lundell
Phoebe mexicana Meissn.
Phoebe mollis Mez

Lecythidaceae
Grias cauliflora L. – Bombo wood, genip

Leguminosae (see Caesalpiniaceae, Fabaceae, Mimosaceae)

Liliaceae
Dracaena americana Donn. Sm. – Candle wood
Yucca elephantipes Reg.

Loganiaceae
Buddleia americana L.

Malpighiaceae
Bunchosia cornifolia HBK.
Bunchosia lanceolata Turcz. – Cojón del fraile
Bunchosia swartziana Griseb.
Byrsonima bucidaefolia Standl. – Craboo
Byrsonima crassifolia (L.) DC. – Craboo
Malpighia glabra L. – Wild craboo
Malpighia lundellii Morton – Hicatee plum

Malvaceae
Hampea euryphylla Standl. – Majagua, moho
Hampea trilobata Standl. – Moho
Hibiscus tiliaceus L. – Blue moho
Thespesia populnea (L.) Soland. – Cork tree

Melastomataceae
Bellucia costaricensis Cogn. – Maya
Bellucia grossularioides (L.) Triana – Black moir
Conostegia caelestis Standl.
Conostegia icosandra (Sw.) Urb.
Conostegia plumosa L. Wms.
Conostegia xalapensis (Bonpl.) Don – Uva
Henriettella fascicularis Triana
Henriettella seemannii Naud.
Henriettella succosa Aubl. – Wild guava
Miconia affinis DC. – Maya
Miconia amplexans (Creug.) Cogn.
Miconia argentea (Sw.) DC. – White maya
Miconia borealis Gleason
Miconia calvescens DC.
Miconia centrodesma Naud.
Miconia chrysophylla (L. Rich.) Urb. – Red maya
Miconia dodecandra (Desr.) Cogn. – Maya
Miconia elata (SW.) DC.
Miconia fulvostellata L. Wms. – Mountain sirín
Miconia glaberrima (Schecht.) Naud.
Miconia hondurensis Donn. Sm.
Miconia hyperprasina Naud.
Miconia impetiolaris (Sw.) Don – Maya
Miconia involucrata Donn. Sm.
Miconia lundelliana L. Wms.
Miconia matthaei Naud.
Miconia mirabilis (Aubl.) L. Wms.
Miconia nervosa (Smith) Triana
Miconia obovalis Naud.
Miconia ochroleuca Standl.
Miconia prasina (Sw.) DC.
Miconia punctata (Desr.) Don – Red maya
Miconia reducens Triana
Miconia schlimii Triana
Miconia serrulata (DC.) Naud.
Miconia tomentosa (L. Rich.) Don
Miconia virescens (Vahl) Triana
Mouriri exilis Gleason – Jug
Mouriri myrtilloides (Sw.) Poir. – Jug, half crown
Tococa guianensis Aubl.
Topobea laevigata (D. Don) Naud.
Topobea watsonii Cogn.

Meliaceae
Carapa guianensis Aubl. – Bastard mahogany
Cedrela mexicana Roem. – Cedar
Guarea glabra Vahl – Wild orange
Guarea grandifolia DC. – Wild akee
Guarea excelsa HBK. – Cramantee
**Melia azedarach* L. – Paradise tree
Swietenia macrophylla King – Mahogany
Trichilia breviflora Blake & Standl.
Trichilia erythrocarpa Lundell
Trichilia havanensis Jacq. – Bastard lime
Trichilia hirta L. – Red cedar
Trichilia martiana C. DC. – Bastard grand Betty
Trichilia minutiflora Standl. – Wild lime
Trichilia moschata Sw.
Trichilia pallida Sw. – Carbón del río

Menispermaceae
Hyperbaena mexicana Miers
Hyperbaena winzerlingii Standl.

Mimosaceae
Acacia angustissima (Miller) Kuntze
Acacia collinsii Safford – Cockspur
Acacia cookii Safford – Cockspur, ant thorn
Acacia costaricensis Schenck – Cockspur
Acacia dolichostachya Blake
Acacia farnesiana (L.) Willd. – Cashaw, cuntich
Acacia gentlei Standl. – Red cockspur
Acacia glomerosa Benth. – White tamarind
Albizzia adinocephala (Donn. Sm.) Britt. & Rose
Albizzia idiopoda (Blake) Britt. & Rose – Salem
Albizzia tomentosa (Micheli) Standl. – Wild tamarind
Calliandra belizensis (Britt. & Rose) Standl.
Enterolobium cyclocarpum (Jacq.) Griseb. – Tubroos
Inga belizensis Standl.
Inga edulis Mart. – Guamo, bribri
Inga leptoloba Schlecht.
Inga lindeniana Benth.
Inga pinetorum Pitt.
Inga punctata Willd.
Inga quaternata Poepp.
Inga recordii Britt. & Rose – Bribri macho
Inga rodrigueziana Pitt. – Tamatama
Inga roussoviana Pitt.
Inga sapindoides Willd.
Inga spuria (Willd.) Leon
Leucaena guatemalensis Britt. & Rose
Lysiloma bahamense Benth. – Salom
Lysiloma desmostachys Benth. – Wild tamarind
Mimosa hemiendyta Rose & Robins. – Bastard logwood
Pithecellobium albicans (Kunth) Benth.
Pithecellobium arboreum (L.) Urb. – Barba jolote
Pithecellobium belizense Standl.
Pithecellobium brownii –Standl. – Red Fowl
Pithecellobium donnell-smithii (Britt. & Rose) Standl.
Pithecellobium dulce (Roxb.) Benth.
Pithecellobium erythrocarpum Standl.
Pithecellobium gigantifolium (Schery) Leon
Pithecellobium graciliflorum Blake
Pithecellobium halogenes Standl.
Pithecellobium insigne Micheli
Pithecellobium lanceolatum (Humb. & Bonpl.) Benth. – Red fowl
Pithecellobium leucocalyx (Britt. & Rose) Standl.
Pithecellobium macrandrium Donn. Sm. – Prickle wood
Pithecellobium pachypus Pitt.
Pithecellobium peckii (Robins.) Standl.
Pithecellobium pistaciifolium Standl.
Pithecellobium recordii (Britt. & Rose) Standl. – Turtlebone
Pithecellobium saman (Jacq.) Benth. – Rain tree
Pithecellobium stevensonii (Standl.) Standl. & Steyerm.

Monimiaceae
Mollinedia guatemalensis Perkins
Siparuna nicaraguensis Hemsl. – Wild coffee

Moraceae
**Artocarpus altilis* (Parkinson) Fosberg – Breadfruit
Brosimum alicastrum Sw. – Breadnut, ramón
Brosimum guianense (Aubl.) Huber
Brosimum lactescens (S. Moore) C. C. Berg
Castilla elastica Sessé – Wild rubber
Castilla tuna Hemsl.
Cecropia obtusifolia Bertol. – Trumpet
Cecropia peltata L. – Trumpet
Chlorophora tinctoria (L.) Guad. – Fustic
Ficus colubrinae Standl. – Fig [dependent]
Ficus costaricana (Liebm.) Miq. – Fig [dependent]
Ficus glabrata HBK. – Fig
Ficus goldmanii Standl. – Matapalo [dependent]
Ficus guajavoides Lundell – Fig
Ficus hemsleyana Standl. – Fig
Ficus insipida Willd. – Fig
Ficus involuta (Liebm.) Miq. – Fig [dependent]
Ficus lapathifolia (Liebm.) Miq. – Fig [dependent]
Ficus oerstediana Miq. – Fig
Ficus ovalis (Liebm.) Miq. – Matapalo [dependent]
Ficus padifolia HBK. – Fig [dependent]
Ficus panamensis Standl. Fig [dependent]
Ficus popenoei Standl. – Fig [dependent]
Ficus radula Willd. – Fig
Ficus schippii Standl. – Fig [dependent]
Ficus tecolutensis (Liebm.) Miq. – Fig
Ficus tuerckheimii Standl. – Fig
Ficus velutina Willd. – Fig
Poulsenia armata (Miq.) Standl.
Pourouma aspera Trecul. – Trumpet
Pseudolmedia oxyphyllaria Donn. Sm. – Cherry
Pseudolmedia spuria (Sw.) Griseb. – Cherry
Trophis chorizantha Standl.
Trophis racemosa (L.) Urb. – Red breadnut, white ramón

Moringaceae
**Moringa oleifera* Lam – Maranga

Myricaceae
Myrica cerifera L. – Tea bark

Myristicaceae
Compsoneura sprucei (A. DC.) Warb.
Virola koschnyi Warb. – Banak

Myrsinaceae
Ardisia compressa HBK. – Male blossom berry grape
Ardisia densiflora Krug. & Urb. – Wild spice
Ardisia escallonioides Schlecht. & Cham. – Hullaba
Ardisia nigrescens Oerst. – Blossom berry
Ardisia nigropunctata Oerst. – Blossom berry
Ardisia paschalis Donn. Sm.
Ardisia revoluta HBK.
Ardisia schippii Standl.
Parathesis belizensis Lundell
Parathesis chrysophylla Lundell – Uva
Parathesis rufa Lundell
Parathesis sessilifolia Donn. Sm.
Rapanea guianensis Aubl.

Myrtaceae
**Callistemon lanceolatum* DC.
Calyptranthes chytraculia (L.) Sw.
Calyptranthes cuneifolia Lundell
Calyptranthes megistophylla Standl.
Eugenia acapulcensis Steud.
Eugenia aeruginea DC.
Eugenia axillaris (Sw.) Willd.
Eugenia biflora (L.) DC.
Eugenia bumelioides Standl.
Eugenia buxifolia (Sw.) Willd.
Eugenia capuli (Schlecht. & Cham.) Berg
Eugenia farameoides A. Rich.
Eugenia laevis Berg
Eugenia octopleura Krug & Urb.
Eugenia oerstedeana Berg
Eugenia percivalii Lundell
Eugenia riograndis Lundell
Eugenia tikalana Lundell
Eugenia toledinensis Lundell
Eugenia trikii Lundell
Eugenia vacana Lundell
Eugenia yucatanensis Standl.
Myrcia leptoclada DC. – Parrot plum
Myrcia splendens (Sw.) DC.
Myrcianthes fragrans (Sw.) McVaugh
Myrciaria floribunda (Willd.) Berg
Pimenta dioica (L.) Merrill – Allspice
Psidium anglohondurense (Lundell) McVaugh
Psidium biloculare McVaugh
Psidium guajava L. – Guava
Psidium mouririoides (Lundell) McVaugh – Wild guava
Psidium sartorianum (Berg.) Ndzu.
**Syszgium cumini* (L.) Skeels
**Syszgium malaccensis* (L.) Merr. & Perry – Water apple

Nyctaginaceae
Neea belizensis Lundell
Pisonia macranthocarpa Donn. Sm.
Torrubia linearibracteata (Heimerl) Standl.

Ochnaceae
Ouratea lucens (HBK.) Engler
Ouratea nitida (Sw.) Engl. – Bastard blossom berries

Olacaceae
Heisteria media Blake — Wild cinnamon
Schoepfia schreberi Gmel.
Ximenia americana L.

Oleaceae
Forestiera rhamnifolia Griseb.
Linociera domingensis (Lam.) Krug & Urb.
Linociera oblanceolata Robins.

Onagraceae
Hauya lundellii Standl.

Palmae
Acrocomia belizensis Bailey — Suba
Acrocomia mexicana Karw.
Astrocaryum mexicanum Liebm. — Warree cohune
Bactris trichophylla Burret
Cocos nucifera L. — Coconut
Cryosophila argentea Bartlett — Give-and-take
Euterpe macrospadix Oerst. — Cabbaga palm
Geonoma binervia Oerst.
Geonoma longipetiolata Oerst. — Monkey-tail palm
Manicaria saccifera Gaertn. — Comfray palm
Opsiandra maya Cook
Orbignya cohune (Mart.) Dahlg. — Cohune
Paurotis wrightii (Griseb. & Wendl.) Britt. — Palmetto
Roystonea oleracea (Jacq.) Cook — Royal palm
Sabal morrisiana Bartlett — Botán palm
Sabal nematoclada Burret
Schippia concolor Burret — Silver palmetto
Thrinax radiata Lodd. — Silver thatch palm

Pinaceae
Pinus caribaea Morelet — Honduran pine
**Pinus elliottii* Engleman — Slash pine
Pinus oocarpa Schiede — Pine

Piperaceae
Piper aduncum L. — Spanish elder
Piper amalago L. — Spanish elder
Piper auritum HBK. — Cowfoot, bullhoof
Piper diandrum C. DC.
Piper donnell-smithii C. DC.
Piper geniculatum Sw. — Cordoncillo
Piper pansamalanum C. DC.
Piper psilorhachis C. DC. — Spanish elder
Piper schippianum Trel. & Standl.
Piper sempervirens (Trel.) Lundell

Podocarpaceae
Podocarpus guatemalensis Standl. — Cypress

Polygonaceae
Coccoloba belizensis Standl. — Wild grape
Coccoloba corozalensis Lundell — Pigeon plum
Coccoloba cozumelensis Hemsl. — Wild grape
Coccoloba hondurensis Lundell
Coccoloba laurifolia Jacq.
Coccoloba reflexiflora Standl.
Coccoloba schiedeana Lindau — Wild grape
Coccoloba schippii Lundell
Coccoloba tuerckheimii Donn. Sm. — Wild grape
Coccoloba uvifera (L.) Jacq. — Sea grape
Gymnopodium floribundum Rolfe — Bastard logwood

Proteaceae
Roupala complicata HBK.
Roupala montana Aubl.

Punicaceae
**Punica granatum* L. — Pomegrenate

Quiinaceae
Quiina schippii Standl. — Pigeon plum

Rhamnaceae
Krugiodendron ferreum (Vahl) Urb. — Axemaster, quebracho
**Zizyphus mauritiana* Lam.

Rhizophoraceae
Cassipourea guianensis Aubl. — Water wood
Rhizophora mangle L. — Red mengrove

Rosaceae
Photinia microcarpa Standl.

Rubiaceae
Alibertia edulis (L. Rich.) A. Rich. — Wild guava
Alseis hondurensis Standl.
Alseis yucatanensis Standl. — Wild mammee
Anisomeris protracta (Bart.) Standl.
Antirhea lucida (Sw.) Benth. & Hook.
Cephaelis elata Sw.
Coussarea imitans L. Wms.
Exostema mexicanum Gray
Faramea belizensis Standl.
Faramea occidentalis (L.) A. Rich.
Guettarda combsii Urb. — Glassy wood
Guettarda elliptica Sw. — Prickle wood
Hamelia patens Jacq.
Ixora nicaraguensis Wernh.
Machaonia acuminata Humb. & Bonpl.
Morinda asperula Standl.
Morinda panamensis Seem. — Yellow wood
Posoqueria latifolia (Rudge) R. & S. — Mountain guava
Psychotria chiapensis Standl. — Cassada, white wood
Psychotria flava Oerst.
Psychotria grandis Sw.
Psychotria lundellii Standl.
Psychotria schippii Standl. & Steyerm.
Psychotria simiarum Standl.
Randia gentlei Lundell
Rondeletia belizensis Standl.
Rondeletia buddleioides Benth.
Simira salvadorensis (Standl). Steyerm. — John Crow redwood

Rutaceae
Amyris belizensis Lundell
Amyris rhomboidea Standl.
Casimiroa tetrameria Millsp.
**Citrus aurantifolia* (Christ.) Swingle — Lime
**Citrus aurantium* L. — Sour orange
**Citrus grandis* (L.) Osbeck — Pummelo
**Citrus medica* L. — Citron
**Citrus paradisi* Maaf. — Grapefruit
**Citrus reticulata* Blanco — Tangerine
**Citrus sinensis* Osbeck — Sweet orange
Esenbeckia pentaphylla (Macfad.) Griseb. — Candle wood
Pilocarpus racemosa Vahl
Zanthoxylum caribaeum Lam. — Bastard prickly yellow
Zanthoxylum kellermanii P. Wilson — Male prickly yellow
Zanthoxylum mayanum Standl. — Prickly yellow
Zanthoxylum procerum Donn. Sm. — Black prickly yellow

Salicaceae
Salix chilensis Molina — Willow

Sapindaceae
Allophyllus campostachya Blake — Bastard axemaster
Allophyllus cominia (L.) Sw. — Cherry, huesillo
**Blighia sapida* Koenig — Akee
Cupania auriculata Standl. — Grande Betty
Cupania belizensis Standl. — Bastard Grand Betty
Cupania macrophylla A. Rich.
Cupania rufescens Tr. & Planch. — White Grande Betty
Cupania schippii Standl.
Exothea diphylla (Standl.) Lundell — Ueyamcox
Exothea paniculata (Juss.) Redkl.
Matayba oppositifolia (A. Rich.) Britt. — Boy job
Sapindus saponaria L. — Soap-seed tree
Talisia oliviformis HBK.
Thouinia paucidentata Radlk.

Sapotaceae
Bumelia celestrina HBK.
Bumelia obtusifolia Roem. & Schult.
Bumelia retusa Sw.
Chrysophyllum cainito L. — Caimito, star apple
Chrysophyllum mexicanum Cronq. — Wild star apple
Dipholis durifolia Standl.
Dipholis salicifolia (L.) A. DC. — Cháchiga, mijico
Dipholis stevensonii Standl. — Faisán
Manilkara breviloba Gilly
Manilkara chicle (Pitt.) Gilly — Chicle macho
Manilkara stamlnodella Gilly

Manilkara zapota (L.) van Royen – Sapodilla, sapote
Mastichodendron belizense (Lundell) Cronq.
Mastichodendron foetidissimum (Jacq.) Cronq. – Cream tree
Micropholis mexicana Gilly
Pouteria amygdalina (Standl.) Baehni – Silly young
Pouteria campechiana (HBK.) Baehni – Mammee ciruela
Pouteria durlandii (Standl.) Baehni – Mammee cerera
Pouteria gallifructa Cronq.
Pouteria izabalensis (Standl.) Baehni – Red silión
Pouteria lundellii (Standl.) L. Wms.
Pouteria mammosa (L.) Cronq. – Mammee apple, mammee zapote
Pouteria neglecta Cronq. – Red man wood
Pouteria unilocularis (Donn. Sm.) Baehni – Zepotillo

Simaroubaceae
Alvaradoa amorphoides Liebm.
Picramnia antidesma Sw.
Quassia amara L.
Simarouba amara Aubl. – Negrito
Simarouba glauca DC. – Negrito

Solanaceae
Cestrum megalophyllum Dunal
Cestrum racemosum R. & P. – Night bloom
Solanum rugosum Dunal

Staphyleaceae
Turpinia paniculata Vent.

Sterculiaceae
Guazuma ulmifolia Lam. – Bay cedar, bestard cedar
Ptervgota excelsa
Sterculia mexicana Humb. & Bonpl.
Theobroma cacao L. – Cacao

Symplocaceae
Symplocos bicolor L. Wms. – Male pigeon plum

Theaceae
Freziera grisebachii Krug & Urb.
Symplocarpon lucidum Lundell
Ternstroemia tepezapote Schlecht. & Cham. – River craboo

Theophrastaceae
Jacquinia aurantiaca Ait. – Knock-me-back
Jacquinia paludicola Standl.
Jacquinia schippii Standl.

Tiliaceae
Belotia campbellii Sprague – Narrowleaf moho
Carpodiptera ameliae Lundell
Christiana africana DC.
Heliocarpus donnell-smithii Rose – Broadleaf moho
Luehea seemannii Tr. & Planch. – Caulote
Luehea speciosa Willd. – Caulote, mountain moho

Turneraceae
Erblichia odorata Seem. – Butterfly tree

Ulmaceae
Ampelocera hottlei (Standl.) Standl. – Female bullhoof
Celtis schippii Standl. – Female bullhoof
Trema micrantha (L.) Blume – Capulin

Urticaceae
Myriocarpa heterostachya Donn. Sm.
Myriocarpa obovata Donn. Sm.
Myriocarpa yzabalensis (Donn. Sm.) Killip
Urera alceifolia Gaud.
Urera baccifera (L.) Gaud. – Cow itch
Urera elata (Sw.) Griseb.

Verbenaceae
Aegiphila elata Sw.
Aegiphila monstrosa Moldenke – Vara blanca
Aegiphila pauciflora Standl.
Citharexylum caudatum L. – Bird seed, pigeon feed
Citharexylum crassifolium Greenm.
Citharexylum hexangulare Greenm.
Citharexylum pterocladum Donn. Sm.
Cornutia pyramidata L. – Matasano
**Gmelina arborea* Roxb.
Lippia myriocephala Schlecht. & Cham.
Lippia substrigosa Turcz.
Rehdera penninervia Standl. & Moldenke – Hinge hinge
**Tectona grandis* L. – Teak
Vitex gaumeri Greenm. – Fiddlewood, yashnik

Violaceae
Gloeospermum ferrugineostictum Robyns
Orthion malpighiifolium (Standl.) Standl. & Steyerm.
Orthion subsessile (Standl.) Standl. & Steyerm.
Rinorea guatemalensis (Wats.) Bart. – Wild coffee
Rinorea hummelii Sprague – Wild coffee

Vochysiaceae
Vochysia hondurensis Sprague – Yemeri