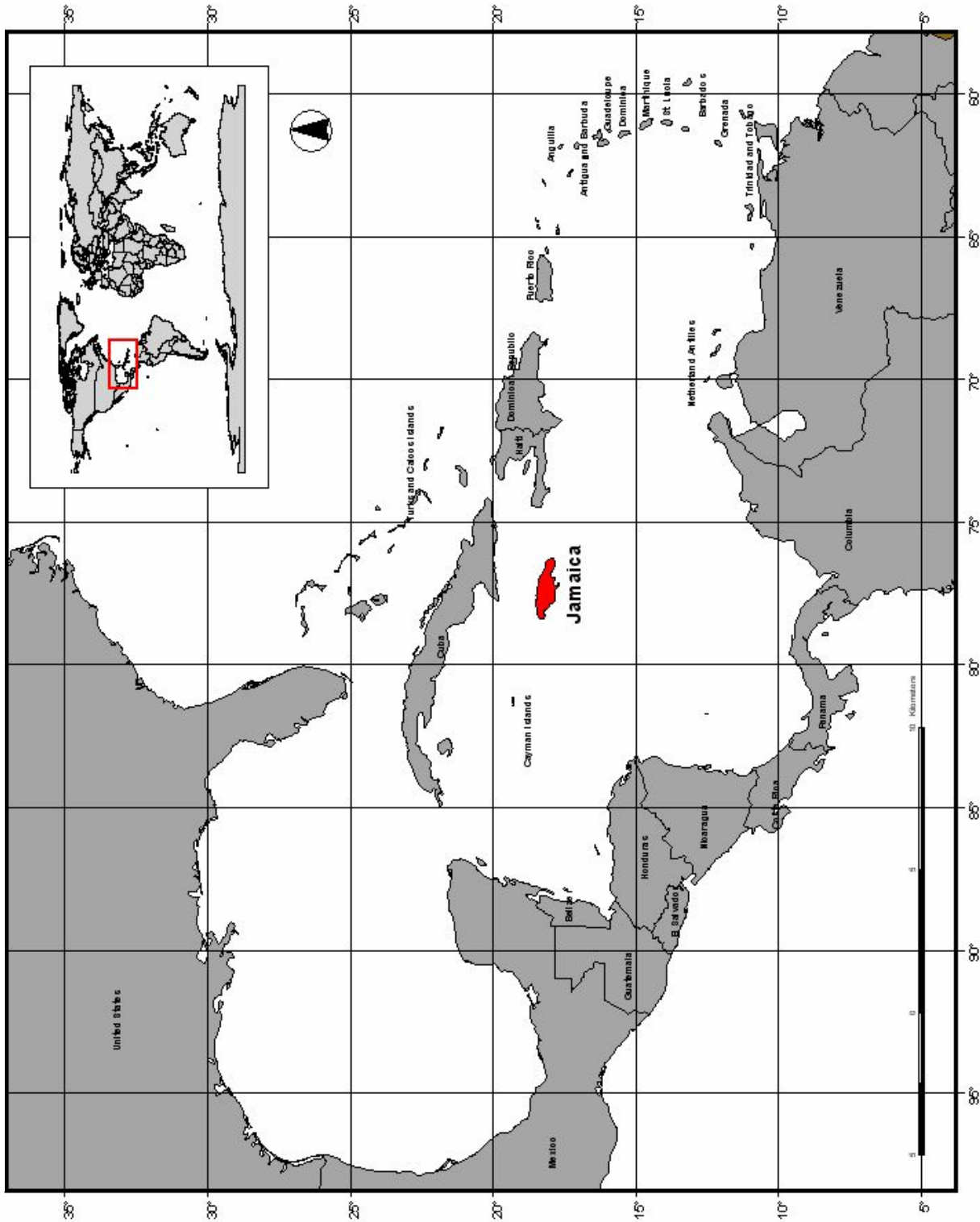


parish capitals are located along the coast and represents the main population centres.

LOCATION MAP OF JAMAICA

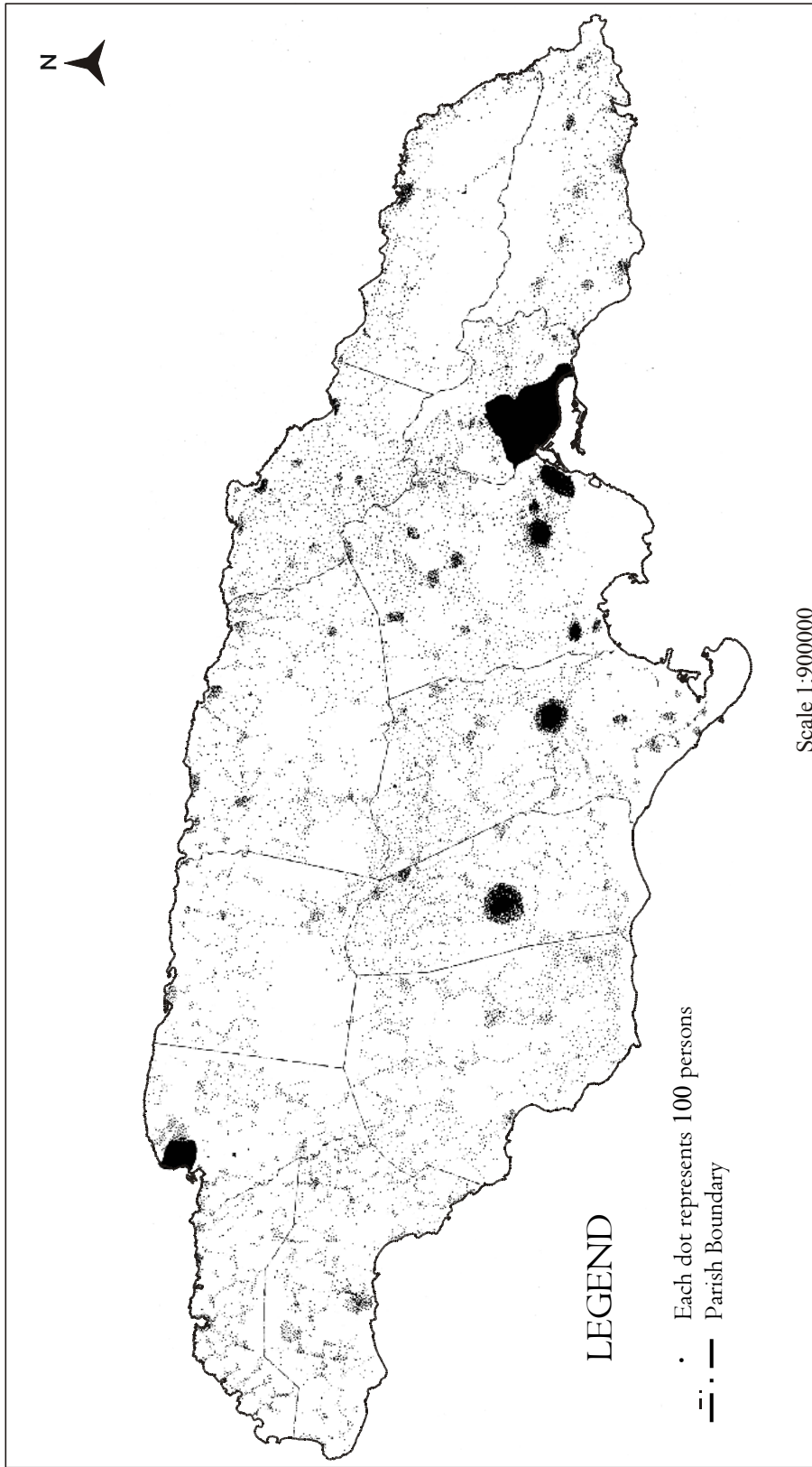
MAP I



Source: Environmental Systems Research Institute (ESRI)

POPULATION DISTRIBUTION MAP

MAP 2



Source: National Atlas of Jamaica, 1989

1.1.3 Economic Development

Natural resources have played an important role in Jamaica's development in both the pre - and post-colonial periods. The island's major economic sectors, agriculture, tourism and mining, are all based on natural resources.

The pattern of economic development and urbanisation has contributed substantially to the destruction of biodiversity. Initially, the increasing demand (in Europe) for sugar led to the development of estates for the cultivation of sugar cane in the lowland areas of the island. Later, agricultural production expanded to include crops such as bananas, coconuts, coffee and citrus. This agricultural development required the clearing of primary forests and was ecologically very destructive.

While the main impact of sugar cane and banana cultivation may have been confined to lowland areas, coffee cultivation has caused substantial deforestation of the upland areas mainly as a result of the felling and clearing of forest vegetation in preparation for planting coffee. In addition, the effects of chemical fertilisers and pesticides used in crop production have implications for the viability of non-target populations including crop pollinators. The impact of harmful agricultural chemical residues in surface and ground water on coral reefs is also of concern.

The discovery of commercial deposits of bauxite in the 1950s triggered a major change in the pattern of resource exploitation. Large areas of vegetation were cleared to allow ore extraction and construction of the necessary physical infrastructure to support mining operations and transport of products. Mining and processing of bauxite ore also contribute to land degradation, and air and ground water pollution.

During the 1950s, the Government provided incentives to encourage foreign investments through the "Industrialisation by Invitation" programme. By the 1970s, this led to the transformation of the main urban areas into centres with industries of considerable size. Hotel construction proceeded rapidly in coastal locations such as Montego Bay and Ocho Rios. The need for land to support the growing manufacturing and tourism sectors contributed to the destruction of forest and mangrove biodiversity. Air, ground and coastal water pollution also occurred.

The negative impact of tourism and manufacturing on biodiversity has been exacerbated by the unprecedented urban growth and unplanned developments in the

coastal areas between 1943 and 1975. Planned and unplanned urbanisation and informal (squatter) settlement construction have resulted in the loss of prime agricultural land. In addition, alteration and destruction of coastal and marine ecosystems are jeopardising biodiversity in these areas and beyond.

1.2 Jamaica's Biodiversity-Biological and Other Natural Resources

Jamaica's biodiversity is influenced by a variety of physical factors such as topography, geology, terrain and climate.

1.2.1 Physical Diversity

Jamaica has an exceptionally broad diversity of topography, geology and climate (Map 3).

1.2.1.1 Topography

The country's topography consists of a highland interior, formed by a backbone of peaks, hills and plateaux running the length of the island, which is surrounded by flat coastal plains. The highest peaks are to the east, with the Blue Mountain peak reaching a maximum height of 2,256 m. The central and western parts of the island are mainly limestone hills and plateaux.

The plateaux are dissected by faults and have been karstified to varying degrees. The most developed karst topography is in the Cockpit Country. It is an important ecological area of the country and is still relatively undisturbed.

Elsewhere, the karst is less developed and the terrain generally comprises rolling hills, sinkholes, ridges and caves.

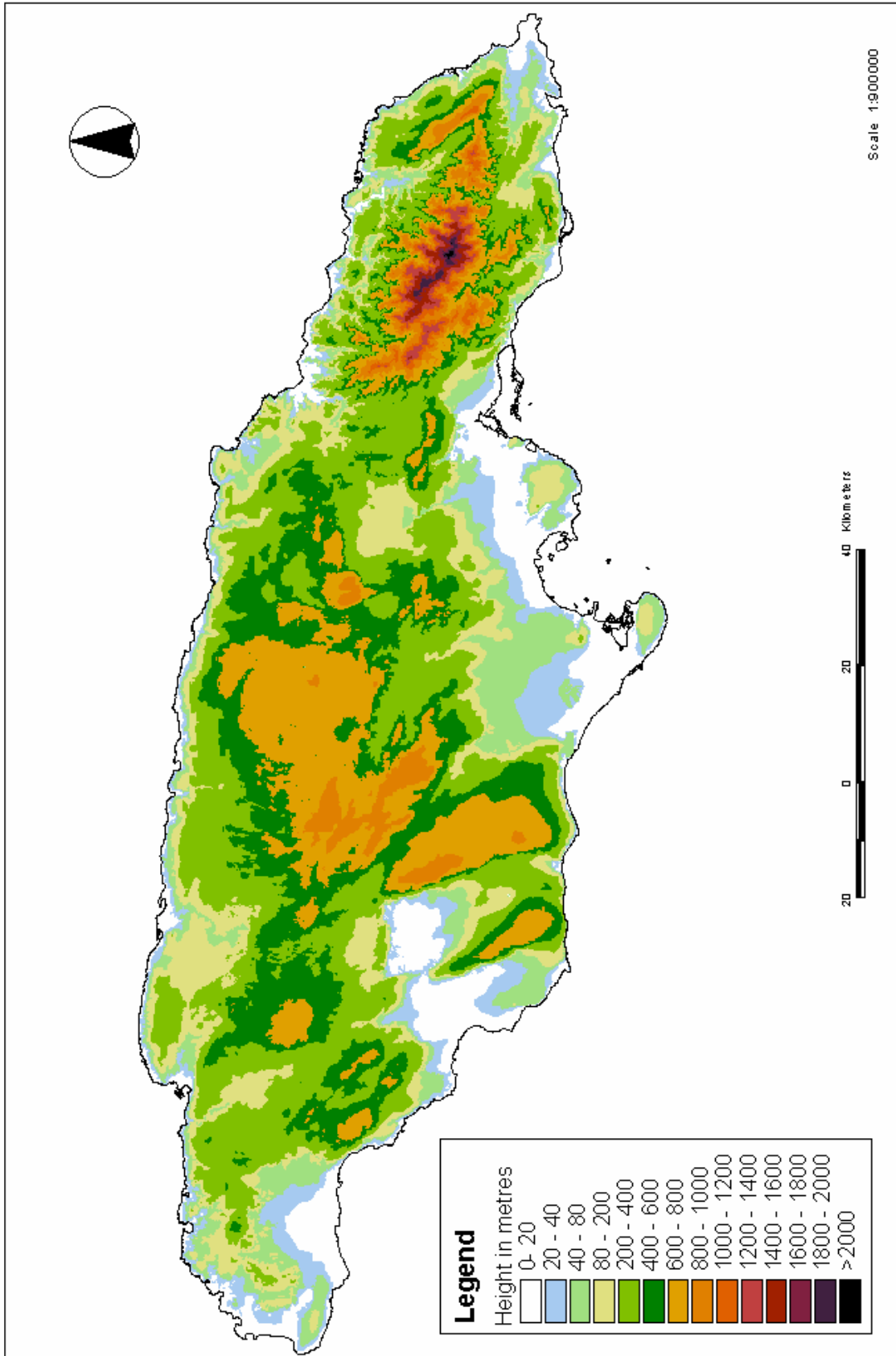
The coastal plains are narrow on the north coast and tend to be wider along the south coast. These include alluvial areas such as the plains of Clarendon, St. Catherine and St. Andrew. There are some extensive wetlands on the coastal plains. These include the Black River Upper and Lower Morasses, the St. Thomas Great Morass, West Harbour and the Negril Morass. In addition to coastal lowlands, there are three interior valleys. The coastal plains and the interior valleys are the prime agricultural areas.

1.2.1.2 Geology

Jamaica has an igneous and metamorphic core, covered to a great extent by limestone deposited during periods of marine submergence.

TOPOGRAPHY MAP OF JAMAICA

MAP 3



Source: Information Technology Branch, National Environment and Planning Agency

Approximately 70% of the island's surface area is covered by limestone. The remaining 30% is covered by igneous and metamorphic rocks, shale, and alluvium cover.

The soils of the country are a reflection of the geology. In the upland plateaux for example, soils are formed from weathered limestone and constitute approximately 64% of the island's soil, while the alluvial soils of the flood plains, river terraces, inland valleys and coastal plains, constitute approximately 14%.

1.2.1.3 Climate

Jamaica has a tropical maritime climate which is influenced by northeast trade winds and land and sea breezes. In the cooler months of January and February, the average temperature is approximately 25° Celsius (C). Temperatures in the warmest months, July and August, range from 28°C to 30°C. Temperature is significantly affected by altitude. In the higher elevations of the Blue Mountains and some plateaux, temperatures may be as much as 15 degrees cooler.

Rainfall is marked by monthly, annual and spatial variability, with the average annual rainfall for the country being approximately 200 cm.

The northeast portion of Jamaica receives the highest annual rainfall, which is in excess of 330 cm. Areas in the southern coastal plains receive less than 127 cm annually and water shortages are common occurrences, especially along the southern coastal plains. The rainfall pattern is bimodal with peaks in May and October. Heavy rainfall associated with passing storm systems may also occur during the annual hurricane season (June to November). Other natural phenomena, which affect the island's biodiversity, include hurricanes, earthquakes, floods and droughts.

1.2.2 Species Diversity

Jamaica has been rated fifth in islands of the world in terms of endemic plants. As illustrated in Table 1, there is also a high level of endemism for many species of animals including snails, terrestrial grapsid crabs, amphibians, reptiles, and land birds.

The status of species of fungi, bacteria, viruses and some invertebrates is not yet well known. According to Jamaica's Conservation Data Centre database (CDC), at least 221 endemic species are classified as 'critically imperilled' and 'especially vulnerable to extinction'. However this database is incomplete.



Banded Coral Shrimp (*Stenopus hispidus*)

1.2.2.1 Terrestrial Animal Species

At least six species of terrestrial vertebrates are thought to have become extinct in Jamaica in the last 150 years, and many more species are considered endangered, threatened or rare. Species diversity in Jamaica is well documented for vertebrates, as shown in Table 1.

Table 1 Species richness and endemism of selected invertebrates and vertebrates (excluding fish) of Jamaica

Terrestrial Fauna	Total Number of Indigenous Species	Number of Endemic Species	% Endemic Species
Rotifers	211	<21	<10
Land Snails	514	505	98.2
Grapsid Crabs	9	9	100.0
Jumping Spiders	26	20	76.9
Fireflies	48	45	93.8
Butterflies	133	20	15.0
Ants	59	6	10.3
Amphibians	22	22	100.0
Reptiles	43	33	76.7
Shore and Sea Birds	39	1	2.6
Land Birds	67	30	44.8
Bats	21	2	9.5
Other Mammals	2	2	100.0

Source: Terrestrial Animal Assessment Report, 1999

1.2.2.2 Marine Animal Species

Jamaica enjoys a rich diversity of marine species which includes species of fish, sea anemones, black corals, stony corals, sea fans, molluscs, turtles, and marine mammals including whales, dolphins and manatees.

The main fisheries resources include: coral reef fish, Spiny Lobsters, Queen Conch, small coastal pelagic finfish, and large offshore pelagic finfish.

The reef fish of major economic importance in Jamaica include representatives from the families: Mullidae (goatfish), Haemulidae (grunt), Serranidae (grouper), Acanthuridae (doctorfish), Lutjanidae (snapper), Carangidae (jack), Holocentridae (squirrelfish), Holacanthidae (angelfish), Balistidae (triggerfish), and Scaridae (parrotfish).

Several finfish species provide recreation for individuals and groups that engage in various types of sporting activities. The annual Marlin (*Istiophoridae*) tournament for example, is extremely popular.



Magnificent Feather Duster (*Sabellastarte magnifica*) attached to coral

1.2.2.3 Freshwater Animal Species

There are three endemic freshwater fish species: *Cubanichthys pengellyi*, *Limia melanogaster* and *Gambusia wrayi*. Little information is available on the ecology of these endemic species or on Jamaica's freshwater ecosystems.

Two families of freshwater shrimp are found in Jamaica, Atyidae, which includes eight species, and Palaemonidae which has six species. The early life cycle stages of these shrimps require a saline environment. Artisan and subsistence fisheries utilise these resources which are of considerable economic importance to communities.

There is one endemic freshwater turtle, *Trachemys terrapen* (Slider Turtle) in Jamaica. The status of its population is unknown.

1.2.2.4 Terrestrial Plant Species

Current estimates indicate that at least 3,304 species of vascular plants occur in Jamaica, of which 923 (27.9%) are endemic. Knowledge of Jamaica's flora is incomplete and the number of species in some families is unknown.

Research results in several new species of plants being discovered each year. Species richness and endemism are shown in Table 2.

The status of Jamaica's terrestrial plant species is poorly documented as the only published assessment of levels of threat is based on the World Conservation Union (IUCN) system, which is more than ten years old.

Species thought to be extinct in Jamaica

- Monk Seal (*Monachus tropicalis*);
- Giant Galliwasp (*Celestus occidus*);
- Black Racer (*Alsophis alter*);
- Jamaican Rice Rat (*Oryzomys antillarum*);
- Jamaican Parauque (*Siphonorhis americana*); and
- Black-capped Petrel/Blue Mountain Duck (*Pterodroma hasitata caribaea*)

1.2.2.5 Marine/Wetland Plant Species

The dominant marine plant species are sea grasses, calcareous algae and mangroves.

Wetland vegetation includes: Swamp Cabbage Palm (*Roystonea princeps*), Red Mangrove (*Rhizophora mangle*), Black Mangrove (*Avicennia germinans*), Button Mangrove (*Conocarpus erectus*), White Mangrove (*Laguncularia racemosa*), and Anchovy Pear (*Grias cauliflora*). Saline marshes are dominated by Sawgrass (*Cladium jamaicensis*).

Table 2 Species richness and endemism in plants

Terrestrial Flora	Total Number of Indigenous Species	Number of Endemic Species	% Endemic Species
Bromeliads	60	22	36.7
Orchids	230	60	26
Ferns	579	67	11.5
Cacti	20	10	50
Palms	10	7	70
Grasses	~200	1	0.5

Source: Institute of Jamaica, 2000

1.2.2.6 Freshwater Plant Species

Freshwater plants consist of rooted emergent vegetation such as the Reed (*Phragmites* sp.) and the Bullrush (*Typha* sp.); rooted, floating vegetation such as the Water lily (*Nymphaea* sp.); and floating plants such as the Water hyacinth (*Eichhornia* sp.) and *Salvinia* sp.



Nuns-hood Orchid (*Phaius tancarvilleae*)

©Institute of Jamaica

1.2.3 Forest Resources

The wide range in microclimates, soils and physical features give rise to a variety of forest types. The major forest types in Jamaica are: lower montane mist forest, montane mist forest, dry limestone forest, wet limestone forest, mangrove woodland, herbaceous swamp and marsh forest.

Jamaica's forests are the main repositories of biodiversity, especially of endemic flora and fauna. Forests play an important function in air purification, conservation of water supplies, soil formation, climate modification and protection of the coastal lowlands and marine ecosystems from the effects of flash flooding and sedimentation.

Jamaica's forests provide diverse economic employment opportunities. Products extracted from the forest include: fuel wood; medicinal plants; yam sticks; lumber for construction and furniture; fence-posts; wood for fish pots; and wicker and other materials for craft items.

Wood and charcoal provide the energy used in the popular jerk food industry as well as being used for domestic purposes.

Many of Jamaica's rare and threatened animals depend on the forest for their survival, thus the conservation and sustainable use of forest resources are a critical component of Jamaica's overall biodiversity conservation strategy.

The most recent assessment of forest cover in Jamaica was carried out in 1998. Nearly 30.1% of

the total land area or approximately 336,000 ha, is classified as forest (Table 3).

Within the forest class, approximately 90,000 ha (8% of the island's area) is classified as *closed broadleaved forest* with minimal human disturbance. Most of the remaining 260,000 ha is classified as *disturbed broadleaved forest* or *dry open forest*, having varying degrees of human disturbance. The latter is often referred to as woodland or scrub, however the dry open forests are important components of Jamaica's forest ecology.

The area of Forest Reserves and Crown lands (land owned by Government) managed by the Forestry Department amounts to approximately 109,500 ha. Most of this area is protected as forest reserves, protected areas or national parks. Approximately 35% of all forests are designated as protected areas and over 73% of closed broadleaf forests (natural forest) have protected status.

The Forestry Department has established 3,309 ha of hardwood plantations throughout Jamaica. Blue Mahoe (*Hibiscus elatus*) and Honduras Mahogany (*Swietenia macrophylla*) account for 40% and 45% respectively of trees planted. Other species include West Indian Cedar (*Cedrela odorata*), Caribbean Pine (*Pinus caribbea*), Santa Maria (*Calophyllum calaba*), Teak (*Tectona grandis*), Broadleaf (*Terminalia latifolia*) and West Indian Mahogany (*Swietenia mahogani*).

Table 3 Forestry inventory assessment

Land Use	Thousands of Hectares	% of Total Land Area
Natural forest (Primary Forest)	88.2	8%
Other Forest	247.7	22.6%
Total Forest	335.9	30.6%
Mixture of forest and other cultivation	332.9	30.4%

Source: National Forest Management and Conservation Plan, March 2001

1.2.3.1 Forest Types

The soils of the Blue and Port Royal Mountains are derived from volcanic rocks and as such their montane forests are quite different from the limestone mountains in the other areas of Jamaica. The forest in these two mountains is mainly classified as closed broadleaved showing minimal disturbance. Of the 59 tree species identified there, 24 are considered endemic locally or nationally.

The John Crow Mountains support one of the largest expanses of natural forests remaining in Jamaica. Undisturbed broadleaved forests are found from altitudes of about 380 m upwards. The

lower reach of this forest type is typical lower montane 'rain forest', with a canopy of about 24 to 28 m high.

This forest is a rich mixture of species with the Santa Maria often dominating. The ground flora abounds with ferns and there is a wealth of 'mechanically dependent' species or epiphytes. Endemic species are high in number and are localised; in the Hog House Hill area, nearly 40% of forest species are endemic to Jamaica and 10% of these are apparently confined to the eastern end of Jamaica.

The John Crow Mountains along with the Blue Mountains were gazetted as a forest reserve in 1950 and were declared a National Park in 1993.

The Cockpit Country, characterised by its well developed, conical or "cockpit" karst topography, supports a high degree of biodiversity and species endemism. At least 1000 species of vascular plants, two species of tree frogs, one gecko and one galliwasp are found only in this area. The hillsides and tops usually have little or no soil, while the depressions or 'cockpits' contain deposits of highly fertile soil, which when undisturbed, support the growth of very large trees.

The much shorter dense forests of the rocky hills remain in a more pristine condition and are richer in species than the cockpits which have often been cleared for agriculture. Valuable timber trees have been extensively cut throughout Cockpit Country. This area is being proposed as a National Park.

The dry limestone forests of Jamaica are found mainly along the south coast in the Hellshire Hills, Portland Ridge, Braziletto Mountains, and Kemps Hill though there are remaining areas on the north coast, particularly in Trelawny and St. James.

These dry limestone forests have a high degree of endemism of both plant and animal species, and several species require special protection including species of Orchidaceae, Cactaceae and the Jamaican Iguana (*Cyclura collei*). Many of the hillsides that appear as intact forests are in fact secondary forests. Only 8% of Jamaica's forests remain in an undisturbed state.

1.2.4 Watersheds

Jamaica is primarily a mountainous country with over sixty percent of the island having an altitude of over 230m. The mountains are characterised by a central ridge that transverses the length of the

island. The Blue Mountain Range is composed of igneous and metamorphic rocks and the topography is characterised by steep-sided ravines. This type of land formation gives rise to surface drainage through a large network of streams and rivers. The remainder of the island is composed of limestone with a few scattered occurrences of igneous and metamorphic rocks. Surface drainage in the form of rivers is far less dominant in these limestone areas.

Limestone aquifers provide the main source (84%) of Jamaica's freshwater resources, while the remaining 16% is provided by surface water.

The island is divided into 26 Watershed Management Units (WMUs) containing over 100 streams and rivers. These WMUs are essentially composites of watersheds that fall within 10 hydrological basins (regions). Ten watersheds have been deemed in critical condition: Rio Grande, Hope, Swift, Wag Water, Rio Cobre, Yallahs, Rio Minho, Buff Bay, Oracabessa and Morant Rivers. Rehabilitation of these watersheds has been designated as high priority by the Government.

Several ecosystem rehabilitation programmes are being undertaken to increase the quality and quantity of water for human consumption and assist in the conservation of Jamaica's biodiversity.



View of a waterfall in Cascade, Hanover

©Andrew Smith

1.2.5 Freshwater Resources

Jamaica's freshwater resources are quite extensive and support several diverse faunal and floral communities. There are ten hydrological basins throughout the island containing over 100 streams

and rivers, in addition to a multitude of subterranean waterways, ponds, springs and blue holes.

Jamaicans depend on water from these sources for domestic purposes, as well as for agricultural irrigation and industrial processes. In addition, the natural fauna and flora supported by these lotic and lentic habitats are a major food source for rural, inland communities and also support commercial activities such as shrimp, fish and snail harvesting for sale as food or ornamental items.

1.2.6 Coastal and Marine Resources

Jamaica's irregular coastline is 795 km long and has diverse ecosystems including sandy beaches, rocky shores, estuaries, wetlands, seagrass beds and coral reefs. The majority of living marine resources are found on the island shelf and nine oceanic banks which cover an area of 4,170 sq. km. The island shelf is much wider on the south coast with a maximum width of approximately 24 km. On the north coast the island shelf averages only 1.6 km in width.

On the south coast, fringing coral reefs extend almost continuously along the edge of the shelf from Negril to Morant Point. The greater part of the shelf is actually devoid of major coral reefs, except on the eastern portion between Kingston and Portland Bight (Old Harbour Bay) and at Alligator Reef (off Alligator Pond), where larger reefs and numerous coral cays exist. On the western section of the south coast, the reefs tend to be small, patchy and undeveloped, possibly due to the freshwater discharge from several large rivers.



A section of the Font Hill beach in St. Elizabeth

1.2.6.1 Wetlands

Wetlands were at one time estimated to cover approximately 2% of Jamaica's total surface area. The total area of wetlands has declined over the years due to reclamation, for activities such as

road construction, port and harbour development, housing and other development projects.

Jamaica's wetlands are found mainly in low-lying coastal areas particularly along the south coast. The role of coastal wetland ecosystems in maintaining shoreline stability and preserving biodiversity is well established and includes the protection of the shoreline from erosion by wave action; protection against flooding by acting as a sponge; functioning as a sediment trap and providing a habitat for wildlife.

There are two main classifications for wetlands in Jamaica: swamps and marshes. Swamp wetlands are dominated by woody vegetation and can be subdivided into saline swamps, which are composed mainly of mangroves, and freshwater swamps, which are either swamp forest or palm swamps.

Marsh wetlands include saline marshes and freshwater marshes. These wetlands provide habitats for a large number of animal species such as fish, oysters, birds, the crocodile, the endemic pond turtle (*Trachemys terrapen*) and lizards.

The largest wetland areas are the Negril Morass in Westmoreland, the Great Morass in St. Thomas, and the Black River Upper and Lower Morasses in St. Elizabeth. The Black River Lower Morass was declared a wetland of international importance under the Ramsar Convention in 1998. Biological, social and economic data were gathered on the area during the project entitled "Towards the Management of the Black River Morass".

1.2.6.2 Marine Plants

Sea grasses are found in the shallow coastal waters around Jamaica. These include: Turtle grass (*Thalassia testudinum*), Manatee grass (*Syringodium filiforme*) and Shoal grass (*Halodule wrightii*). They provide important feeding areas for endangered marine turtles and manatees, as well as nursery areas for important commercial fish, including herring (Clupeidae) and jacks (Carangidae).

Seaweeds are also important to many Jamaicans as they are used in traditional or folk medicine. Examples include: *Udotea* sp., *Microdictyon* sp., *Caulerpa racemosa*, *Dictyosphaeria cavernosa* and *Polycavernosa debilis*.

1.2.6.3 Coral Reefs

Coral reefs are of major social, economic and biophysical importance to Jamaica. Reefs act as natural barriers by protecting coastlines from erosion,

are a source of food and income for local communities and support tourism and recreational activities.

In the late 1970s, nine reefs on the north coast had a coral cover averaging 52% at a depth of 10 m. However, by the late 1990s this declined to 3%. At the same time the fleshy macroalgae on reefs increased from 4% to 92%².

1.2.7 Agro-biodiversity Resources

Wild species of flora and fauna make a significant contribution to Jamaica's economy. In agriculture, animals act as pollinators, seed dispersers and reducers of dead organic material. Major pollinators include bees, butterflies, nectarivorous bats and moths and hummingbirds. Fruit-eating birds and bats and seed-eating birds are important seed dispersers.

Genetic resources from both wild animals and plants are used to improve domestic breeds and varieties respectively.

1.2.7.1 Domestic Plants and Crops

Jamaica is primarily an agricultural country. The vast majority of Jamaica's farmers exist on relatively small farms in the hilly interior. The 'small farm' sector supports an estimated 150,000 rural families and is the country's largest source of employment. Agricultural plant resources comprise two principal groups: traditional and non-traditional crops. Traditional crops, which dominate the export market, include sugar, bananas, coffee, cocoa and citrus. Non-traditional crops include a variety of tubers, of which yam (*Dioscorea* spp.) is the most important. Also in this group are herbs, spices, fruits, vegetables and horticultural crops.

Most of Jamaica's agricultural crops come from imported genetic resources. However, there are also a number of indigenous and endemic plants being used, such as pineapple and *Zamia* sp. respectively.

1.2.7.2 Domestic Farm Animals

Livestock make an important contribution to Jamaica's economy. Several breeds of cattle have been bred for local environmental conditions including the Jamaica Hope for milk production and the Jamaican Brahman for meat production. Jamaica also has a long history of breeding horses, mules and donkeys. There is a large domestic market for poultry, pigs, and goats. Sheep have

been introduced but are less popular as there is a local preference for goat meat.

Some of Jamaica's livestock breeds have been exported to other Caribbean and Latin American countries.

Efforts continue to improve the contribution of livestock to the local economy and to enhance food security. These include further development of the Jamaica Hope; preservation and maintenance of three Jamaican beef cattle breeds (the Jamaican Red, Jamaican Black and the Jamaican Brahman); and improved breeds of goats and pigs.

Bees (*Apis* sp.) were introduced to Jamaica by British settlers and have been crossed with other imported breeds. Honey is locally produced.



One of Jamaica's beef cattle, the Jamaica Red

1.2.8 Genetic Resources and Biotechnology

Jamaica has been involved in traditional biotechnology since the 16th century, producing by fermentation rum and vinegar from sugar cane. Current research and development activities using modern biotechnology for conserving and utilising biodiversity are currently being carried out by agencies such as the Scientific Research Council and the Biotechnology Centre at the University of the West Indies (UWI). Other organisations, which utilise biotechnology, are the Forensic Laboratory and the Jamaica Broilers Group of Companies.

A tissue culture unit was established at the Scientific Research Council in 1982 with financial support from the World Bank and the Organization of American States (OAS). The primary aims of the Unit are to preserve rare, endangered and economically important species; increase the competitive edge of the agricultural sector by promoting the use of tissue culture; and provide farmers with commercial quantities of high quality, disease-free planting material at reasonable prices.

² Status of Coral Reefs of the World, 1998, pg 150