

**Jamaica -**

**A Terrestrial Ecoregional Assessment**

First Draft

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**Preface**

The mission of The Nature Conservancy (TNC) is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive. More specifically by 2015, The Nature Conservancy will work with others to ensure the effective conservation of places that represent at least 10% of every Major Habitat Type on Earth. Recognizing the importance of Jamaica to global biodiversity, TNC has made a commitment to support the expansion of conservation efforts and capacity in Jamaica. In particular TNC-Jamaica is committed to assisting the Government of Jamaica to meet its obligations related to protected areas under the Convention on Biodiversity, through the National Implementation Support Partnership (NISP).

TNC's approach focuses on identification of important sites for conservation of biodiversity through a participatory process, driven by the best available data. This document and the accompanying data CD represent the results of the Jamaica ecoregional assessment. This effort was particularly timely, as it coincided with the Government of Jamaica's Protected Areas System/Master Planning process. The ecoregional assessment will provide the main biodiversity inputs for the plan as well as for the National Ecological Gap Assessment for the Convention on Biodiversity.

This is the first comprehensive assessment of the country's terrestrial biodiversity. It confirms the continued biological importance of the richly diverse terrestrial systems despite the many stresses that have altered the natural environment. It indicates that broadly the current protected area system has made a good start at protecting the biodiversity of the island - but there is much room for improvement.

The assessment has identified and portfolio of priority terrestrial areas for conservation and management in Jamaica. In reading this document it is very important that the reader should understand that the intention is to identify the sites that need protection, not to suggest or prescribe detailed strategies for managing particular sites. Such strategies must be developed in close consultation with our partners, in the context of a detailed, site-by-site analysis of biological, socioeconomic, and political circumstances.

In many other places, TNC's ecoregional assessments have catalyzed important conservation actions. We hope that the Jamaica terrestrial assessment will help Jamaica form a new vision for conservation and increase commitment to management. We trust it will reinforce the many outstanding conservation efforts already underway and will provide an impetus to new ones.

As well as providing the results to the Government of Jamaica, TNC plans to use the assessment to guide our own conservation work, to forge new partnerships and design new conservation strategies. We look forward to working with our partners to make a significant contribution to the conservation of Jamaica's terrestrial ecological riches, for the benefit of present and future generations.

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The Nature Conservancy.

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**Abbreviations used in the text**

CBD Convention on Biodiversity

CERP Caribbean Eco-regional Plan

COP-7 Seventh Conference of Parties

GIS Geographic Information Systems

IUCN World Conservation Union

JCDT Jamaica Conservation and Development Trust

JERP Jamaica Eco-regional Plan/Assessment

NEPA National Environment and Planning Agency

NHD Natural History Division of the Institute of Jamaica

NISP National Implementation Support Partnership

PoW Programme of Work

RAPPAM Rapid Assessment of Protected Areas Management

TES Terrestrial Ecological System

TNC The Nature Conservancy

UWI University of the West Indies

WWF Wordwide Fund for Nature

1.0 I**ntroduction**

1.1 **Background to the Jamaica Eco-regional Plan**

In 2003 The Nature Conservancy embarked on a programme to develop a comprehensive Eco-Regional Plan for the wider Caribbean basin - defined as the island nations of the Caribbean; the contiguous marine ecosystems of the Caribbean Sea and the adjacent coastal systems of Central America, Mexico, Eastern South America, and Florida.

The objectives of the Caribbean Eco-Regional Plan (currently known as the Caribbean Decision Support System) were to:

* Define a dynamic vision of conservation success amongst the protectors, managers, and users of biodiversity in the Caribbean through practical application of best available conservation science tools.
* Integrate TNC technical tools and planning methods into local, national and international conservation planning and resource management forums.
* Develop management systems within TNC that will allow efficient science-based decision-making and implementation of conservation strategies across regional, divisional and national boundaries.

Early in the process it was recognized that at this scale it would be difficult to produce detailed plans that could be implemented on the ground. Three territories, Jamaica, Puerto Rico and Dominican Republic were selected for more detailed attention.

**1.2 Objectives of the Jamaica Ecoregional Plan**

The overall objectives of the Jamaica Ecoregional Plan (JERP) include:

* To select and design a network “of conservation sites that will conserve the diversity of species, communities, and ecological systems” in the Jamaican ecoregion (Groves *et al*., 2000).
* To provide input as a “deep geography” into the Caribbean Ecoregional Plan (CERP), both in terms of providing data and in reviewing the relevance and accuracy of regional analyses and strategies.
* To provide a scientific basis for conservation planning in Jamaica including the development of short-term and long-term strategies.

JERP plays an important supporting role in the national biodiversity planning process (including the National Biodiversity Strategy and Action Plan and the National Implementation Support Partnership). In preparation for COP-7 of the Convention on Biodiversity in 2004, TNC, Conservation International, BirdLife International, World Wildlife Fund, Wildlife Conservation Society, and World Resources Institute encouraged countries to develop National Implementation Strategies (NISPs) that would identify ways for government agencies to work collaboratively to implement priority actions identified under their National Biodiversity Strategies and Action Plans. Jamaica was one of the first countries to accept this challenge. The Forestry Department, the Ministry of Land and Environment and the National Environment and Planning Agency (NEPA) are the main partners in this effort. This has provided a special opportunity to integrate biodiversity conservation initiatives and to integrate TNC-J’s efforts into the national agenda. Implementation will be through Jamaica Protected Areas Trust - a trust fund established by the partners with funds secured by TNC through a Debt for Nature Swap under the Tropical Forest Conservation Act.

At the same time that the NISP was being developed, NEPA and a local ENGO – the National Environmental Societies Trust (NEST) were implementing a project to develop a new Protected Areas System Plan (PASP). This project ended in 2006. The work continued as the development of a Master Plan for Protected Areas for Jamaica. Data and analyses derived and developed from the JERP will provide the basis for the following aspects of the Master Plan in relation to biodiversity:

* Review of biodiversity aspects of the current system, including:
  + Identification of gaps in the existing protected area system, (including a gap assessment report to enable Jamaica to meet her commitments under the CBD)
  + Recommendations for species and ecosystems that require special conservation measures
  + Identification of threats and strategies to address them
  + Recommendations for methods for analysis of the above issues
  + Recommendations for expansion and consolidation of the system
* Selection and prioritization of areas: recommendations for the criteria and procedures for the selection and prioritization of new areas in the system plan
* Selection and prioritization of sites to be funded through the Jamaica Protected Area Trust Fund.

2.0 **Description of Jamaican Terrestrial Biodiversity**

With a total area of 10,990 km2, Jamaica is the third largest island in the West Indies. The climate is tropical maritime, seasonally influenced in the winter by northeast trade winds and in the summer by tropical waves from the west that interact with the diurnal pattern of land breezes during the night, and sea breezes at night. Rainfall peaks in May and October and January-March are the driest months.

The centre of the island is mountainous. The highest point is Blue Mountain Peak, in the Blue Mountains at 2290 m asl. This range produces a rain shadow to the south. Most of the island is over 300 m asl with steep slopes giving rise to short, fast-flowing rivers. The east is mountainous and the central and western parts of the island are mainly limestone hills and plateaux with particularly well developed karst in the Cockpit Country.

The eastern mountains are predominantly cretaceous (approximately 65-100 million ybp) in origin, dominated by igneous and metamorphic rock and shale - but seventy percent of the island is covered by younger limestones. This reflects the complex geological history during which limestone was laid down over submarine volcanoes. The coastal plains are largely alluvial. Jamaica probably started to emerge from the sea about 12 million ybp and was never connected to the mainland (Porter *et al*. 1982). The WWF recognizes 2 terrestrial eco-regions in Jamaica - Jamaican moist forests, Jamaican dry forests and Greater Antilles mangroves (Anderson 2001) (Figure 1).

Topography, geology, climate and geographic isolation have contributed to high levels of endemism in many groups of plants and animals. Jamaica has at least 3,304 species of flowering plants of which 923 (28%) are endemic and 579 fern species with 82 (14%) endemics ranking it the fifth island in the world for plant endemism (Armstrong 2001). Endemism is particularly high in forest-dependent families such as palms, cacti, orchids and bromeliads and very low in grasses (Table 1). This reflects the dominance of Jamaica's original vegetation by forests.

Geographic isolation has resulted in a fauna with few mammals, but Jamaica has more endemic species of birds than any other Caribbean island. There is also an outstanding diversity in many other groups of animals including land snails, fireflies and grapsid crabs (Table 2). Jamaica's land snail diversity is one of the highest in the world - 506 (90%) of the 961 native land snails are endemic (G. Rosenberg pers. comm. 2006).

Although Jamaica was once almost totally forested, only about 30% (332,015 ha) (31%) remains so (Evelyn *et al.* 2003) and only about 8% is old growth or primary forest (ref.). Conversion for agriculture, settlements and bauxite mining are the main causes of forest loss. Deforestation and the introduction of invasive species are thought to be the main causes of extinctions. Vertebrate extinctions include two species of birds and a rice rat that have been lost since the nineteenth century. Invertebrate and plant extinctions have never been quantified.

In the regional context, high levels of endemism in Caribbean forests and low levels of correlation between species lists among forests between islands, mean that the irreplaceability of Jamaican forests is very high. Therefore Jamaican priorities should also be considered as regional priorities. The importance of protection of Caribbean dry forest is increasingly being appreciated at the regional scale (Miles 2006) and therefore Jamaica should continue to place a great emphasis on this habitat while it is still fairly widespread.

3.0 **Methods**

N.b. A detailed technical description of the methods is included in Appendix 1.

3.1 **Conservation Targets and Sources of Data**

The objective of this assessment was to identify and conserve the full range of Jamaica's biological diversity. The first step is to select conservation targets. These are the basic elements of biological diversity, such as species and their habitats or ecosystems which will be the focus of conservation and management efforts. A few outstanding and representative examples are selected because it would be impossible to identify or plan for all the potential threatened, endemic or rare species and ecosystems that need attention (see Appendices 5 and 6). Therefore a set of habitats and species (targets) was selected to represent the terrestrial biodiversity of Jamaica. Two categories of targets were used - coarse and fine filter. **Coarse filter targets** were ecosystems (terrestrial ecological systems). They set the broad context for conservation. Coarse-filter targetsare habitats, communities and ecosystems selected to represent the majority of ecosystems, species and their functional relationships. This ecosystem approach is based on the assumption that conservation of a representative selection of all major ecosystems will contribute to the conservation of an equally representative selection of the species found in these ecosystems (Noss 1987). The selection of coarse filter targets posed a major problem because there was no agreed and mapped national classification of vegetation. An existing land use classification, developed by the Forestry Department (Camirand and Evelyn 2003) was adapted based on rainfall and geology. This produced a new set of vegetation classes called Terrestrial Ecological Systems (TES) (Figure 2). Mangroves and non-mangrove wetlands were included in the terrestrial analysis as they were included in the WWF categories and because they have specific management requirements related to terrestrial targets that may not necessarily have been captured in the other analyses. They were also included in the freshwater and marine analyses. The TES were a surrogate for a comprehensive, peer-reviewed, ground-truthed vegetation classification, which is urgently needed for Jamaica.

The full pattern of distribution of biodiversity cannot be effectively captured through focusing on ecosystems alone. In particular threatened and endangered species and habitats are less likely than common species to be included with the coarse filter targets. Many of these species require individual attention because management of their current habitats is unlikely to be sufficient to ensure their long-term survival without additional measures. Some of these species may be declining faster than their habitats. Other species - known as keystone species - are crucial for maintaining ecosystems. Such species are called **fine filter targets**. TNC criteria for selection of fine filter targets are included in Box 1.

In the absence of ecological and distributional information about keystone species, this assessment focused on threatened species. Only threatened for which island-wide data sets were available could be included. The fine filter targets included: threatened cave bats, Jamaican Hutia *Geocapromys brownii*, Jamaican Iguana *Cyclura colei*, Yellow Boa *Epicrates subflavus*, threatened endemic frogs, Giant Swallowtail butterfly *Papilio homerus*, West Indian Whistling Duck *Dendrocygna arborea* and assemblages of threatened plants (Proctor 2003).

**Box 1: TNC criteria for selection of fine filter targets**

1. All species which are critically endangered, endangered or vulnerable

2. A representative subset (those unlikely to be captured by coarse filter targets) of species which are:

* Declining
* Endemic
* Disjunct (populations are geographically isolated)
* Vulnerable (usually abundant, may or may not be declining but an element of their life history causes them to be vulnerable)
* Or focal ('species which have spatial, compositional and functional requirements that may encompass other species in the ecoregiona and may help to address the functionality of ecosystems). Two examples are keystone and wide-ranging species.

(Groves *et al.* 2000).

The main sources of information about the terrestrial ecological systems and species targets are described in Table 3. Some targets are well researched while for others there is little information. To ensure relative comparability only datasets that were complete at the national level were included. This meant that some potential targets and many datasets could not be included.

**3.2 Gap analysis (see also Sutton 2007)**

The purpose of the gap analysis is to identify biogeographical weaknesses in current protected area system as it relates to biodiversity conservation. Three types of gaps are generally included in a gap analysis. These are representational, ecological and management gaps.

* **Representational gaps:**

Representational gaps include species, ecosystems and ecological processes that are missed entirely by the protected area system. Representational gaps were identified by comparing the current protected area system against the 10% goal to which Jamaica is committed under the CBD.

* **Ecological gaps**

Ecological gaps occur when biodiversity is nominally protected within the system but with insufficient quality or quantity to guarantee long term survival of species, habitats and functions. This can occur when the areas or species are not sufficiently represented in the protected area system or are not being appropriately managed within a protected area, when the total area or connectivity of areas have been reduced below a critical threshold, when the there are macro-or micro-climatic changes, when keystone species are lost from an ecosystem or when other conditions reduce viability.

In the following analysis ecological gaps were deemed to exist whern the level of protection was less than the ecological/adaptive goals (see below).

3.2.3 **Management gaps**

Management gaps are weaknesses in the protected area system, planning, legislation, staffing, training and other factors related to implementation of practical conservation measures in protected areas. Management gaps related to protected areas have been described in a comprehensive report on management effectiveness (Hayman 2006).

**3.3 Conservation Goals**

Conservation goals are designed to define the amount and spatial distribution needed to ensure full representation of Jamaican terrestrial biodiversity. Recognising that it is not possible to conserve every occurrence of every target islandwide, the goals were used to identify priority areas where efforts could be focused. This does not mean that any part of the distribution of any target is not important for conservation.

There is no specific formula for determining conservation goals for a conservation target, whether by area or number of populations. Representational goals are set in relation to abundance and distribution (Groves e*t al.* 2000; Groves 2003). Generally goals are set in the 30-40% range, based on the assumption that this will capture 80-90% of the species (Groves 2003). It is also important to consider historical distribution and to set higher goals for species and ecosystems that have been substantially reduced in distribution or abundance. In Jamaica, many ecosystems, particularly those on the fertile coastal plains, have been seriously depleted in extent, and some have been totally lost. There are no extant descriptions of these ecosystems and no information about their historical extent. In the absence of such information, all Jamaican TES that had a current or historical range of less than 20,000 ha were considered rare or imperiled (on the assumption that small area itself is a threat) and were assigned a 90% goal (Table 6).

Current distribution for some species may already be below the area needed for them to persist in the long-term. Iin the absence of any information about the minimum population sizes needed for targets, all targets were assumed to be at least minimally stable at their current extent.

**3.4 Stratification of targets**

Stratification is used to ensure full geographic representation of disjunct populations. Models for stratification that were considered included the use of the WWF eco-regions (Greater Antillean Mangroves, Jamaican Dry Forests, Jamaican Moist Forests) or an east-west stratification (based on rainfall and geology). These considerations were already inherent in the TES model. Therefore no stratification was needed.

**3.5 Threats and cost surface**

The cost surface (or "human footprint") is a way of steering the selection of conservation areas away from places where human activity is most intense and potentially prejudicial to effective conservation. For example an area that is subject to intensive agriculture or settlement is likely to be less suitable for conservation than a less developed one. It may also be more costly to achieve conservation in such an area.

Spatial data were compiled for human impacts or threats (Box 2) including road density, population density, urban and industrial areas, invasive species, intensive agriculture, mixed agriculture. Intensities were assigned for each threat (Table 10) and a cost surface was generated by totaling the intensities (Figure 5).

Box 2: A **stress** is a factor that impacts or degrades the site condition or landscape context of a conservation target and thereby reduces its viability. Together the **stress** and the **source of stress** are called a **threat**. (Groves *et al.* 2000)

In the absence of information about the current status of most of the more than 2000 occurrences of the targets, the cost surface was used as a surrogate for viability.

**3.6 Selection of conservation areas**

The first step towards effective site conservation is the design of a conservation portfolio - an integrated network of priority conservation areas. The assumption is that if these areas were effectively conserved representative biodiversity would also be effectively conserved.

The development of the portfolio started with the assembly of information followed by the use of MARXAN - a site selection programme (Ball and Possingham 2000). This provided a way to analyse targets, goals, threats and other factors in a rigorous way. The analyses can be repeated in the future with updated values and decisions revised.

Jamaica was divided into 4503 hexagonal planning units with 1 km/side, each representing 260 ha. (Planning units are the smallest units within which targets and cost surface are tracked. Assigning target and cost information to a finite set of planning units streamlines decision-making. Hexagons are used (rather than squares or rectangles) because their six sides facilitate flexible aggregations.)

The basic input to the MARXAN model included

* Amount and distribution of each conservation target in each planning unit
* A specific conservation goal for each target
* A cost factor for each planning unit (as defined by the cost surface)
* Planning unit boundaries.

In addition to the targets, goals and suitability factors there are several settings that must be identified before running the programme. These include the number of times the programme will run through the simulated annealing process, the number of iterations per run the penalty factor (that determines how much weight will be placed on not reaching the conservation goal for a specific target) and the boundary length modifier (that determines how much emphasis will be placed on selecting areas that are close together or clumped rather than widely dispersed). The parameters that were use in the Jamaican analysis are summarized in Table 11.

The analysis produced two types of output that were used to guide the development of the conservation portfolio. These were the "best solution" and the "summed solution". The best solution is the set of planning units that best meets the conservation goals for all targets at the minimum cost. The summed solution (Figure 13) can be regarded as showing a measure of the relative biological importance and potential conservation value of planning units. It can be used to identify core areas that contribute most to the design of a set of conservation areas.

The selection of conservation areas through the MARXAN analysis was refined based on expert opinion and by comparison with a range of similar analyses including habitat quality (Edwards 2006), Relative Biodiversity Index, connectivity analysis (Schill 2006) and Important Bird Areas (Vogel 2006) and slopes greater than 30 degrees (see Appendix 1 for details).

4.0 **Results and discussion**

4.1 **Gap analysis**

Jamaica's existing protected area system meets most of the representational goals, but there are large gaps in ecological goals (see below) and management (Hayman 2006).

4.1.2 **Representational Gaps - Convention on Biodiversity Diversity - Ten percent goal**

At a national scale all the extant TES are represented in the existing protected area system to varying extents, either as protected areas under the NRCA Act (e.g. National Park, Protected Area, Environmental Protection Area), Forest Reserves or Game Reserves (Table 6). All except three TES meet the 10% goal. Wet forest on alluvium (9%), mesic forest on alluvium (9%) and mesic forest on shale (2%) fail to meet the goal. Two others - wet forest on serpentine (12%) and mesic forest on limestone (12%) - barely exceed it.

All the fine filter targets are represented in the system to some extent (Table 7) but nine assemblages of threatened plants have no form of protection at all. They represent 48% of the total area occupied by these assemblages (Tables 7 & 8). Inshore islets (mainly in Portland Bight and Port Royal Protected Areas) are mostly protected but there is no protection for offshore islets in the Morant and Pedro Cays groups.

4.1.2 **Ecological gaps**:

The only TES that met the ecological/adaptive goals were montane summit savanna and montane cloud forest, which were restricted to the highest parts of the Blue Mountain range. All other TES failed to meet their ecological goals (Table 6). Of particular concern are all the TES whose total area is small (around 10,000 ha or less) and whose protection status is less than 100%. These are Very Wet Forest on limestone (John Crow Mountains), Wet Forest on alluvium (river corridors in Portland), Wet Forest on Serpentine (Arntully, St. Thomas), Fairly Dry Forest on alluvium (south coast), Dry Forest on Alluvium (south St. Thomas) and Dry Forest on Shale.

Most of the fine filter targets are protected to some extent under the current protected area system but only the Jamaican Iguana is receiving any special attention, in the form of a specific recovery plan. Some research has also been carried out into the status of West Indian Whistling Ducks (e.g. Haynes-Sutton 1995).

**Threatened cave bats**

As far as is known both MacLeay's Moustached Bat *Pteronotus macleayii* and the Jamaican Flower Bat *Phyllonycterus aphilla* have very restricted ranges and are declining. Five of the nine known caves that support either or both of these bats have no protection in the current system.

**Threatened parrots** (Appendix 12)

While the core areas of the distributions of these parrots in the Cockpit Country and Blue and John Crow Mountains are protected, these areas do not cover their full ranges and may not sufficiently cover their habitat requirements, specially feeding habitats. Overall only 23% of recorded occurrences are within protected areas.

**Threatened frogs** (Appendix 9)

Globally frog populations are in decline. There are no baseline data on Jamaican frogs and new species are still being discovered. The ranges of most frog species are protected to some extent (23% of the total), but there are no specific management measures being implemented for any frog species. Baseline surveys of selected species are needed. Several species are only known from one or two caves. These require special management planning and implementation.

**Jamaican Hutia** (Appendix 11)

No status survey for this species has been carried out for more than 20 years (Oliver *et al.* 1980). Some parts of its range are protected (notably in the Blue and John Crow Mountains) but others, specially in upper St. Catherine, are not. A status survey for this species is urgently needed.

**Threatened Reptiles**

The Jamaican Iguana is an endangered species, whose range is totally within the boundaries of the Hellshire Hills in the Portland Bight Protected Area. This is the only species for which a recovery action plan has been developed and active conservation measures including removal of predators and captive rearing are in place.

The Yellow Boa is more widespread, and seems to be able to co-exist with people on the edge of its forest habitats. Thirty percent of known occurrences are protected but apart from the efforts of Windsor Research centre, no conservation measures are being implemented for this species.

**Threatened Butterfly**

The Giant Swallowtail's range and threats to its survival are relatively well researched in the Blue and John Crow Mountains and there is an on-going survey in the Cockpit Country (Davies and Hay, in prep.). The Giant Swallowtail's core habitats in the Blue and John Crow Mountains and the Cockpit Country are protected but some of the areas where it is regularly seen lie outside the protected areas.

**Threatened Waterfowl** (Appendix 13)

Parts of the range of the West Indian Whistling Duck are in protected areas (i.e. Negril Morass and Portland Bight) but their most important habitats (e.g. in Black River) are only protected as game reserves. Overall only 24% of known occurrences are protected to some extent. The game reserve category provides no real protection for the species or its habitats.

**Ecological processes**

Specific ecological processes that maintain Jamaican ecosystems and species have not been well studied and could not be included in the analysis. A preliminary assessment of key ecological factors and their influence on Jamaican ecosystems is included in Appendix 8.

**Connectivity**

The TES map (Figure 2) shows that despite extensive deforestation, Jamaica's natural and semi-natural terrestrial ecosystems are largely contiguous. Jamaican connectivity has never been studied. Three main geographical types can be identified. These are east-west along the spinal forest, east-west along the north and south coasts and north-south (e.g. along major river valleys or north-south fault lines. Jamaica is fortunate that to considerable extent there are extant forests suitable for conservation throughout most of the spinal forest, as well as along the south coast. With the exception of fishing villages and ports the entire coastline from Hellshire west of Kingston, to Pedro Bluff is hardly developed. This is an immensely important ecological resource. The current network of protected areas does very little to preserve north-south or east-west connectivity. Exceptions are the eastern mountains, where the upper Blue Mountains and John Crow Mountains are effectively protected in contiguous blocks, Negril Conservation Area (which includes the entire watershed) and Portland Bight Protected.Area which includes a long stretch of coastline, mangroves and adjacent coastal hills. Portland Bight has the longest contiguous mangrove coastline in the island.

The importance of building connectivity into the design of protected areas will increase as climate change affects the distribution of habitats. For example, in Portland a proposed corridor joins the Blue and John Crow Mountains National Park to the sea in the propsed Port Antonio Marine Park and another has been proposed along the Driver's River corridor (John 2006). A similar approach has been suggested for western Jamaica linking the Cockpit Country to the sea to the south via the proposed Black River protected area and Ramsar site and to the Martha Brae watershed to the north.

Connectivity was modeled and compared with the current protected area system and with the MARXAN portfolio (Figures

There is little understanding of the current importance of connectivity to Jamaica's endemic species and sub-species. For example little is known of minimal habitat requirements for Jamaican birds. Some have altitudinal migration patterns. For example the near-threatened Plain Pigeon *Columba inornata* breeds in the forests in Cockpit Country and Blue and John Crow Mountains and winters in the mangroves on the coast (e.g. in Portland Bight). The importance of the intervening habitats has not been assessed. There is very little information on the most basic aspects of ecology, such as nesting requirements or feeding territory size for any endemic bird species.

4.2 **Identification of conservation areas**

The MARXAN analysis produced two types of output that were used to guide the development of the conservation portfolio. These were the "best solution" and the "summed solution". The best solution is the set of planning units that best meets the conservation goals for all targets at the minimum cost. The best solution for this assessment (Figure 12) resulted in a portfolio including 40% of Jamaica'a land area (1809 of 4503 planning units. The best solution met the conservation goals for most targets and exceeded goals for some (Table 12.)

The summed solution (Figure 13) can be regarded as showing a measure of the relative biological importance and potential conservation value of planning units. It can be used to identify core areas that contribute most to the design of a set of conservation areas.

* **Habitat quality**

The results of the analysis were compared to habitat quality maps (see above). The results showed that all the higher quality areas were included in the draft portfolio (Figure 11). The draft portfolio includes extensive areas of low quality habitat (Figure 9). These areas may require restoration and other forms of creative management to sustain and increase their importance for biodiversity.

* **Relative Biodiversity Index**

RBI provides a summary of known information about the distribution of biodiversity but like other analyses that do not include modeling is constrained by biased sampling of biodiversity. Nonetheless it is a convenient way to summarise large amounts of information. The maps show that the there were many important sites that are not included in the current protected area system. Most of them are included in the draft portfolio (Figure 10) but some adjustment of boundaries will be necessary Figure 11).

* **Important Bird Areas**

All major Important Bird Areas (Vogel 2006) were included in the draft portfolio.

* **Slope**

Forestry Department policy is that all slopes greater than 30 degrees should be in permanent forest cover. Most of the proposed and existing protected areas are on steeply sloping land, but many steeply sloping areas are outside the protected area system and many of these have been cleared for agriculture (Figure 12). The draft portfolio includes a substantial proportion of the steeply sloping land (Figure 13).

The conservation areas described below, depict only the most preliminary approximations of the boundaries of specific sites. They are intended to be refined based on discussions with partners and experts based on undated site specific information.

4.4 **Threats**

Only threats for which GIS information was available could be included in the current analyses. The cost surface (Figure 8) shows:

* Human activities: These are most intense on the fertile coastal plains, where the majority of the population is located.
* Road density, population density, urban development.
* Intensive activities (industrialized agriculture and monoculture, mining, and mining leases),
* Invasive species (bamboo). Bamboo is the only invasive species for which there is an islandwide data set. It is very widespread, especially in the hills of upper St. Andrew and St. Mary where is occupies extensive areas and prevents regeneration of natural forest over large areas. Some examples of other invasive terrestrial and wetland species in Jamaica for which data on distribution and impacts are incomplete or non-existent are included in Table 14.

The threats to terrestrial biodiversity were previously described in detail for the Biodiversity Strategy and Action Plan (see appendices 17 and 18) and more recently in the "National Report on Management Effectiveness and Capacity Development for the Protected Areas Plan" (Hayman 2006) (see Appendix 19). In addition the major threats for the major portfolio sites were identified (see below). Common themes include invasive species, habitat disturbance and destruction as a result of human activities and unsustainable exploitation. Specially developed strategies will be necessary to address these threats.

4.5 **Data gaps and limitations**

The analysis was based on national data sets only. More detailed data are available for some areas and these may be applied for local conservation planning.

There are also many data limitations that should be considered while using this assessment. Although they do not affect the assessment's overall integrity, they are sources of uncertainty at the ecoregional scale and are priorities for further research.

* **Vegetation classes and distribution**

The most important and critical information gap is the need for the development of an accepted classification and assessment of the status of the vegetation of Jamaica. The classes used in this paper represents the best that could be generated based on existing knowledge and geo-spatial information in a manner consistent and broadly comparable to classifications for other islands (e.g. Keel 2003). The revised classification needs to recognize special habitat types such as those listed in Appendix 17. However it is unlikely to please any expert who has detailed knowledge of the vegetation of Jamaica or of the quality of the basic information. Weaknesses in the climatic information, combined with problems with the accuracy of land cover information mean that this forms a poor basis for the analysis. However it is the best available. A new classification generated using the IKONOS imagery and ground truthing is urgently needed and is one of the highest priority research needs identified by the current project.

* **Climate change**

Climate change is expected to result in an overall drying of the climates in the insular Caribbean combined with more frequent intense hurricanes (Neelin *et al*. 2006). The impacts of changes on the Jamaican vegetation and endemic species have not been modeled.

* **Distribution**

The selection of species targets was severely constrained by the availability of comprehensive island-wide geo-referenced information on the distribution of threatened endangered and endemic species. For example Kelly (1988) identified 427 threatened plant species in Jamaica but there are no comprehensive distribution maps for any of them. The Institute of Jamaica has a huge specimen collection, which should be georeferenced. Even when this has been done there will be a strong geographical bias because most biological research has been carried out in accessible areas close to universities and field stations.

* **Threats**

Similarly the assessment of threats was limited by lack of information about the distribution and intensity of threats to biodiversity including invasive species, forest fragmentation, over-exploitation and other human activities (including agriculture, industry, and air pollution).

* **Other information gaps**

These include:

* + Lack of information about minimal viable areas for species and habitats
  + Lack of basic status, distribution or life history information for most target species
  + Lack of models of functional connectivity.

4.6 **Areas identified for conservation**

A brief description of these areas follows with a list of targets and a brief indication of likely threats. This is intended as a starting point for Conservation Area Planning for areas that have not gone through this process. These descriptions include only the most readily available information and require further review by stakeholders.

4.6.1 **Negril**

*Location*: Coastal forests, wetlands and hills surrounding Negril in western Jamaica

*Management Agency*: Negril Environment Protection Trust

*Current conservation status*: Game Reserve, Environment Protection Area

*Principal targets*: Swamp, West Indian Whistling Duck

*Principal threats*: Tourism and housing development, pollution, agriculture, fire, altered water regimes.

*On-going conservation programmes*: Negril Environment Trust implementing management plan. A bird management strategy for Royal Palm Reserve is under development.

*Description of the area*: Includes entire Negril watershed, forests, non-mangrove wetlands (including swamp forest), mangroves and inhabited areas, ponds, rivers, streams and canals, abutting on marine area with reefs and seagrass beds.

*Ecological function and connectivity*: Connectivity from hills to wetlands, beaches and marine ecosystems, supports species and provides coastal protection. Links to Dolphin Head, and along the coast to Cabaritta (see below)

*Main gaps*:

* Restoration programmes for rare habitats (e.g. swamp forest)
* Conservation strategy for rare plants (including *Hohenbergia negrilensis* and *Boughtonia negrilensis* and a newly discovered *Agave* species)
* .Assessment of rare remnants of mesic forest on alluvium
* Implementation of management plan for West Indian Whistling-Ducks.

4.6.2 **Cabaritta and Paradise Wetlands**

*Location*: Cabaritta and Paradise wetlands, southern Westmoreland

*Management Agency*: Frome sugar estate, private land owners

*Current conservation status*: Game reserve

*Principal targets*: Mangroves (including unusual inland mangroves), swamp forest, West Indian Whistling Duck

*Principal threats*: Coastal development, pollution

*On-going conservation programmes*: None known.

*Description of the area*: Coastal wetland systems, including swamp forest and mangroves, important mudflats and over-wintering habitat for sea ducks; nesting colony for seabirds

*Ecological functions and connectivity*: Coastal protection. Links to Dolphin Head, and along the coast to Negril (see above)

*Main gaps*:

* Needs biological assessment to determine conservation priority

4.6.3 **Blue Mountains of Shaftson and other coastal hills of Westmoreland**

*Location*: Coastal hills, north of Bluefields and other coastal hills (e.g. Deans Valley, Chebuctoo)

*Management Agency*: Privately owned

*Current conservation status*: None

*Principal targets*: Wet, mesic and dry forest on limestone, wet and mesic forest on alluvium, yellow boa.

*Principal threats*: timber extraction, coastal development

*On-going conservation programmes*: None known

Description of the area: No information available.

*Ecological function and connectivity:* Watershed, connectivity to other coastal and inland forests.

*Main gaps:*

* Needs biological assessment to determine conservation priority and programmes.

4.6.4 **Black River Upper and Lower Morass and coastal St. Elizabeth**

*Location and size*: Includes 3 basins along the Black River system (Appleton, Upper Morass, Lower Morass) plus adjacent wetlands ( Font Hill/Luana, Parottee and Thatchfield).

*Management Agency*: None (area includes government-owned land as well as extensive private holdings)

*Current conservation status*: Includes game reserves and Ramsar site

*Principal targets*: Non-mangrove wetland (including very rare swamp forest and riverine forest), mangrove wetland, dry limestone forest, West Indian Whistling Duck; threatened plant aggregations

*Principal threats*: Aquatic pollution, invasive plants and animals, potential abstraction of water, coastal development, tourism, fire, fire, potential peat mining, alteration of water regime and urban sprawl, extraction of lumber

*On-going conservation programmes*: Petroleum Corporation of Jamaica has protected Luana/Font Hill Nature Reserve.

*Description of the area*: Includes coastal wetlands, freshwater wetlands, ponds and adjacent limestone hills. Black River town is a national heritage site.

*Ecological functions and connectivity*: Important wetland (coastal protection, flood protection, links to coastal fisheries), crocodile habitat, connectivity to Cockpit Country to north and coastal connectivity.

*Main gaps*:

* Already identified as high priority site for protection but detailed strategy to achieve this not developed
* Update on impact of invasive species
* Design of protected area to cover coastal (east-west) and river basin connectivity (including need for new approaches to allow for conservation on private lands).as well as small isolated freshwater ponds with threatened species.
* Draft management plan (Massa and Haynes-Sutton 1999) requires updating and public consultation.

4.6.5 **Canoe Valley**

*Location*: Includes the coastline from Farquhars Beach to Alligator Pond and the wetland and escarpment

*Management Agency*: None, includes government and private lands. NEPA manages the Alligator Hole River Project

*Current status*: Game Reserve. Proposed protected area, with funding from USAID for implementation

*Principal targets*: Non-mangrove wetlands and mangrove wetlands, dry and fairly dry limestone forest, Dry alluvial forest, Fairly dry shale forest, West Indian Whistling Duck

*Principal threats*: Squatting, illegal timber harvest, fire

*On-going conservation programmes*: Alligator Hole River Project (wetlands interpretation), biological inventory (on-going)

*Description of the area*: Includes good examples of most typical coastal ecosystems - coastal wetlands (including a unique large stand of *Sabal jamaicensis*) and important nesting habitat for sea turtles and crocodiles. There is extensive dry and fairly dry limestione forest, including at least one local endemic plant. Important functions include coastal protection and coastal connectivity.

*Main gaps*: The area needs to be formally included in the protected area system.

4.6.6 **Portland Bight**

*Location*: Includes the coastline from Port Henderson Hill (west of Kingston) to Round Hill south of Milk River, Clarendon.

*Management Agency*: The majority of the area is a declared Protected Area (under the NRCA Act), Management is delegated to CCAM and Urban Development Corporation.

*Current status*: Declared Protected Area, including several Game Reserves and two Forest Reserves. A draft management plan has been prepared but is not being implemented.

*Principal targets*: Non-mangrove wetlands and mangrove wetlands, dry and fairly dry forest on limestone Dry forest on alluvium, Fairly dry forest on shale, Jamaican Iguana (whose entire global range falls in the area), West Indian Whistling Duck; Jamaican Hutia, Jamaican Yellow Boa, threatened cave bats, threatened frogs, islets.

*Principal threats*: Urban expansion and sprawl, fire, invasive species, illegal hunting, charcoal burning, timber extraction, hurricane damage

*On-going conservation programmes*:: Jamaican Iguana conservation programme.

*Description of the area*: Portland Bight includes the best remaining examples of dry forest on limestone, good examples of dry and very dry forest on alluvium, the longest contiguous mangrove coastlines, the best preserved examples of inshore islets and many highly range restricted faunal targets.

*Main gaps*: Due to lack of regulations and funding the Protected Area is not being implemented. The mangroves were very badly affected by Hurricane Ivan but there are no programmes to restore them or monitor their recovery. There are no programmes to manage the many range restricted species of the area.

4.6.7 **South eastern Port Royal Mountains - Long Mountain to Yallahs**

*Location*: East of Kingston, including Long Mountain, Dallas Mountain, Cane River Falls, the Yallahs Valley and Yallahs Hills.

*Management Agency*: Includes several small Forest Reserves

*Current conservation status*: Mostly unprotected.

*Principal targets*: Wet, Mesic, Dry and Fairly Dry Forest on Limestone, Wet, Mesic and Fairly Dry forest on shale, Wet Forest on Serpentine, West Indian Whistling Duck, Yellow Boa

*Principal threats*: Quarrying (limestone and gypsum); urban sprawl, agriculture on steep slopes. invasive species

*On-going conservation programmes*: None known. Forestry Department is carrying out a biophysical inventory in the upper Yallahs watershed but this is mainly in the Blue and John Crow Mountains National Park (considered separately)..

*Description of the area*: Coastal hills and valleys include possible locations for uncommon TES and several sites of special importance for threatened plant species (including Long Mountain, Cane River Falls). The current connectivity between the the Blue Mountains and the Port Royal Mountains to the sea should be maintained and formalized through sustainable land management and protected areas. Due to its proximity to Kingston as well as the many archaeological, historical and scenic sites, this area has very high potential for educational and recreational activities.

*Main gaps*:

* The intersection of geology and climate suggest that there should be several uncommon TES in the area, but little botanical work has been done in the area. Ground truthing is needed to determine whether there are viable remnants of important TES (e.g. wet forest on serpentine).

**4.6.8 St Thomas Great Morass**

*Location*: Extreme eastern point of Jamaica

*Management Agency*: Privately owned

*Current conservation status*: Game Reserve and proposed protected area

*Principal targets:* Mangrove wetlands, wet forest on limestone

*Principal threats:* hurricane damage, hotel development

*On-going conservation programmes*: None known

*Description of the area*: Includes extensive mangrove wetlands, beaches and coastal forests.

*Ecological functions and connectivity:* Coastal protection, links to marine ecosystems.

*Main gaps*:

* No published descriptions of the ecology of the area but an assessment is currently underway by University of the West Indies with funding from Ramsar (D. Webber, pers. comm.. 2006)

**4.6.9 Blue and John Crow Mountains**

*Location*: Upper Blue and John Crow Mountains in eastern Jamaica

*Management Agency*: Jamaica Conservation and Development Trust, Forestry Department

*Current conservation status*: National Park, Forest Reserve

*Principal targets:* Montane summit savanna, montane cloud forest, very wet, wet forest on limestone, very wet, wet forest on shale, wet forest on alluvium, wet forest on serpentine,many frogs, bats, Yellow Boa, Giant Swallowtail Butterfly

*Principal threats*: poor and illegal agricultural practices, illegal timber harvest, mining, hurricane damage, invasive species

*On-going conservation programmes*: programmes being implemented by Jamaica Conservation and Development Trust in accordance with their management plan. Forestry Department carrying out a biophysical inventory. Proposal for designation as World Heritage site under development.

*Description of the area*: Upper reaches of the two mountain ranges, includes two of the largest areas of intact natural forests, areas of outstanding importance for biodiversity, landscape

*Ecological functions and connectivity:* Very important watershed, landscape, important part of spinal forest.

*Main gaps*:

* Management programmes for threatened species and habitats (specially wet forest on serpentine)
* Control of invasive species
* Connectivity to sea (e.g. north, east to Drivers River and south)

**4.6.10 Coastal St Mary and Portland**

*Location:* Coastal and inland hills east of Port Maria (Quebec) and south of Annotto Bay

*Management Agency:* Mostly privately owned

*Current conservation status:* None, but some private landowners are interested in conservation

*Principal targets:* Wet and mesic forest on shale; mesic forest on alluvium, mesic forest on limestone

*Principal threats*: Coastal development, settlement, agriculture, road development, invasive species (including bamboo)

*On-going conservation programmes*: None known

*Description of the area:* One of the last remaining relatively undeveloped parts of the north coast, includes coastal hills and important links to marine ecosystems

*Ecological functions and connectivity:* Coastal protection, watershed, links to marine ecosystems.

*Main gaps*:

* This area urgently needs to be assessed for conservation potential as it includes potentially important examples of wet and mesic forests on shale and alluvium and is important for coastal connectivity.

**4.6.11 Central spinal forest - Upper St. Andrew, St. Catherine, Upper Clarendon, St. Ann, Manchester**

*Location:* Central spine of Jamaica between the Blue Mountains and Cockpit Country

*Management Agency:* Private land owners, Forestry Department, bauxite companies

*Current conservation status:* Includes Forest Reserves.

*Principal targets*: Includes Wet, mesic and fairly dry forest on limestone, wet and mesic forest on alluvium, wet and mesic forest on shale, many threatened plant and amphibian sites, parrots, yellow boa, Jamaican Hutia

*Principal threats*: Invasive species, settlement unsustainable agriculture, urban development, mining

*On-going conservation programmes*: Forest restoration and biodiversity assessment in Mocho and Mount Diablo; Mason River Field Station

*Description of the area:* Central hills of Jamaica, includes many remnants of natural forest, some with outstanding importance for threatened species

*Ecological functions and connectivity*:

Watershed value, connectivity along spine, landscape value

*Main gaps*:

* Many areas require conservation assessment (e.g. Above Rocks, Troja, Luidas Vale, Peckham Woods, St Johns Red Hills and many others)
* Detailed review of potential sites is needed to prioritize areas in need for conservation assessment

**4.6.12 Cockpit Country**

*Location:* Area of karst limestone in west central Jamaica

*Management Agency:* Forestry Department, private landowners

*Current conservation status:* Forest reserve, game reserve

*Principal targets:* Wet forest on limestone, many endemic plant assemblages, and faunal targets (including bats, yellow snake, parrots, amphibians, Jamaican Hutia, Giant Swallowtail Butterfly)

*Principal threats*: potential bauxite mining, settlement, illegal and unsustainable agriculture, pollution, invasive species, fire.

*On-going conservation programmes*: TNC Parks-in-Peril programme ends June 2007.

*Description of the area*: Outstandingly important relatively intact natural forests, with historical and cultural values.

*Ecological functions and connectivity*: Watershed value (covers upper watershed for most of western Jamaica), connectivity to Black River morass system to the south and Martha Brae watershed to the north.

*Main gaps*:

* Habitat and species management (including restoration, control of invasive species)
* Enforcement
* Data - most of the area has never been visited by scientists
* Functional assessment/resource valuation

**4.6.13 Dolphin Head**

*Location:* Inland hills South of Lucea, Hanover

*Management Agency:* Forestry Department and private landowners, Dolphin Head Conservation Trust

*Current conservation status:* Forest Reserve

*Principal targets:* Wet forest on limestone, threatened pland assemblages

*Principal threats:* Timber harvest, invasive species, fire

*On-going conservation programmes:* Dolphin Head Trust and Forestry Department working to develop programmes

*Description of the area:* Area of limestone forest of outstanding importance for threatened plant species

*Ecological functions and connectivity*: Watershed value, landscape and endemic plant hotspot.

*Main gaps*:

* Research
* Enforcement
* Reserve design, to conserve connectivity.

**4.6.14 Northern coastal forests**

*Location:* North coastal hills from Lucea to Port Maria

*Management Agency:* Mostly privately owned

*Current conservation status:* Includes Game Reserves, Coral Spring Protected Area

*Principal targets*: Dry and mesic forest on Limestone, mangrove wetlands; threatened plant aggregations, Yellow Boa

*Principal threats:* Coastal development, selective extraction of lumber, road construction, invasive species

*On-going conservation programmes*: Not known.

*Description of the area:* Despite intense pressure from expansion of population and tourism, some outstanding examples of forest on limestone persist, but are under severe pressure.

*Ecological functions and connectivity*: Important in coastal protection, as well as links to marine ecosystems. As well as maintaining the coastal forests areas such as the lower Martha Brae watershed are specially important because they provide connectivity between the Cockpit Country to the south and the coastal forests. The forests in the Llandovery area may also contribute to connectivity with the central spinal forests.

*Main gaps:*

* With the exception of the very small Coral Spring Protected Area these north coast forests have no protection.
* Only the area surrounding the Discovery Bay Marine Laboratory is relatively well studied.

4.7 **Some priority areas for actions (not in order of importance)**

This preliminary list of areas is presented for review. Criteria for prioritization (including contribution to meeting gaps, feasibility, connectivity, threat and the extent to which the area complements the rest of the system) are yet to be developed and discussed with stakeholders.

"Existing" Protected Areas

* Blue and John Crow Mountains National Park - need for increased connectivity with coastal habitats
* Cockpit Country Forest Reserve - need for increased implementation of conservation programmes
* Portland Bight Protected Area - need for implementation of protected area
* Black River - Upper and Lower Morasses Ramsar site and Game Reserve - need to upgrade to a higher level of conservation management
* Dolphin Head Forest Reserve

Areas outside current protected area system

* Central spinal forest - areas of outstanding biodiversity require assessment and management
* Coastal St. Mary - could include important remnant habitats
* North coastal forest - connectivity to Cockpit Country

**5.0 Strategies**

The most important strategies are summarized in Box 3.

|  |  |  |
| --- | --- | --- |
| **Box 3: Major strategies to conserve terrestrial biodiversity** | | |
| HEADING | T-JERP GAPS | APPROACH (General approach and selected high priority actions) |
| POLICIES | Policy framework does not adequately cover protected areas and target | Existing policies (e.g. protected areas) need to be revised or developed (e.g. wildlife) |
| LEGISLATION and ENFORCEMENT | Regulations necessary to control land use on private land (e.g. under Watershed Protection Act) and conservation easements do not exist.  Most agencies lack capacity to enforce laws | Examine options for developing regulations under Watershed Protection Act  Promote enactment of draft regulations relating to conservation easements  Support proposed revisions to Forest Act. |
| TARGETS | The classification of Jamaica's vegetation has not been standardized and there is no information about current extent. Many areas require assessment of actual conservation value.  The distributions for most fine filter targets are based on data that are more than 20 years old.  Key ecological factors for most target species are not well understood. | Seek funding and innovative approaches to promoting basic research into target species ecology and distribution (including digitizing existing information, ecological modeling and ground truthing  Support ecological assessments of areas whose potential conservation importance requires assessment.  Support status surveys for selected species.  Assess key ecological factors for selected species. |
| THREATS | Cross-cutting threats include invasive species, habitat destruction and over-explotation | Support projects to control selected invasive species. |
| PROTECTED AREAS – representation | The current protected area system nominally protects the majority of major habitat types and species. However several apparently important areas are outside the system. | Management effectiveness assessment is needed to determine the quality of protection and to prioritize issues.  Review current status of selected areas, especially southern St. Thomas. |
| PROTECTED AREAS – categories | The current categories of PAs are not standardized and do not correspond to IUCN categories | Develop consensus on need to revise categories or develop a working categorization to use on a site-by-site basis. |
| PROTECTED AREAS – management and boundaries | Some protected areas and most Forest Reserves lack management plans and do not adequately protect biodiversity | - Select Forest Reserves for more intensive biodiversity management  - Review boundaries against conservation targets  - Develop Conservation Area Planning as a tool for management planning |
| PROTECTED AREAS – connectivity | E-W and N-S connectivity not adequate to ensure stability and adaptation to climate change | - Improve design of system to ensure ridge to reef connectivity (e.g. Cockpit Country-Black River, Blue and John Crow Mountains-coast)  - Identify, adapt and develop appropriate measures e.g. through Development Orders and Watershed Protection Act |
| PROTECTED AREAS - restoration | Swamp forests persist only has degraded remnants | - design project to restore swamp foresta at Negril Royal Palm Reserve. |

**6.0 Conclusions**

This report shows how much of value remains in Jamaica - and how threatened it is. This challenge is to find ways to conserve the wildlife while meeting the economic and social needs of the country.

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**Tables**

Table 1: **Species richness and endemism in selected families of plants**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Total number**  **of species** | **Number of**  **endemic species** | **Percent**  **Endemic species** |
| **Ferns** | 579 | 82 | 14 |
| **Grasses** | 200 | 1 | 0.5 |
| **Orchids** | 230 | 60 | 26 |
| **Palms** | 10 | 7 | 70 |
| **Cacti** | 20 | 10 | 50 |
| **Bromeliads** | 60 | 22 | 37 |
| **Total** | 3304 | 923 | 28 |
| Source: NEPA 2002 | | | |

Table 2: **Species richness and endemism in terrestrial vertebrates and selected invertebrates of Jamaica**.

|  | **Total number**  **of native species** | **Number of**  **endemic species** | **Percent**  **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 |
| N.b. This table includes native species that may have gone extinct recently and excludes introduced species. | | | | |
| Source: NEPA 2002 | | | | |

Table 3. **Conservation Targets - sources of information**

| **Target/Sub-target** | **Common name** | **Sources of information** |
| --- | --- | --- |
| **TERRESTRIAL ECOLOGICAL SYSTEMS** | 20 categories derived from Lu98, rainfall and geology | Grossman; Muchoney; Camirand; Trees for Tomorrow |
| **THREATENED ENDEMIC CAVE BATS** |  |  |
| *Pteronotus macleayii* | Macleay's Moustached Bat | Koenig 2004 |
| *Phyllonycterus aphylla* | Jamaican Flower Bat | Koenig 2004 |
| TH**REATENED PARROTS** |  |  |
| *Amazona agilis* | Black-billed Parrot | Koenig 2004 |
| *Amazona collaria* | Yellow-billed Parrot |  |
| **THREATENED FROGS** |  | Koenig 2004 |
| *Eleutherodactylus cundalli* | Whistling Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Eleutherodactylus alticola* | Whistling Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Eleutherodactylus cavernicola* | Whistling Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Eleutherodactylus fuscus* | Whistling Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Eleutherodactylus grabhami* | Whistling Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Eleutherodactylus griphus* | Whistling Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Eleutherodactylus junori* | Whistling Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Eleutherodactylus luteolus* | Whistling Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Eleutherodactylus andrewsi* | Whistling Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Eleutherodactylus nubicola* | Whistling Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Eleutherodactylus orcutti* | Whistling Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Osteopilus crucialis* | Snoring Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Osteopilus marianae* | Yellow Bromeliad Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Osteopilus wilderi* | Green Bromeliad Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Eleutherodactylus jamaicensis* | Tree Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Eleutherodactylus pentasyringos* | Tree Frog | Schwartz & Henderson 1991; Hedges 2003 |
| *Eleutherodactylus sisyphodemus* | Tree Frog | Schwartz & Henderson 1991; Hedges 2003 |
| **OTHER THREATENED MAMMALS** |  |  |
| *Geocapromys brownii* | Jamaican Hutia | Koenig 2004 |
| **THREATENED REPTILES** |  |  |
| *Cyclura collei* | Jamaican Iguana | Koenig 2004 |
| *Epicrates subflavus* | Jamaican Yellow Boa | Koenig 2004 |
| **THREATENED BUTTERFLIES** |  |  |
| *Papilio homerus* | Giant Swallowtail Butterfly | Koenig 2004 |
| **OTHER THREATENED BIRDS** |  |  |
| *Dendrocygna arborea* | West Indian Whistling Duck | Koenig 2004 |
| **THREATENED PLANTS** |  |  |
| Threatened plant aggregations | Aggregations of more than 4 threatened plant species | Proctor 2003 |

Table 4: **Conservation Targets - Description of Terrestrial Ecological Systems**

|  |  |  |  |
| --- | --- | --- | --- |
| Terrestrial Ecological Systems | Corresponding Land Cover/Use Types (Grossman 1992; Muchoney 1994;Trees for Tomorrow Project 2002; Asprey and Robbins 1952) | Floristic Description | Examples |
| Dry Forest on Alluvium | Cactus thorn scrub | Diagnostic species include columnar cacti (*Stenocereus hystrix*, Dildo Pear) and *Cephalocereus swartzii* and other spiny species. | Great Bay, Treasure Beach and Billy's Bay, St. Elizabeth |
| Dry Forest on Limestone | In coastal areas:  Dry Limestone Scrub/Dry Limestone Thicket/Dry Semievergreen thicket over limestone,  Strand Woodland  Dry Limestone Forest/Dry semi-evergren forest over shale (see below) | **Strand woodland**  Diagnostic species include *Coccoloba uvifera* (Seaside Grape) and *Thespesia populnea* (Seaside Mahoe).  **Islets**  Dominated by *Capparis ferruginea* (Stinking Berry), *Cordia sebestena* (Red Cordia), *Erithalis fruticosum* and several other species  **Dry Limestone Forest**  Common trees include *Metopium brownii*; *Ateramnus lucidus* (Crab Wood), *Drypetes lateriflora* (Wild Orange), *Bumelia salicifolia, Brya ebenus (*Jamaica Ebony) and *Diospyros lateriflora* (Clamberry). *Bursera simaruba* (Red Birch) is a common emergent and there are many smaller species.  Some areas may be dominated by *Thrinax parviflora* (Broom Thatch) | Along the coast e.g. Hellshire, Canoe Valley, Westmoreland  Goat Island, Portland Bight Cays  Long Mountain, Hellshire, Portland Ridge, Canoe Valley. Pedro Bluff, Coastal St. James  E.g. parts of Hellshire |
| Dry Forest on Shale | Not determined | Requires assessment | Margins of Hellshire and Port Henderson Hill |
| Fairly Dry Forest on Alluvium | Thorn scrub over alluvial soils/Partly deciduous thorn thicket | **Thorn scrub**  Dominated by thorny leguminous phanerophytes 3-10 m tall. Common species include *Propopis juliflora* and *Acacia tortuosa.* (probably an anthropogenic formation)  In poor drainage ponding may occur and very rare mud-loving species (*Isoetes jamaicensis*) may occur. | Canoe Valley, Manchester/Clarendon.  Abandoned cane lands in southern St. Catherine  Harris Savanna, Clarendon |
| Fairly Dry Forest on Limestone (see also Dry Forest on Limestone above) | Dry Limestone Forest/Dry semi-evergreen forest over limestone | Common trees include *Metopium brownii*; *Ateramnus lucidus* (Crab Wood), *Drypetes lateriflora* (Wild Orange), *Bumelia salicifolia* and *Diospyros lateriflora* (Clamberry). *Bursera simaruba* (Red Birch) is a common emergent and there are many smaller species.  Some areas may be dominated by *Thrinax parviflora* (Broom Thatch)  Also includes areas that are not well described (e.g. southern St Thomas, Old Harbour) | E.g. South of Discovery Bay, Brazeillettos,  Old Harbour Hills  Negril Hills |
| Fairly Dry Forest on Shale | Not determined | Require assessment. | Port Royal Mountains (e.g. Gordon Castle) |
| Mesic Forest on Alluvium | Not determined | Require assessment. | E.g. in central inlier e.g. small patches along rivers in Upper Clarendon and Linstead , lower Yallahs Valley |
| Mesic Forest on Limestone | Mesic Limestone Forest/  Evergreen seasonal Forest | Canopy 16-20 m, emergents to 24 m. Very species rich, with high levels of local endemism. Undisturbed areas have *Podocarpus purdieanus.* Other frequent species include *Guapira fragrans, Bumelia nigra, Nectandra patens, Coccoloba swartzii, Cinnamomum montanum. Terminalia latifolia* and *Cedrela odorata* are occasional emergents. | Central Jamaica, e.g. Mount Diablo |
| Mesic Forest on Shale | Not determined | Requires assessment | E.g. Port Royal Mountains, Southern St. Thomas and Black Sands, St Mary |
| Wet Forest on Alluvium | Not determined | Requires assessment | River corridors in Portland |
| Wet Forest onLimestone | Lower Montane over Limestone | Diagnostic tree species include *Calophyllum calaba* (Santa Maria), *Calyptronoma occidentalis* (Long Thatch), *Drypetes alba* (Ironwood). *Heliconia caribea* (Wild Plantain) and *Cyathea grevilleana* (tree fern) and endemic *Pilea* spp. are also present. | John Crow Mountains |
| Wet Forest on Serpentine | Lower Montane |  | Arntully, St. Thomas |
| Wet Forest on Shale | Lower Montane over shale (including several variants) | Canopy 12-33 m. Lauraceae and Myrtaceae frequent and in some areas tree ferns are abundant. Frequent tree species include *Pouteria multiflora, Dendropanax arboreus, Guarea glabra, Brosimum alicastrum, Calophyllum calaba.*  N.b. See also Very wet shale forest. | Port Royal Mountains, South slopes of Blue Mountains  Hollywell Park, St. Andrew/Portland |
| Very Wet Forest on Limestone | Upper Montane Rain Forest over Limestone/  Upper Montane over Limestone | Canopy 8-11 m. Trees upright no buttresses or prop roots. Few trees with DBH>15 cm. Ground layer dominated by *Diplazium costale*. Climbers frequent, epiphytes abundant. Common species include *Calyptronoma occidentalis, Cordia elliptica, Ardisia brittonii, Solanum acropterum* | Upper John Crow Mountains |
|  | High altitude over limestone/montane Limestone Thicket/Upper Montane Thicket Complex over limestone | Canopy height 4-6 m; May be dominated by *Clusia havetoides*, forming dense tangles. | Cliffs and areas of poor soil and high rainfall in the John Crow Mountains |
| Very Wet Forest on Shale | Upper Montane Rain Forest over Shale (includes several variants) | Canopy height 5-13 m. Constant tree species include *Alchornea latifolia* *Clethera occidentalis, Clusia havetoides*, etc. | North slopes of Blue Mountains |
| Montane Cloud Forest | High Altitude Scrub Forest over Shale | Epiphytes and tree ferns abundant. Cloud forest characterized by stunted and gnarled trees, including tree ferns, with high basal area, small diameters, and slow growth rates, probably as a result of strong winds and water saturated soils. Trees evergreen and sclerophyllous. Trunks covered with epiphytes. Common species include *Clethera alexandri*; *Eugenia alpina,*etc. | Upper Blue Mountains - Blue Mountain Peak |
| Montane Summit Savanna | Montane summit savanna | Grassland dominated by caespitose high altitude grass *Danthonia domingensis* which forms a monospecific stand to about 1 m. | Confined to the N side of High Peak in the Blue Mountains |
| Non-mangrove Wetlands | Herbaceous wetlands | Freshwater Herbaceous Wetlands   * Freshwater Mudflat * Sedge Savanna * Riparian Swale   - graminoid-dominated riparian swale  - fern-dominated riparian swale | Black River Upper and Lower Morass,  Negril Morass  Canoe Valley |
|  |  | Brackish-water Herbaceous Wetlands   * Estuarine Mudflat * Herbaceous Salt Marsh (salina) | Margins of mangrove wetlands e.g. Rocky Point, Clarendon |
|  | Riparian Forest | Almost completely destroyed. Probably dominated by an undescribed species of *Lonchocarpus* and *Crudia spicata* | Black River near Lacovia and |
|  | Swamp Forest | Dominated by *Symphonia globulifera* (Hog Gum, Boar Gum) and *Roystonea princeps* (Swamp Cabbage, Morass Royal Palm), *Grias cauliflora* (Anchovy Pear) and *Calyptronoma occidentalis* (Long Thatch) | Frenchmans, St. Elizabeth; Negril Royal Palm Reserve and Paradise Westmoreland |
|  | Palm woodland | Disturbed woodlands dominated by palms on poorly drained soils. Dominated by *Roystonea princeps* (Swamp Cabbage, Morass Royal Palm), *Sabal jamaicensis* (Bull Thatch, Big Thatch) or *Thrinax* spp. (palmetto) | Hudson's Bottom, Manchester  Negril (near airstrip) |

|  |  |  |  |
| --- | --- | --- | --- |
| Mangrove Wetlands | Mangrove Forest | Forest dominated by *Rhizophora mangle* (Red Mangrove), *Avicennia germinans* (Black Mangrove) or *Languncularia racemosa* (White Mangrove) | Coastal areas islandwide e.g. Portland Bight, St. Thomas Great Morass, Falmouth |
|  | Mangrove Scrub | Similar species composition to the previous formation but stunted and canopy may not be closed. | Jackson's Bay, |

Table 5: **Conservation Goals: Convention on Biodiversity - Ten percent goals**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| WWF ECOREGION | TERRESTRIAL ECOLOGICAL SYSTEM | TOTAL REMAINING AREA (ha) | 10% GOAL (ha) | TOTAL AREA UNDER PROTECTION (all categories) | PERCENT PROTECTED % (all categories) | MEETS 10% GOAL? |
| Jamaica moist forest | Montane Summit Savanna | 2.2 | 0.2 | 2.2 | 100 | YES |
|  | Montane Cloud Forest | 875.8 | 87.6 | 875.8 | 100 | YES |
|  | Very Wet Forest on limestone | 7379.8 | 738.0 | 5730.1 | 78 | YES |
|  | Very Wet Forest on shale | 22096.4 | 2209.6 | 16860.3 | 76 | YES |
|  | Wet Forest on alluvium | 7529.6 | 753.0 | 678.6 | 9 | NO |
|  | Wet Forest on limestone | 163168.4 | 16316.8 | 37746.8 | 23 | YES |
|  | Wet Forest on serpentine | 425.3 | 42.5 | 56.5 | 13 | YES |
|  | Wet Forest on shale | 52921.5 | 5292.2 | 16978.5 | 32 | YES |
| Jamaican moist forest/ Jamaican Dry forest | Mesic Forest on alluvium | 10572.2 | 1057.2 | 1003.9 | 9 | NO |
|  | Mesic Forest on limestone | 175444.1 | 17544.4 | 20869.4 | 12 | YES |
|  | Mesic forest on shale | 44454.0 | 4445.4 | 685.4 | 2 | NO |
|  | Fairly Dry Forest on Alluvium | 4977.0 | 497.7 | 2668.1 | 54 | YES |
|  | Fairly Dry Forest on limestone | 84308.5 | 8430.9 | 9911.9 | 12 | YES |
|  | Fairly Dry Forest on Shale | 5223.2 | 522.3 | 652.4 | 12 | YES |
| Jamaican Dry Forest | Dry Forest on alluvium | 1091.0 | 109.1 | 641.3 | 59 | YES |
|  | Dry Forest on limestone | 22248.7 | 2224.9 | 14149.9 | 64 | YES |
|  | Dry Forest On shale | 641.1 | 64.1 | 486.8 | 76 | YES |
| Greater Antillean Mangroves | Mangrove Wetland | 16152.3 | 1615.2 | 11597.7 | 72 | YES |
|  | Non-mangrove wetland | 13276.3 | 1327.6 | 11131.3 | 84 | YES |
|  | TOTAL | 632787.6 | 63278.8 | 152726.8 | 24 | YES |

Table 6: **Gap analysis for terrestrial ecological systems - Adaptive/Ecological Goals**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| TERRESTRIAL ECOLOGICAL SYSTEM | TOTAL REMAINING AREA | ECOLOGICAL  /ADAPTIVE GOAL (%) | ECOLOGICAL /ADAPTIVE GOAL (ha) | TOTAL AREA UNDER PROTECTION (all categories) | PERCENT PROTECTED % (all categories) | MEETS ECOLOGICAL/ADAPTIVE GOAL? |
| Montane Summit Savanna | 2.2 | 90 | 2.0 | 2.2 | 100 | YES |
| Montane Cloud Forest | 875.8 | 90 | 788.2 | 875.8 | 100 | YES |
| Very Wet Forest on limestone | 7379.8 | 90 | 6641.8 | 5730.1 | 78 | NO |
| Very Wet Forest on shale | 22096.4 | 80 | 17677.1 | 16860.3 | 76 | NO |
| Wet Forest on alluvium | 7529.6 | 90 | 6776.7 | 678.6 | 9 | NO |
| Wet Forest on limestone | 163168.4 | 40 | 65267.4 | 37746.8 | 23 | NO |
| Wet Forest on serpentine | 425.3 | 90 | 382.8 | 56.5 | 13 | NO |
| Wet Forest on shale | 52921.5 | 80 | 42337.2 | 16978.5 | 32 | NO |
| Mesic Forest on alluvium | 10572.2 | 90 | 9515.0 | 1003.9 | 9 | NO |
| Mesic Forest on limestone | 175444.1 | 40 | 70177.6 | 20869.4 | 12 | NO |
| Mesic forest on shale | 44454.0 | 80 | 35563.2 | 685.4 | 2 | NO |
| Fairly Dry Forest on Alluvium | 4977.0 | 90 | 4479.3 | 2668.1 | 54 | NO |
| Fairly Dry Forest on limestone | 84308.5 | 60 | 50585.1 | 9911.9 | 12 | NO |
| Fairly Dry Forest on Shale | 5223.2 | 90 | 4700.9 | 652.4 | 12 | NO |
| Dry Forest on alluvium | 1091.0 | 90 | 981.9 | 641.3 | 59 | NO |
| Dry Forest on limestone | 22248.7 | 80 | 17799.0 | 14149.9 | 64 | NO |
| Dry Forest On shale | 641.1 | 90 | 577.0 | 486.8 | 76 | NO |
| Mangrove Wetland | 16152.3 | 90 | 14537.0 | 11597.7 | 72 | NO |
| Non-mangrove wetland | 13276.3 | 90 | 11948.7 | 11131.3 | 84 | NO |
| TOTAL | 632787.6 |  | 360738.0 | 152726.8 | 24 | NO |

Table 7: **Terrestrial ecological systems - amounts protected as NRCA Protected Areas, Forest Reserves and Game Reserves**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TERRESTRIAL ECOLOGICAL SYSTEMS | TOTAL REMAINING AREA (ha) | NRCA PROTECTED AREAS (ha) | % | FOREST RESERVES (ha) | % | GAME RESERVES (ha) | % | TOTAL UNDER PROTECTION (ha) | % | EXCLUDING GAME RESERVES (ha) | % | HABITAT PROTECTION GAP (ha) |
| Montane Summit Savanna | 2.2 | 2.2 | 100 | 0.0 | 0 | 0.0 | 0 | 2.2 | 100 | 2.2 | 100.0 | 0.0 |
| Montane Cloud Forest | 875.8 | 875.8 | 100 | 0.0 | 0 | 0.0 | 0 | 875.8 | 100 | 875.8 | 100.0 | 0.0 |
| Very Wet Forest on limestone | 7379.8 | 5703.3 | 77 | 26.8 | 0 | 0.0 | 0 | 5730.1 | 78 | 5730.1 | 77.6 | 911.7 |
| Very Wet Forest on shale | 22096.4 | 16761.3 | 76 | 99.0 | 0 | 0.0 | 0 | 16860.3 | 76 | 16860.3 | 76.3 | 816.8 |
| Wet Forest on alluvium | 7529.6 | 558.2 | 7 | 120.4 | 2 | 0.0 | 0 | 678.6 | 9 | 678.6 | 9.0 | 6098.1 |
| Wet Forest on limestone | 163168.4 | 7142.6 | 4 | 30604.2 | 19 | 0.1 | 0 | 37746.8 | 23 | 37746.7 | 23.1 | 27520.7 |
| Wet Forest on serpentine | 425.3 | 56.5 | 13 | 0.0 | 0 | 0.0 | 0 | 56.5 | 13 | 56.5 | 13.3 | 326.3 |
| Wet Forest on shale | 52921.5 | 16478.2 | 31 | 500.3 | 1 | 0.0 | 0 | 16978.5 | 32 | 16978.5 | 32.1 | 25358.7 |
| Mesic Forest on alluvium | 10572.2 | 459.9 | 4 | 117.8 | 1 | 426.1 | 4 | 1003.9 | 9 | 577.8 | 5.5 | 8937.2 |
| Mesic Forest on limestone | 175444.1 | 2852.7 | 2 | 17981.6 | 10 | 35.1 | 0 | 20869.4 | 12 | 20834.3 | 11.9 | 49343.4 |
| Mesic forest on shale | 44454.0 | 199.4 | 0 | 486.0 | 1 | 0.0 | 0 | 685.4 | 2 | 685.4 | 1.5 | 34877.8 |
| Fairly Dry forest on Alluvium | 4977.0 | 2334.5 | 47 | 97.7 | 2 | 236.0 | 5 | 2668.1 | 54 | 2432.2 | 48.9 | 2047.2 |
| Fairly Dry Forest on limestone | 84308.5 | 8234.1 | 10 | 1594.6 | 2 | 83.1 | 0 | 9911.9 | 12 | 9828.8 | 11.7 | 40756.4 |
| Fairly Dry Forest on Shale | 5223.2 | 291.6 | 6 | 360.8 | 7 | 0.0 | 0 | 652.4 | 12 | 652.4 | 12.5 | 4048.5 |
| Dry Forest on alluvium | 1091.0 | 520.7 | 48 | 18.2 | 2 | 102.4 | 9 | 641.3 | 59 | 538.9 | 49.4 | 443.0 |
| Dry Forest on limestone | 22248.7 | 13219.1 | 59 | 211.8 | 1 | 719.0 | 3 | 14149.9 | 64 | 13430.9 | 60.4 | 4368.1 |
| Dry Forest on shale | 641.1 | 455.9 | 71 | 0.0 | 0 | 30.9 | 5 | 486.8 | 76 | 455.9 | 71.1 | 121.1 |
| Mangrove Wetland | 16152.3 | 8045.0 | 50 | 0.1 | 0 | 3552.5 | 22 | 11597.7 | 72 | 8045.1 | 49.8 | 6491.9 |
| Non-mangrove wetland | 13276.3 | 4038.0 | 30 | 2.2 | 0 | 7091.1 | 53 | 11131.3 | 84 | 4040.2 | 30.4 | 7908.5 |
| TOTAL | 632787.6 | 88228.9 |  | 52221.6 |  | 12276.3 |  | 152726.8 | 24 | 140450.5 |  | 220375.3 |

Table 8: **Fine filter targets - goals and gaps**

| **Target/Sub-target** | **Common name** | **Global status (IUCN 200x)** | **Jamaican Population status** | **Range[[1]](#footnote-1)** | **Notes** | **Goal** |
| --- | --- | --- | --- | --- | --- | --- |
| **THREATENED ENDEMIC CAVE BATS** |  |  |  |  |  |  |
| *Pteronotus macleayii* | Macleay's Moustached Bat | Vulnerable | Not assessed | Limited |  | 50 |
| *Phyllonycterus aphylla* | Jamaican Flower Bat | Endangered | Not assessed | Limited |  | 50 |
| TH**REATENED PARROTS** |  |  |  |  |  |  |
| *Amazona agilis* | Black-billed Parrot | Vulnerable | Not assessed | Fairly widespread | Restricted to Cockpit Country, John Crow Mountains and surrounding areas | 50 |
| *Amazona collaria* | Yellow-billed Parrot | Vulnerable | Not assessed | Fairly widespread | Restricted to Cockpit Country, John Crow Mountains and surrounding areas | 50 |
| **THREATENED FROGS** |  |  |  |  |  |  |
| *Eleutherodactylus cundalli* | Whistling Frog | Vulnerable | Declining | Widespread but patchy | Depends on caves | 50 |
| *Eleutherodactylus alticola* | Whistling Frog | Critically endangered | Declining | Very limited | Blue Mountain Peak | 100 |
| *Eleutherodactylus cavernicola* | Whistling Frog | Critically endangered | Declining | Extremely limited | Known only from Jackson's Bay Cave | 100 |
| *Eleutherodactylus fuscus* | Whistling Frog | Critically endangered | Declining | Limited | Western Jamaica spine | 75 |
| *Eleutherodactylus grabhami* | Whistling Frog | Endangered | Declining | Limited | Central and western Jamaica | 75 |
| *Eleutherodactylus griphus* | Whistling Frog | Critically endangered | Declining | Extremely limited | Only from 3 localities in Cockpit | 100 |
| *Eleutherodactylus junori* | Whistling Frog | Critically endangered | Declining | Extremely limited | Central Jamaica - only 4 localities | 100 |
| *Eleutherodactylus luteolus* | Whistling Frog | Endangered | Declining | Fairly limited | West central Jamaica | 50 |
| *Eleutherodactylus andrewsi* | Whistling Frog | Endangered | Declining | Limited | Blue and John Crow Mountains | 75 |
| *Eleutherodactylus nubicola* | Whistling Frog | Endangered | Declining | Very limited | Five localities in Blue Mountains | 100 |
| *Eleutherodactylus orcutti* | Whistling Frog | Critically endangered | Extinct? | Very limited | Main Ridge Blue Mountains | 100 |
| *Osteopilus crucialis* | Snoring Frog | Endangered | Declining | Widespread | Central and western Ja | 0 |
| *Osteopilus marianae* | Yellow Bromeliad Frog | Endangered | Declining | Fairly limited | N/ central Ja | 50 |
| *Osteopilus wilderi* | Green Bromeliad Frog | Endangered | Declining | Widespread | Central Ja | 50 |
| *Eleutherodactylus jamaicensis* | Tree Frog | Endangered | Declining | Fairly limited | Central Jamaica | 50 |
| *Eleutherodactylus pentasyringos* | Tree Frog | Vulnerable | Declining | Fairly limited | Western Jamaica | 50 |
| *Eleutherodactylus sisyphodemus* | Tree Frog | Critically endangered | Declining | Extremely limited | 1 cave 4 mi NW Quickstep | 100 |
| **OTHER THREATENED MAMMALS** |  |  |  |  | |  |
| *Geocapromys brownii* | Jamaican Hutia | Vulnerable | Declining | Fairly widespread? | |  |
| **THREATENED REPTILES** |  |  |  |  |  |  |
| *Cyclura collei* | Jamaican Iguana | Endangered | Stable | Extremely limited | Restricted to Hellshire Hills | 100 |
| *Epicrates subflavus* | Jamaican Yellow Boa | Vulnerable | Declining | Fairly widespread | Forests on limestone | 50 |
| **THREATENED BUTTERFLIES** |  |  |  |  |  |  |
| *Papilio homerus* | Giant Swallowtail Butterfly | Endangered | Declining | Fairly widespread | Cockpit Country and John Crow Mountains | 50 |
| **OTHER THREATENED BIRDS** |  |  |  |  |  |  |
| *Dendrocygna arborea* | West Indian Whistling Duck | Vulnerable | Declining | Fairly widespread | Wetlands | 50 |
| **THREATENED PLANTS** |  |  |  |  |  |  |
| Threatened plant aggregations | Aggregations of more than 4 threatened plant species | (Threatened)[[2]](#footnote-2) | Not assessed | Extremely limited | Locations islandwide | 100 |

Table 9: - **Gap analysis - protection of habitats for selected threatened species (fine filter targets)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Summary Target Name | Occurences/  Area | Declared PA (NRCA Act) | Forest Reserve | Game Reserve | Total protected | Total | % protected |
| Black and Yellow-billed Parrots | Occurrences | 6 | 49 | 0 | 55 | 242 | 23 |
| Threatened Endemic Cave Bats | Occurrences | 1 | 1 | 0 | 2 | 12 | 17 |
| Threatened Endemic frogs | Occurrences | 40 | 49 | 0 | 90 | 397 | 23 |
| Giant Swallowtail | Occurrences | 3 | 4 |  | 7 | 32 | 22 |
| West Indian Whistling Duck | Area | 8496 | 0 | 2283 | 11099 | 46672 | 24 |
| Yellow Boa | Area | 11980 | 237 | 3 | 12230 | 40472 | 30 |

Table 10: **Cost Surface**

|  |  |  |  |
| --- | --- | --- | --- |
| COST FACTOR (THREAT) | UNIT OF MEASUREMENT | INTENSITY VALUE | SOURCE OF DATA |
| Road density | km/analysis unit | >25 km = 500  10-25 km = 400  5-10 km = 300  1-5 km = 200  < 1 km = 100 | Maps provided by Ministry of Transport and Works 2005 |
| High population density | People/analysis unit | > 1000 = 100  < 1000 = 0 | Statin 2000, 2001. |
| Monocultural agriculture | Presence or absence | Monocultural agriculture present = 100  Not present = 0 | Forestry Department LU1998 |
| Invasive species (bamboo) | Presence or absence of bamboo | Bamboo present = 200  Bamboo not present = 0 | Forestry Department LU1998 |
| Mixed land use | Presence or absence of mixed land use | Mixed land use present = 50  Mixed land use not present = 0 | Forestry Department LU1998 |
| Urban development (including heavy industry) | Presence or absence of urban development | Urban development present = 200  Urban development not present = 0 | Forestry Department LU1998 |
| Mining and quarrying (including bauxite plants, mined out areas and quarries) | Presence of active mining or quarrying | Mining/quarrying present = 500  Not present = 0 | Map provided by Commisioner of Mines 2005 |
| Prospecting licences for mining | Licences issued | Licences issued for >x% of area = 125 | Map provided by Commisioner of Mines 2005 |
| Base cost | None | Base cost = 100 | N/a |

Table 11: **Criteria used in MARXAN** (Dorfman 2006)

|  |  |
| --- | --- |
| Criteria |  |
| Planning unit size | Hexagons, 1 km per side area (area 260 ha) |
| Number of planning units | 4503 |
| Baseline modifier - with cost | 0.03 |
| Penalty factor |  |
| Targets | Coarse and fine filter targets included |
| Target weighting | None |
| Goal systems | Ecological/Adaptive goals |
| Number of runs: | 100 runs of 10 million iterations |
| Model used | Without protected areas, with cost |

**Figures**

Figure 1: TNC/WWF Jamaican Terrestrial Ecoregions

Figure 2: Jamaican Terrestrial Ecological Systems

Figure 3: Jamaican Declared Protected Areas

Figure 4: Distribution of fine filter targets

Figure 5: Cost surface

Figure 6: MARXAN "best solution"

Figure 7: MARXAN "summed runs"

Figure 8: MARXAN portfolio and habitat quality

Figure 9: Protected areas and RBI

Figure 10: MARXAN and RBI

Figure 11: Protected Areas and connectivity

Figure 12: MARXAN and connectivity

Figure 13: Protected Areas and slope

Figure 14: MARXAN and slope

1. From analysis of shape files [↑](#footnote-ref-1)
2. This status was based on expert opinion not data published by IUCN [↑](#footnote-ref-2)