Forest Ecosystem Assessment for the Guava to Morant River & Moore Town Sites, Rio Grande Valley, Portland

Prepared for the Jamaica Conservation and Development Trust (JCDT)

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Table of Contents

List of Tables

List of Figures

List of Acronyms

BJCMNP	Blue and John Crow Mountains National Park
GIS	Geographic Information System
JCDT	Jamaica Conservation and Development Trust
JNHT	Jamaica National Heritage Trust
LFMC	Local Forest Management Committee(s)
LFMP	Local Forest Management Plan
LICJ	Land Information Council of Jamaica
LUDC	Land Utilities Development Commission
M&E	Monitoring and Evaluation
MEGJC	Ministry of Economic Growth and Job Creation
MOF	Ministry of Finance
MOU	Memorandum of Understanding
NEPA	National Environmental & Planning Agency
NFAP	National Forestry Action Plan
NFMCP	National Forest Management and Conservation Plan
NGO	Non-Governmental Organization(s)
NLA	National Land Agency
NRCA	Natural Resources Conservation Authority
NWC	National Water Commission
PIOJ	Planning Institute of Jamaica
RADA	Rural Agricultural Development Authority
TEF	Tourism Enhancement Fund
UNESCO	United Nations Educational, Scientific and Cultural Organization
WRA	Water Resources Authority

Executive Summary

The Jamaica Conservations and Development Trust (JCDT) in its bid to sustainably manage the Blue and John Crow Mountains National Park (BJCMNP) have engaged a team of consultants to prepare the following:

- A Report on the status of the forest ecosystems in the targeted areas inclusive of plant plus animals' species and cultural heritage values present, condition of the forest ecosystem (inclusive of threats to the ecosystem); and
- A Conservation Plan for the targeted areas providing strategies and an action plan to secure the complete restoration of the areas to closed broadleaf forest

The forest ecosystem assessment was conducted in samples sites in the Guava to Morant River and Moore Town communities found within the Rio Grande Valley in the parish of Portland, Jamaica. Based on the information gathered from this assessment as well as observations on the ground, the team of consultants has identified the following recommendations that could be implemented for improving the conservation efforts in the study areas of the BJMNP:

- There should be an ongoing public education programme within the BJCMNP geared towards all stakeholders within the Rio Grande Valley.
- Increased monitoring/patrolling of the area should be considered to monitor/prevent further encroachment within the Park.
- Additional signs should be installed across the BJCMNP highlighting the boundaries of the forest reserve.
- More effort should be placed in creating groups within each community that will play an active role in assisting the JCDT with the day to day monitoring and on the ground management of the protected area to reduce the shortfalls relating to the co-management of the natural resources in the study areas.

It has been concluded that the diversity of both sample sites were both relatively low with the Guava to Morant River area being more diverse than the Moore Town area that has been observed to be more degraded by negative human influences. Both areas however, were significantly affected by anthropogenic disturbances, some evidently having occurred many decades ago. The primary human driven adverse effects include unsustainable harvesting of forest products (example lumber), land clearing for agricultural expansion and improper waste disposal.

Based on the ratio of juvenile trees to adults as well as the vegetation identified and recorded at the sites both areas can be classified as secondary forests. The forest is regenerating; this process is known to be a very slow, gradual process (ecological succession) as the forest moves from its current stage to the climax stage of succession. Intervention is needed by the management of the area to decrease the level of deleterious human influences, which may inhibit the succession of the forest in the areas of interest.

1 Introduction

1.1 The Blue and John Crow Mountains National Park

The Blue and John Crow Mountains National Park (BJCMNP) [figure 1] is located in the eastern end of the island of Jamaica and is Jamaica's first and only United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site. The Park is in the parishes of Portland, St. Thomas, St. Andrew and a small section of south-east St. Mary (figure 2). The National Park covers an area of 41,198 hectares (101, 802 acres) and includes Jamaica's highest point – the Blue Mountain Peak at 2,256 metres (JCDT, 2018). The park accounts for 4.4% of Jamaica's land surface. The steep mountain slopes form the upper sections of ten (10) of the island's twenty-six (26) watershed management units. The Blue and John Crow Mountains National Park comprises three mountain ranges – the Port Royal Mountains to the west, the Blue Mountains, and John Crow Mountains in the east; divided by the Buff Bay and Rio Grande Valleys on the north side of the ranges. The Park is surrounded by a buffer zone of 28,494 hectares in which a range of human activities are permitted, the pristine primary forest of the Blue and John Crow Mountains was designated a UNESCO World Heritage Site in 2015 for its natural and cultural heritage.

Figure 1: A section of the Blue and John Crow Mountains National Park. (Photo credit: Denise Chin)

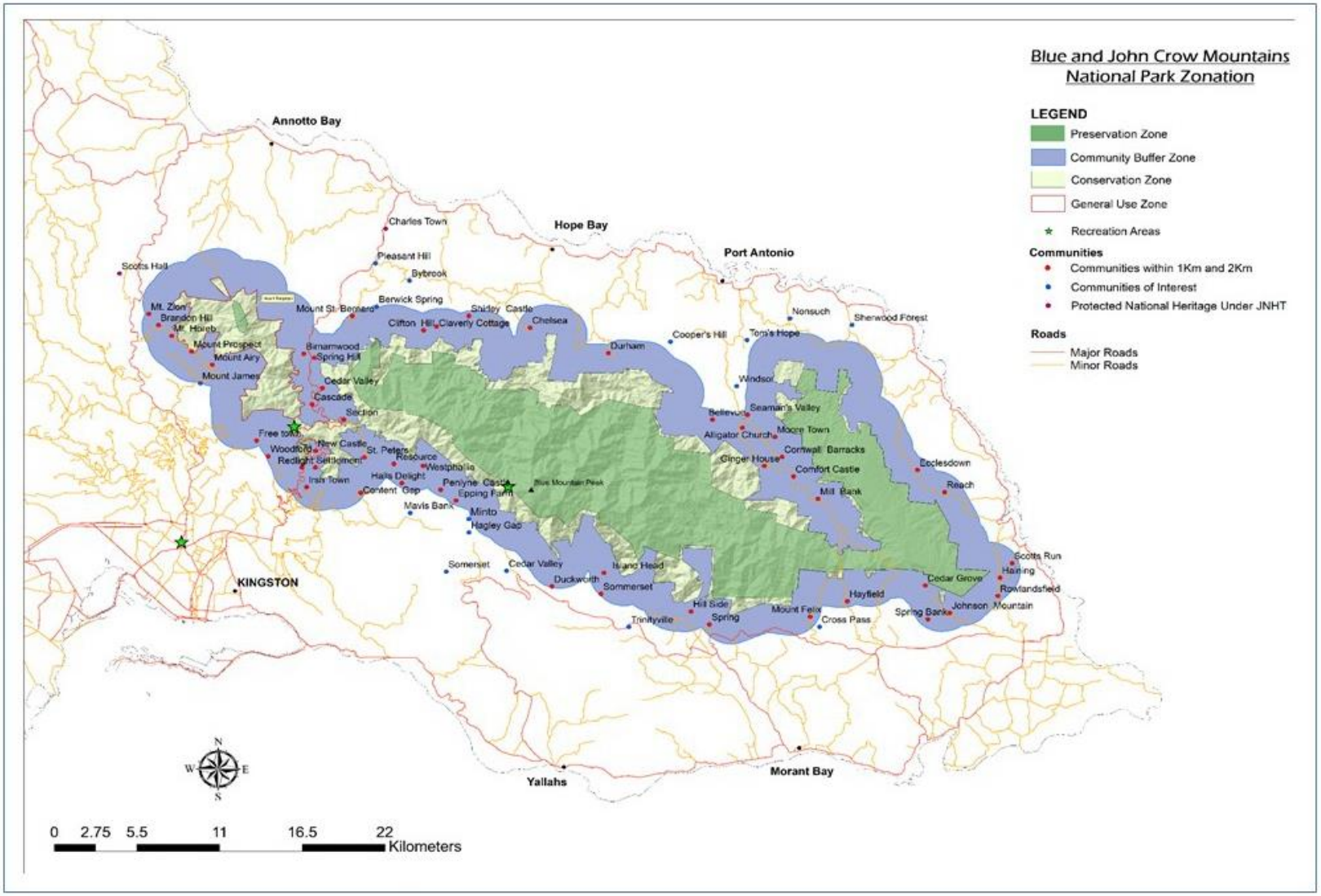

Figure 2: Blue and John Crow Mountains National Park. (Reproduced from JCDT, 2018)

The Blue and John Crow Mountains National Park (BJCMNP) is managed by the Jamaica Conservation and Development Trust (JCDT), a non-government organization (NGO) and registered company and charity (1988) on behalf of the Natural Resources Conservation Authority (NRCA) through the National Environment and Planning Agency (NEPA). The National Park is predominantly closed broadleaf or primary forest (the area designated as a World Heritage Site – about 26,000 ha) there are also pockets of degraded areas e.g. disturbed broadleaf, bamboo and fields.

The National Park overlaps with other protected areas and therefore JCDT coordinates the collaborative management of the site with other entities including the Forestry Department. In 2015, the Forestry Department completed work on the analysis of satellite imagery of the island and this information was used to prepare a map showing land-cover in the National Park (Figure 3).

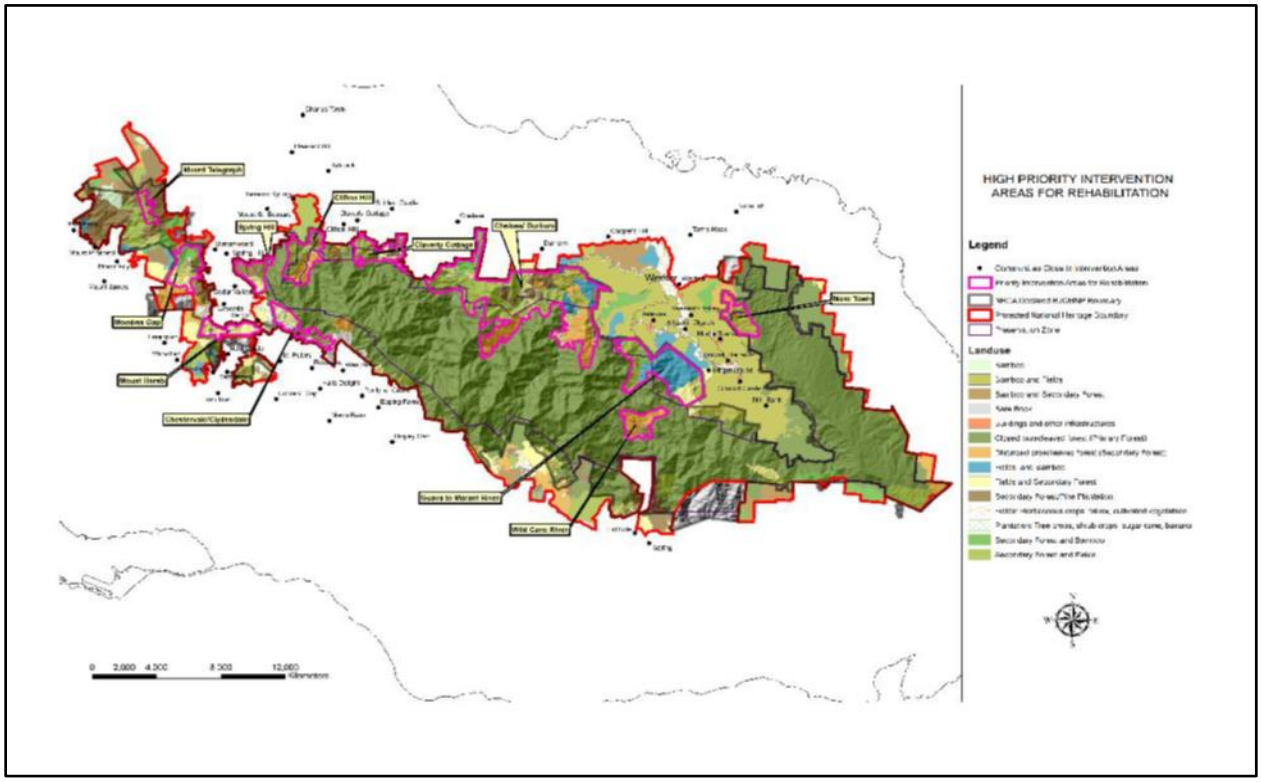

Figure 3: Blue and John Crow Mountains National Park and possible areas for rehabilitation. (Reproduced from JCDT, 2018)

Forests are important as they play key roles in the water cycle, soil conservation, carbon sequestration, and habitat protection. The sustainable management of forests is critical for the protection of biodiversity, effective land and water management, food security and for mitigating against climate change.

Forest on Shale and Limestone are two major conservation targets for the National Park. Deforestation and degradation for agriculture, logging and harvesting of non-timber products as well as the overgrowth of invasive plant species are the main threats to this valuable natural heritage. The Conservation of Natural Heritage Programme in the draft 2017 – 2027 management plan recommends more detailed analysis and ground-truthing of the land cover analysis of satellite imagery to assess the status of degraded forest ecosystems to guide conservation programmes and activities. The Jamaica Conservation and Development Trust (JCDT) manage the Blue and John Crow Mountains (BJCM) National Park and World Heritage Site on behalf of the Government of Jamaica.

The purpose of this Consultancy is to prepare a Forest Ecosystem Conservation Plan covering the sites identified. The first phase of the study is expected to include assessment of the forest ecosystem at the selected sites in terms of species, health, specific threats and trends towards recovery of the closed broadleaf forest. The second phase will use information from the first phase to recommend conservation programmes for the sites including possible reforestation, invasive species control and forest restoration.

Funds are available during the project for reforestation in sections of the Moore Town area, which is being invaded by bamboo (*Bambusa vulgaris*) and which the Moore Town Maroon Council has indicated an interest in reforesting.

1.2 Biodiversity

Jamaica's Blue and John Crow Mountains sustain biodiversity of global significance. It is among the Caribbean's 290 Key Biodiversity Areas and the Caribbean's 48 Wholly Irreplaceable Sites. The National Park is also on the International Union for Conservation of Nature and World Wildlife Fund list of 200 globally important sites for the conservation of plant biological diversity and is noted as an irreplaceable protected area for the conservation of the world's amphibian, bird and mammal species.

1.2.1 Plants

Over half the flowering plants in the national park are found only in Jamaica and about one third are endemic to the national park. At least 40% of the higher plants (flowering and non-flowering) are also endemic to Jamaica. The forest is made up of large trees such as Juniper Cedar (*Juniperus lucayana*), Blue Mahoe (*Hibiscus elatus*) [figure 4] and Soapwood (*Clethra occidentalis*) and smaller shrubs (figure 5) such as Hot-lips (*Cephaelis elata*) and Jamaican Rose (*Blakea trinervia*).

Figure 4: Blue Mahoe (*Hibiscus elatus*)

Figure 5: Hot-lips (*Cephaelis elata*) and Jamaican Rose (*Blakea trinervia*).

To capture sunlight in the thick forest, many plants climb up the trees, like Climbing Bamboo (*Chusquea latifolia*) whilst others spend all their lives on the branches of trees, like orchids and bromeliads (figure 6).

Figure 6: Bromeliad observed in the BJCMP.

Tree ferns and other plants that required a relatively large amount of water are common in the Blue and John Crow Mountains. The trunks and branches of the trees are covered with a wide variety of other plants such as lichens (a combination of algae and fungi) which are usually grey-ish green and are either flat against the tree (or on rocks) or hang from tree branches like Old Man's Beard.

1.2.2 Animals

For most Jamaican land animals, the Blue and John Crow Mountains National Park is their last refuge - a large area of natural forest where they are protected from human disturbance. The region is one of two known habitats of the Giant Swallowtail Butterfly (*Papilio homerus*) – the largest butterfly in the Western Hemisphere. The Cockpit Country is the other location.

Figure 7: Giant Swallowtail Butterfly (*Papilio homerus*).

To support the population of this endangered butterfly species, the Jamaica Conservation and Development Trust has worked with members of the Bowden Pen Farmers' Association, which is based near the habitat of the Giant Swallowtail, to establish a plant nursery that grows the Water Mahoe (*Hernandia catalpifolia*). This plant is the only source of food for the Homerus butterfly caterpillars. The seedlings have been used to reforest several degraded areas, and this has likely contributed to the increasing numbers of the butterflies seen in the area.

The national park is one of the largest bird migratory sites in the Caribbean. Along with Jamaica's endemic birds, it hosts over 200 bird species throughout the year; making it a great location for bird-watching. It is the only place on the island where all Jamaica's unique birds can be observed, including the endangered Jamaican Blackbird (*Nesopsar nigerrimus*). Other highlights for bird enthusiasts include: Rufous-throated Solitaire (*Myadestes genibarbis*); Mountain Witch (*Geotrygon versicolor*); and the Jamaican Tody or Robin Redbreast (*Todus todus*).

Figure 7: Jamaican Blackbird (*Nesopsar nigerrimus*).

Figure 8: Jamaican Tody, Rufous-throated Solitaire and Mountain Witch.

While there are no large or poisonous animals in the Blue and John Crow Mountains National Park, it is home to four of Jamaica's six endemic snakes. The Jamaican Boa (*Epicrates subflavus*) [figure 9] is the largest and can grow up to 2 metres (6 feet).

Figure 9: Jamaican Boa (*Epicrates subflavus*).

The national park is a major habitat for Jamaica's amphibian population; the other being the Cockpit Country. The region supports 11 of the 23 species of endemic frogs; five of which are only found in the Blue and John Crow Mountains National Park. The Blue and John Crow Mountains is also the habitat of the Jamaican Coney (*Geocapromys brownii*) [figure 10]. Once thought to be extinct, the rodent is the largest endemic animal on the island.

Figure 10: The Jamaican Coney (*Geocapromys brownii*).

2 SCOPE OF WORK

The Consultant was expected to provide the necessary technical input into all phases of the Consultancy. The Consultant worked closely with the JCDT to request all required information and to ensure common understanding and produce the Assessment and Plans that meets the objective described above.

Specifically, the Consulting Team was expected to undertake the activities outlined below:-

1. Develop a work plan and implementation schedule for the Consultancy;
2. Request and source relevant technical information, liaising with the JCDT to source local information as needed;
3. Visit the site with the assistance of the JCDT in terms of local arrangements and logistics;
4. Engage with key stakeholders, with the assistance of the JCDT e.g. community meetings and workshops;

5. Liaise with the JCDT, Forestry Department and community members to help locate boundaries so that markers can be placed to reduce encroachment;
6. Prepare a Report on the status of the forest ecosystems in the targeted areas inclusive plant and animals' species and cultural heritage values present, condition of the forest ecosystem (recovering, under invasion, being deforested), threats to the forest ecosystem and cultural heritage, with photographs; and
7. Prepare a Conservation Plan for the targeted areas providing strategies and an action plan to secure the complete restoration of the areas to closed broadleaf forest and ensure conservation of the wildlife, inclusive consideration of possible visitor use – make recommendations regarding the number of types of visitors and activities and recommendation of species for reforestation.

3 Method for Forest Assessment

3.1 Sample Sites

The sample sites for this assessment were Guava to Morant River & Moore Town Sites found within the Rio Grande Valley in the parish of Portland, Jamaica (figure 11). The sites were predetermined based on the terms of reference (ToR). Within each community t*h*e sampling distribution was random and is described in the section 3.2.

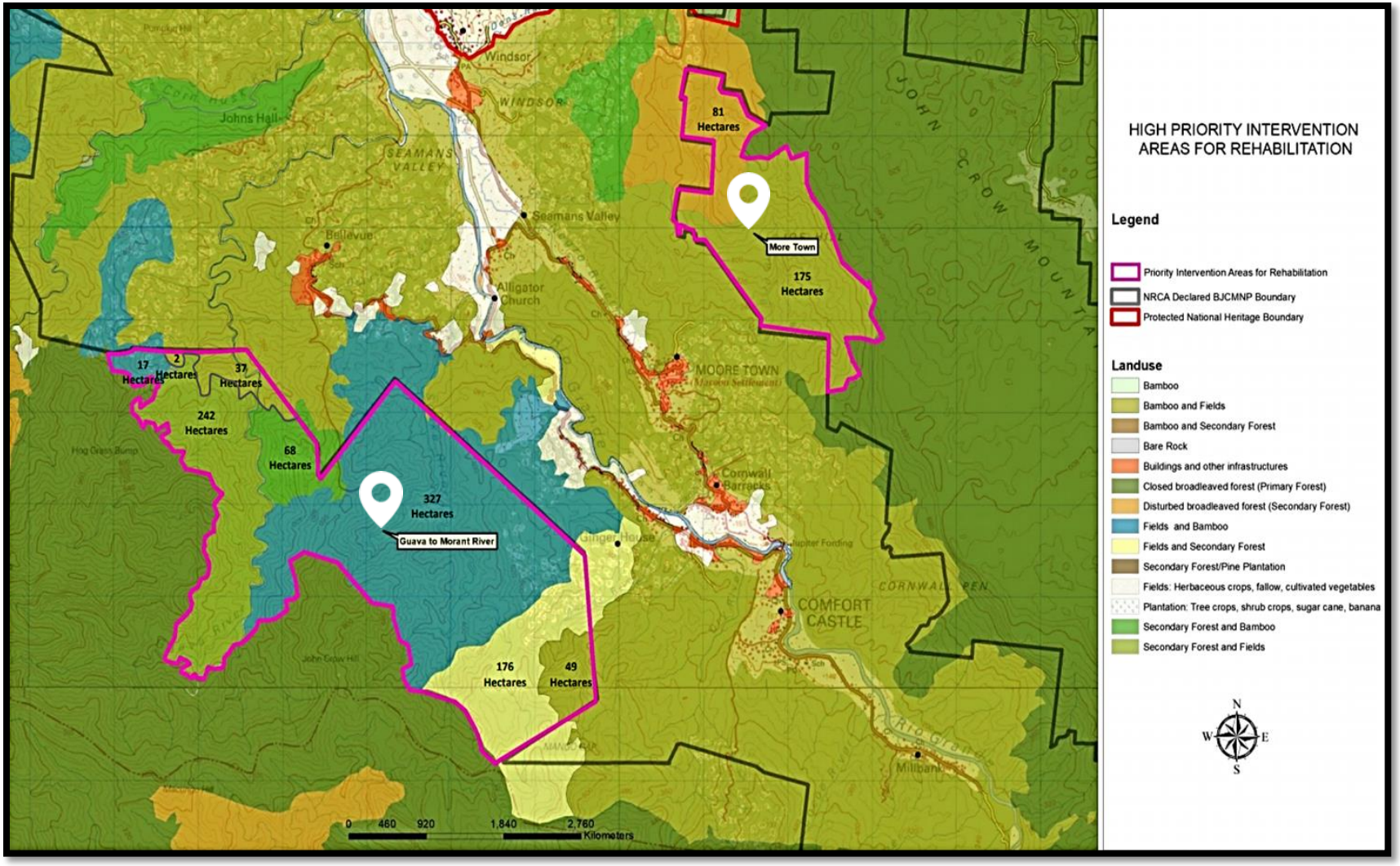

Figure 11: Location Map of the study sites: Guava to Morant River and Moore Town.

3.2 Sample Unit Distribution

The accuracy of a vegetation assessment is heavily reliant on the distribution of sample units across the study area, in order to provide a representational sample of that site. It is essential that sample units are distributed in a random manner throughout the study area, as to not introduce bias to the assessment. To ensure this, a desktop assessment (ArcGIS) of the study area was be carried out that includes the allocation of starting points for transects/sample plots, following the principle of stratified random sampling.

3.3 Sample Unit Size

The size of the sampling units was determined based on data from previous researchers who developed species area curves for ecosystems in Jamaica. Following research done by Tanner (1986), and outline in the Biophysical Inventory Manual (Forestry Department) the ideal sample units for vegetation assessments are as follows:

- Rectangular plot 25 m x 20 m (0.05 ha) for trees with DBH > 10cm
- Rectangular sub - plot 5 m x 10 m (0.005 ha) for the tree/shrub samplings (DBH < 10 cm and Height > 2 m)
- Rectangular sub - plot 1 m x 2 m (0.0002 ha) for the tree/shrub regeneration (height <2 m).

3.4 Establishment of sample plots

Line transects were established throughout the study area. Each line transect was 500 m in length. On each transect four 25 m x 20 m plots will be established for data collection at 100m apart. Within each sample plot, a 5 m x 10 m sub – plot was demarcated for the collection of sapling data. A 1 m x 2 m sub – plot was also established within each plot, in which regeneration data was collected (figure 12).

A GPS handheld device was used to locate the starting point for each line transect, that was pre-determined during the desktop study component of the study. After the starting point was located, the pre-determined azimuth reading was followed using a compass and the full length of the line was measured and demarcated using a distance tape and flagging tape. Corrections were calculated for slope gradient in order to match actual measurements to map measurements where significant slopes were present. Distance adjustments were made using a chart of calculated distance adjustments according to slope; that was done on site, that employed the use of a clinometer to measure the slope when encountered, and the distance over which the slope spans.

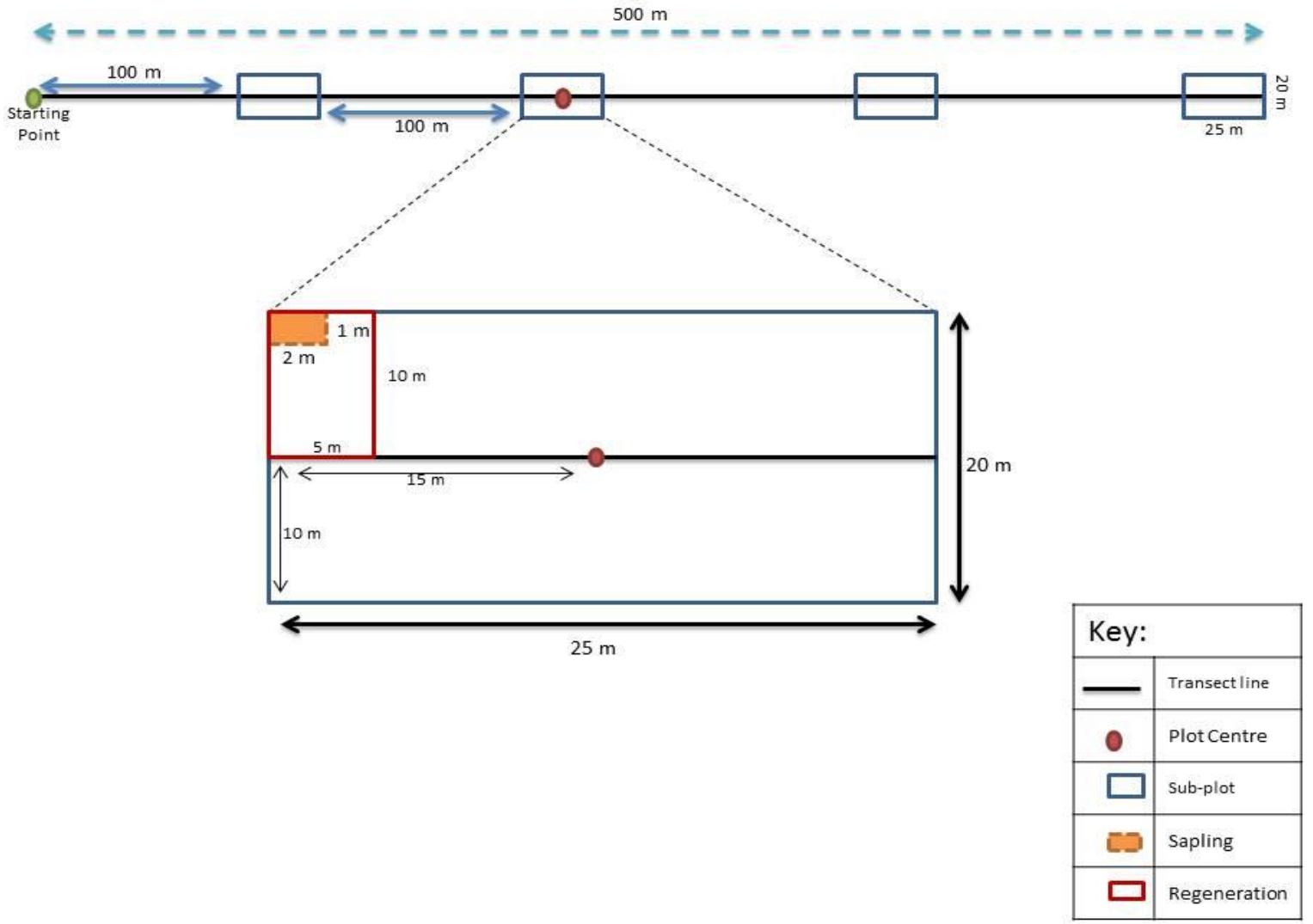

Figure 12: Diagram of a transect line.

3.5 Collection of Vegetation Data

Within each 25 m x 20 m sample plot, all trees that have a diameter breast height (DBH) measurement above 10 cm were identified and the DBH measurement recorded. Within the 5 m x 10 m boundaries of the sample sub – plot, all the saplings were identified per species and the total number of individuals of each species recorded. Tree saplings were classified as vegetation that is between 2 m in height and 9.5 cm in DBH. Within the 1m x 2m sub – plot, all tree regeneration were identified and the number of individuals recorded; tree regeneration were classified as small trees below 2 m in height.

All trees with a DBH of 10 cm and above were measured and recorded on field sheets. Each tree (DBH ≥ 10cm) was identified and its common name recorded. The DBH of a tree was recorded at a point which falls at the vertical distance of 1.3 m above the ground level or 30 cm above the buttress height, if a buttress falls at the 1.3 m mark (figure 13).

Voucher specimens were collected for plant species that were not identifiable *in situ.* The vouchers were identified at the University of the West Indies (UWI) Herbarium. Voucher specimens were assigned a code that corresponds to individuals recorded in the census and placed in a plant press for future identification.

Figure 13: Diagram showing the measurement of DBH.

3.6 Forest Health Assessment

The health of the vegetation was also examined during this study. In each sample plot, a forest health assessment was carried out within the 5 m x 10 m boundaries. The health assessment consisted of the examination of all plants within the sample area for diseases (fungal and bacterial), nutrient deficiencies and the presence of parasites. In cases where any of the aforementioned indicators were observed, the cause/name of parasite was recorded along with the species of tree it is associated with. In addition the presence of indicators such as the percentage of lichen/orchid cover present on the vegetation was estimated and recorded throughout the sample areas.

3.7 Invasive alien species (IAS) Assessment

An assessment was conducted noting the presence/absence of the invasive alien species (IAS). This assessment consisted of a thorough walkthrough assessment of the study sites in which the IAS was identified and the relative density per species estimated. The data collected from this assessment was used to generate a map indicating the current distribution and density of the IAS throughout the study areas.

3.8 Ecological Threat Assessment

An ecological threat assessment was carried out to identify and determine the magnitude of different types of anthropogenic and natural threats to the areas of interest. The threat assessment consisted of an extensive walkthrough of the area to determine the threats that exist and to what extent they were present or anticipated. The threats included, but not limited to, deforestation for use of trees for timber or charcoal production, deforestation for expansion of agricultural lands, invasive alien species, soil erosion due to unsustainable farming practices, and the current/expected effects of climate change.

3.9 Calculation of Biodiversity Indices

A diversity index is a quantitative measure that indicates the species richness (number of different species) that exists in an ecological community, and simultaneously takes into account the species evenness (how evenly the density of each species is distributed) within that same ecological community. For the purpose of this study, the following indices were calculated using the data collected:

3.9.1 Simpson's Index of Diversity

Simpson's Diversity Index is a measure of diversity which takes into account the number of species present, as well as the relative abundance of each species. As species richness and evenness increase, so diversity increases. The index is based on a scale from 0 to 1, with zero (0) being no diversity and one (1) being infinitely diverse. It is calculated as follows:

$$D = \sum n(n-1)/N(N-1)$$

where n = # of individuals by species and N= total # of censured individuals.

3.9.2 Shannon's Index of Diversity

The Shannon index has been a popular diversity index in the ecological literature. Shannon's index accounts for both abundance and evenness of the species present. It is calculated as follows:

$$H = -\sum (p * \ln(p))$$

where p = (n/N) ; n = # of individuals by species and N= total # of individuals.

3.9.3 Importance Value Index

The importance value gives an overall estimate of the influence of importance of a plant species in the community.

IVI = Relative Dominance + Relative Density + Relative Frequency of a species

3.9.4 Margalef's Index of species richness

The Margalef's index was used as a simple measure of species richness using the following formula:

D= (S – 1) / In (N)

where S = total number of species and N = total number of individuals in the sample.

3.9.5 Pielou's Evenness Index

For calculating the evenness of species, the Pielou's Evenness Index was used**.**

J = H / In (S)

where H = Shannon Diversity Index and S = total number of species in the sample.

3.9.6 Total Basal Area

This is a measure of the total area occupied by the cross-section of tree trunks/stems at the base of all standing plants within a given area, and is expressed in m^2/Ha. The term basal area is widely used in forest management and forest ecology.

4 Findings

The forest ecosystem assessment was conducted in the Guava to Morant River and Moore Town communities found within the Rio Grande Valley in the parish of Portland, Jamaica. The findings from this assessment will be discussed based on the two communities and a comparison will be conducted for various indices.

4.1 Morant to Guava River

4.1.1 Trees

A total number of 1577 individuals were identified and measured at the Morant to Guava River area, which comprised of 55 plant species belonging to 33 families. Of the 55 species present, 7 of them have been identified as endemic species. The site can be considered to be of relatively low diversity as a Shannon Index value of 1.82 and a Simpson's Diversity Index value of 0.56 was derived from the data collected.

The Pielou's Index calculated for the area is 0.45 which is relatively low for a tropical forest ecosystem; this indicates that the distribution of the species across the study area is not even. Uneven distribution of species throughout the area means that the biodiversity would be highly scattered throughout the study site. Instead of having representative of all species scattered through the area, what occurs is that some species are observed in some areas and not in others. Zonation is not believed to be the reason for this, but rather anthropogenic disturbances over time. The evenness is expected to increase with time, as the forest ecosystem progresses in ecological succession.

The Margalef's Index value calculated was 7.33, which is relatively low. This is an index of species richness, which takes into account the number of different species in an ecological community. Despite

being relatively low, the Margalef's Index value shows that the species richness of the study area is the major contributor to the overall diversity of the area.

Figure 16 illustrated that the highest ranked species according to the Importance Value Index (IVI) is *Bambusa vulgaris*, and the lowest ranked species being *Miconia dodecandra*. The Importance Value Index is the total of the Relative Dominance, the Relative Density and the Relative Frequency, of all the species censured within the study area. The high value placed on *Bambusa vulgaris* for this ecosystem is due primarily to the high relative density of this species. Relative density is calculated using the number of individuals (number of stems) per species in a sampling unit. *Bambusa vulgaris* have several stems originating from one rhizome; in most cases the number of stems per "bamboo root" is in excess of 25 individuals.

As shown in the graph (figure 14) some of the other species for example *Cecropia peltata*, *Acrocomia spinosa* and *Pinus Caribaea* have a significantly higher relative dominance value than *Bambusa vulgaris*. Relative dominance is calculated using the basal area of the individuals censured (derived from DBH). *Bambusa vulgaris* being a grass (Poaceae), tends to have a relative low DBH measurement (<15 cm DBH), when compared to the other species recorded that are all tree species which tend to have higher DBH measurements (though age dependent).

It is also shown in the graph, that although *Bambusa vulgaris* was the highest ranked species based on IVI, it did not have the highest relative frequency. The relative frequency was calculated per species based on how frequently they were encountered during the assessment, by accounting for how many sampling units in which they were observed.

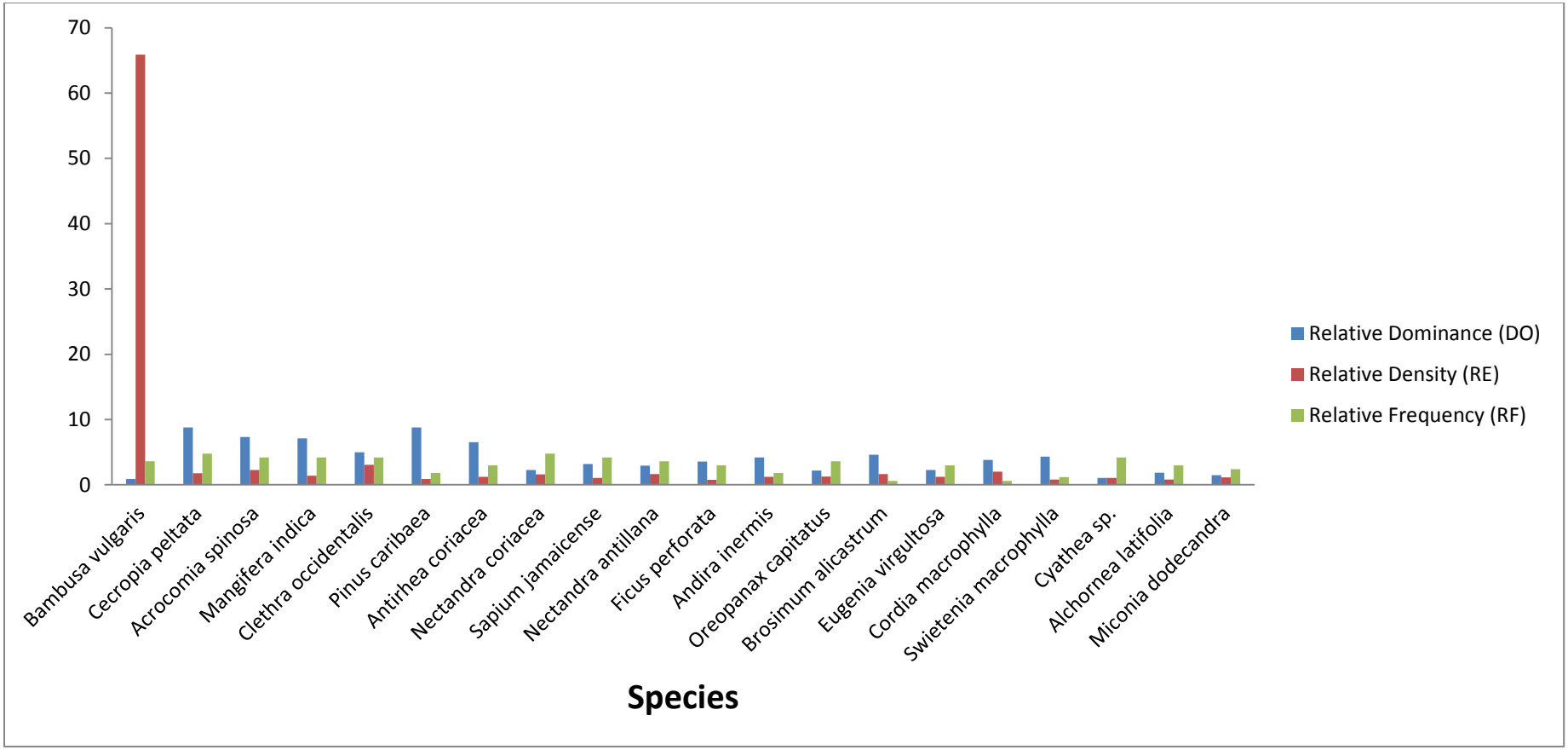

Figure 14: Comparison of relative dominance, density and frequency in Guava to Morant River.

Although *Bambusa Vulgaris* has the highest calculated IVI ranking, it needs to be highlighted that it is not the most frequently occurring species in the area, neither is it the most dominant (based on basal area – the amount of area it occupies). In other word *Bambusa vulgaris* had many stems however it was not as widely distributed across the sample area as some of the other species present.

Diameter distributions are commonly used to assess the disturbance effect within forests (Hett and Loucks, 1976; Davis and Johnson, 1987; Denslow, 1995). A plotted DBH class distribution curve can be used to detect trends in regeneration patterns (Poorter et al., 1996). Following Meyer's (1952) exponential model, based forest structure and dynamics studies, size is often used as an indication of the age of trees, where larger trees are assumed to be older than smaller ones (Davis and Johnson, 1987). The DBH class distribution graph (figure 15) that was plotted for the Morant to Guava River Area is a reversed "J" shaped curve, which is characteristic of a mixed uneven-aged tropical forest (Hitimana et al. 2004). The general model can however be modified by various environmental factors (Brunig, 1983; Denslow, 1995), e.g., biotic agents such as tree cutting, competition for resources, allelopathy between species or between mother trees and seedlings, regeneration patterns, differences in topography or soils, irregular or seasonal climatic events.

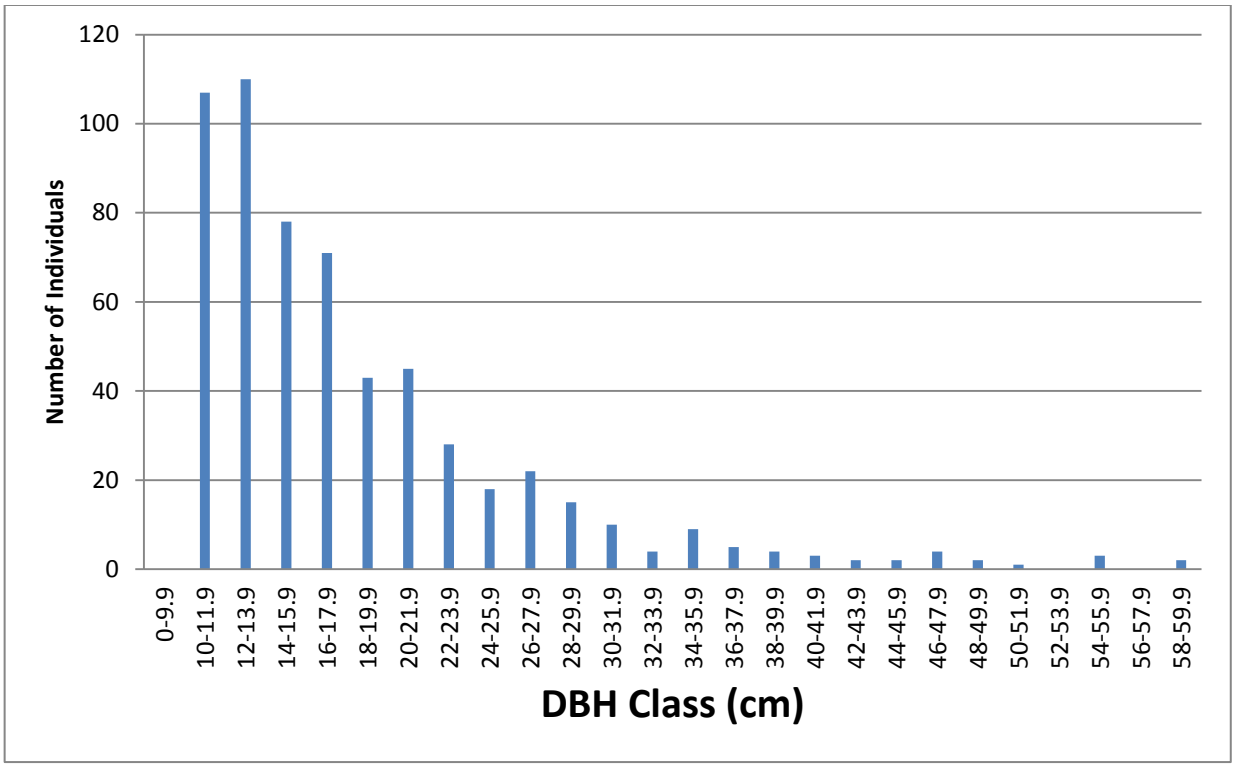

Figure 15: Diameter at Breast Height (DBH) for samples at Morant to Guava River.

For the Guava to Morant River area, 65% of the trees measured were between 10.0 cm and 20.0 cm DBH. The high number of trees falling within this category indicates that the trees at site are primarily younger trees, and therefore the forest is a state of regeneration and can be classified as disturbed broadleaf forest. The absence of greater number of trees with large DBH readings, older trees, is most likely as of a result of excessive logging in the past where certain species were selectively logged hence changing the forest structure over time. In the past, it was typical in areas such as these for larger trees to be cut from the forest for use as lumber production, agricultural expansion and construction activities.

4.1.2 Regenerates and Saplings in the Guava to Morant River area.

A total of 364 individuals were recorded for the samples of regenerates in the Guava to Morant River area, while 640 saplings were recorded for the same area. The regenerates were comprised of 30 species while there were 53 species of saplings.

The species that had the highest density for the regenerates was *Psychotria corymbosa*, *Piper murrayanum* and Brakka. The above species were the most frequently occurring species within the sample plots for regenerates are all pioneer species. This is another indicator of the fact the forest is in a stage of regeneration, from years of anthropogenic disturbances. *Ziziphus chloroxylon*, *Quiina jamaicensis* and *Xylopia muriata* are among the species with the lowest density among the regenerates; all of these species are endemic and are classified as either not frequently occurring or local (Adams, 1972).

For the saplings, the species with the highest density were *Psychotria corymbosa*, *Piper murryanum* and *Miconia dodecandra*. The most frequently occurring saplings that were recorded are also pioneer species. The species with the lowest density includes *Theobroma cacao*, *Psidium montanum* and *Allophylus comina*; with the exception of *Psidium montanum* (endemic species) these saplings are classified as agricultural crops, which seeds may have arrived in the forest by either transfer by a human or by a bird.

The general trend in regenerating ecosystems is for a high dispersal of pioneer species in the early stages of ecological succession, and as succession progresses the number of these pioneer species and there density decreases, while the number of climax species and their density increases. The data collected within the Guava to Morant River area suggests that this forest ecosystem follows this general trend.

4.2 Moore Town

4.2.1 Trees

A total of 607 individuals were recorded for the Moore Town study area. This sample set was comprised of 33 plant species, belonging to 22 different families. A total of 4 endemic plants species were observed in the Moore Town area. The diversity of this area is relatively low diversity as a Shannon Index value of 1.82 and a Simpson's Diversity Index value of 0.56 was derived from the data collected.

The Pielou's Index calculated for the area is relatively low (0.29) for a tropical forest ecosystem; this value highlights the fact that there is uneven distribution of the species across the study area.

The Margalef's Index value calculated was 4.99 which is relatively low. This is an index of species richness, which takes into account the number of different species in an ecological community.

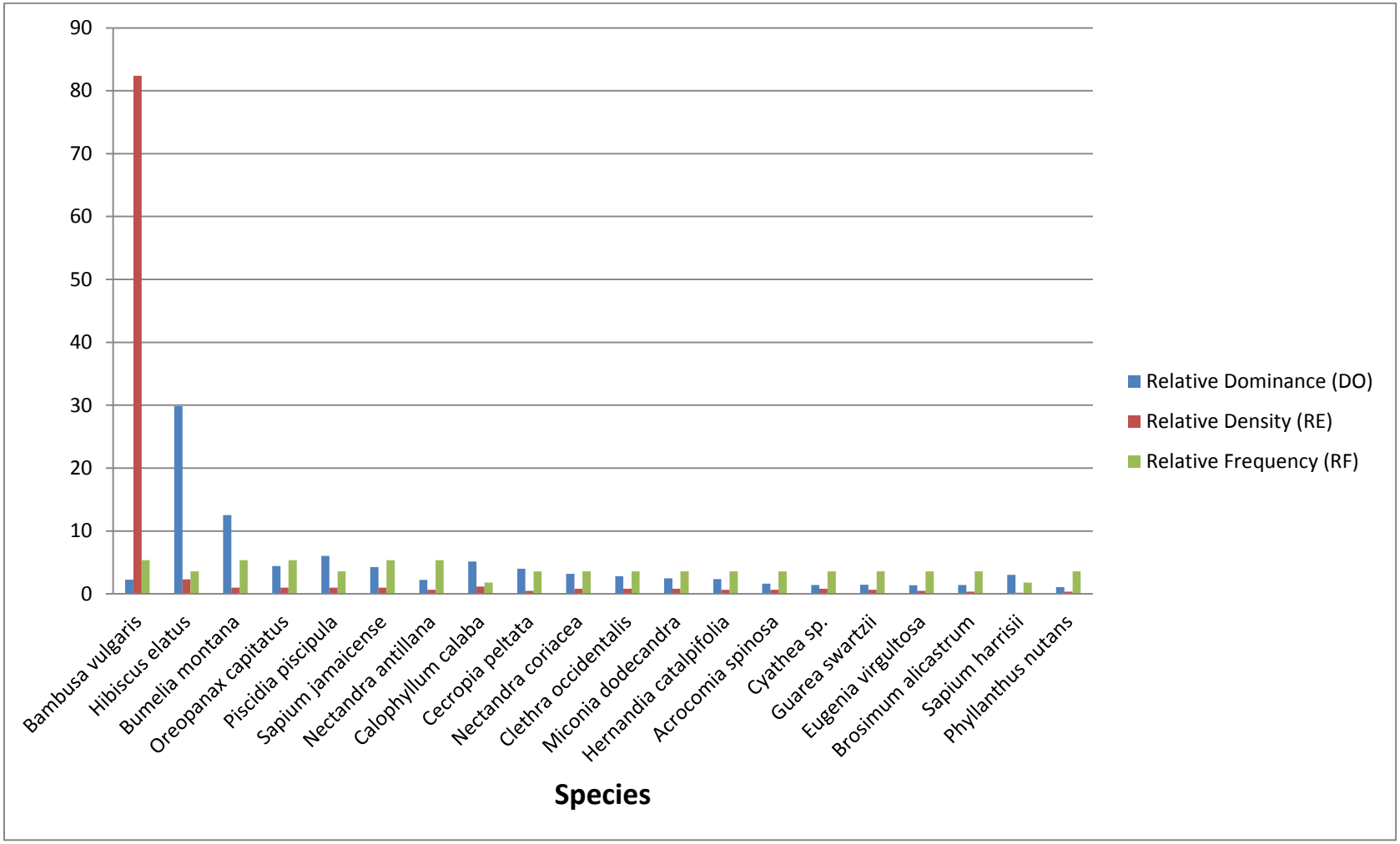

Figure 16: Comparison of relative dominance, density and frequency in Moore Town.

Figure 16 indicated that the highest ranked species according to the Importance Value Index (IVI) is *Bambusa vulgaris*, followed by *Hibiscus elatus* and then *Bumelia montana*, for the top three highest species ranked based on IVI. The three lowest ranked species according to the IVI were *Brosimum alicastrum*, followed by *Sapium Harrissii* and then *Phyllanthus nutans*.

Bambusa vulgaris had the highest IVI primarily due to its high relative density. When compared to *Hibiscus elatus* and *Bumelia montana*, the *Bambusa vulgaris* has a significantly less relative dominance value. This shows that the importance value credited to *Bambusa vulgaris* is due numerous stems associated with the plant and not the amount of area (basal area) the species occupies. The graph also shows that a number of the species that were surveyed are more frequently occurring across the study area than the *Bambusa vulgaris*.

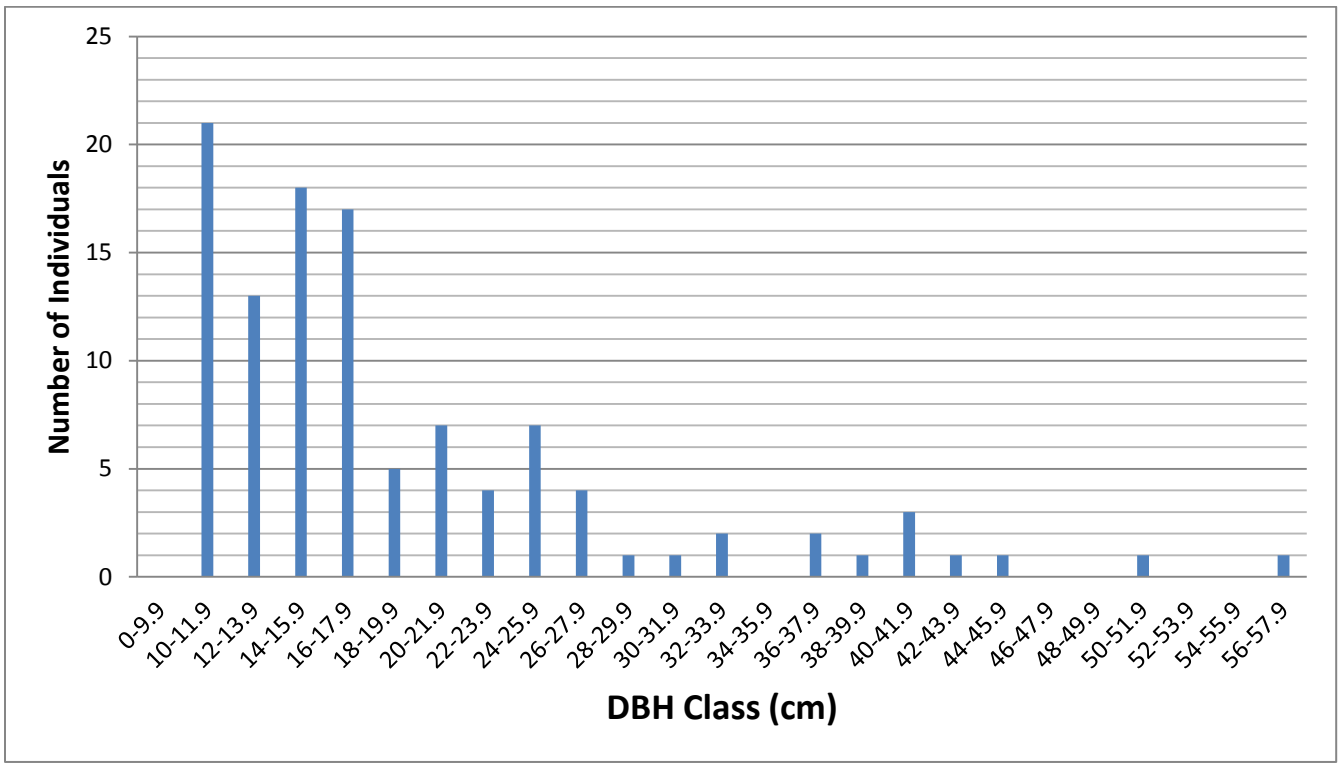

Figure 17: Diameter at Breast Height (DBH) for samples at Moore Town.

The DBH class distribution graph (figure 17) for the Moore Town area is the shape of a reversed "J". The majority of the trees that were recorded (67%) fell between 10.0 cm and 20.0 cm in DBH. This dominance of trees within the smaller DBH categories suggests that the forest in the area is in a state of regeneration, probably after years of anthropogenic disturbances that saw the removal of the more mature trees from the areas. The patchy distribution of the larger DBH classes (>40 cm DHB) may be due to selective logging happening in the past, in the area.

4.2.2 Regenerates and Saplings in the Guava to Moore Town.

A total of 80 individuals were recorded for the samples of regenerates in the Moore Town area, while 257 saplings were recorded for the same area. The regenerates were comprised of 14 species while there were 26 species of saplings.

The species that had the highest density for the regenerates was *Psychotria corymbosa*, *Piper murrayanum* and *Guarea swartzii*. *Brosimum alicastrum*, *Eugenia virgultosa* and *Trifolium dubium* are among the species with the lowest density among the regenerates.

For the saplings, the species with the highest density were *Psychotria corymbosa*, *Piper murryanum* and *Miconia dodecandra*. The species with the lowest density includes *Ziziphus chloroxylon*, *Coccoloba longifolia* and *Syzygium malaccense*.

4.3 Comparison of the Guava to Morant River and the Moore Town.

From the analysis of the data and calculation of the various indices it can be inferred that the Guava to Morant river area is more diverse than the Moore Town area. The Shannon and Simpson indices indicate the diversity of an area. The data suggests that Guava to Morant River area is significantly more diverse than Moore Town (Table 1). Similarly both Pielou's and Margalef's indicators of eveness and species richness are higher at the Morant River site than at Moore Town site. Although Moore Town study area is a quarter the area of the Guava to Morant River area calculation of the indices is not size related. Total number of stems and total number of species are however related to the acreage of the study area. The Guava to Morant river Area was calculated to have 6,070 stems per hectare in comparison with the Moore town area have 3,943 stems per hectare or just over 40% less than that of Guava to Morant River. Guava to Morant River had an estimated 45.43m^2 basal area /ha, just less than 11 % more that Moore Town having an estimated 40.5m^2 basal area/ha.

Table 1: Comparison of various indices of Guava to Morant River and Moore Town.

	Guava to Morant River	**Moore Town**
Area of Sample Site (m^2)	4,000	1,000
Number of individuals recorded	1,577	607
Number of species	55	33
Number of families	35	22
Number of endemics	7	4
Total basal area (m^2)	18.71	4.05
Number of stems/Ha	3,943	6,070
Basal area/Ha (m^2/Ha)	45.43	40.5
Top 5 most important species (based on IVI)	• *Bambusa vulgaris* • *Cecropia peltata* • *Acrocomia spinosa* • *Mangifera indica* • *Clethra occidentalis*	• *Bambusa vulgaris* • *Hibiscus elatus* • *Bumelia montana* • *Oreopanax capitatus* • *Piscidia piscipula*
Shannon's Index	1.82	1.02
Simpson's Index	0.56	0.32
Pielou's Index	0.45	0.29
Margalef's Index	7.33	4.99

There are a number of factors that are likely to have influenced the differences across the two sites, the proximity of the site to the surrounding communities allow for greater/easier access. At Moore town site, it is relatively much more easily accessible on two fronts communities are not only close but also the size allows for more of it to be impacted by human activity. The Moore Town site is also said to be owned by the Moroons of Moore Town granted to them by treaty. Due to this ownership community members utilize the lands for agriculture; other forestry resources are also used. Land use in this area is far less restricted and magnitude of protection by the JCDT as compared to the Guava to Morant River site. Guava to Morant River study site is less accessible the boundaries of the site is further away from the surrounding communities. Both sites are similar in climatic conditions, vegetation type and elevation the factor that account for the differences between the two sites can be attributed to the level of disturbance occurring on each site.

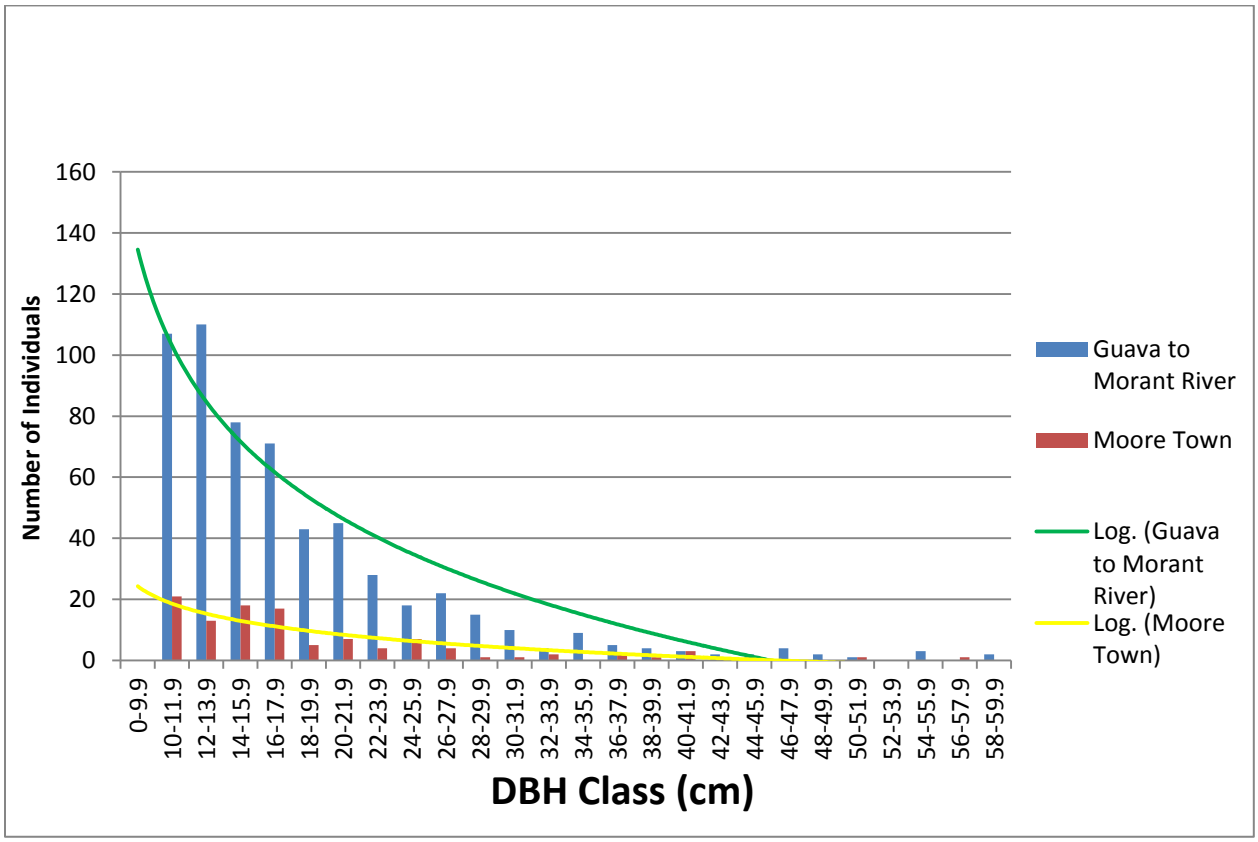

Figure 18: Comparison of DBH of Guava to Morant River and Moore Town.

4.4 Forest Health Assessment

The assessment and monitoring of forest health is an important component to the overall management of forest ecosystems. Forests are invaluable as they provide ecological, economic, aesthetic and cultural services. Forests are generally sensitive to biotic and abiotic stresses, hence the need for assessing the current condition to allow any problem arising to be identified.

There are different terms and concepts that are used as synonyms in the context of forest health, which can generate some confusion when attempting to discuss the point. With regards to trees it is important to note the differences between health, condition and vigor (Innes, 1993), although some relationship does exist among them.

Tree health should is considered in a pathological sense, as it is defined as the incidence of biotic and abiotic factors affecting trees. Tree condition is a more general term which refers to the outer appearance of trees. Tree vigour refers to the growth of a tree in relation to a hypothetical optimum. Tree vitality and crown vigour are also terms sometimes used (e.g. Jukola-Sulonen *et al*., 1990; Strand, 1995) as synonymous of condition and/or health.

For the purpose of this study several indicators were used to deduce if the forest is in a healthy state or not. The health assessment consisted of the examination of all plants within the sample area for diseases (fungal and bacterial), nutrient deficiencies and the presence of parasites.

The health assessment conducted found no evidence of diseases, nutrient deficiencies or the presence of parasites.

4.5 Land Use – Forestry Department Satellite Analysis vs. on the ground

In 2015, the Forestry Department completed work on the analysis of satellite imagery of the island and this information was used to prepare a map showing land-cover in the National Park.

4.6 Invasive Alien Species

Invasive alien species (IAS) are plants, animals, pathogens and other organisms that are non-native to an ecosystem, and which may cause economic or environmental harm or adversely affect human health (CBD, 2006). IAS have an adverse impact biodiversity, including decline or elimination of native species - through competition, predation, or transmission of pathogens - and the disruption of local ecosystems and ecosystem functions. IAS is an internally recognized phenomenon with globalization being the primary reason for the proliferation of IAS. There surge of IAS worldwide is as result of an increase in trade between countries, improvement in transportation, travel and tourism worldwide, all of which can facilitate the introduction and spread of species that are not native to an area. Once a new habitat is similar enough to a species' native habitat, it may survive and reproduce. A major factor leading to the non-native species becoming established in the new habitat is the lack of predators.

Invasive alien species, introduced and/or spread outside their natural habitats, have affected native biodiversity in almost every ecosystem type on earth and are one of the greatest threats to biodiversity. Since the 17th century, invasive alien species have contributed to nearly 40% of all animal extinctions for which the cause is known (CBD, 2006).

Table 2: List of Invasive Alien Species Observed in the Study Areas.

Scientific Name	**Common Name**
Angiopteris evecta	Giant fern
Bambusa vulgaris	Bamboo
Flemingia strobiliflora	Wild hops
Hedychium spp.	Wild ginger lily
Panicum maximum	Guinea grass
Syzygium jambos	Rose Apple

In the Guava to Morant River and Moore Town, areas a total of 6 invasive plant species were observed during the study that affected both sites. The most dominant IAS in areas is *Bambusa vulgaris* (figure 19), followed by *Panicum maximum*.

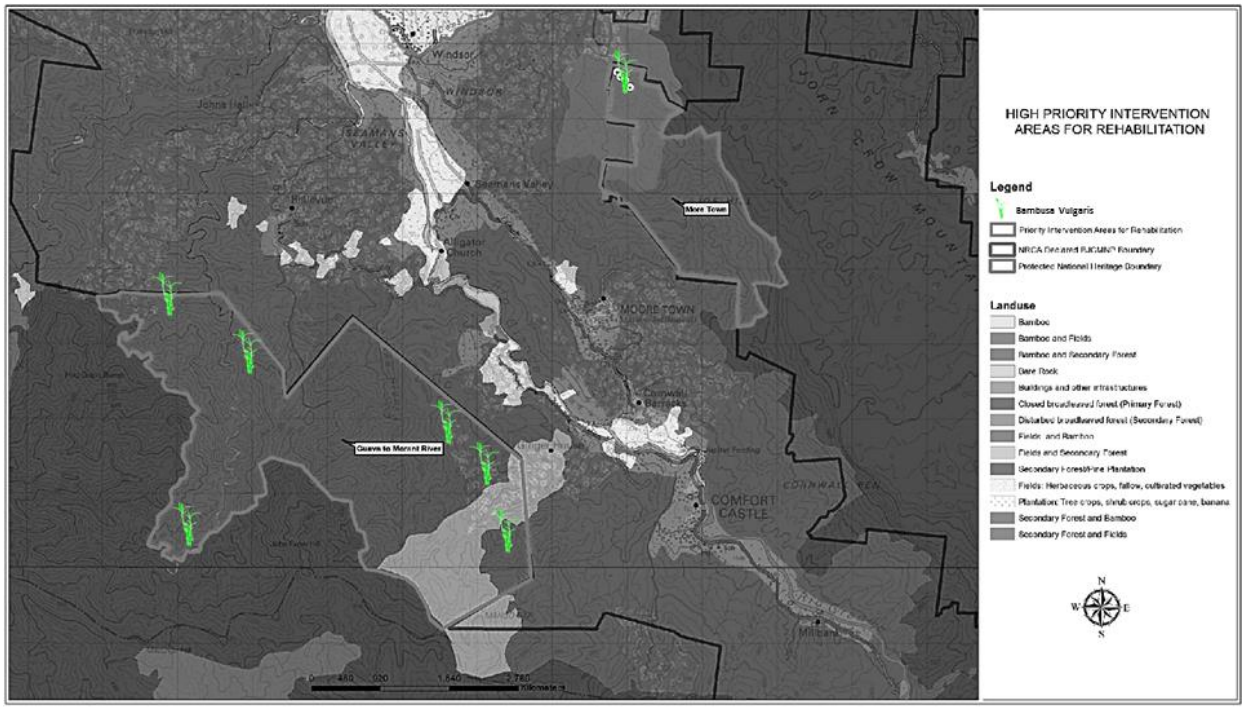

Figure 19: Distribution of *Bambusa vulgaris* in the study area.

The IAS's affecting the study area are primarily affecting native species by out-competing them for space. As outlined previously, the forest is in a state of regeneration, the presence of fast growing grasses such as *Bambusa vulgaris* (figure 20) and *Panicum maximum*, is a serious issue as they can impede or prevent the growth of seedlings or sapling by shading out sunlight, using up nutrients and water, or by competing for root space below ground.

Figure 20: A section of the BJMNP dominated by the invasive *Bambusa vulgaris*.

It was observed in the field that some of these IAS (*Bambusa vulgaris*, *Panicum maximum* and *Flemingia strobiliflora*) are associated with agricultural expansion. Bamboo for example is primarily spread by farmers, who introduce the plant to areas, via using them as yam sticks or for construction of shelters. The *Bambusa vulgaris* in many cases begin to grow in the area in which it is introduced and becomes established.

Wild ginger and wild hops (figure 21) are not widespread (mostly associated with animal husbandry) and should be targeted for control.

Figure 21: *Hedychium spp*. (Wild ginger lily) and *Flemingia strobiliflora* (Wild hops).

4.7 Giant Swallowtail Butterfly

The Giant Swallowtail Butterfly also called Homerus swallowtail (*Papilio homerus*), family Papilionidae, is the largest butterfly in the Western Hemisphere and is endemic to Jamaica (Brown *et a*l., 1994). The species is listed in the IUCN Red Data Book, *Threatened Swallowtail Butterflies of the World* (Collins, 1985), and is protected as an Appendix I species by the Convention for International Trade in Endangered Species (CITES) and the Jamaican Wildlife Act of 1988. There are two known populations of *Papilio homerus* in Jamaica, the Cockpit Country in western Jamaica, and the Blue and John Crow Mountains in eastern Jamaica.

In Eastern Jamaica, the only confirmed host plant for the larvae of *P. Homerus* is the native plant *Hernandia catalpifolia*, locally known as water mahoe and pumpkin wood (Emmel et al., 1990). Adult *P. Homerus* lay their eggs on these plants, and during the larval stage of its life cycle, the plant is used as the food source. The presence of *H. catalpifolia* is therefore important for the survival of this critically endangered species of butterfly.

A major threat to the survival of *P. Homerus* is habitat destruction. Loss on intact forests due to clear cutting and agricultural expansion not only decreases the size of the habitat available, but also influences the micro-climate needed for the survival of this species.

Another significant threat to the habitat of *P. Homerus* is the presence of invasive alien species such as *Bambusa vulgaris*. B. Vulgaris grows rapidly and survives in a wide variety of environmental conditions; these invasive plants could potentially out-compete the larval food of *P. Homerus* (Laurance, 2004).

Throughout this study, no *P. Homerus* individuals were observed in the study area, however the presence of *H. catalpifolia* is an indication that the sites highlighted in figure 22 may be in the range of the butterfly species.

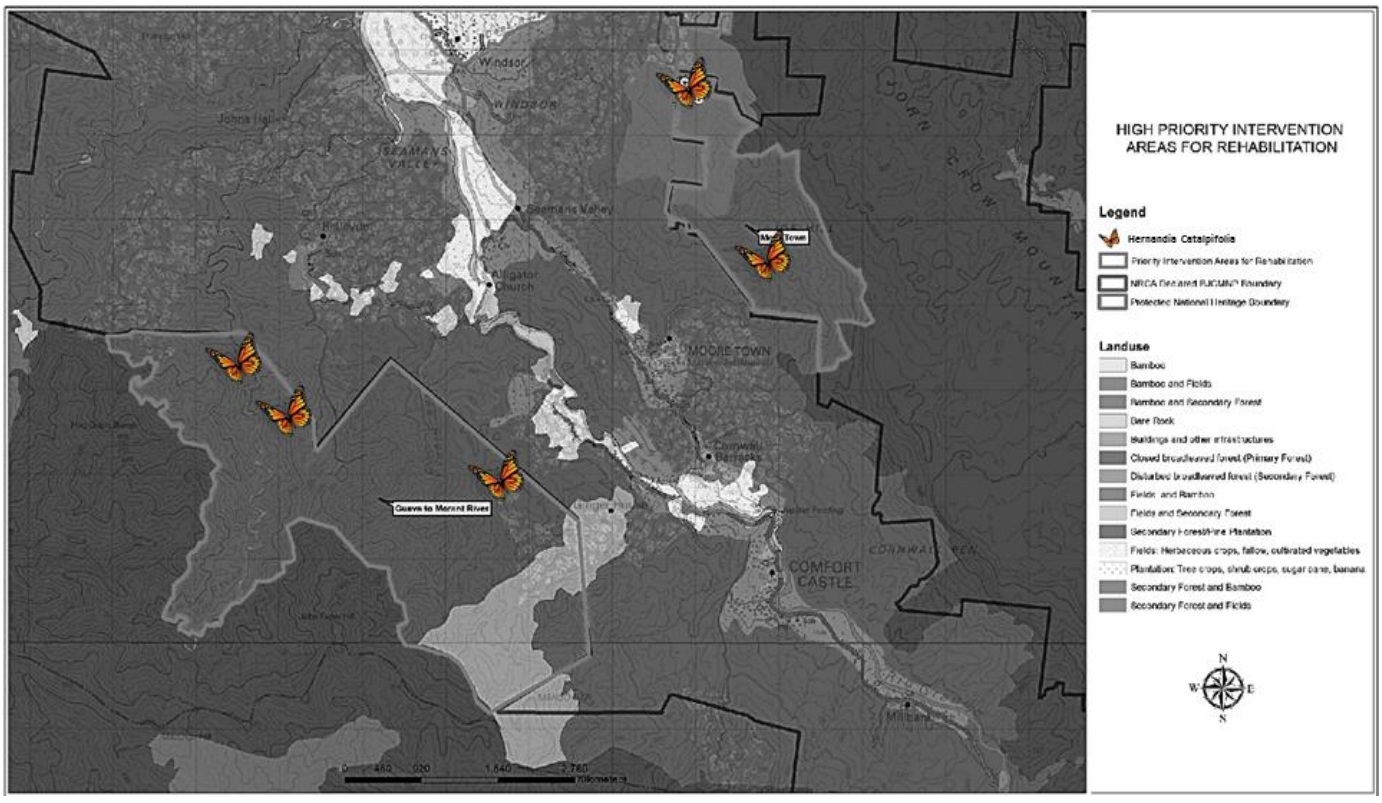

Figure 22: Distribution of *H. catalpifolia* in the study area.

4.8 Jamaican Coney

The Jamaican Coney (*Geocapromys brownii*), also known as the Jamaican hutia and the Browns hutia belongs to the order Rodentia and the family Capromyidae. It is a nocturnal, terrestrial land mammal found in the rocky, forested areas of Jamaica, and is endemic to Jamaica. The Jamaican Coney has sixteen population sites that have been located on the island, including the John Crow and Blue Mountains of Portland in the east, the Hellshire Hills and the Brazilletto Mountains in the south and the Cockpit Country in the northwest. It is classified as an endangered species (Kennerley, Turvey & Young 2018). Within the study sites of the BJCMNP, the Jamaican Coney has been observed and/or hunted by the locals. Though this study is focused on the general forest ecosystem of the sample area, figure 23 illustrates an informal distribution map of the Jamaican Coney based on the personal communications with various locals. It should be noted that the points highlighted were within sampling areas.

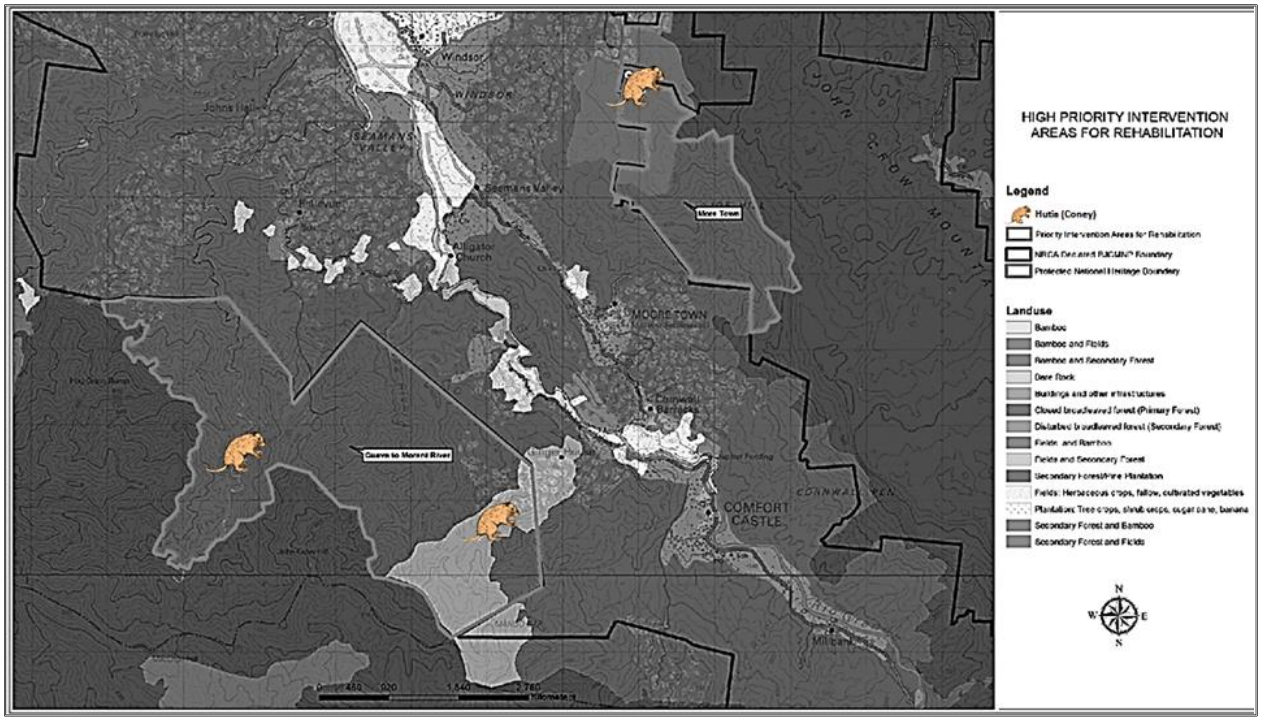

Figure 23: Distribution of the Jamaican Coney within sampling area.

4.9 Overview of Human Activities in the Study Area

There are a number of human activities that have the historically and currently have negatively impact the biodiversity of the park these activities based on location are being done well outside the buffer zone. The primary activities that have an adverse impact are:

- Harvesting of non-forest produce (yams, vines and poles)
- Subsistence farming
- Animal Husbandry

4.9.1 Harvesting of Non-forest produce

Wild yams are being harvested widely across the both areas as evident by the many holes left after these yams are removed. In order to get to the yams trails are being created and as it becomes more difficult to finds yams movements are made even further in to the core of the undisturbed forest. Trails that are created allow greater access to other individuals for other activity such as the hunting of both wild boars and domesticated pigs that have escaped into the wild. The movement of persons in and out of the forest increases the possibility for the introduction of IAS to new areas.

Juvenile trees (poles) are also being removed from the forest to be used for construction purposes within the surrounding communities, poles are also cut to construct pasture fencing both on privately owned lands and within the protected areas. The removal of the poles has reduced the number of stem available to replace older trees to enable smooth succession of the forest especially seeing that many of the areas within the study is already highly disturbed and clearly has a small number of large stems. The species that are frequently removed are *Cletha occidentalis*, *Cocolobia spp*., *Nectrandra spp*. and *Miconia spp*.; they are sought for their durability or straight pole for ease of use.

The removal of poles also allows for space that could be readily occupied if invasive is introduced or areas that IAS present can expand their presence.

The harvesting of other Non-forest produce if not managed which clear is the case reduces biodiversity while at the same time makes the harvesting of these produces unsustainable leading to decline and ultimately impacting the livelihood of individuals that depend on such produces.

4.9.2 Subsistence Farming

Very small scale farming is done well within the park boundaries the removal of primary forest to cultivate crop occurs infrequently in remote parts of the park's forest cover removal is more of an issue in the vicinity of communities as farmers are able to acquire the labour needed to undertake such conversion. In more remotes areas farmers tend to occupy lands that have already been clear of larger vegetation therefore the removal of forest cover is not as significant an issue, the greater issue is the method these farmer use to clear the lands. Fire is largely used to remove low vegetation and debris, no fire management techniques are generally used (figure 24). These fires post a great risk to forest cover and the faunal species present; there is great potential for the fires to move from disturbed forest into Closed Broad-leaf forest with disastrous effects on the forest cover. Farmers move to new patches of land as soon as the plots are being used declines in fertility compounding the fire hazard as land clearing is again undertaken. Farmers also use bamboo as yams sticks that can introduce the IAS to new area, samplings are used both in the cultivation and for construction of small temporary shelter.

Figure 24: A section of the BJCMNP being cleared by fire for farming.

4.9.3 Animal Husbandry

The pasturing of animals just outside the boundary of the study area and within the boundary of the study area, present a major challenges to the regeneration of the forest the study area. Farmers cut poles to make fencing for pastors from the forest, poles are routinely cut to repair fences damaged by weather and the animals. The removal of poles interferes with the process of forest succession. To a greater extent however pasturing of animals mainly cattle but also goats and pigs within the study area pose even greater risk and is doing much more damage to forest regeneration. Cattle held in pastures outside study area boundaries have limited range and unless either are release from or escapes these

pastures do not pose additional threat to the forest. Animals are allowed to roam freely within the forest boundaries with very little concern range these animals graze on the vegetation extensively moving into more accessible areas as grazing becomes harder closer to inhabited area. The cattle severely depress the understory vegetation by grazing no edible vegetation is spared and could include endemics and or threaten species. The constant movement of animals also makes the ground unstable on some slopes additionally frequently used paths create channels leading to increased water runoff causing soil erosion and land slippages (figure 25). The presence of cattle within the study is likely to be negatively impact forest dynamics.

Figure 25: A goat pen observed in a section of the BJMNP.

5 Recommendations

Based on the information gathered from the ecosystem assessment as well as observations on the ground, the team of consultants has identified the following recommendations that could be implemented for improving the conservation efforts in the study areas of the BJMNP:

- There should be an ongoing public education programme within the BJCMNP. This programme should be geared towards all stakeholders within the Rio Grande Valley. An environmental programme could be considered for the primary and secondary educational levels. The programme should focus on the importance of the forest, natural resources ecosystem services, IAS, sustainable farming practices and the impacts of climate change.

- Increased monitoring/patrolling of the area should be considered. This will assist to monitor/prevent further encroachment has also been identified. There needs to be more frequent patrolling by rangers in the protected areas. It is recommended that monitoring is conducted in a random manner to create the perception that the area is constantly being monitored. Additionally, the range monitored should be expanded to reduce the illegal activities within the interior regions of the protected area.

- Additional signs should be installed across the BJCMNP highlighting the boundaries of the forest reserve.

- There are shortfalls relating to the co-management of the natural resources in the study areas. More effort should be placed in creating groups within each community that will play an active role in assisting the JCDT with the day to day monitoring and on the ground management of the protected area.

- Reforestation is strongly recommended for areas within the protected area that have a low vegetation density.
- Encourage agro-forestry in areas close to the boundary of the BJCMNP.
- Removal of invasive plant species should be considered and replacing them with recommended species.

5.1 Reforestation (Planting) Proposal for Degraded Areas

5.1.1 Land identification

Lands within the focus area should be identified using GIS technology to locate bare areas suitable for planting. The most recent versions of Ikonos images or google images should be used to determine initial suitability for planting. Bare areas of those areas with low vegetation should then be pinpointed then marked and size estimate made (ha). Each area identified should then be uploaded to a GPS unit to enable navigation to points. At least 30% more land should be identified as it is likely that not all areas seem remotely will be suitable for planting when reached on the ground. Maps off the area can then be produced, maps should include location of the lands identified the topography and roads and trails where available.

5.1.2 Reconnaissance and Surveying

GPS units will be used to navigate to the areas using trails roads and trails if possible, on site and assessment should be done before surveys are done. Assessment is based on criteria outlined in appendix 1. The perimeter of the lands identified will be surveyed using GPS. Lands surveyed will then

be downloaded and maps produced. The area (acre) obtain will be used in the contracting of persons to do the actual planting.

5.1.3 Land Preparation

Land preparation should commence at least a month before the projected start of the planting which should correspond with the start of the rainy season (April – June) and (September – November) depending on the weather at the time planting may commence earlier of end later. Land preparation should include spot clearing, pegging and digging of holes.

5.1.4 Planting

Planting should take place during the rainy periods, and commence as soon as the land preparation has been completed and at least three day of substantial showers. A mix of as many species as possible should be planted to mimic what actually happens in nature. This mix should include as many shade intolerant species (pioneers) as possible to improve conditions suitable for the more shade tolerant species (table 3). Only native trees should be considered for planting with some emphasis on planting at least five trees that provide food for birds on every hectare. The dispersal of seeds by birds may assist in the rehabilitation of the forest.

The total number of seedling that would be required to cover 10 hectares is 6,300 at approximately at 4x4 meter spacing; however it is expected that some vegetation should be present in each hectare thus less than the 625 seedlings per hectare will be required. A recommended 550 seedling as a minimum should be considered about 125 reduction from the 625 per hectare. Reduced spacing should be considered to increase total number of seedlings per hectare in areas where desirable vegetation is present. Seedlings should be spot weeded at least three times during the first year, twice in the second

year and once in the third year after planting to reduce competition from weeds and encourage high survival rates.

Table 3: Recommended plants for reforestation.

Common name	**Botanical name**	**Shade intolerant**
Broke Axe	*Miconia Spp*	✓
Down Tree	*Ochroma peltata*	✓
Trumpet	*Cecropia peltata*	✓
Rod Wood	*Eugenia spp*	✓
Jointer	*Piper*	✓
Blue Mahoe	*Hibiscus elatus*	✓
Jamaican Mahogany	*Swietenia mahagoni*	
Drum Wood	*Turpina occidentalis*	
Puran	*Prunus occidentalis*	
Corn Wood	*Alcornia latifolia*	
Water Mahoe	*Hernandia catalpa*	
Spanish Elm	*Cordia spp*	
Sweet Wood	*Nectandra spp*	

Soap Wood	*Cletra occidentalis*	
Bastard Cabbage	*Andira inermis*	
Cherry Fig	*Ficus perforata*	
Hog Berry	*Brysonima coriacea*	
Bitter Damson	*Simaruba glauca*	
Sand Box	*Hura crepetanis*	

6 Conclusion

The diversity of both sites were both relatively low, however it was determined that the Guava to Morant River area is more diverse than the Moore Town area. Both areas were significantly affected by anthropogenic disturbances, some evidently having occurred many decades ago. The primary human driven adverse effects include unsustainable harvesting of forest products (example lumber), land clearing for agricultural expansion and improper waste disposal.

It was determined that the Moore Town area has been more degraded by negative human influences than the Guava to Morant River area. The DBH class distribution graph for both areas concurred the observation of human disturbances in the forested areas, as there was a dominance of trees with small DBH measurements (>60% of all trees measured) in both sites. This is further evidence that the areas have been affected greatly over the past by deforestation, and is currently going through a stage of regeneration.

Based on the ratio of juvenile trees to adults as well as the vegetation identified and recorded at the sites both areas can be classified as secondary forests. The forest is regenerating; this process is known to be a very slow, gradual process (ecological succession) as the forest moves from its current stage to the climax stage of succession. Intervention is needed by the management of the area to decrease the level of deleterious human influences, which may inhibit the succession of the forest in the areas of interest.

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8 Appendix I

8.1 Plant Species List of Guava to Morant River Area

Scientific Name (S)	**Family**
Bambusa vulgairs	Poaceae
Cecropia peltata	Moraceae
Acrocomia spinosa	Arecaceae
Mangifera indica	Anacardiaceae
Clethra occidentalis	Clethraceae
Pinus caribaea	Pinaceae
Antirhea coriacea	Rubiaceae
Nectandra coriacea	Lauraceae
Sapium jamaicense	Euphorbiaceae
Nectandra antillana	Lauraceae
Ficus perforata	Moraceae
Andira inermis	Fabaceae
Oreopanax capitatus	Araliaceae
Brosimum alicastrum	Moraceae
Eugenia virgultosa	Myrtaceae
Cordia macrophylla	Boraginaceae
Swietenia macrophylla	Meliaceae
Cyathea sp.	Cyatheaceae

Alchornea latifolia	Euphorbiaceae
Miconia dodecandra	Melastomataceae
Syzygium jambos	Myrtaceae
Fagara martinicensis	Rutaceae
Bassa come	Bassa come
Artocarpus altilis	Moraceae
Hernandia catalpifolia	Hernandiaceae
Eugenia monticola	Myrtaceae
Sloanea jamaicensis	Tiliaceae
Eugenia axillaris	Myrtaceae
Bumelia montana	Sapotaceae
Byrsonima coriacea	Malpighiaceae
Comocladia pinnatifolia	Anacardiaceae
Ambrosia peruviana	Asteraceae
Calophyllum calaba	Clusiaceae
Artocarpus heterophyllus	Moraceae
Guarea swartzii	Meliaceae
Dendropanax nutans	Araliaceae
Coccoloba diversifolia	Polygonaceae
Hibiscus elatus	Malvaceae
Ficus pertusa	Moraceae
Casearia guianensis	Flacourtiaceae
Sand wood	Sand wood

Psychotria corymbosa	Rubiaceae
Buchenavia capitata	Combretaceae
Symphonia globulifera	Clusiaceae
Psidium montanum	Myrtaceae
Trophis racemosa	Moraceae
Matayba apetala	Sapindaceae
Cordia gerascanthus	Boraginaceae
Fagara elephantiasis	Rutaceae
Pimenta jamaicensis	Myrtaceae
Ziziphus chloroxylon	Rhamnaceae
Tectona grandis	Verbenaceae
Prunus occidentalis	Rosaceae
Bridal wiss	Bridal wiss
Picrasma excelsa	Simaroubaceae

8.2 Plant Species List of Moore Town area

Scientific Name (S)	Family
Bambusa vulgairs	Poaceae
Hibiscus elatus	Malvaceae
Bumelia montana	Sapotaceae
Oreopanax capitatus	Araliaceae
Piscidia piscipula	Fabaceae
Sapium jamaicense	Euphorbiaceae
Nectandra antillana	Lauraceae
Calophyllum calaba	Clusiaceae
Cecropia peltata	Moraceae
Nectandra coriacea	Lauraceae
Clethra occidentalis	Clethraceae
Miconia dodecandra	Melastomataceae
Hernandia catalpifolia	Hernandiaceae
Acrocomia spinosa	Arecaceae
Cyathea sp.	Cyatheaceae
Guarea swartzii	Meliaceae
Eugenia virgultosa	Myrtaceae
Brosimum alicastrum	Moraceae
Sapium harrisii	Euphorbiaceae
Phyllanthus nutans	Euphorbiaceae
Allophylus cominia	Sapindaceae

Artocarpus altilis	Moraceae
Ficus perforata	Moraceae
Psychotria corymbosa	Rubiaceae
Alchornea latifolia	Euphorbiaceae
Allophylus jamaicensis	Sapindaceae
Byrsonima coriacea	Malpighiaceae
Matayba apetala	Sapindaceae
Mangifera indica	Anacardiaceae
Prunus occidentalis	Rosaceae
Psychotria pendunculata	Rubiaceae
Syzygium malaccense	Myrtaceae
Coccoloba longifolia	Polygonaceae

9 Appendix II

9.1 Terms of Reference

Forest Ecosystem Assessment and Conservation Plans for four main locations in the Rio Grande Valley area of the BJCM National Park.

OVERVIEW

The Jamaica Conservation and Development Trust (JCDT) manages the Blue and John Crow Mountains (BJCM) National Park and World Heritage Site on behalf of the Government of Jamaica. The draft 2017 – 2027 management plan for this globally significant protected area recommends more detailed analysis and ground-truthing of the land cover analysis of satellite imagery (completed by the Forestry Department in 2015) to assess the status of degraded forest ecosystems in order to guide conservation programmes and activities.

The JCDT has funds from the Global Environment Facility – Small Grant Programme (GEF-SGP) for a project in the Rio Grande Valley area. The project includes funds for the contracting of a consultant or team of consultants for the preparation of Forest Ecosystem Assessment and Conservation Plans for at least two main locations in the Rio Grande Valley area of the BJCM National Park.

The JCDT therefore invites proposals from interested parties for the preparation of a Forest Ecosystem Assessment and Conservation Plans in the Rio Grande Valley area of the BJCM National Park. This document provides the Terms of Reference for the assessment and plans and should guide prospective consultants or teams of consultants in the preparation of their Technical and Financial Proposals. Proposals must include 2 of the main locations proposed (Moore Town and Guava to Morant River) however proposals that provide some consideration to the Chelsea/Durham, Wild Cane and Cunha Cunha Pass Trail areas will be at an advantage (Figure 1). JCDT intends to seek helicopter reconnaissance assistance from the Jamaica Defence Force to aid in the assessment.

BACKGROUND AND GENERAL INFORMATION

The Jamaica Conservation and Development Trust (JCDT) is a non-government organisation and registered company and charity (1988). We manage the Blue and John Crow Mountains National Park (Jamaica's first and only UNESCO World Heritage Site) on behalf of the Natural Resources Conservation Authority (NRCA) through the National Environment and Planning Agency (NEPA).

The National Park overlaps with other protected areas and therefore JCDT coordinates the collaborative management of the site with other entities including the Forestry Department. In 2015, the Forestry Department completed work on the analysis of satellite imagery of the island and this information was used to prepare a map showing land-cover in the National Park. The National Park is about 41,000 ha and the information from the satellite imagery analysis indicates that whilst the vast majority at the core

of the National Park is closed broadleaf or primary forest (the area designated as a World Heritage Site – about 26,000 ha) there are pockets of degraded areas e.g. disturbed broadleaf or secondary forest, bamboo and fields.

Forest on Shale and Limestone are two major conservation targets for the National Park. Deforestation and degradation for agriculture, logging and harvesting of non-timber products as well as the overgrowth of invasive plant species are the main threats to this valuable natural heritage. The Conservation of Natural Heritage Programme in the draft 2017 – 2027 management plan recommends more detailed analysis and ground-truthing of the land cover analysis of satellite imagery to assess the status of degraded forest ecosystems to guide conservation programmes and activities.

THE PROJECT

The JCDT has funds from the Global Environment Facility – Small Grant Programme (GEF- SGP) for a project in the Rio Grande Valley area. The project includes funds to contract personnel for:-

(**i) Forest Ecosystem Assessment and Restoration Plans for at least two sites;**

(ii) Conservation and Visitor Impact Management Plans for four sites;

(iii) Coney Population Study and Conservation Management Plan;

(iv) Reforestation in the Moore Town area and

(v) Agro-forestry training in 4 communities.

SITES

The GEF-SGP Project is focused on the conservation of natural and cultural heritage in the Rio Grande Valley and therefore the sites for consideration under this consultancy are (as identified in Figure 1):-

(i) Moore Town

(ii) Guava to Morant River and possibly,

(iii) Chelsea/Durham

(iv) Wild Cane River

OBJECTIVES OF THE CONSULTANCY

The purpose of this Consultancy is to prepare a Forest Ecosystem Conservation Plan covering the sites identified. The first phase of the study is expected to include assessment of the forest ecosystem at the selected sites in terms of species, health, specific threats and trends towards recovery of the closed broadleaf forest. The second phase will use information from the first phase to recommend conservation programmes for the sites including possible reforestation, invasive species control and forest restoration. Funds are available during the project for some reforestation in the Moore Town area

which is definitely invaded by bamboo (*Bambusa vulgaris*) and which the Moore Town Maroon Council has indicated its interest in reforesting.

SCOPE OF WORK

The Consultant will provide the necessary technical input into all phases of the Consultancy. The Consultant will work closely with the JCDT to request all required information and to ensure common understanding and produce the Assessment and Plans that meets the objective described above. Specifically, the Consulting Team will undertake the activities outlined below:-

1. Develop a workplan and implementation schedule for the Consultancy;

2. Request and source relevant technical information, liaising with the JCDT to source local information as needed;

3. Visit the site with the assistance of the JCDT in terms of local arrangements and logistics;

4. Engage with key stakeholders, with the assistance of the JCDT e.g. community meetings and workshops;

5. Conduct the necessary forest ecosystem assessment procedures inclusive use of a drone camera and helicopter reconnaissance and field work, which the JCDT will play a key role in organising and participating in;

6. Liaise with the JCDT, Forestry Department and community members to help locate boundaries so that markers can be placed to reduce encroachment;

7. Prepare a Report on the status of the forest ecosystems in the targeted areas inclusive plant and animals species and cultural heritage values present, condition of the forest ecosystem (recovering, under invasion, being deforested), threats to the forest ecosystem and cultural heritage, with photographs; and

8. Prepare a Conservation Plan for the targeted areas providing strategies and an action plan to secure the complete restoration of the areas to closed broadleaf forest and ensure conservation of the wildlife, inclusive consideration of possible visitor use – make recommendations regarding the number of types of visitors and activities and recommendation of species for reforestation.

EXPECTED DELIVERABLES

The Consultant will be responsible for satisfactory delivery of:-

1. A detailed methodology with work-plan for the Forest Ecosystem Assessment and Conservation Plan Consultancy by the first month of the contract.

2. Forest Ecosystem Assessment Report, as described above for the targeted sites (draft by the beginning of the fifth month and final report by the beginning of the

sixth month of the contract).

3. Conservation Plan for the targeted sites, as described above (draft by the end of the fifth month and final report by the end of the sixth month of the contract).

PAYMENT AND SCHEDULE

The Consultant will be paid a total of JA$2,000,000.00 in fees over the 6 month period and up to JA$300,000.00 for reimbursables e.g. mileage/transportation, accommodation and meals during field work, stationery etc. This amount is inclusive of taxes and the Consultant will be responsible for making any payments of taxes due to the Government of Jamaica.

Mileage will be paid at a rate of JA$40/km on submission of information including distance travelled, destination and purpose of travel (project travel must be arranged in conjunction with the JCDT so joint visits can be arranged as possible for savings on travel). Any expenditure over $15,000 for reimbursables should be checked with the JCDT first to see if alternatives can be found e.g. printing may be done at our office and arrangements for accommodation and meals will be facilitated by the JCDT.

The fees will be paid on submission of satisfactory deliverables and invoice as follows:-

10% on submission of acceptable detailed methodology with work-plan for the

Consultancy – by end of first month of the contract.

20% on submission of the Draft Forest Ecosystem Assessment Report for the targeted sites by the beginning of the fifth month of the project.

25% on submission of Final Forest Ecosystem Assessment Report for the targeted sites by beginning of the sixth month of the project.

20% on submission of the Draft Conservation Plan for the targeted sites by end of the fifth month of the project.

25% on submission of Final Conservation Plan for the targeted sites by end of the sixth

month of the project.

ROLE OF THE JCDT

The Contractor is expected to work very closely with the JCDT and to ensure that capacity is built amongst key personnel – namely the Project Officer and National Park Rangers who will be involved, to ensure the sustainability of the National Park's Conservation Programme.

The JCDT will:-

1. Assist with arrangements for the Site Visits and Field work including accommodation, meals and field assistants.

2. Assist with the sourcing local information.

3. Assist with the provision of technical support.

4. Work with the Jamaica Defence Force to arrange helicopter reconnaissance, photography and filming to assist with the Forest Ecosystem Assessment.

5. Make available as possible, some equipment for field work.

6. Make all payments of consultancy fees and mileage as per the payment schedule to the Consultant.