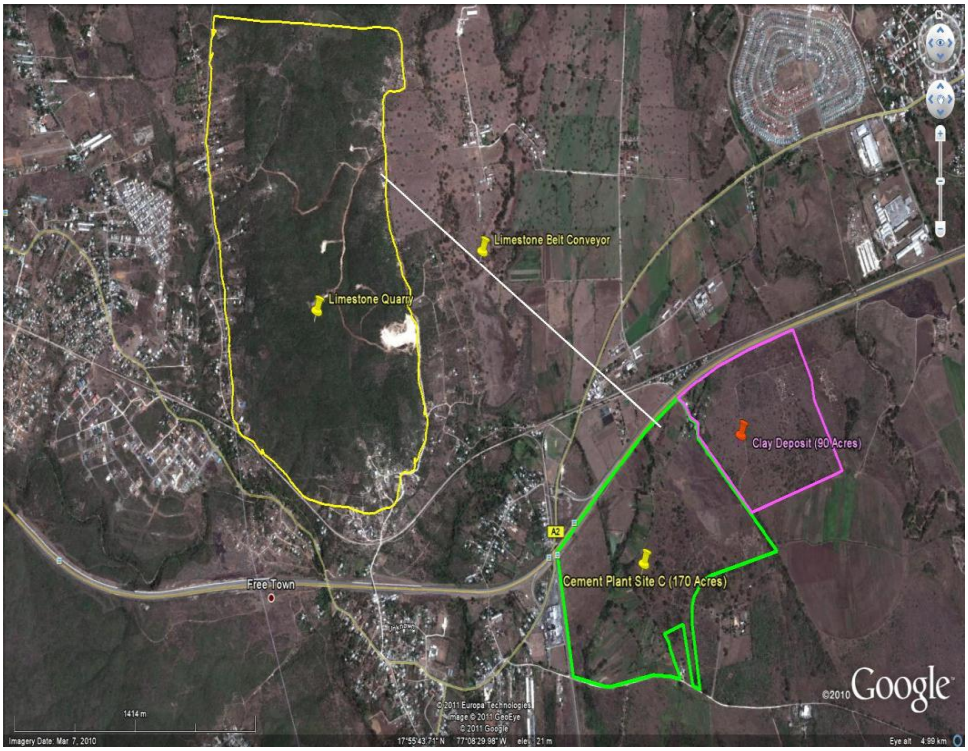
ENVIRONMENTAL IMPACT ASSESSMENT

FOR THE PROPOSED CEMENT PLANT AND QUARRY OPERATIONS
BY CEMENT JAMAICA LIMITED AT PORT ESQUIVEL
INDUSTRIALCOMPLEX, ST CATHERINE AND
ROSE HALL DISTRICT CLARENDON,
JAMAICA

August 2011

FLORA & FAUNA ASSESSMENT REPORT



EnviroPlanners Limited

17 Munroe Road, Kingston 6, Jamaica
Tel: (876) 969-9153; Fax: (876) 925-3163
Email: enviroplannersltd@yahoo.com • www.enviroplannersltd.com

TABLE OF CONTENTS

PART 1: LIMESTONE QUARRY SITE — **Page**

BACKGROUND 7

Survey Objective 9

Area Surveyed 10

METHODOLOGY 12

Flora (vegetation) Analysis 13

Fauna Analysis 15

LIMITATIONS 16

RESULTS 17

CONCLUSION 35

PART 2: CEMENT PLANT & CLAY

BACKGROUND 38

Survey Objective 38

Area Surveyed 38

METHODOLOGY 40

Flora (vegetation) Analysis 40

Fauna Analysis 41

LIMITATIONS 44

RESULTS 45

CONCLUSION 70

REFERNCES 74

LIST OF FIGURES

Figure 1A	Jamaica map showing life zones
Figure 1B	Forest type within the project area
Figure 2	Aerial view of the proposed project area with neighbouring communities
Figure 3A	View of project area from main road at Bodles
Figure 3B	View of project area from main road at Bodles
Figure 4	Quadrant overlaid on project area
Figure 5	Vegetation and differentiation of type due to soil depth and human activity
Figure 6	Grouped Quadrat (80,000 m^2) random chosen numbers 1, 9, 12, 20 and 24
Figure 7	Sample of vegetation undergrowth
Figure 8	Photo of some significant features
Figure 9	Transect sampling method with the line-intercept on map of area
Figure 10	Photo of fauna habitat observed
Figure 11	Photo of stones gathered due to intrusion by human
Figure 12	Photo of HIPRO FEEDS seen from the plant site
Figure 13	Photo of wet areas on project site
Figure 14	Photo Line-intersect through varying stratification levels of habitat
Figure 15	Photo of Fauna and Flora sampled as they pass through varying zones
Figure 16	Photo of ground board sampling on plant site
Figure 17	Photo of some aspects of the environment as they were sampled/measured
Figure 18	Photo of different scenes during the rapid ecology study of plant site
Figure 19	Photo of equipment used in data collection and species identification
Figure 20	Photo of aquatic life at various points in the area
Figure 21	Photo of grab sample collection process
Figure 22	Photo of some of the beneficial insects and arachnids observed
Figure 23	Photo of sceneries of the some of the water ways observed

LIST OF TABLES

PART 1: LIMESTONE QUARRY SITE

Table 1 Some important assessment factors.

Table 2 Compilation of Flora seen within project area

Table 3 Flora undergrowth

Table 4 Fauna – Birds and Mammals

Table 5 Fauna – Invertebrates

PART 2: CEMENT PLANT & CLAY

Table 1 Some important assessment factors.

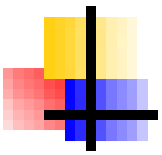
Table 2 Compilation of Flora seen within project area

Table 3 Flora undergrowth

Table 4 Fauna – Birds and Mammals

Table 5 Fauna – Amphibian

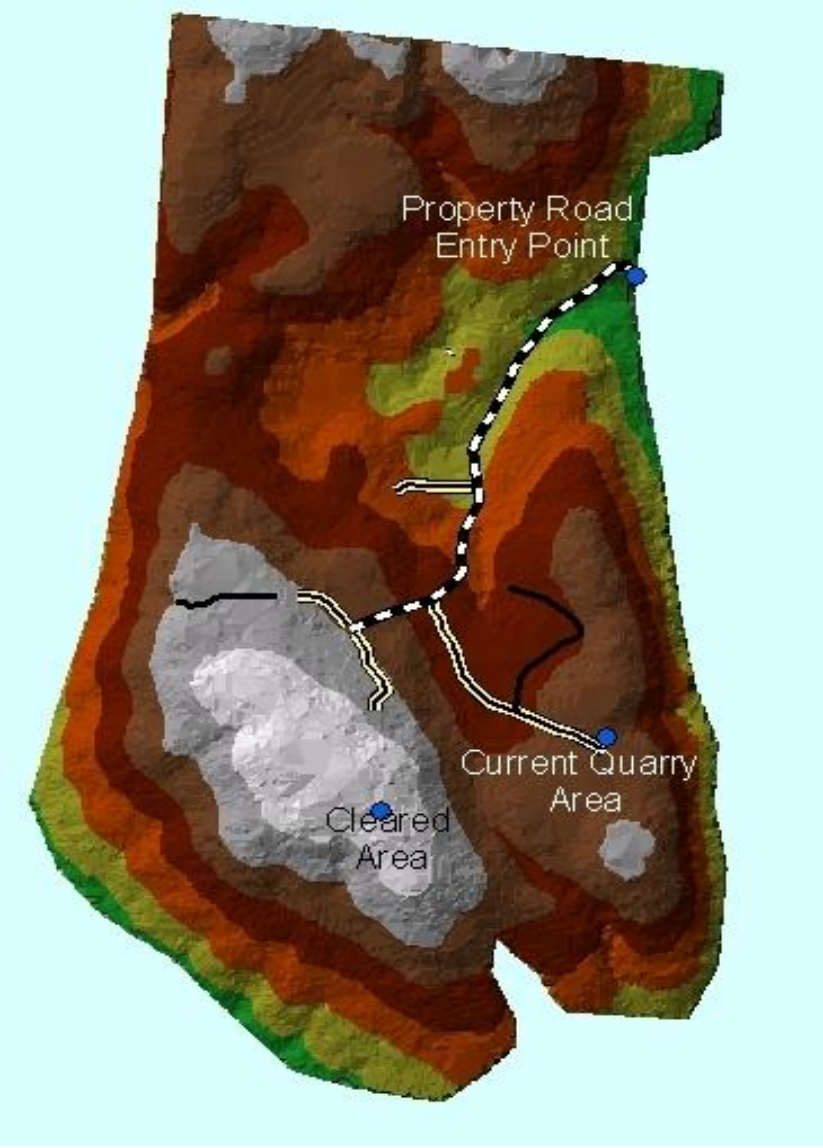
Table 6 Invertebrates



PART 1

Limestone Quarry

FLORA, FAUNA AND ECOLOGICAL STUDY OF THE PROPOSED LIMESTONE QUARRY SITE - OLD HARBOUR HILLS/ROSE HALL AREA ST. CATHERINE



BACKGROUND

Jamaica has a unique physical location, size and climate which have allowed a high biodiversity of flora and fauna to develop and thrive. There are a number of migrant species that visit our shores adding to this diversity.

In an effort to help protect and preserve the large numbers of flora and fauna that are at various classification and status, within Jamaica and the region, the Jamaican Government has designated a number of national parks both marine and terrestrial including forest reserves to include flora and faunas species of global importance as well as protection for areas not yet fully explored that may contain species of significance and conservational importance.

The Environmental Protection and Planning Acts were put in place as measures to protect the environment in a holistic way and in doing so protect the estimated thirty species that are threatened by extinction within the next one hundred years.

Therefore projects that may disrupt any significant portion of the nation's forests', wetlands and marine environment must be surveyed to determine the impact of such disturbance.

The project area falls within the Tropical dry forests of St Catherine. Dry forests are known to provide habitat for a number of endemic species of Flora and Fauna some of which are classified as rear, threatened and endangered on the International Union for Conservation of Nature (IUCN) red list and at various schedules of the Endangered Species Act (2000)

Tropical dry forests are the predominant forest type in the island stretching in an almost unbroken band along the alluvial plains and narrow pre coast zones around the island; this is visible on the map in figure 1 which shows the Life Zones in Jamaica adopted from Holdridge (Forestry Department 1971)

Flora and Fauna are very similar within this zone and especially within the close areas of each parish. The project site is no exception as it is almost entirely enclosed by this forest type. There is very little variation of environmental factors such as topography, soil or climate within the project area which would indicate that here should be little habitat variation/diversity or biological community. It is noted that within these localize zones the endemism may be high but species richness may remain constant throughout the zone.

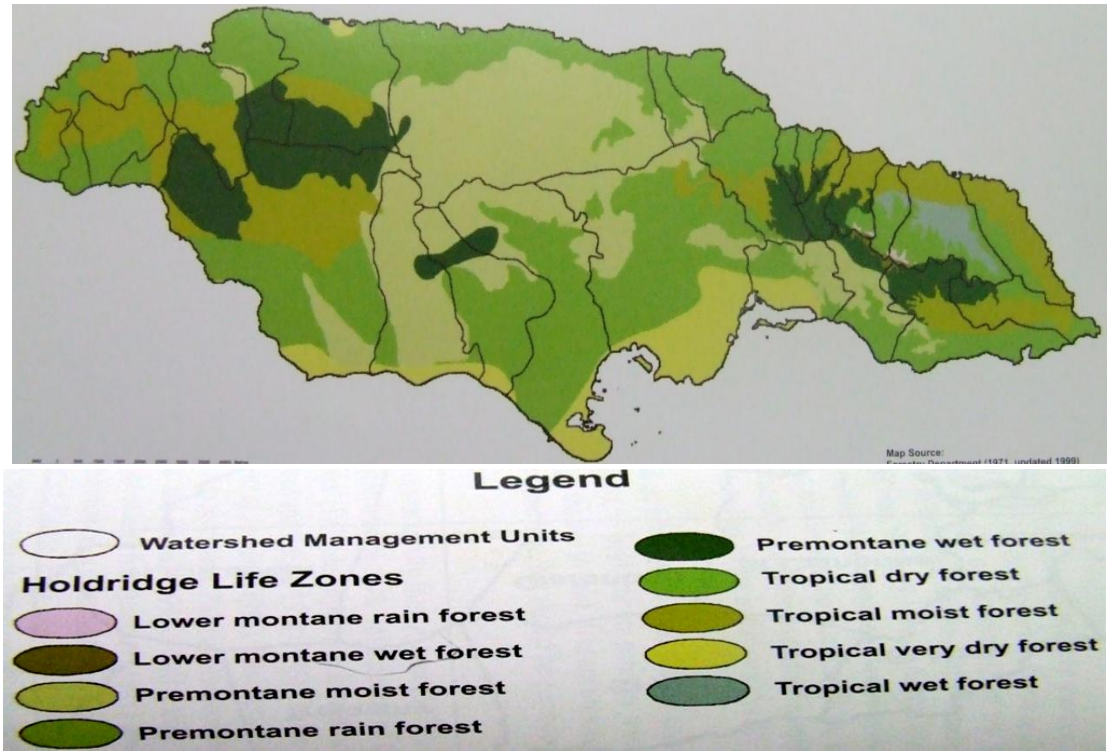


Figure 1A: Jamaica map showing life zones **courtesy Forest Department**

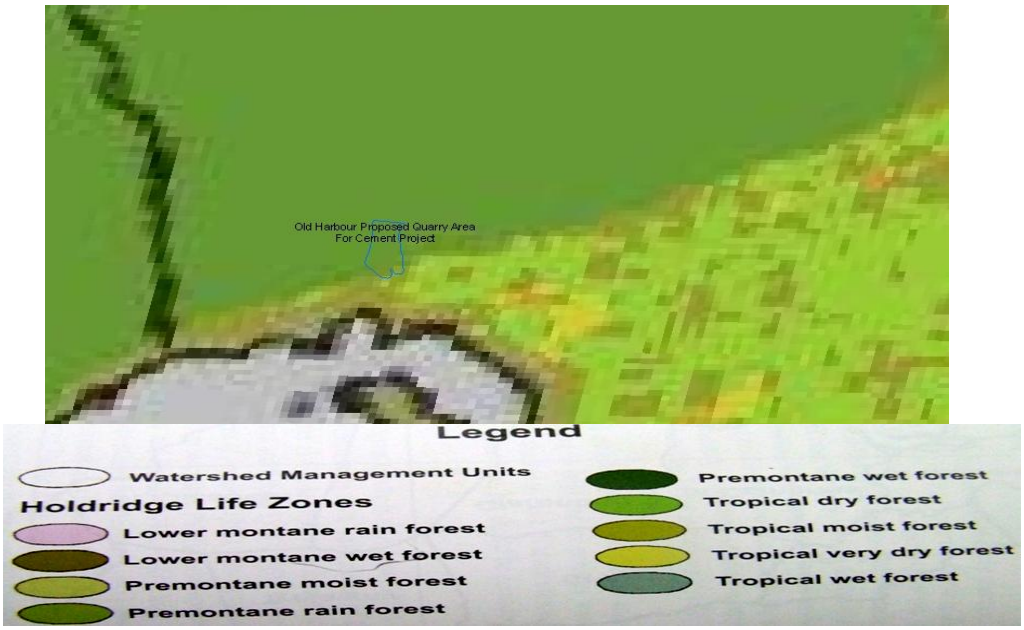


Figure 1B: Showing the forest type within the project area

Survey Objectives

The survey seeks to; enumerate the existing condition of the biological environment and identify concerns and mitigation, which may arise out of displacement of flora and or fauna residing within that project area, which may occur as a result of the proposed activity.

List the flora and fauna seen within the area and tell their status frequency of occurrence and classification.

To develop conservation plans for any species of flora and or fauna classified as important (some importance factors that were considered are listed in table 1. below) and needing special attention and or intervention as a result of possible displacement occurring due to the project's activities.

Table 1: ***SOME IMPORTANT ASSESSMENT FACTORS***

ECOLOGICAL FACTORS			***HUMAN FACTORS***		
Physical and Chemical .Environment	Biotic Environment	Biological Indicator	Economic	Legal	Aesthetics
Migrating species' range	Habitat diversity	Species diversity	Timber	Endangered species	Unique species
.	Vegetation cover	Productivity	Crop production	Protected species	Beautiful species
.	Breeding site	Biomass	Soil conservation	Regulated species	Scenic environment
.	Protective cover	Density	Hazard to Human health	Wild life refuge	Unique habitat
.	Zonation	Dominant species	Zoning Laws		Wilderness . open space

These objectives are in keeping with the above factors and the potential biotic change in relation to the proposed environmental changes.

The project propose to permanently change the topographical feature of the landscape as it clears the vegetation, lower the elevation of the hills (at least within the inner sections), as the limestone is excavated as the main resource for the project.

The units under survey include all macro Flora and Fauna residing in the project area and were

surveyed (see methodology) using a mix of approaches including a compilation of a floristic list and a description and measurement of the form of the vegetation (**physiognomy).** The relative abundance and standardize indices of abundance, point survey and trail counts of Fauna,

Area Surveyed

The target area named the Old Harbour Hills is bordered by the Rose Hall, Bodles, and Freetown communities in Parish of St Catherine to the East and Sandy Bay and Rosewell in Clarendon to the West.

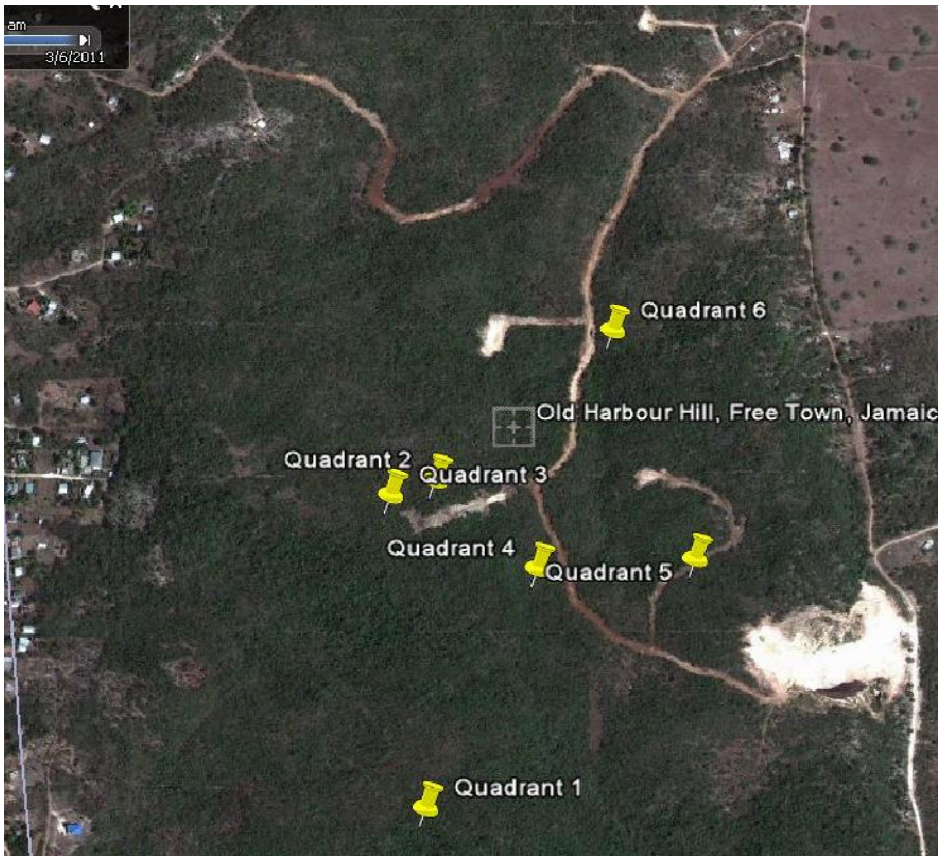


Figure 2: Aerial view of the proposed project area showing neighbouring communities.

This project area falls just adjacent to, and outside of the Rio Minho Watershed and the Portland Bite protected areas. It is in a dry limestone forest at an elevation range of 28 **m** – 130 **m** and is predominately limestone aggregates with thin patches of shallow soil scattered through. It covers an approximate topographical area of 200 Hectares (500 acre) in a very rough trapezoidal shape. It can be seen from the main road leading from Freetown to Old Harbour (on your left) and from

Old Harbour to Freetown (on your right). See Fig 3A and Fig 3B.

Figure 3A: View of project area from main road at Bodles

Figure 3B: View of project area from main road at Bodles

METHODOLOGY

Surveying flora and fauna have varied approaches to describe the community according to the desired usage of the information to be collected. In this instance the data is to be used as a measure of the status of flora and fauna within the project area, to ascertain the need for any mitigation measures to be put in place for species that may reside within the project area that have that special need.

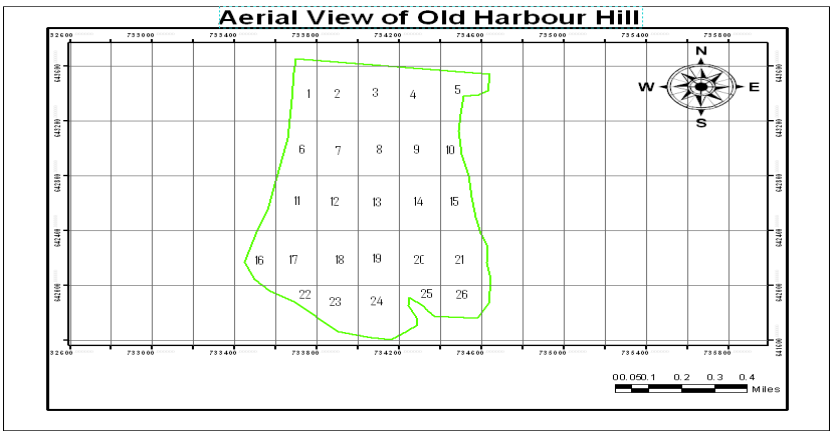
The Flora and Fauna were approached and measured differently, although the specific aspects of the community organization were measured for both. They include **species diversity, zonation and stratification** from which status was obtained using literature from FORESTRY DEPARTMENT, MINISTRY OF AGRICULTURE, NEPA, and the INSTITUTE of JAMAICA.

The 200 Hectare project area was viewed from an aerial photographed using Google Earth version 2011 and grids of 1 hectare overlaid using Arc Gis version 9.2. The density of the flora was noted and formed a basis for consideration in the planned visits to the site for data collection for both Flora and Fauna.

These grids were grouped into rectangular quadrats of 80,000-m^2 sampling area, making a total number of 25 quadrats.

From the aerial photographs and walkthrough, matching points using hand held GPS (Garmin e*trex* and Milligan platinum equipment) the density of the vegetation was ascertained and used in determining the best technique (**Point – Quarter sampling**, **Quadrant**, and or **Plot/Quadrat method**) for the given sub area (group of 8 grid of 1 hectare). The Fauna was assessed using **Line Transect** (strip-census) method.

Figure 4: Quadrant overlaid on project area



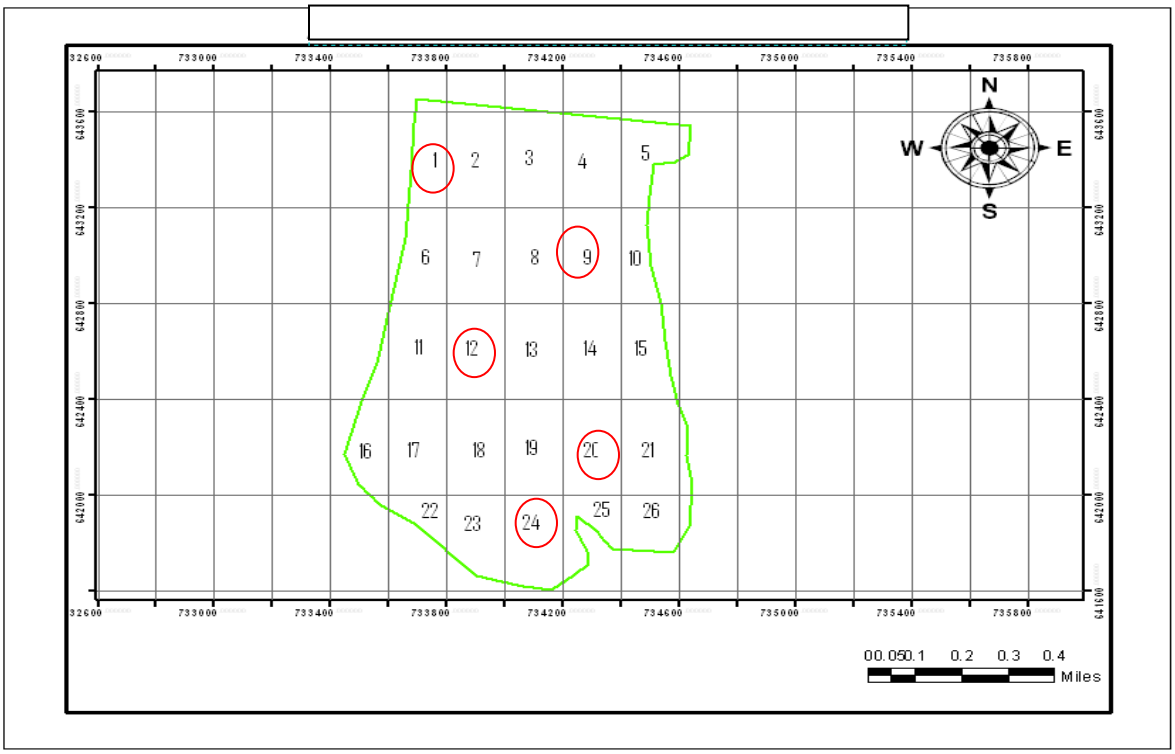
Flora (vegetation) Analysis

Note that the main aim of the analysis of the plant species population was to ascertain the status of the resident species of Flora, or their importance to Fauna that, feed on, and or within, inhabit or visit, the Flora of the project area.

Figure 5: Some vegetation and differentiation of type due to soil depth and human activity

The approach taken for survey of the Flora was the Point-Quadrat method were a rectangular quadrat of 80,000 m^2 (or eight of the 1 hectare grid placed together) in a 2:1 ratio. The quadrats were then numbered and the numbers shuffled and five number drawn at random. The quadrats drawn were then viewed from aerial photographs and identified by GPS reference points. This ensured that they correspond to actual space walked on the ground. Where a quadrat fell in an area of very sparse vegetation it was removed and another drawn. This was to reduce any bias that may occur as the area is of mainly heavy cover even within areas of intrusion.

Figure 6: Grouped Quadrat (80,000 m^2) random chosen numbers 1, 9, 12, 20 and 24



A walk through was done in each of the five quadrat selected and all species were examined and recorded. Plots of 100 m^2 (7.07 x 14.14 m) were then used to sample the population density by counting all species within these 100 m^2 plots. The other twenty quadrats were walked through and species counted using the **TRANSECT SAMPLING method** with the **line-intercept technique.** Flora that was not seen in the other five quadrats and flora of special status seen in these quadrats, were counted whether or not they fell on an intercept. Some plants were rarely seen or were confined to a few quadrats in "contagious" pattern.

Figure 7: Lilies undergrowth **Pokeweed** **Wild bamboo**

Fauna Analysis

The main aim of the analysis of the Fauna population was to ascertain the identification and status of the resident or visiting species and the importance of the project area for their food, habitat, or range.

Figure 8: Coal burning activity ***Cleared area for agriculture activity*** ***Canine remains found in area***

The approach used was the strip census where a distance of 100 m was covered within 15 minutes and the number of animals seen recorded (as species seen per 100 m unit area), or line-intersect technique where transect line was established at random within the project area using lines created by overlaying ArcGis and hand held GPS equipment. An observer walked this line and fauna flushed or otherwise observed are counted and the distance measured from observer to animal (or Group of animals). The assumptions made were; animals were randomly distributed, the sighting of one animal does not influence sightings of others and all members (eg. All ages and both sexes) are equally likely to be flushed and observed.

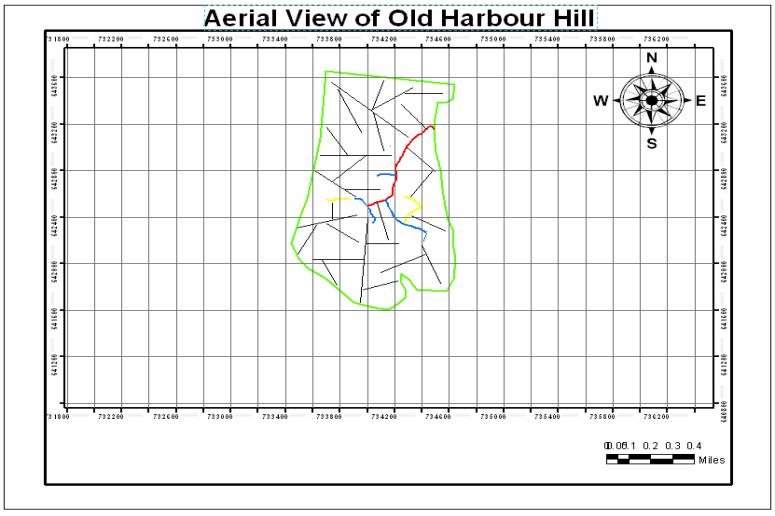


Figure 9: TRANSECT SAMPLING method with the line-intercept on map of area

Trail (roadside) count was another method used to record Fauna, as animals were sometimes easier recognized as they crossed these open spaces. As the trails and roadways are traversed during Flora measurements as well as entering and exiting of the project area, all fauna sighted are counted and recorded. Bird calls and nest (nesting site) were used as indicators of presence and residence of birds. Butterfly and moths species pollinators of the flora as well as other invertebrates, lizards, snails were noted.

Figure 10: Bee hive in rock **Nest of nightingale** **Oldman bird**

Early morning to evening and evening to morning observations were conducted to ensure fauna were noted through movements (sight) and calls (hearing) for both diurnal and nocturnal species

The interviews conducted on persons working within the area (coal burners, loggers, farmers, herbalists and residents of the peripheral communities) yielded information suggesting that there have been no sightings by themselves or heard of any sightings of fauna that we have not seen or heard within the area ourselves.

LIMITATIONS

Some limitations during the observation of Flora and Fauna over the period were the capture for counting of some species especially small shrub and tree invertebrates. These were mainly bugs which were identified only to the order but not to the species level as some did not fall to the ground when foliage was shaken or whacked but instead flew away and were too small to be photographed with much from a distance with the camera equipment we had. Time limits increased the possibility of biases in trapping, photographing and indirect sign indices, as the number of visits to the area, seasonality of fruiting and flowering, fauna feeding, breeding and migrating habits all added to the limitations of this survey

RESULTS

The flora of the area is varied, is in keeping with the expectations of dry limestone forest of 28 m – 130 m elevation and within this proximity (less than 5 miles) to the sea. Plants are listed in tables 2-5 and will show the relative species occurrence (frequency), the distribution pattern and the quadrats in which they were found. The table outline species status as reported by the Institute of Jamaica, IUCN listing. The dominant species of flora in frequency and distribution was noted as the lignum vitae, Red birch sweet wood.

Table 2 **Compilation of Flora seen within project area trees and shrubs**
ALQ= ALL QUADRATS # X = QUADRAT NUMBER NotA= NOT ASCERTAINED Rs = resident ; N = native; T = threatened ; EN = endangered; E = endemic; I = introduced S = safe R= rarely; O = occasional; F = frequent; Vf= very frequent D = dominant
Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random C = contagious 1 Will survive in similar environment 2 solely dependent 3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	Scientific name	Quadrat	Growth Habitat	Species dependence	Frequency	Distribution pattern	Classification Origin
Red Birch	Bursera simaruba	ALQ	tree	4	F	Ra	N
Park Nut	Acacia macracantha	1, 2, 3, 4 ,5 ,8, 9, 10 11, 12, 13, 20 21, 14 25 26	tree	4	O	C	N
Bull Hoof	Bauhinia divaricata	ALQ	tree	4	F	C	E
Maiden Plum	Comocladia pinnatifolia	ALQ	tree	4	F	Ra C	NotA
Velvet leaf Maden plum	Comocladia velutina	ALQ	tree	4	F	Ra C	E
Clammy Cherry	Cordial collococca	ALQ	tree	4	F	Ra C	NotA
Bastard Cherry	Ehretia tinifolia	ALQ	tree	4	F		NotA
Redwood	Eugenia axillaris	ALQ	tree	4	F	Ra	NotA
	Gymnanthes integra	ALQ	tree	4	F		
Logwood	Haematoxylum campechianum	3, 4 ,5 ,8, 9, 10 11, 12, 13 20 21, 14 25 26	tree	4	F	Ra C	
Dildo	Harrisia gracilis	ALQ	Cacti	4	O	Ra C	NotA
Lead Tree	Leucaena leucocephala	ALQ	tree	4	F	U C	Endemic

	Lasiorcrpton harrisii	ALQ	tree	4			Endemic
Wild Mahogany	Trichilia hirta		tree	4	O	C	introduced
Prickly Yellow	Zanthoxylum martinicense	ALQ	tree	4	O	C	Native
Lignum Vitae	Guaiacum officinale	ALQ	tree	4	F	U C	introduced
Spice wood	Ocotea staminea	ALQ	tree	4	F	U	Endemic

Table 2 continued
ALQ= ALL QUADRATS # X = QUADRAT NUMBER NA= NOT ASCERTAINED Rs = resident ; N = native; T = threatened ; EN = endangered; E = endemic; I = introduced S = safe R= rarely; O = occasional; F = frequent; Vf= very frequent D = dominant
Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random C = contagious 1 Will survive in similar environment 2 solely dependent 3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Quadrat**	**Species dependence**	**Frequency**	**Population dynamics**	**Classification Origin**
Green ebony	Sebastiania spicata	ALQ	4	O	Ra	E
Wild poponax	Acacia tortuosa	ALQ	4	O	Ra	NotA
Red bead tree	Adenanthera pavonina	ALQ	4	O	Ra C	I
Privet	Pithecellobium dulce	17 ,18, 19, 20, 22, 23, 24	4	O	C	I
May pole	Bromeliad Bromelia sp.	ALQ	4	F/C	R C	
Boar wood	Metopium brownii	ALQ	4	F	U C	NotA
Woman wood	Dendropanax arboreus	ALQ	4	F	C	NotA
White cedar	Tabebuia riparia	ALQ	4	F	U C	NotA
Yellow elder	Tecoma stans	8, 9, 10, 13, 14, 15, 19 20 21	4	O	C	N
White cinnamon	Canella winterana	ALQ	4	R	C	NotA
Clamberry	Diospyros tetrasperma	ALQ	4	O	C	I
Caca shrub	Erythoxylum areolatum	ALQ	4	O	C	NotA
Dove wood	Alchornea latifolia	ALQ	4	O	C	NotA
Galba	Calophyllum calaba	ALQ	4	O	C	E

Capberry sweetwood	Licaria triandra	ALQ	4	O	C	NotA
Braziletto	Peltophorum linnaei	8, 9, 10, 13, 14, 15, 19 20 21	4	O	Ra	NotA
Stinking peas	Cassia bicapsularis	ALQ	4	F	U C	I

Table 2 continued
ALQ= ALL QUADRATS # X = QUADRAT NUMBER NotA= NOT ASCERTAINED Rs = resident ; N = native; T = threatened ; EN = endangered; E = endemic; I = introduced S = safe R= rarely; O = occasional; F = frequent; Vf= very frequent D = dominant
Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random C = contagious 1 Will survive in similar environment 2 solely dependent 3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Quadrat**	**Species dependence**	**Frequency**	**Distribution pattern**	**Classification Origin**
Cashaw macca	Prosopis juliflora	ALQ	4	F	U C	Naturalised
Jamaican ebony	Brya ebenus	ALQ	4	F	U C	NotA
Soap berry tree	Sapindus saponaria	18 19 23 24	4	**R**	C	NotA
Breadnut	Brosimum alicastrum	1, 2, 3, 4, 6, 7, 11 12, 16, 18, 23, 24	4	R	R	NotA
Ramoon	Trophis racemosa	1, 2, 3, 4, 6, 7, 11 12, 16, 18, 23, 24	4	R	R	NotA
Broom thatch	Thrinax parviflora	ALQ	4	F	U C	E
Sea thatch	Thrinax radiata	ALQ	4	F	C	NotA
Pigeon plum	Coccoloba swartzii	ALQ	4	O	R	NotA
Cogwood	Ziziphus Chloroxylon	ALQ	4	O	R	E
Bastard lignum vite	Ziziphus sarcomphalus	ALQ	4	F	Ra	E
Pigeon wood	Matayba apetala	ALQ	4	O	Ra	NotA
Bitter damsel	Simarouba glauca		4	R	Ra	NotA
Braziletto	Peltophornum linnaei		4	O	U Ra	I
Sweet sop	Annona squamosa	ALQ	4	O	C	NotA

Genuip	Exothea paniculata	ALQ	4	O	C	NotA
Mastwood	Catalpa longissima	ALQ	4	O	C	NotA
Cotton tree	Ceiba pentandra	ALQ	4	O	C	NotA
Small laeved sweetwood	Nectandra coriacea	ALQ	4	F	C	NotA
Long leaved sweetwood	Nectandra antillana	8, 9, 10, 13, 14, 15, 19 20 21	4	F	Ra	NotA
Divi Divi	Caesalpinia coriaria	ALQ	4	F	U C	NotA

Table 2 continued
ALQ= ALL QUADRATS # X = QUADRAT NUMBER NotA= NOT ASCERTAINED Rs = resident ; N = native; T = threatened ; EN = endangered; E = endemic; I = introduced S = safe R= rarely; O = occasional; F = frequent; Vf= very frequent D = dominant
Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random C = contagious 1 Will survive in similar environment 2 solely dependent 3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Quadrat**	**Species dependence**	**Frequency**	**Distribution pattern**	**Classification Origin**
Woman tongue	Albizia lebbeck	1, 2, 3, 4, 6, 7, 11 12, 16, 18, 23, 24	4	F	U C	NotA
Cherry fig	Ficus perforata	ALQ	4	F	R C	NotA
Wild ackee	Cupania glabra	ALQ	4	**R**	C	NotA
White ironwood	Hypelate trifoliata	ALQ	4	R	Ra	Endemic
White bully	Bumelia salicifolia	ALQ	4	R	R	NotA
Broad leaf	Lasiocroton macrophyllus	ALQ	4	F	U C	Endemic
Torchwood	Amyris elemifera	ALQ	4	F	C	NotAc
			4			

Table 3 **Flora undergrowth shrubs, climbers and grasses**

ALQ= ALL QUADRATS # X = QUADRAT NUMBER NotA= NOT ASCERTAINED Rs = resident ; N = native; T = threatened ; EN = endangered; E = endemic; I = introduced S = safe R= rarely; O = occasional; F = frequent; Vf= very frequent D = dominant Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random C = contagious 1 Will survive in similar environment 2 solely dependent 3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	Scientific name	Quadrat	Species dependence	Frequency	Distribution pattern	Classification Origin
Ping Wing	Bromelia pinguin	ALQ	4	F	C	E
Duppy Gun	Ruella tuberosa	14, 15, 9, 20, 21	4	R	C	N
Broom Weed	Sida acuta	14, 15, 9, 20, 21	4	O	C	N
Vervine	Stachytarpheta jamaicensis	14, 15, 9, 20, 21	4	O	C	N
Strong Back	Morinda royoc	ALQ	4	F	U	N
Guaco	Mikania micrantha	ALQ	4	O	C	N
Guinea Grass	Panicum maximum	ALQ	4	O	C	N
Castor Oil plant	Ricinus communis	ALQ	4	O	C	NotA
John Crow Bead	Abrus precatorius	ALQ	4	F	U C	NotA
Wild Callaloo	Amaranthus virdis	ALQ	4	O	C	N otA
West Indian Gherkin	Cucumis anguria	14, 15, 19, 20, 21	4	O	C	NotA
Morning glory	Ipomoea tiliacea	14, 15, 19, 20, 21	4	O	C	Native
Purple morning glory	Ipomoea purpurea	, 4, 6, 7, 11 12, 16, 18, 23, 24	4	O	C	NotA
False daisy	Eclipta prostrata	14, 15, 19, 20, 21	4	O	C	NotA

Fatten barrow	Synedrella nodiflora	14, 15, 16, 17, 18, 19, 20, 21	4	O	C	Native
Money bush	Senna obtusifloria	14, 15, 16, 17, 18, 19, 20, 21	4	O	C	Native
Coffee senna	Senna occidentalis	14, 15, 16, 17, 18, 19, 20, 21	4	O	C	Native
Wild okra	Cleome viscosa	14, 15, 19, 20, 21	4	O	C	NotA
Water grass	Commelina diffusa	14, 15, 16, 17, 18, 19, 20, 21	4	O	C	Native
Water grass	Commelina elegans	14, 15, 19, 20, 21	4	O	C	Native
Milk weed	Euphorbia hirta	ALQ	4	O	C M	NotA

Table 3 **Flora undergrowth shrubs, climbers and grasses**

ALQ= ALL QUADRATS # X = QUADRAT NUMBER NotA= NOT ASCERTAINED Rs = resident ; N = native; T = threatened ; EN = endangered; E = endemic; I = introduced S = safe R= rarely; O = occasional; F = frequent; Vf= very frequent D = dominant Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random C = contagious 1 Will survive in similar environment 2 solely dependent 3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	Scientific name	Quadrat	Species dependence	Frequency	Distribution pattern	Classification Origin
Macca flowers	Croton hirtus	14, 15, 16, 17, 18, 19, 20, 21	4	F	C	Native
Red milk weed	Euphorbia heterophylla	14, 15, 16, 17, 18, 19, 20, 21	4	R	C	Native
Ground mint	Hyptis atrorubens	14, 15, 16, 17, 18, 19, 20, 21	4	O	C	Native
Orange bud	Abutilon indicum	14, 15, 9, 20, 21	4	O	C	Native
Wild hemp	Malachra fasciata	14, 15, 9, 20, 21	4	F	U	Native
Broom weed	Sida acuta	14, 15, 9, 20, 21	4	O	C	Native
Cow pops	Physalis angulata	14, 15, 9, 20, 21	4	O	C	Native
Turkey berry	Solanum torvum	14, 15, 9, 20, 21	4	O	C	Native
White sage	Lantana camara	14, 15, 9, 20, 21	4	F	U C	Native
White vervine	Stachytarpheta cayennensis	14, 15, 9, 20, 21	4	O	C	Native
Guzzu mumma	Solonum americanum	14, 15, 9, 20, 21	4	O	C	Native
Pokeweed	Phytolacca icosandra	14, 15, 9, 20, 21	4	O	C	Native
Dog blood	Rivina humillis	14, 15, 16, 17, 18, 19, 20, 21	4	F	U	Native

wildpine	Bromiliadea	AQL	4	O	C	NotA
Greenwithe	Vanilla claviculata	1, 2, 3, 4. 5. 14, 15, 16, 17, 18, 19, 20, 21	4	O	C	NotA
Goose wis	Cissus verticellata	1, 2, 3, 4. 5. 14, 15, 16, 17, 18, 19, 20, 21	4	O	C	Native
Piano grass	Rhynchelytrum repens	1, 2, 3, 4. 5. 14, 15, 16, 17, 18, 19, 20, 21	4	F	U C	Native

Table 3 **Flora undergrowth shrubs, climbers and grasses**

ALQ= ALL QUADRATS # X = QUADRAT NUMBER NotA= NOT ASCERTAINED Rs = resident ; N = native; T = threatened ; EN = endangered; E = endemic; I = introduced S = safe R= rarely; O = occasional; F = frequent; Vf= very frequent D = dominant Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random C = contagious 1 Will survive in similar environment 2 solely dependent 3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	Scientific name	Quadrat	Species dependence	Frequency	Distribution pattern	Classification Origin and
Pusley	Portulaca oleracea	14, 15, 16, 17, 18, 19, 20, 21	4	F	C	N
Burfruit	Triumfetta semitriloba	14, 15, 9, 20, 21	4	O	C	N
Jackini bush	Verbesina	14, 15, 9, 20, 21	4	F	U	NotA
Tall dasey	Synedrella nodiflora	14, 15, 9, 20, 21	4	O	C	N
Cowitch	Mucuna pruriens	14, 15, 9, 20, 21	4	O	C	N
Duppy Gun	Ruella tuberosa	14, 15, 9, 20, 21	4	O	C	N
Vervine	Stachytarpheta jamaicensis	14, 15, 9, 20, 21	4	F	U C	N
Green tassel	Acalypha alopecuroides	1, 2, 3, 4. 5. 14, 15, 16, 17, 18, 19, 20, 21	4	R	C	N
Wild croton		1, 2, 3, 4. 5. 14, 15, 16, 17, 18, 19, 20, 21	4	O	C	NotA
Broadleaf nettle	Laportea aestuans	1, 2, 3, 4. 5. 14, 15, 16, 17, 18, 19, 20, 21	4	O	C	N

Table 4 **Fauna Birds Mammals Reptiles**
NotA= NOT ASCERTAINED Rs = resident ; N = native; E = endemic; I = introduced
R= rarely; O = occasional; F = frequent; Vf= very frequent D = dominant contagious 1 Will survive in similar environment 2 solely dependent 3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Frequency**	**Classification Origin**
		4		
White winged dove	Zenaida asiatica	4	F	Resident
Nightingale	Mimus polyglottos	4	F	Resident
King bird	Tyrannus caudifasciatus	4	F	Resident
Mangrove cuckoo	Coccyzus minor	4	O	Resident
Bananaquit	Coereba flaveola	4	O	Resident
Stolid flycatcher	Myiarchus stolidus	4	O	Resident
grassquit	Loxipasser anoxanthus	4	F	Endemic
Blackfaced gressquit	Tiaris bicolor	4	F	Resident
Jamaican glaenia	Myiopagis cotta	4	O	Endemic
Black-wiskered vireo	Vireo altiloquus	4	F	Resident
Common ground dove	Columbina passerina	4	VF	Native
Long-tailed Pea dove	Zenaida macroura	4	F	Native
Cattle egret		4	O	Introduced
Smooth-Billed Ani	Crotophaga ani	4	O	Resident
Jamaican woodpecker	Melanerpes radiolatus	4	O	Endemic
Sad flycatcher	Myiarchus barbirostris	4	F	Endemic
Jamaican pewee	Contopus pallidus	4	O	Endemic
Arrowheaded warbler	Dendroica pharetra	4	O	Endemic
Jamaican vireo	Vireo modestus	4		Endemic

Table 4 **Fauna** **Birds** **Mammals** **Reptiles**

Not A= NOT ASCERTAINED Rs = resident ; N = native; ; E = endemic; I = introduced
R= rarely; O = occasional; F = frequent; Vf= very frequent D = dominant

Common name	**Scientific name**	**Species dependence**	**Frequency**	**Classification Origin**
Jamaican spandalis	Spindalis nigricephala	4	F	Endemic
Rufous tailed fly catcher	Myiarchus validus	4	F	Endemic
White belly Caribbean dove	Leptotila jamaicensis	4	F	Resident
Greater Antillean Greackle	Quiscalus niger	4	O	Rs
Killdeer	Charadrius vociferous	4	O	Resident
Jamaican oriole	Leterus leucopteryx	4	F	Resident
Black-billed streamertail	Trochilus scitulus	4	F	Resident
Jamaican Mango	Anthracothorax mango	4	F	Endemic
Eastern Kingbird	Tyrannus tyrannus	4	O	vagrant
		4		
Bats	* Artibeus jamaicensis	4	O	Resident
Mongoose	Herpestes jajanicus	4	O	Introduced
Common tree lizard	Anolis lineatopus	4	F	Native
Blue tree lizard	Anolis grahami	4	O	Native
Green lizerd	Anolis garmani	4	O	Introduced
		4		

Table 5 **Fauna** **Invertebrates**

NotA= NOT ASCERTAINED Rs = resident ; N = native; E = endemic; I = introduced R= rarely; O = occasional; F = frequent; D = dominant

Common name	**Scientific name**	**Species dependence**	**Frequency**	**Classification Origin**
Butterflies		4		
Citrus dog	Cuban swallowtail	4	O	E
Lignum viate butterfly	Kricogonia lyside	4	F	N
Antillean Great White	Ascia monuste	4	O	N
Jamaican satyra	Calistro zangis	4	O	E
Glippus	Danaus gilippus	4	O	Rs
Zebra	Heliconius charitonus	4	O	Rs
Jamaican White Peacock	Anartia jatrophae jamaicensis	4	O	E
Buckeye	Junonia evarete	4	O	Rs
Swallowtail		4	O	Rs
Checkered Skipper	Pyrgus oileus	4	O	Rs
		4		
Other arthropods		4		
		4		
Fireflies	Lampyridae Elateridae	4	O	E R
Black bees	*	4	O	Rs
Dragon flies	Odanata	4	F	R
Red Wasp	Polistes crinitus	4	F	
Stone wasp	Polistes hunteri	4	O	
Cop Cop .	Crematogaster sp	4	O	
Red / Carpenter Ants	Companotus sp.	4	O	
Common name	**Scientific name**	**Species dependence**	**Frequency**	**Classification Origin**
Running Ants	Phediole	4	O	Rs

Leafcutter Bee	Megachile poyei	4	O	Rs
Leafcutter Bee	Megachilie consigna	4	O	Rs
Honey Bees	Apis mellifera	4	F	Rs
spiders	Arachnid	4	F	
Crickets **Grasshopper**		4		
	Schistocers niterus	4		
	Orphutella punctata	4	R	
	Neoconocephalus pipulus	4	O	
Termites		4		
Duckants	Nasutitermes nigriceps	4		
Mulloscs Snails	Halpithus sp.	4	O	VF **
	Orthalicus undatus jamacacensis	4	O	N
	Hemitrochus graminicola	4	O	E
	Pleurodonte lucerna	4	O	E
	Pleurodonte invalida	4	O	E
	Bulumus diaphanous	4	O	I

** = In localised areas around water collection points

CONCLUSION

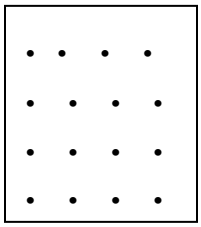
Approximately 69 tree species and 52 shrubs made up the Flora seen in the area, while for the Fauna, 32 species of birds five (5) other species of vertebrates and over 31 species of invertebrates were recorded, making a total in excess of 189 species of Flora and Fauna recognised within the project area.

The endangered species observed within the proposed project area that was not also observed in the surrounding areas is soapberry (*Sapindus* spp). Due to its potential value attention could be given to its long term future.

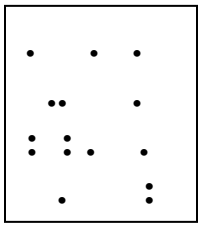
Other plants of significance observed included the Lignum vitae, the national flower, guinep (food, probably introduced), flame of Jamaica (aesthetic) and hard woods (economic, eg, coal burning). Numerous medicinal shrubs were also observed, example Virvine, pokeweed etc.

In terms of fauna observation the wide variety of bird and insect species observed would have been due to the number of plant species which provide a source of food and shelter to these species. One social insect of significant economic importance, the honey bee, was observed hiving in rocks within the area and are frequent within the flora canopy. This is significant since their survival is hinged on a constant supply of pollen producing plants.

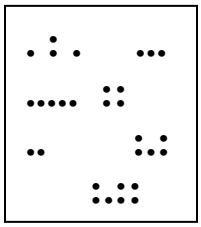
There were at least three types of dispersion pattern noted within the project area, namely uniform, random and contagious (also referred to as patchy, clumped or clustered)



Uniform



Contagious

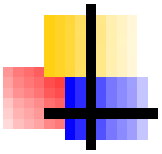


Random

The area had signs of years of disturbance by farming activates clearing of vegetation and habitation by people over time. Figure 8 shows stone heaping in what looked like farming activity. This activity may be responsible for some of the distribution patterns observed for many

species as well as the open and close forested areas. This mixture of diversity and the noted human intrusion gives the impression that some species were dispersed by this intrusion likewise some others patterns of dispersion.

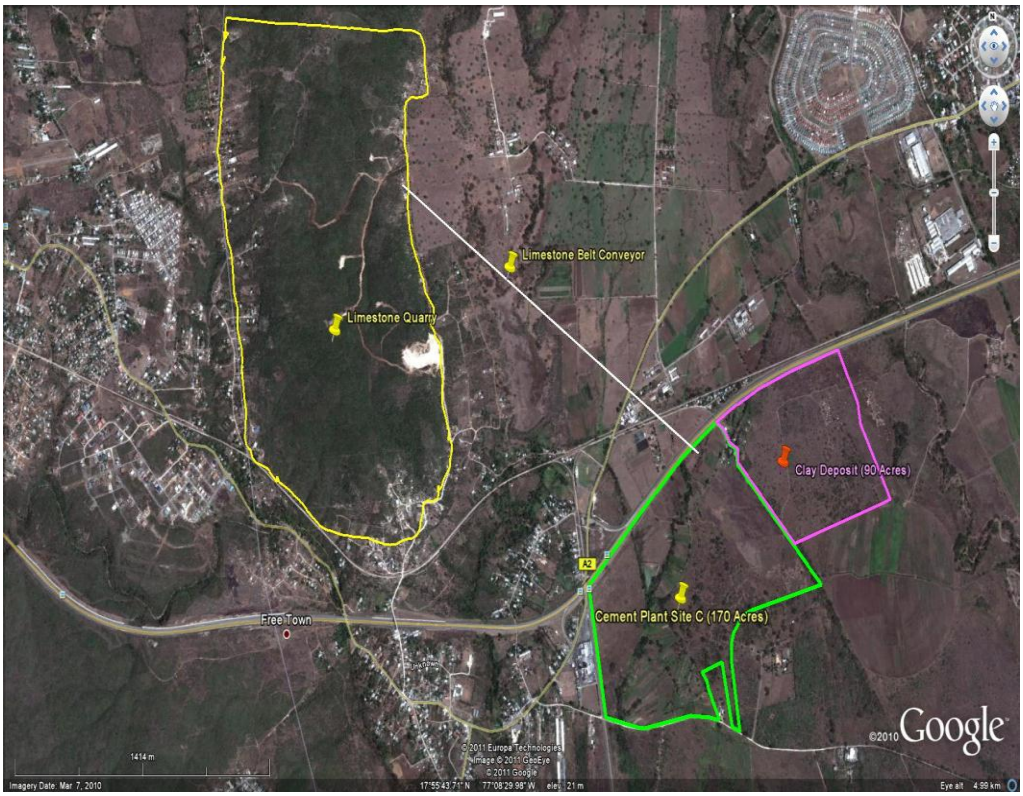
Figure 11: Stones gathered due to intrusion by human



PART 2

Cement Plant and Clay Quarry

FLORA AND FAUNA STUDY OF THE PROPOSED CEMENT PLANT & CLAY QUARRY SITES – PORT ESQUIVEL INDUSTRIALCOMPLEX, ST CATHERINE



BACKGROUND

This study is to establish the existing situation as it relates to the flora and fauna of the proposed development site/s. The information will provide the basis on which to determine the impact of the project on the biological environment and hence the interventions required to minimize the negative impacts.

Survey Objectives

There is a need for a detailed description of flora and fauna (terrestrial and aquatic) of the area, with special emphasis on rear, endemic, protected or endangered species. Evaluation migratory species, micro organism, micro habitat species dependency, richness and evenness, niche specificity, community structure, population dynamics and carrying capacity,

This survey seeks to; satisfy all concerns of any measure, which may arise out of displacement of Flora and or Fauna residing within that project area, which may occur as a result of the proposed activity.

List the Flora and Fauna seen within the area and tell their status frequency of occurrence and classification.

To develop conservation plans for any species of Flora and or Fauna classified as important (some importance factors that were considered are listed in table 1. below) and needing special attention and or intervention as a result of possible displacement occurring due to the project's activities.

Area Surveyed

The survey covers the area proposed for the cement plant and clay quarry. This area falls adjacent to and borders by the Hi-Pro Feed Manufacturing Plant, Rail road, Highway 2000, Boodles Research Centre of Excellence and a farming community. It is a few hundred meters from Port Esquivel. Old Harbour town centre is approximately 3 Km away and the Century Dairies just outside the boundaries the ethanol plant fifteen hundred meters away makes this site well within a commercial industrial zone.

Figure 12: HIPRO FEEDS seen from the plant site and road way alongside the railroad

The plant site exhibited differing biological community structure, as well as habitat variation. Some feature differences include the present of water bodies, three lotic (one from Bodles the second from Hi-Pro and the third the irrigation canal), one lentic (a pond near the centre of the site) soil type being predominately clayey, a major grassland open field area and a segregated farming community.

Figure 13: Wet areas Lotic Lentic Lotic

METHODOLOGY

Surveying flora and fauna have varied approaches to describe the community according to the desired usage of the information to be collected. In this instance the data is to be used as a measure of the status of Flora and Fauna within the project area, to ascertain the need for any mitigation measures to be put in place for species that may reside within the project area which may have that special need.

The Flora and Fauna were approached and measured differently, although the specific aspects of the community organization were measured for both. They include all the criteria listed in the objective and guided by literature from FORESTRY DEPARTMENT, MINISTRY OF AGRICULTURE, NEPA, EFJ, as well as INSTITUTE of JAMAICA.

The data that was analyzed to give the information needed above was collected in a number of ways; the main ones are listed and discussed below. The use of these chosen methods was in keeping with the type of vegetation, practicability, terrain, contiguous stages in ecological successions and transition zones.

Flora (Vegetation) Analysis

The main methods used in the collection and analysis of this data were the **line-intercept** technique and the **belt transect**. The **line-intercept** involves the tabulation of data collected on the plants lying on a straight line cutting across the area (community) under study. This allows for the estimates of densities to be calculated. The **belt transects** uses a long strip marked out in the area within which all the organisms are measured /counted. The belt was divided into intervals and each treated as a plot.

Procedure

Line-intercept

A 100m cord line was stretched between the two points marked on the habitat chosen for analysis and the cord marked into 1m long span for the grass land areas and 10m long spans within the more stratified forested areas where plants are more widely spaced. Beginning at one end all individuals intercepted by the cord line were recorded and each segment treated as a separate unit of transect. The data was then analyzed to give frequency and species diversity.

Figure 14: Line-intersect through varying stratification levels of habitat ***(late evening photo lighted by flash)***

Belt transect

The directional orientation of each belt was selected on the map outline of the project area within each community to be studied, by connecting two points chosen at random and then geo-referenced for a match. GPS coordinates were then taken and stakes used to mark the actual points on the ground effectively creating a long strip of the terrain or belt. The data collected in these belts help in determining overall species composition, population dynamics, richness and evenness in the area and within each chosen community or habitat.

Where there seemed to be or was obviously noted community transition the orientation was modified slightly with a bias along the transition or recognized gradient. This was replicated three times within each of the community chosen

Each transect was divided into contiguous segments which made it easier to analyze for the frequency of species within the habitat using the presence or absence of individual species in each interval

The results are presented in table form in the result section where each species identified are rated in these categories

Fauna Analysis (terrestrial and aquatic)

For this section of the project area similar approach used in the quarry segment was employed. In addition to those previously used, **drop boards and pit fall traps** were more frequently employed along the line transects for those cryptozoans and nocturnal that were not easily counted during the day time or moved very quickly during the night-time and as the leaf litter was spars in this area. Sticky traps and sweep net were employed more frequently as the

population and frequency of fauna seemed greater. **Grab sampling** used in the analysis of aquatic species was backed up by **photograph**, long and short handle scoop and dip nets and makeshift **wilding sampler.** The relative shallow depth of the water enabled these methods to provide enough data for adequate rapid ecological analysis. Snails, fish, crayfish, frog/ toad, aquatic insects and birds were some of the fauna identified.

Figure 15: Drop boards at random for sampling ground dwelling hidden animals (spider under lifted board)

The approach used were the **strip census** where a distance of 100 m was covered within 15 minutes and the number of animals seen recorded (as species seen per 100 m unit area), or line-intersect technique where transect line was established at random within the project area using lines created by overlaying ArcGis and hand held GPS equipment. Fauna flushed or otherwise observed along the line were counted and the distance measured from observer to animal (or Group of animals). The assumptions made were; animals were randomly distributed, the sighting of one animal does not influence sightings of others and all members (eg. All ages and both sexes) are equally likely to be flushed and observed.

Figure 16: Fauna and Flora counted and sampled along strips as they pass through varying zones and habitat

Trail (roadside) **count** was another method used to record fauna, as animals were sometimes easier recognised as they crossed these open spaces. As the trails and roadways are traversed during flora measurements as well as entering and exiting of the project area, all fauna sighted are counted and recorded. Bird calls and nest (nesting site) were used as indicators of presence and residence of birds. Butterfly and moths species pollinators of the flora as well as other invertebrates, lizards, snails were noted. Carrion, body parts/segments and or bones are also used as indicator of presence of a species within the area.

Early morning to evening and evening to morning observations were conducted to ensure fauna were noted through movements (sight) and calls (hearing) for both diurnal and nocturnal (terrestrial and aquatic) species.

Dragonflies foraging ***orio resting*** ***foraging grasshopper*** ***garden spider***

Beehive in a log *Leopard Frog in lentic waterway* *crab borrowing* *cochoo in casha tree*

Snail eggs on grass *silver perch piping in lentic waterway* *zebra butterfly being measured*

Figure 17: Some aspects of the environment as they were sampled/measured during the rapid ecology study

The interviews conducted on persons working within the area (coal burners, loggers, farmers, herbalists and residents of the peripheral communities) yielded information suggesting that there have been no sightings by themselves or heard of any sightings of fauna that were not seen or heard within the area during the survey. This helped in confirmation of flora and fauna within the area as well as the land use history that made it easier to distinguish transition in farm holdings and other habitat.

LIMITATIONS

The main limitation was that time did not allow for a fulsome seasonal variation that takes place over an annual cycle. As the area was studied it was also noted that there are difference within the community at varying time of the year as rain and dry periods cause the wetlands to swell and recede, resulting in varying levels of habitat components such as food, shelter, space water (as well as natural enemy/predators). The niche width(or the diversity of resources used) for each species identified was a high estimate as the seasonal presence or abundance of some plants due to conditions stated above and others as a result of weather and time of year. For this reason, the result may be less than optimal though adequate when both areas are analyzed together.

RESULTS

The flora of the area varied however there are many similarities. Grassland is the dominant habitat type, while not discounting the other habitat types within the area include aquatic both **lentic** (a fairly large pond) and **lotic (**two main streams of water passing through the area), **farmed plots** (a number of holdings or seemingly abandoned holdings of up to five acres of cultivated plots) **contagious forested areas** (of mainly leucenia trees and logwood) and highly stratified forested areas which include areas of human intrusion of varying time periods of currently occupied and recently reforested after abandonment. There is also a strip of abandoned traverse way used during the construction of highway 2000 that is mostly re-growth and or new growth with leucenia and highway crab grass various small shrubs and climbing legumes. The many and varied grass types are compounded by the current and previous land usage of farms such as Century (dairy) Farm which had many pastures within the area, intermittent flooding of the area during torrential rainfall with water runoff from the boodles research station which also rear cattle among other livestock that forage grasses.

The functional role of a species with its environment or **niche** was examined and found to be varied and diversified however not very different from the wider surrounding areas. Honey bees were found hiving in trees as they pollinate the many flowering plants within the area as well as provide fodder for dragonflies, spiders, birds and other predatory animals within the "larger" ecosystem. At least one farmer keeps bees on his holdings. There are other lentic and lotic water within close proximity of the area extending the habitat range of many of the fauna seen within the area.

A similar niche occurred for the crabs in and around the lotic wetland area where they benefit from the softened moisturized soil to excavate borrows and the more constant lush vegetation there for food.

The carrying capacity or maximum population size of each species that the area can sustain indefinitely is quite variable due mainly to the fluctuation of food, space, water and cover. These fluctuations occur due to human activities within the recent past and continue presently as they clear areas for farming, housing logging and coal burning.

This among other factors such as flooding, varying soil type and habitat has given the area a diversity of community structure and therefore the population dynamics and diversity is quite

with the range of the neighbouring areas that fall within this type of environment.

Species evenness and richness seem also in keeping with the general wider environment within the areas of intrusion and habitat diversity and structures.

The dynamics of the study area seem good as for both flora and fauns the varying life stages was observed from juvenile to adult/mature in more than 70% of the total species identified. Birds nest, hatch and reproduce, plants cut down and re-grow (from ratoon or seeds) and also give space for the seeds of other trees to grow and begin a new cycle.

Moorhen and young ***trumpet snails and red claw crayfish*** ***bones of juvenile dog*** ***mosquito fish***

Figure 18: Richness in the area as in the varied habitat and niche

Plants are listed in tables 2-5 and will show the relative species occurrence (frequency), the distribution pattern and species dependence as they were found. Most species were not more dependent on the area as the unique habitat of which they were solely tied however as species interaction to the biotic and physical environment the area does support many and varied types of niche. These communities, habitat and niche when interrupted should see the displaced fauna moving to neighbouring areas as they are of very similar environmental conditions and flora cover.

Table 2 **Compilation of Flora seen within project area trees and shrubs** NotA= NOT ASCERTAINED Rs = resident ; N = native; T = threatened ; EN = endangered; E = endemic; I = introduced S = safe R= rarely; O = occasional; F = frequent; Vf= very frequent D = dominant Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random C = contagious 1 Will survive in similar environment 2 solely dependent 3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**	**Classification Origin**
Red Birch	Bursera simaruba	4	Dy	O	As in the upper area
Park Nut	Acacia macracantha	4	Dy	O	As in the upper area
Bull Hoof	Bauhinia divaricata	4	Dy	O	As in the upper area
Maiden Plum	Comocladia pinnatifolia	4	Dy	O	As in the upper area
Velvet leaf Maden plum	Comocladia velutina	4	Dy	O	As in the upper area
Clammy Cherry	Cordial collococca	4	Dy	O	As in the upper area
Bastard Cherry	Ehretia tinifolia	4	Dy	O	As in the upper area
Logwood	Haematoxylum campechianum	4	Vd	O	As in the upper area
Dildo	Harrisia gracilis	4	nd	O	As in the upper area
Lead Tree	Leucaena leucocephala	4	Vd	F C	As in the upper area
Lignum Vitae	Gulalacum offinale	4	Nd	R	As in the upper area

Table 2 continued Dy dynamic
R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random C = contagious NA= not ascertained
1 Will survive in similar environment 2 solely dependent 3 Dependent on wetland 4 not dependent on area alone Vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**	**Classification Origin**
Black sweethood	Ocotea floribunda	1 4	Dy	O	As in the upper area
Stinking peas	Senna bicapsularis	1 4	Dy	O	As in the upper area
Red bead tree	Adenanthera pavonina	1 4	Dy	O	As in the upper area
Privet	Pithecellobium dulce	1 4	Dy	O	As in the upper area
Cashaw macca	Prosopis juliflora	1 4	Dy	O	As in the upper area
Jamaican ebony	Brya ebenus	1 4	Dy	O	As in the upper area
Sweet sop	Annona squemosa	1 4	Dy	O	As in the upper area
Genuip	Melicoccus bijugatus	1 4	Dy	O	As in the upper area
Cotton tree	Ceiba pentandra	1 4	Dy	O	As in the upper area
Small laeved sweetwood	Nectandra coriacea	1 4	Dy	R	As in the upper area
Wild ackee	Cupania glabra	1 4	Vd	R	As in the upper area
Broad leaf almond	Lasiocroton macrophyllus	1 4	Dy	O	native
jackfruit	Artocarpus heterophyllus	1 4	Dy	O	Introduced

Table 2 continued Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant
U = uniform Ra = random C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic on area alone

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**	**Classification Origin**
Guango	Samanea saman	1 4	Dy	O	**Introduced**
Oatit apple	Syzygium malaccense	1 4	Dy	O	**Introduced**
Sour sop	Annona muricata	1 4	Dy	O	**native**
Common Mango	Mangifera indica	1 4	Dy	O	**Introduced**
Number Mango	Mangifera indica	1 4	Dy	O	**Introduced**
Eastindian mango	Mangifera indica	1 4	Dy	O	**Introduced**
Haden mango	Mangifera indica	1 4	Dy	O	**Introduced**
Bombay mango	Mangifera indica	1 4	Dy	O	**Introduced**
Fineskin mango	Mangifera indica	1 4	Dy	O	**Introduced**
Julie mango	Mangifera indica	1 4	Dy	F C	**Introduced**
Bastard cedar	Guazuma ulmifolia	1 4	Dy	R	**Introduced**
Cotton	Ceiba pentandra	1 4	Dy	O	**Introduced**
Grow stake	Gliricidia sepium	1 4	Dy	O	**Rs**
Ackee	Blighia sapida	1 4	Dy	O	**I**

Table 2 continued Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant
U = uniform Ra = random C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**	**Classification Origin**
Mahagony	Swietenia mahagoni	1 4	Dy	O	**Rs**
June plum	Spondias dulcis	1 4	Dy	O	**I**
Papaya	Corris papaya	1 4	Dy	O	**I**
Plantain	Musa	1 4	Dy	O	**I**
Banana	Musa	1 4	Dy	O	**I**
Coconut	Cocos nucifera	1 4	Dy	O	**Rs**
Teak	Tectona grandis	1 4	Dy	O	**I I**
Pomegranate	Punica granatum	1 4	Dy	O	**I**
Cashew	Anacardium accidentalis	1 4	Dy	O	**I**
Ribena		1 4	Dy	F C	**I**
Coolie plum	Ziziphus muritiana	1 4	Dy	R	**I**
Breadfruit	Artocarpus altilis	1 4	Dy	O	**I**
Lime	Citrus aurantifolia	1 4	Dy	O	**I**
Mangrove **Buttonwood**	Conocarpus erectus	1 4	Dy	O	**R**
Nonie	Morinda citrifolia	1 4	Dy	O	**R**

Table 2 continued Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform
Ra = random C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**	**Classification Origin**
Barbados cherry	malpighiaceae	1 4	**Dy**	**O**	**I**
Bamboo	Bambusa vulgaris	4	**Dy**	**O C**	**I**
River koko	Inga vera	4	**Dy**	**O C**	**RS**
Avocado	Persea americana	4	**Dy**	**O**	**I**
Cherry fig	Ficus perforata	4	**Dy**	**R**	**RS**
May Jamaica plum	Spondias purpurea	4	**Dy**	**O**	**RS**

I

Table 3 **Flora Grasses (Poaceae) sage (Cyperacea) and related Families** continued
Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent 3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**	**Classification Origin**
Tassle grass	Andropogan bicornis	4	Vd	F C	Rs
Broad leaf grass	Anthraxon hispidus	4	Vd	F C	Rs
Bur grass	Cenchrus euinatus L.	4	Vd	F C	Rs
Highway grass	Chloris radiata	4	Vd	F C	Rs
Swamp weed	Coix lacryma-jobi L	4	Vd	F C	Rs
Bermuda grass	Cynadon dactylon L	4	Vd	F C	Rs
Little purple top	Cynadon nlemfuensis	4	Vd	F C	Rs
Dry parra grass	Digitara abyssinica	4	Vd	F C	Rs
Fowl foot	Eleusine indica	4	Vd	F C	Rs
Tuft grass	Eragrostis tenuifolia	4	Vd	F C	Rs
Corn grass	Ixophorus unisetus	4	Vd	F C	Rs
Piano grass	Melinis minutiflora P.Beauv	4	Vd	F C	I
Red top	Oplismenus bermannii	4	Vd	F C	Rs

I

Table 3 **Flor Grasses (Poaceae) sage (Cyperacea) and related Families** continued Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent 3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**	**Classification Origin**
Angel grass	Paspalum paniculatum	4	Vd	F C	Rs
Knot grass	Pannisetm clandestinum	4	Vd	F C	Rs
Birds nest grass	Poa annua L	4	Vd	F C	Rs
Christmas grass	Rhynchelytrum repens	4	Vd	F C	Rs
Ginnuea grass	Panicum maximum	4	Vd	D C	Rs
Buffalo grass	Panicum conjugatum	4	Vd	F C	Rs
Pangola	Digitaria decumbens	4	Vd	F C	Rs
Crab grass	Digitaria bicornis	4	Vd	F C	Rs
Seymour grass	Bothriochloa pertusa	4	Vd	D C	Rs
Sword grass	Paspalum virgatum	4	Vd	F C	Rs
Marvet	Setaria barbata	4	Vd	F C	Rs
Dry rice	Sorghum helepense	4	Vd	F C	Rs

Table 3 continued **Flora** **Grasses (Poaceae) sage (Cyperacea) and related Families**

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**	**Classification Origin**
Itch grass	Rottboellia cochininesis	4	Vd	F C	Rs
Feather grass	Setaria parviflora	4	Vd	F C	Rs
Tuff grass	Sporobolus indicus	4	Vd	F C	Rs
Short leaf guinea grass	Panicum trichoides	4	Vd	F C	Rs
Razor grass	Cuperus laxus	4	Vd	F C	Rs
White top razor grass	Cyperus luzulae	4	Vd	F C	Rs
Nut grass	Cyperus rotundus	4	Vd	F C	Rs
Swamp nut grass	Cyperus tenuis	4	Vd	F C	Rs
Button top	Kyllinga brevifolia	4	Vd	F C	Rs
Button top	Kyllinga odorata	4	Vd	F C	Rs
White star	Rhynchospora nervosa	4	Vd	O C	Rs
Wondering Jew	Tradescantia zebrine	4	Vd	F C	Rs

Table 3 continued **Flora** **Grasses (Poaceae) sage (Cyperacea) and related Families**

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**	**Classification Origin**
Tall watergrass	Tinantia erecta	4	Vd	F C	Rs
Common watergrass	Commelina diffusa	4	Vd	F C	Rs
Hog grass	Commelina erecta	4	Vd	F C	Rs
Yellow top grass	Hypoxis decumbens	4	Vd	F C	Rs
Lavender grass	Sisyrinchium micranthum	4	Vd	F C	Rs
Sugarcane	Saccharum officinarum	4	Vd	O C	Rs
Elephant grass	Pennisetum purpureum	4	Vd	O C	Rs

Table 4 **Flora under growth, shrubs, herbs and medicinal**

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**	**Classification Origin**
Sweet William	Ipomoea quamoclit	4	Vd	O C	Rs
Bur wiss	Cissampelos pareira	4	Vd	O C	Rs
Diwi fern	Nephrolepis multiflora	4	Vd	O C	Rs
Field fern	Thelypteris dentata	4	Vd	O C	Rs
Milk weed	Chamaesyce hirta	4	Vd	O C	Rs
Macca flowers	Croton hirtus	4	Vd	O C	Rs
Red milk weed	Euphorbia heterophylla	4	Vd	O C	Rs
Ground mint	Hyptis atrorubens	4	Vd	O C	Rs
Orange bud	Abutilon indicum	4	Vd	O	Rs

Table 4 continued **Flora under growth, shrubs, herbs and medicinal**

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Wild hemp	Malachra fusciata	4	Vd	**Frequency**
Broom weed	Sida acuta	4	Vd	O C
Cow pops	Physalis angulata	4	Vd	O C
Turkey berry	Solanum torvum	4	Vd	O C
Lemon verbane	Lippa alba	4	Vd	O C
Circee sirsee	Momordica charantia	4	Dy	O C
Jackass bitters	Neurolaena lobata	4	Vd	O C
Rosemerry	Rosmarinus officinalis	4	Vd	O C
River fern	Polypodium decamanum	1 3 4	Vd	O C
Prickle bush	Mimosa alda	4	Vd	O C
Shame old lady	Mimosa pudica	4	Vd	O C

Table 4 continued **Flora under growth, shrubs, herbs and medicinal**

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**
Spanish needle	Bidens pilosa	4	Vd	F
Purple peas	Desmodium adscendens	4	Vd	F
Rat peas	Teramnus uncinatus	4	Vd	F
Clover	Oxalis corniculata	4	Dy	O
Purple clover	Oxalis deblis	4	Dy	O
Giant clover	Oxalis latiflia	4	Dy	O
River coco	Colocasia esculanta	4	Dy	O
White sage	Lantana camara	4	Vd	F
White vervine	Stachytarpheta cayennensis	4	Vd	F
Guzzu mumma	Solonum americanum	4	Vd	F
Pokeweed	Phytolacca icosandra	4	Dy	O

Table 4 continued **Flora under growth, shrubs, herbs and medicinal**

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**
Dog blood	Rivina humillis	4	Vd	O C
wildpine	Bromiliadea	4	N d	O
Greenwis	Similax dominguensis	4	Vd	F
Goose wis	Ciccus verticellata	4	Vd	F
Plantain	Plantago major	4	Vd	F
Pusley	Portulaca oleracea	4	Vd	F
King of the forest	Cassia reticulata	4	Vd	O C
Gully bean	Solanium torvum	4	Vd	O
Burfruit	Triumfetta semitriloba	4	Vd	F C
Jackini bush	Verbesina turbacensis	4	Vd	O
Tall daisy	Synedrella nodiflora	4	Vd	F C
Cow itch	Mucuna pruriens	4	Vd	O
			Vd	

Table 4 continued **Flora under growth, shrubs, herbs and medicinal**

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**
Duppy Gun	Ruella tuberosa	4	Vd	F
Vervine	Stachytarpheta jamaicensis	4	Vd	F
Green tassel	Acalypha alopecuroides	4	Vd	O C
Wild croton		4	Vd	F C
Broadleaf nettle	Laportea aestuans	4	Vd	O
Ping Wing	Bromelia penguin	4	Vd	R
Devils horsewhip	Achyranthes aspera			
Devils horsewhip	Achyranthes indica			
Broom Weed	Sida acuta	4	Vd	F
Nettle spurge	Jatropha gossypiifolia	4	Vd	F
Strong Back	Morinda royoc	4	Vd	F
Guaco	Mikania micrantha	4	Vd	F
Guinea hen weed	Petiveria alliacea		VD	F C

Table 4 continued **Flora under growth, shrubs, herbs and medicinal**

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**
Castor Oil plant	Ricinus comunis	4	Dy	F
John Crow Bead	Abrus precatorius	4	Dy	F
Wild Callaloo	Amaranthus virdis	4	Vd	F
West Indian Gherkin	Cucumis anguria	4	Dy	O
False daisy	Eclipta prostrata	4	Dy	F
Morning glory	Ipomoea tiliacea	4	Dy	F
Purple morning glory	Ipomoea purpurea	4	Dy	F
Maras	Utricularia vulgaris	1 3 4	Vd	F
Arrow head	Sagittaria japonica	1 3 4	Dy	F
Duck weed	Lemna minor	1 3 4	Dy	F
Water hyacinth	Eichornia cressipes	1 3 4	Dy	F
Water lettuce	Pastia stratiotes	1 3 4	Dy	F
Cat tail	Typha latifolia	1 3 4	Dy	F

Table 5 **Fauna** **Birds**

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**
Little blue heron	Egretta caerulea	3	Nd	O
White wing dove	Zenaida asiatica	4	Dy	F
Nightingale	Mimus polyglottos	4	Dy	F
King bird	Tyrannus caudifasciatus	4	Dy	F
Mangrove cuchoo	Coccyzus minor	4	Dy	F
Banana quit	Coereba flaveola	4	Dy	F
Stolid flycatcher	Myiarchus asiatica	4	Dy	F
Yellow shoulder grass quit	Loxipasser anoxanthus	4	Dy	F
Brown grass quit	Tiaris sp	4	Dy	F
Blackface grass quit	Tiaris bicolor	4	Dy	F
Jamaican glaenia	Myiopagis cotta	4	Dy	F

Table 5 continues **Fauna** **Birds**

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**
Black-wiskered vireo	Vireo altiloquus	4	Dy	F
Common Ground dove	Coumbina passerine	4	Dy	F
Pea dove	Zenaida macroura	4	Dy	F
Cattle egret	Bubulcus ibis	4	Nd	F
Smooth Billed Ani	Crotophaga ani	4	Dy	F
Jamaican woodpecker	Melanerpes radiolatus	4	Nd	O
Sad flycatcher	Myiarchus barbirostris	4	Dy	F
Jamaican pewee	Contopus pallidus	4	Dy	F
Arrow headed warbler	Dentroica pharetra	4	Dy	F
Jamaican vireo	Vireo modestus	4	Dy	F

Table 5 **Fauna** **Birds**

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**
Jamaican spandalis	Spindalis nigricephalus	4	Dy	F
Rufous tailed fly catcher	Myiarchus validus	4	Dy	F
White belly Caribbean dove	Leptotilia jamaicensis	4	Dy	F
Greater Antillean Grackle	Quiscalus niger	4	Dy	F
Killdeer	Charadrius vociferous	4	Dy	F
Jamaican oriole	Lcterus leucopteryx	4	Dy	F
Black-billed streamertail	Trochilus scitulus	4	Dy	F
Jamaican Mango	Anthracothorax mango	4	Dy	F
Eastern Kingbird	Tyrannus tyrannus	4	Dy	F
Red ibis glossy ibis	Plegadis falcinellus	4	Nd	F

Table 5 **Fauna Birds amphibian fish mammals anoles**

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**
Common moorhen	Gallinule chloropus	4	Dy	F
Australian red claw	Cherax quadricarinatus	4	Dy	F
Pigeon	Columba livia	4	Dy	F
Leopard frog		1 3 4	Dy	F
Cane toad Bullfrog	Bufos americanos	1 3 4	Dy	F
Mosquito fish	Gambusia affinis	1 3 4	Dy	F
Spotted perch		1 3 4	Dy	F
Silver tilapia		1 3 4	Dy	F
Bats	* Artibeus jamaicensis	4	Dy	F
Mongoose	Herpestes jajanicus	4	Dy	F
Common tree lizard	Anolis lineatopus	4	Dy	F
Blue tree lizard	Anolis grahami	4	Dy	F
Green lizard	Anolis garmani	4	Dy	F

Table 6 **Fauna Invertebrates**

Dy=dynamic; R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random

C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**
Butterflies				
Citrus dog	Cuban swallowtail	4	E	O
Lignum viate butterfly	Kricogonia lyside	4	N	F
Antillean Great White	Ascia monuste	4	N	O
Jamaican satyra	Calistro zangis	4	I	O
Glippus	Danaus gilippus	4	E	O
Zebra	Heliconius charitonus	4	Rs	O
Jamaican White Peacock	Anartia jatrophae jamaicensis	4	Rs	O
Buckeye	Junonia evarete	4	E	O
Swallowtail		4	Rs	O
Checkered Skipper	Pyrgus oileus	4	Rs	O

Table 6 **Fauna invertebrates**

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**
Other arthropods				
Fireflies	Lampyridae and Elateridae	4	Dy	F
Black bees	HYMNOPTERA*	4	Dy	F
Dragon flies	ODANTA	4	Dy	F
Red Wasp	Polistes crinitus	4	Dy	F
Stone wasp	Polistes hunteri	4	Dy	O
Cop Cop .	Crematogaster sp	4	Dy	O
Red / Carpenter Ants	Companotus sp.	4	Dy	F
Running Ants	Phediole	4	Dy	F
Leafcutter Bee	Megachile poyei	4	Dy	O
Leafcutter Bee	Megachilie consigna	4	Dy	O
Honey Bees	Apis magllifera	4	Dy	F

Table 6 **Fauna** **Invertebrates**

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**
spiders	ARACHNID	4	Dy	F
Crickets **Grasshopper**				
	Schistocers niterus	4	Dy	F
	Orphutella punctata	4	Dy	F
Termites	Neoconocephalus pipulus	4	Dy	F
Duck ants	Nasutitermes nigriceps	4	Dy	F
Molluscs Snails	Halpithus sp.	4	Dy	O
	Orthalicus undatus jamacacensis	4	Dy	O
	Hemitrochus graminicola	4	Dy	O
	Pleurodonte lucerna	4	Dy	O
	Pleurodonte invalida	4	Dy	O
	Bulumus diaphanous	4	Dy	O

Table 6 **Fauna** **Invertebrates** molluscs

Dy dynamic R= rarely; O = occasional; F = frequent; D = dominant U = uniform Ra = random
C = contagious NA= not ascertained 1 Will survive in similar environment 2 solely dependent
3 Dependent on wetland 4 not dependent on area alone vd = very dynamic Nd not dynamic

Common name	**Scientific name**	**Species dependence**	**Population dynamics**	**Frequency**
Trumpet snail	Melanoides tuberculata	1 3 4	Dy	F
Common pond snail	Lymnaea peregra	1 3 4	Dy	F
Pouch snail	Physidae	1 3 4	Dy	F
Rams horn snail	planorbidae	1 3 4	Dy	F
Lampet	Anchlus fluviatillis	1 3 4	Dy	F

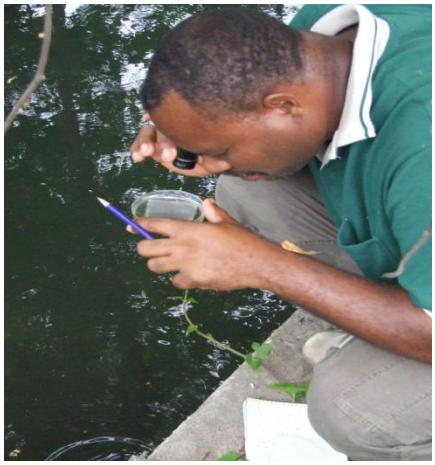
** = In localised areas around water collection points

CONCLUSION

Approximately 60 tree species and 111 shrubs made up the flora seen in the area, while for the fauna there were 60 species making a total in excess of 265 species of flora and fauna identified within the project area.

In terms of fauna observation the wide variety of bird and insect species observed would have been due to the variety and source of food and shelter to these species. One social insect of significant economic importance, the honey bee, was observed hiving in a cavity in a tree within the area and are frequent within the flora canopy. This is significant since their survival is hinged on a constant supply of pollen producing plants of which there are many including those cultivated by the farmers.

The area had signs of years of disturbance by farming activates clearing of vegetation and habitation by people over time. This activity may be responsible for some of the distribution patterns observed for many species as well as the open and close forested areas. This mixture of diversity and the noted human intrusion gives the impression that some species were dispersed by this intrusion likewise some others patterns of dispersion.



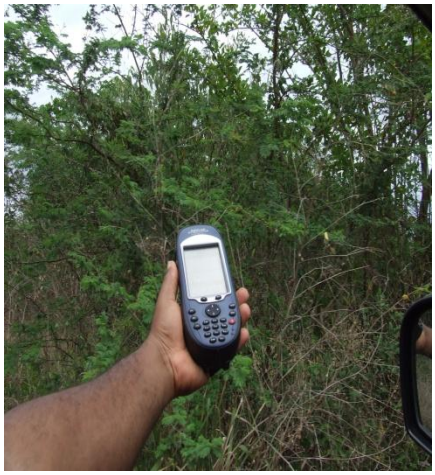


Figure 19: Some equipment used in data collection species identification and verification in the field

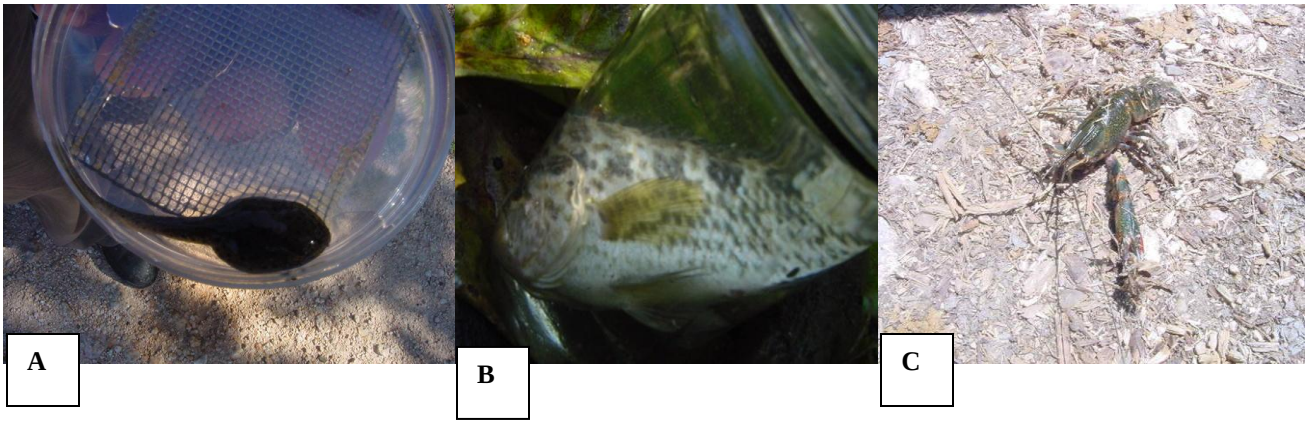


Figure 20: Aquatic life at various points in the area: A-Leopard Frog larva; B-June Fish?? C- Australian Red Claw crayfish

Figure 21: Grab sample collection process to determine aquatic life characteristics

Figure 22: Some of the beneficial insects and arachnids observed: A-Bumble bee; B-Argiope spp; C-Pirate bug

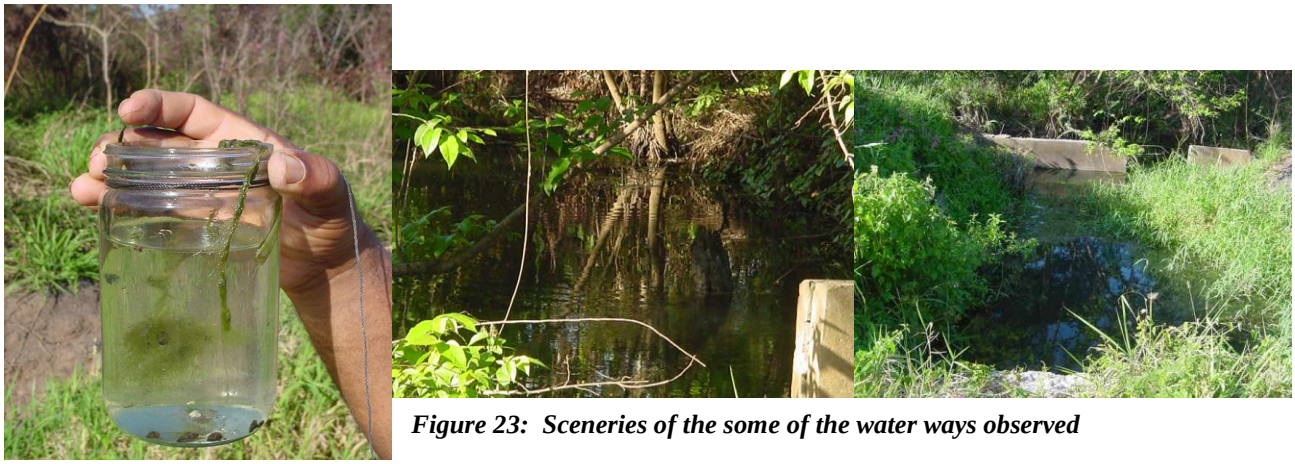


Figure 23: Sceneries of the some of the water ways observed

REFERENCES

A Guide to the Birds of the West Indies raffaele et al. 1998 princeton university press new jersey

A guide to improved pastures for the drier areas of the eastern Caribbean R T

An introduction to the Study of insects 4th edition donnold j borror etal

1976 holt Rinehart and Winston new york

A textbook of entomology 3rd edition Herbert h ross john wiley and son inc new York 1965

Weeds of thPublisher: INRA Editions (June 1994) **e leser Antilles Jaques Fournet et al**

Flowering plants of Jamaica cd adams the university pres Glasgow 1972

Manual of dendrology Jamaica tracy parker 2003 forestry department min of agri

Endemic trees of Jamaica keron c. St E campbell2010mapco printers kgn jamaica

Ecology of Tropical Dry Forest

Peter G. Murphy; Ariel E. Lugo

Annual Review of Ecology and Systematics, Vol. 17. (1986), pp. 67-88.a gide

Genetics and conservation of rare plants

By Donald A. Falk, Kent E. Holsinger New York Oxford University Press Inc, 1991

AN ON-LINE AND HARD-COPY IDENTIFICATION MANUAL FOR AQUATIC INSECTS FROM STREAMS IN THE NEW ENGLAND REGION.

PROJECT DIRECTOR: CHANDLER, D. S. BURGER, J. F.

PERFORMING ORGANIZATION
ZOOLOGY
UNIVERSITY OF NEW HAMPSHIRE
DURHAM,NH 03824 www.reeis.usda.gov/web/crisprojectpages/201607.html

An Introduction to Ecology and the Biosphere Important words and concepts from Chapter 50, Campbell & Reece, 2002 (3/25/2005):by Stephen T. Abedon **(**abedon.1@osu.edu**) for** Biology 113 **at the** Ohio State University http://mansfield.osu.edu/~sabedon/campbl50.htm
Why *study* Ecological and Environmental Sciences? | Ecological ...
www.ed.ac.uk/schools-departments/geosciences/.../why-ecology - Cached
Environmental Education - Climate change affects us all.
www.unfoundation.org
Field *Study* | Social *Ecology* Student Services
students.soceco.uci.edu/pages/field-study
Field of *Study*: *Ecology*
www.iseek.org/education/fieldOfStudy?id=140702 - United States
Jamaica Wildlife
utahpictures.com/**jamaica**/**Jamaica_Wildlife**.php

***Jamaica Wildlife* & Animals: *Wildlife* & Animals of *Jamaica*, Caribbean**
www.jamaica.worldweb.com/Photos/WildlifeAnimals/
Ecology*.com | The Evolution of *Trees
ecology.com/features/quietevolutiontrees/quietevolutiontrees.html
***Tree Ecology* the role of trees in the ecosystem ...**
www.monkey-do.net/Tree%20ecology.pdf
Life on a limb: *ecology* of the *tree* agama (Acanthocercus a. atricollis ...
journals.cambridge.org/production/action/cjoGetFulltext?fulltextid
Forests.org: *Ecology*/Plants/*Trees* Links
forests.org/links/Ecology/Plants/Trees/welcome.asp
Images for *grassland ecosystem* - Report images

***Grassland ecosystem* definition of *Grassland ecosystem* in the Free ...**
encyclopedia2.thefreedictionary.com/Grassland+ecosystem
Pilot analysis of global ecosystems: *Grassland ecosystems* | World ...
www.wri.org/.../pilot-analysis-global-ecosystems-grassland-ecosyste
Images for *pond ecosystem* - Report images

Pond ecosystems
www.pond-o-mania.com › Learning Center

Pond Ecosystem
www.buzzle.com/articles/pond-ecosystem.html

Pond Ecosystem
www.ecostudies.org/chp/Module1/1B3_pond_ecosystem_reading.pdf

***Freshwater* Biomes**
www.thewildclassroom.com/biomes/FRESHWATER.html
The Ecology *Ecosystem* of a *Pond* System: Learn more about the ...
www.brighthub.com › ... › Biodiversity
What's It Like Where You Live?

www.mbgnet.net/fresh/lakes/index.htm
Images for *forest ecosystem* - Report images

***Forest Ecosystems* and Biodiversity** - The Ecology of Forest **...**
forestry.about.com/od/environmentalissues/a/forest_ecosystem.htm
Terrestrial *Ecosystems* - Forests
techalive.mtu.edu/meec/module11/title.htm
***Forest ecosystem*:** Definition from Answers.com
www.answers.com › Library › Science
The *Forest Ecosystem* | Environmental Shelter and Living Conditions
www.controllingpollution.com › Ecosystem
Incentives to sustain *forest ecosystem* servicespubs.iied.org/pubs/pdfs/13555IIED.pdf

Biotic *Components*
www.bcgrasslands.org › ... › Grasslands Ecosystems
Abiotic *Components*
www.bcgrasslands.org › ... › Grasslands Ecosystems
Introduction to *Forestry*, *Forest* Policy and Economics » 1 **...**
foper.unu.edu/course/?page_id=142
Carrying capacity - Wikipedia, the free encyclopedia
en.wikipedia.org/wiki/Carrying_capacity

Carrying Capacity
www.sustainablescale.org › ... › Understanding Scale › Measuring Scale

What is *Carrying Capacity*?
www.gdrc.org/uem/footprints/carrying-capacity.html
Images for *carrying capacity* - Report images

The Environmental Literacy Council - *Carrying Capacity*
www.enviroliteracy.org/article.php/1361.html
Carrying capacity | Define *Carrying capacity* at Dictionary.com
dictionary.reference.com/browse/carrying+capacity
What is the *formula* for calculating *population density*
wiki.answers.com › Wiki Answers › Categories › Science › Biology
Introduction to *Population* Ecology
ipmworld.umn.edu/chapters/ecology.htm
Use of score methods **in water quality monitoring "Bio-monitoring"**
www.ku.edu.np/aec/sharmaPDF/M.Sc/AQ/61%20Biotic%20indices.pdf
Performance of different biotic **indices and** sampling methods **in ...**
cat.inist.fr/?aModele=afficheN&cpsidt=1429475

Sampling **of Air,Goal of Biological** Sampling**,Microorganisms,Abiotic ...**
www.microbiologyprocedure.com/microbes-and-atmosphere/sampling-of-air.html

SAMPLING SEDENTARY ORGANISMS

uncw.edu/people/emslies/ecology/lab/sampling.htm

The Transect Method - Digital Desert Library
horizon.nmsu.edu/kids/explore/chihuahua_study/transect.html

Use of Artificial Substrates for Sampling Benthic
www.pjoes.com/pdf/13.5/579-584.pdf · PDF file

Methods for evaluating stream, riparian, and biotic conditions
www.fs.fed.us/rm/pubs_int/int_gtr138.pdf

Macroinvertebrate Sampling - 2000 (original)
www.tentowns.org/10t/macroo0.htm

Studying Ecosystems: Ecological Experiments, Sampling Techniques ...
scienceaid.co.uk/biology/ecology/studying.html

Biotic Integrity Index Development for Forested Ecosystems ...
extra.mdc.mo.gov/fish/watershed/niangua/biotic

Index of Biotic Integrity Applied to a Flow-regulated River System
www.mesc.usgs.gov/Products/Publications/3222/3222_full.html

Aquatic Macroinvertebrate Biotic Field Surveys and Taxonomy - 1999 ...
www.dnr.wisconsin.gov/org/land/er/nhi/projects/wolf/pdfs/Appendix_E1.pdf

Field Sampling Methods - Biology Department
biology.wsc.ma.edu/Biol128Labs/book/export/html/158