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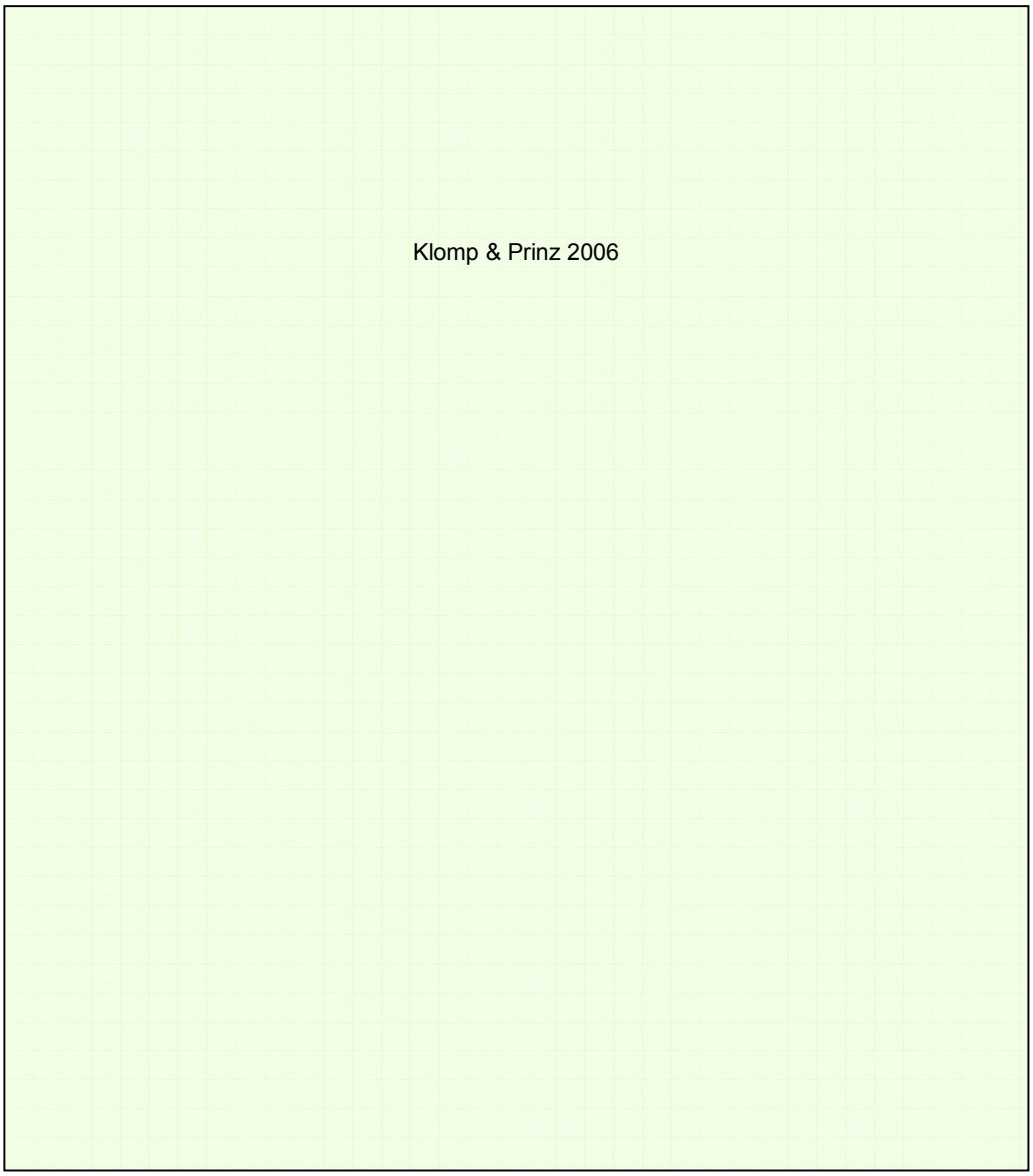

How to combine Nature & Ecotourism on a former Cocoa Plantation?

UNESCO's Man and the Biosphere Reserve concept as a guideline for a land use management plan of the Charlotteville Estate, Tobago

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Imprint

Final thesis for Animal Management studies
Van Hall Larenstein University, part of Wageningen UR.

Key Words
Zonation, ArcGIS, Man and the Biosphere Reserve, ecotourism, land use management, Tobago, Charlotteville, cocoa, planataion, nature

Citation
Klomp, J.S.T. and Prinz, S.A. (2007*),* How to combine Nature & Ecotourism on Cocoa Plantation, *UNESCO's Man and the Biosphere Reserve concept as a guideline for a land use management plan of the Charlotteville Estate, Tobago;* Final Thesis for Animal Management studies. Van Hall Larenstein University part of Wageningen UR, Leeuwarden, The Netherlands.

Commissioner
Charlotteville Estate Ltd. – Patricia Turpin, Charlotteville, Tobago.

Realisation
Organisation: Eco-Project Ltd., Springfield Ave# 1 Valsayn, Trinidad.
Students: Jasper Klomp and Sebastian Prinz (Animal Management)
Supervisors: Berend van Wijk, Bob Jonge Poerink and Hans Bezuijen

Photo's on cover
View on Pirates Bay and Man-O-War Bay from a trail on the Charlotteville estate,
Tourists enjoying the view on St.-Gilles Island from the Charlotteville Estate,
A yellow nocturnal frog, *Phrynohyas venulosa,*
The fruits of a cocoa tree, cocoa pops.

Leeuwarden, 18.04.2007

Foreword

We are glad to present to you our bachelor thesis report based on the fieldwork and literature research we conducted from November 2006 until February 2007.

For the achievement of this final product several stages were undergone.

For graduating in Animal Management specializing in Wildlife Management, an internship in an English speaking country is compulsory. Conducting an internship in the Caribbean evolved during an orientation period on interesting projects in foreign countries. In the beginning we applied for an internship at Eco-Project Ltd. that focused on artificial reef development in the Caribbean Sea. Expecting an under water working atmosphere, the placement was suddenly not necessary anymore, since the project was already finished. But the company offered us another challenging job. A biodiversity assessment in Charlottesville's forests together with an evaluation of ecotourism possibilities in the Charlotteville Estate on Tobago was requested. We chose to do the biodiversity assessment as an internship, while the second assignment was accepted as our thesis study.

After doing the biodiversity assessment from July – November 2006successfully as our internship, we started with the thesis work. In the first place the idea was to assess ecotourism activities and opportunities in the Charlotteville Estate as a recommendation for future land use management. Many ecotourism developments are taking place at the moment in Charlotteville. With this background, an inventory of existing projects, respectively a proposal for new ones was not necessary anymore and a priority-shift lead to changes in the assignment that had to be accepted. The consequence for us was to focus on a favourable land use zonation of the 400 ha comprising Charlotteville Estate. Due to increasing costs, this former cocoa plantation stopped all production in 1990. Nowadays, a new income source is expected in the ecotourism potential of the area. To stimulate a positive ecotourism development the landowner decided to develop a land use management plan that is based on UNESCO's Man and the Biosphere Reserve zonation concept (MAB).

One of the important objectives of zonation includes addressing different areas with a high percentage of e.g. untouched natural vegetation to nature protection zones, while other areas with less valuable vegetation composition are defined to zones for residential or agricultural development. Due to the lack of time on site, we chose instead of comprehensive field based vegetation plotting, to identify all necessary and existing biological data about the research area.
Another objective was not only to identify the wishes of the landowner but also to absorb the concerns of the people of Charlotteville into the recommendation. All data together, provide the basis for a sound evaluation of possible and favourable solutions.

We came back to the Netherlands in December 2006 to work on the report and spatial analysis. For the spatial analysis ArcGIS was recommended, a GIS program in which we created all the maps including our final zonation advice. Before we could create the maps, we attended a course about ArcGIS in which we learned the basics for our calculations and visualizations.

Nevertheless being confronted with all obstacles during the process, we are both grateful for the challenging assignment and satisfied to provide a result that will play an important role as an advising tool and an integral part for the development of the Charlotteville Estate in the nearby future.

Acknowledgements

This research has only been possible, due to the consequent and permanent support of many people.

First of all, without his enthusiasm, his ideas and support of our supervisor and Director of Eco Project Ltd., Aljoscha Wothke, this project would have never been initiated. We are grateful to have had the unique possibility to conduct an independent field study to support the knowledge about species presence on Tobago and provide a contribution for the future use of the natural beauties of Charlotteville. Especially when we realized that biologists from the US and Germany were not chosen for this assignment.

Many thanks to our supervisors: Berend van Wijk, Bob Jonge Poerink and Hans Bezuijen, who all did their best to support us during the preparation or the process of our first thesis eagerly. For his constant support and advice during our biodiversity assessment we want to thank also Martijn Weterings.

We would like to thank the community Charlotteville, especially the community members, who gave useful information about species, trails, tips, myths and stories of the surrounding forest and its inhabitants. The same goes to all our guides and the enthusiast audience during our biodiversity presentations.

Further we want to thank the Manager of the Charlotteville Estates Ltd. and President of Environment Tobago, Patricia Turpin, who was very helpful during the investigations, providing us with accommodation, material and useful information. The same gratitude goes to the staff of the Man-O-War Bay Cottages.

We would also like to express our gratitude to the team of Environment Tobago and the Charlotteville Public Library, who provided us with important literature.

And of course we both would like to say a word of thanks to our families, friends and girl friends, who supported us with their attention, patience and love during the five months far away from home.

We hope you will enjoy this report and share the same fascination that we experienced during our Tobago investigations.

Jasper and Sebastian

Leeuwarden, 25.03.2007

Abstract

This research was done by order of Van Hall Larenstein, part of the Wageningen UR, in Leeuwarden, the Netherlands and Eco-Project Ltd, Valsayn, Trinidad and Tobago.

Tobago is the smaller of the two main islands that make up the Republic of Trinidad and Tobago. With its strong colonial background, this island was used for the production of products e.g. sugar cane and cocoa, this was dominating the small island industry. Large proportions of the islands have been converted to agricultural use, reducing the natural vegetation of Tobago to less than a quarter. Pristine vegetation is located mostly to the Northern part of the island and can be found in state lands or in the Main Ridge Forest Reserve that became the first official protected rainforest in the western hemisphere in 1765.
Tobago, labelled as **"*Ecotourism destination of the year 2003"***, wants to improve its ecotourism facilities, this applies for the Charlotteville Estate particularly. A former Cocoa plantation that was not profitable anymore under the old management strategy and production was closed in 1990. The landowner of the total 400 ha comprising manor decided to switch to a new promising business: **ecotourism**.
To prepare this new business strategy, a new management plan was needed. Part of this plan is a zonation of the estate for the maintenance of the biological richness and the use of potential ecotourism areas.
The question arose: **"How to zonate a former cocoa plantation based on available information?"** There are numerous possible approaches to achieve a zonation that focuses on different priorities in the context of nature protection and ecotourism. Three different approaches have been chosen combining vegetation-, key species presence- and land interest-data of the stakeholders to illustrate possible zonation priorities that go along with the vision of the landowner: **"To manage the area according UNESCO's MAB concept by developing ecotourism activities and protect as much as possible."**
The **first approach** includes the importance of key species and the location where they have been found. During a biodiversity assessment in 2006 a total of 238 species were found. A number of 15 species have been categorized as key species that have a special entity in terms of endemism, rarity, beauty and affection and play a major role for ecotourism and the biological value of the area. Key species hot spots were identified; endemic and rare species locations were advised as potential core zone priority areas.
The **second approach** is based on pristine vegetation preservation assuming that these are precious areas that provide the valuable habitats for different species. While the first two approaches could be answered with the species and spatial data, the last and **third approach** could only be answered by conducting a preliminary interview with the involved parties. The interview questions were on interviewee perception, wishes and ideas about land use, eco tourism and nature protection. 40 citizens of Charlotteville and the main stakeholder, the owner of the Charlotteville Estate Ltd. were interviewed.
The resulting maps of the three approaches are weighed in a Multi Criteria Analysis (MCA) according to translated **MAB criteria** comprising of**: conservation-, development-** and **research suitability aspects**. Finally they are brought to one solution: a combination all important maps to a **high priority area**, which is discussed and refined. Together with a 150m buffer it covers key species hotspots, pristine vegetation, and stakeholder demands and includes three streams for future protection while the transition zone provides development opportunities for the village and the local population. The **core area** becomes the new heart of the zonation.

Content

List of Figures and Tables

Figures

Tables

List of Abbreviations

CE	Charlotteville Estate
CEL	Charlotteville Estates Ltd.
CTO	Caribbean Tourism Organization
EMA	Environmental Management Authority
ET	Environment Tobago
GIS	Geographical Information System
GPS	Global Positioning System
ITTO	International Tropical Timber Organization
IUCN	International Union for Conservation of Nature
MAB	Man And the Biosphere
MRA	Methodological Research Approach
NBSAP	National Biodiversity Strategy and Action Plan
NEP	National Environmental Policy
NGO	Non Governmental Organisation
NTP	National Tourism Policy
PRDI	Policy Research and Development Institute
SFM	Sustainable Forest Management
THA	Tobago House of Assembly
T&T	Trinidad and Tobago
UNEP	United Nations Environmental Program
UNESCO	United Nations Education, Science and Culture Organization
USAID	US Agency for International Development
WTO	World Tourism Organization

1 Introduction

In this chapter the problem is described in its socio-economic context. After this, the main research goal together with the research questions and the general approach are formulated. The give an overall idea of the research performed.
The terms zonation, key species and mapping are defined together with the methodology in chapter 3.

1.1 Problem Description

The future of the world's biodiversity is strongly connected to the cooperation and encouragement of all nations to protect the earth's last pristine ecosystems and habitats. With the Millennium Ecosystem Assessment in 2005, it was revealed that about 60% of all ecosystem services which sustain life on earth, are being degraded or exploited in an unsustainable way. This degradation is expected to increase significantly in the next 50 years. (UN, 2005)
One of the most important factors is the expansion of agriculture and is the source of habitat conversion (Nietsen, Rice, Ratay, & Paratore, 2005).
All over the globe, people convert more and more natural ecosystems into farms, suburbs, roads, etc., while the remaining parcels of natural ecosystems become more and more like islands, small isolated and fragile (Gibbs, Hunter, & Sterling, 1998).
In developing countries, the area dedicated to soybean, oil palm, cocoa and coffee is increased with 100% in the last 30 years, from 50 million hectares to 100 million hectares. A lot of these changes are located in tropical regions with a high biodiversity, which should undergo immediate protection measures. (Kaimowitz, Mertens, Wunder, & Pacheco, 2004)

Environmental degradation goes nearly always together with species impoverishment. According to the Millennium Development Goal VII, environmental resource management and sustainable development are of crucial importance for reversing habitat destruction worldwide. (UN, 2006) Some protected areas have significant economical value and play an important role as providers of other environmental services. (Balmford et al, 2003; Costanza et al, 1997). Watersheds for example are preserved because of their role in ensuring water quality and the prevention of soil erosion. (Hamilton & King, 1983)

Due to the combination of economic and ecological factors, the worlds small island states owe valuable but also vulnerable biota, especially in developing countries.(Gibbs, Hunter, & Sterling, 1998). Trinidad and Tobago is also subject to species impoverishment. Still for its size it has a surprising biodiversity. This is a result of its proximity to other Caribbean islands, and in particular to its close vicinity to continental South America. More than 2280 species have been recorded with 215 of them endemic. With over 100 mammal species it owns the richest mammal fauna in the Caribbean. (ITTO, 2005)

One mammal, four bird, five reptile, nine amphibian and one plant specimen are listed as critically endangered, endangered or vulnerable on the IUCN red list of threatened species. Together Trinidad and Tobago has listed 49 plant species in CITES Appendix II (CITES, 2007).

With a growing development rate, the islands surface is confronted with an increasing demand for housing. The infrastructure is continually improving. Parts of the island that were difficult to reach by transportation are now common destinations and subject to promoting resorts and residential developments and makes biodiversity extremely accessible (Joseph, 1999).
Due to this, the natural forests on Tobago are affected by over-harvesting, encroachment by residential buildings, fires and other forms of damage. Individually licensed loggers are able to cut a specified number of trees or volume as defined by the Forestry Division. The boundaries of protected areas are not properly maintained and frequent incursions were observed. Some of the protected forests are managed and often used for ecotourism issues. On the other hand, private land is seldom under legal protection, while the largest reserve, the Main Ridge Forest, is still waiting for its national park status. (ITTO, 2005)

There are different zonation concepts with contain different management aspects. The Man and the Biosphere reserves of the UNESCO promote solutions to reconcile the conservation of biodiversity with its sustainable use (UNESCO, 2007a).

Biosphere reserves are intended to fulfil 3 basic functions, which are complementary and mutually reinforcing:

- a **conservation function** - to contribute to the conservation of landscapes, ecosystems, species and genetic variation;
- a **development function** - to foster economic and human development which is socio-culturally and ecologically sustainable;
- a **logistic function** - to provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development.

Source: http://www.unesco.org/mab/mabProg.shtml

See annex II for more information about UNESCO's biosphere reserves.

The Charlotteville Estates Ltd. owns a former cocoa plantation in North-Eastern Tobago for which a zonation is needed to redefine current land use management to promote and sustain ecotourism developments. The basis of the update is a zonation of the estate into areas of different usage.

The main obstacle for a zonation is the lack of research data on vegetation types and animal species. An effective conservation of an area includes not just one species but all species. It is important, to deal in particular with key species within an ecosystem that have to be identified as the focus of conservation. (Smith & Maltby, 2003)

A biodiversity assessment was held in 2006 to analyze the areas potential for ecotourism. This evaluation was performed on different terrestrial animal species and focused on: birds, reptiles, amphibians, spiders and butterflies in the Charlotteville Estate (CE). Species with a special ability, i.e. in terms of; beauty, peculiarity, endemism, affection, scientific interest and/or rarity of occurrence were compiled in a list. The outcome of the assessment was analyzed and a key animal species list was compiled in cooperation with Eco-Project Ltd., the University of the West Indies, the Smithsonian Institute, the field researchers and the landowner. The resulting species list can be used as biological indicators for the value of the area and the marketing of ecotourism project developments in the CE.
The term “key animal species” describes in this context the group of selected species that play a vital role in attracting tourists and in the planning of habitat protection.
Together with data on area features including vegetation types, former plantation boundaries, stream, road and trail locations and the wishes and concerns of the stake holding parties the essential data is provided. As a preliminary step, towards the management plan, a zonation advice is necessary to determine at which sites which activities can take place.

The following paragraphs will inform about the goal, the objectives of the research and the research questions.

1.2 Aims and Objectives

The research is done for Eco Project Ltd., Valsayn, Trinidad, as an advising tool for the preparation of a land use management plan of the CE.

The goal of this study was to give a land use advice by developing a zone map of the CE according to UNESCO's Man and the Biosphere Reserve concept. The zone map will be used as an advising tool for the development of a favourable land use management plan.

The following paragraph will describe the research questions. The research questions are answered in a chronological order.

1.3 Research Question

Which area zonation based on UNESCO's Man and the Biosphere Reserve concept is most favourable for the Charlotteville Estate, Tobago?

Sub questions:

Stakeholder related questions

1. Who are the main stakeholders?
2. What are wishes and concerns of the most important stake holding parties about land use, ecotourism and development?

Infrastructure related questions

3. What are the borders of the Estate?
4. What is the village border / residential area?
5. Where are roads and trails in the area?
6. Where are streams in the area?
7. What is the former plantation area?

Biotic factor related questions

8. Which vegetation type is present in the area?
9. Which area of the estate is covered by which vegetation?
10. Which key species* can be found where?
11. Where are key species* hot spots?

Evaluation related question

12. Which priorities must be set for the zonation approach based on the gathered data and MAB criteria?

*see terminology

The research questions and sub questions will be answered and analyzed separately using the data of the literature research, the fieldwork and the interview results.
The field work includes mapping of roads, trails, streams and the village area with GPS. The study area is described in chapter two, including detailed information about the island of Tobago. Definitions about zoning, key species

and mapping are given in chapter three, terminology. How mapping and the interview were conducted can be read in chapter four as well as zonation approaches. Results are presented in chapter five followed by the conclusion in chapter six. The discussion is handled in chapter seven, the final map and zone recommendations that are made are presented in chapter eight.

The next chapter will introduce with background information about Tobago and playing factors.

2 Area Description

This chapter contains a general description of Tobago and the fishing village Charlotteville. It is divided into 4 paragraphs. These paragraphs contain: general information about Tobago, information about flora and fauna of the island, protected areas and environmental threats. It provides useful information to understand the broader context and problems concerning land use management and developments in Tobago.

2.1 General Information

This paragraph gives an overview about the island Tobago in general. The overview is focussed on information about; location, climate, geography, agriculture, fishing and development plans for the region. For readers with interest in Tobago's history, political situation, economy and tourism characteristics see annex V.

Location, Climate and Geography

Trinidad and Tobago are the southernmost islands of the Caribbean archipelago, and are geologically an extension of the South American continent.
Tobago is the smaller of the two main islands that make up the Republic of Trinidad and Tobago. It is located in the southern Caribbean Sea, at latitude 11° 9' N, longitude 60° 40' W, slightly north of Trinidad (see Fig.1). Tobago has a land area of 300 km², and is approximately 42 km long and 10 km wide. (see Fig.1&2) (THA, 2006)

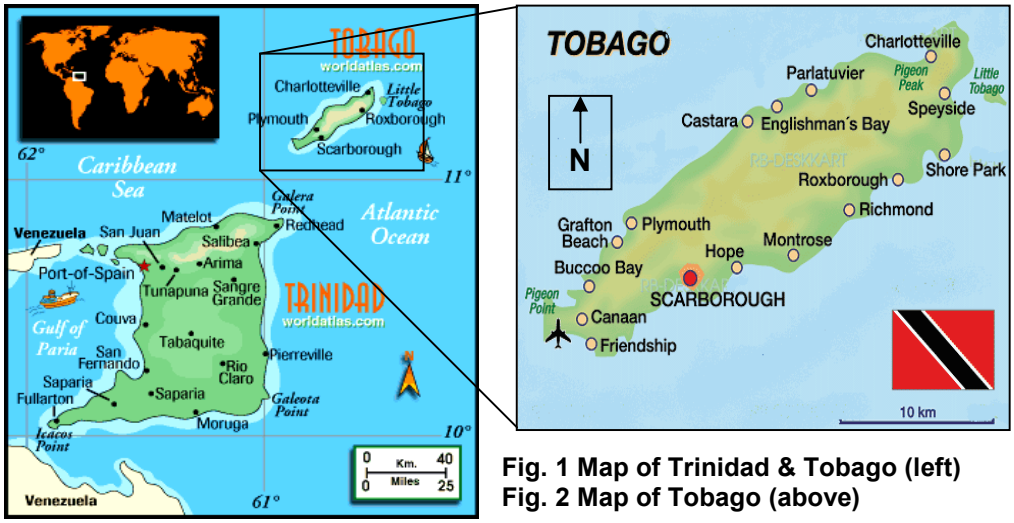


Fig. 1 Map of Trinidad & Tobago (left)
Fig. 2 Map of Tobago (above)

Source: http://www.worldatlas.com & www.welt-atlas.de

Tobago belongs to the wet tropics. It has a tropical climate with average maximum temperatures of about 27°C. There is a dry season from January to May and a wet season from June to December with a higher probability of thunderstorms in the later months of the year. Tropical depressions are a

common phenomenon, while hurricanes affect the island infrequent. Locally there is a large range in rainfall, which varies with annual peaks of 3500mm to minimum values of 1200mm. As a mean annual rainfall is about 200 cm over most of the country. (Joseph, 1999; T&T-Government, 2007a)
Tobago's Eastern inland rises steeply into tall peaks with lower lying lands that include a protected reserve area. It is for a large part covered with secondary tropical rainforest, some parts still contain primary rainforest e.g. the main ridge reserve, which was announced the first tropical rainforest reserve of the western hemisphere (WTO, 2004). This ridge is the dominant feature of the island. Though there is no well-defined peak, it is running like a backbone along the northern part of the island and reaching a height of 650 meter(T&T-Government, 2007d).
Tobago is characterized by lowland rainforest, while coastal zones show deciduous seasonal forest. Since large proportions of the island have been converted to agriculture use, the natural vegetation of Tobago is found predominantly in the Main Ridge Forest, forming less than one quarter of the island's vegetation. (ffrench, 2003)
A full population count was held in 2000 and comprises 54,084 inhabitants. (Witt, 2006) According to the UN, the urban population growth rate for 2000–2005 was 1.1% resulting in an approximate population of about 54,700.

Agriculture & Fishing

Agricultural activity in Tobago is at a small-scale or subsistence level. This involves the production of food and fruit crops within small mixed farm systems. (Narrine, 2006) The majority of the production is for domestic consumption, the food crops grown are suitable for the hilly terrain e.g. plantain, banana, dasheen, pumpkin. A common used destructive method of preparing field by farmers in the area is slash and burn. On the other hand there is minimal chemical use of pesticides and fungicides. (PRDI, 2002)
The biophysical conditions in North East Tobago differ from the conditions on the rest of the island. On average, the North East receives more rainfall annually than other regions. The geological formation is very rugged relief with slopes varying from 10 to 30 degrees; the main ridge is a good example of this. Rivers are due to this short and fast flowing. As a result of these aspects and some other geological influences the north east region is highly susceptible for soil erosion and land slides. Altogether, this reduces the proportion of land suitable for agriculture and most of the area is classified as suitable for tree crops and forest only. (PRDI, 2002)

For Charlotteville as a traditional fishing village, fishing is still one of the most important income sources. Currently there are about 100 people and 60 boats involved in fishing, at least on a part time basis. It is said that Charlotteville is responsible for 60% of the islands catch. The total catch off for Tobago in 1996 was estimated by Potts (2000) at 183 metric tons. There is however no

disaggregated data available to show the relative contribution of fishing in Charlotteville as a total off-take. (PRDI, 1998)
Fishery is for the most part a non-sophisticated arisanal fishery, relying on one or two men with a boat and minimal fishing gear. Main fishing technique is line fishing. While trawling in coastal waters, a maximum of 5 fishing lines is used. Anecdotal reports indicate that fish catches are declining, but it is not known if this is the result of improved technology, an increase in the numbers of fishermen, or natural fluctuations. In the absence of this data together with a comprehensive stock assessment, a conclusive statement concerning the sustainability of current levels of exploitation of fisheries resource of Charlotteville cannot be made. A coastal survey and inventory was recommended to remedy the gaps in the currently available information. There is a similar need for an assessment of the current status of fisheries and fish stocks as the basis for development of that sector. The future plan for Tobago's North East assigned the conservation of coastal habitats of Charlotteville as a priority for any development and advices on knowledge and capacity training of local fisherman concerning sustainable fishing. (PRDI, 1998)

Existing Development Programs

The North East Tobago management plan, 2002, PRDI
Development in North East Tobago states that it development should be focussed on 5 prime sectors; tourism, fisheries, agriculture, small business and conservation of the natural environment. The investment initiative should primarily come from the private sector. The role of the THA is to provide the enabling environment to support and encourage the community development initiatives.
Given the characteristics of the area the logical focus of development it further implies that it should focus on nature tourism, aiming to attract a larger proportion of tourists, to this part of the island, who seek a close encounter with Tobago's nature. This would be adherent to what is stated in the Tourism Master Plan for nature based tourism focussed on the area 's natural resources. A new development should be closely linked to already existing activities in the fisheries and agricultural sector. It should also assist in creating new markets for the traditional products and more opportunities for investment and employment. New opportunities would include agro tourism to give tourists, foreign and local, an opportunity to see/experience Tobago crops in the field. Gain understanding about the crop production process about techniques used and see how many of the goods they buy are grown.
The area has the facilities for this form of Community Based (Nature) Tourism and will take away the focus on larger hotels in favour of small scale home stays and smaller guest houses. Community Based Nature Tourism consists of the following types of tourism; Community tourism, Nature tourism, Agro tourism, Active (soft adventure) tourism and Eco tourism.

The key aspect in planning of this process is the development of concepts and infrastructure that are environmentally sensitive so that the natural beauty of the area is enhanced and protected for future generations. (PRDI, 2002, , 2005)

2.2 Flora and Fauna

South America together with the Latin America & the Caribbean region is exceptionally rich in biodiversity. The region's ecosystems are home to 40% of the plant and animal species of the planet and are considered to have the highest floristic biodiversity in the world. (USAID, 2003)
Flora and fauna are natural extensions of the South American populations. Disconnection on such short, geological time scale, has not allowed for the evolution of separate species and therefore island endemism is not a critical factor in T&T. The small distance between the country and the main land does not represent a barrier to flying species, nor to many terrestrial plants or animals. However, on Tobago there are a number of endemic species and sub-species of different plants and animals found. The island lies in the close vicinity of the Orinoco Delta which brings nutrients from the South American Mainland. The large amount of low saltine water, nutrients and floating vegetation provides the marine ecosystem a rich resource of fish populations. On the basis of the country's size, biodiversity measured by unit area is relatively high. Tobago's biodiversity represents a potential source of opportunities and is a significant base for nature tourism. There are probably 2500 species of plants and about 10 times as many animal species, the majority being insects and other invertebrates (see Table 1). (Joseph, 1999)

Table 1 Species Diversity on Trinidad and Tobago (Joseph, 1999)

Major Groups	Number Of Species
Vascular Plants	2160
Birds	450
Mammals	95
Reptiles	85
Snakes	55
Amphibians	30
Freshwater fishes	45
Marine fishes	354
Butterflies	600
Nematodes	200-300

Although a considerable amount of taxonomic research has been done on Tobago in recent years, the existing ecological information on Tobago forests that can be used for management planning is limited in literature and coverage.(Hardy, 1982) Studies that indicate data on population levels of plant and animal biodiversity in T&T simply do not exist (Joseph, 1999).

Flora

There was no published botanical inventory since the study of J.S. Beard in 1944. The plant formations of Tobago are an expression of the interplay of the environmental factors of climate, topography and soil. Beard (1944) arranges them into four groups – Rainforests, Seasonal Forests, Littoral Forests and Mangrove Forests.
His publication is the only published source of information on the islands natural vegetation. Beard's list of trees native to Tobago identifies 162 species in 121 genera and 50 families which mainly comprises the South American flora. The Tobago flora represents the South American flora more than the flora of the Caribbean.

Fauna

The fauna of Tobago is predominantly of South American origin, although some West Indian species also occur on the island (Hardy 1982). Hardy states further that the Caribbean influence is strongest in the terrestrial insect and fresh-water invertebrate fauna.

The vertebrate group of Tobago is less diverse than the vertebrate group on Trinidad in both, total numbers and species but Tobago is unique for the occurrence of several South American mainland species which do not occur on Trinidad. This phenomenon can be seen in birds, mammals, reptiles and amphibians. (Murphy, 1997)

According to R. ffrench, (ffrench, 2003) Tobago is home to 210 species of birds. During preliminary research on biodiversity numbers on the CE, a list of 216 possible Tobago species was compiled. The possibility of finding all these species is low, due to extinction, incidental spotting or recordings that date back several decades e.g. *Ara ararauna*, Blue-and-yellow Macaw, probably extinct in wild and *Buteo brachyurus*, Short-tailed Hawk, 1 sight record in 1964.

Tobago has a diverse reptile fauna covering skinks, lizards, gecko's and snakes totalling 38 different species according to J. D. Hardy, (Hardy, 1982) and H. E. A. Boos, (Boos, 2001). 21 different snake species of which one is endemic, *Erythrolamprus ocellatus*, Tobago False Coral or Red Snake, and two endemic subspecies can be found. The remaining 17 species are legged reptiles of which three are endemic, *Gonatodes ocellatus*, Ocellated Gecko and *Bachia flavescens* and *Bachia heteropa alleni*, which have no English names but are both considered skink species.

Amphibians are described by J. C. Murphy, (Murphy, 1997) and J. D. Hardy, (Hardy, 1982), a total of 16 species can be found, but both sources state that more research is needed to confirm this number. Two species are endemic

Mannophryne olmonae, Bloody Bay Poisoned Frog and *Eleutherodactylus charlottevillensis* which are found only in northeast Tobago.

Butterfly research was done in 1968 (Barcant, 1970) of which a publication was made in 1970 (Butterflies of Trinidad and Tobago), a total of 423 species are described in this book but due to many impacts on butterfly habitat e.g. hurricanes, pesticides and conversion from forest to agricultural land, this number is not reliable. More research on present butterfly species is necessary according to the University of the West Indies Prof. C.A. Starr (personal conversation).

Research performed on terrestrial animals, consisting of amphibians, birds, butterflies, mammals, reptiles, spiders and other insects, in the 400 ha CE by Klomp & Prinz (2006) revealed 243 animal species on a small fragment, 400 ha, which is only 1,3% of the island's surface (see Fig.3).

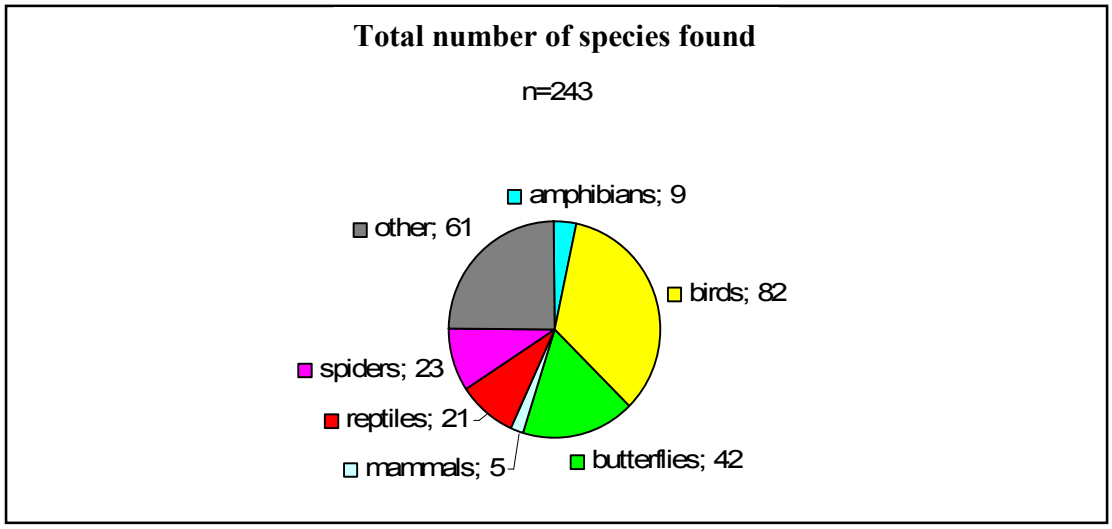


Fig. 3 Total Number and Division of Species Found in the Charlotteville Estate
"Other" are invertebrates except butterflies and spiders Source: Klomp & Prinz 2006

A key species list of all found species was developed in cooperation of the researchers, Eco-Project Ltd., professors of the UWI and the Smithsonian Institute, the landowner and tourists that were asked for their opinion. Combining of the different opinions resulted in a list of 15 species which are for this research brand as key species. For a more detailed description see chapter three, terminology. Table 2 presents the complete list of the 15 assigned key species.

The key Species list contains the 15 classified key species of amphibian, reptile, butterflies and birds:

Table 2 List of the 15 Key Species (Klomp & Prinz 2006)

Scientific Name	Common Name	Class
1. *Eleutherodactylus charlottevillensis*	No English Name Given	Amphibian
2. *Mannophryne olmonae*	Bloody Bay Poisoned Frog	Amphibian
3. *Erythrolamprus ocellatus*	Tobago False Coral, Red Snake	Reptile
4. *Mastigodryas boddaerti dunni*	Machete Couesse	Reptile
5. *Gonatodes ocellatus*	Ocellated gecko	Reptile
6. *Caligo teucer*	Cacao Mort Bleu	Butterfly
7. *Anthracothorax nigricollis*	Black-throated Mango	Bird
8. *Asio clamator*	Striped Owl	Bird
9. *Chiroxiphia pareola*	Blue-backed Manakin	Bird
10. *Cyanerpes cyaneus*	Red-legged Honeycreeper	Bird
11. *Florisuga mellivora*	White-necked Jacobin	Bird
12. *Galbula ruficauda*	Rufous-tailed Jacamar	Bird
13. *Glaucis hirsuta*	Rufous-breasted Hermit	Bird
14. *Nyctibius griseus*	Common Potoo	Bird
15. *Trogon collaris*	Collared Trogon	Bird

2.3 Protected Areas

On the North East side of Tobago some 6000 ha are currently designated or proposed for protection and managed by the forest section division of agriculture, lands and marketing in the THA. (Joseph, 1999) The effectiveness of conservation in these areas is constraint due to the limited manpower and resources of the state institutions responsible for natural resource management. (PRDI, 2002)
The three areas of main importance are described below.

Main Ridge Forest Reserve

The Main Ridge Forest Reserve is a former state reserve, which was established in 1765 to cover a 3958 ha of forestlands along and on the Northern and Southern slopes of the main ridge. Under its current legal status management of the reserve is the responsibility of the National Parks & Protected Area Management section of the department of natural resources and environment. Logging in the reserve is prohibited but the area is used for hunting and harvesting of minor resources as crayfish and crabs and for recreational purposes e.g. hiking and bird watching. The Main Ridge Forest Reserve management is applying for a status as a national park to insure a higher protective state. (PRDI, 1998) This protected area is of interest for managing the CE. It is bordering the estate in the Southeast and could be a significant factor when it comes to the planning of a wildlife corridor.

St. Gilles Island

St. Gilles Island is a 28 ha offshore island, just off the CE, designated as a wildlife sanctuary in 1968 was donated by the Turpin family. It is mainly a breeding colony for several seabirds and is subject to the legislation by the National Parks & Protected Area Management section of the department of natural resources and environment. Hunting and entrance is prohibited without a permit. (PRDI, 2002)
The present management situation by the department of natural resources and environment has lead to a decrease in (breeding) bird numbers due to an increase in poaching as stated during a conversation with the former owner of the St. Gilles Islands, Patricia Turpin. Due to these developments, the Turpin family regrets the donation of property rights and management of the island to the government. (Personal conversation, Patricia Turpin)

Little Tobago

Another important sanctuary is Little Tobago Island, which lies just offshore from the fishing-village of Speyside. This sanctuary is also known as 'Bird of Paradise Island'. This distinctive name was given due to the following historic event; in 1909 Sir William Ingram introduced the Greater Bird of Paradise, *Paradisaea apoda* to the island. He did this in an attempt to save the species from over hunting for plume trade in its native New Guinea. 45 juvenile birds were introduced to the island and left by themselves to start a new population, this attempt failed and the birds were last seen in 1958. After Ingram's death in 1924 his heirs deeded the island to the Government of Trinidad and Tobago as a wildlife sanctuary, it stayed as such until today. (Wikipedia, 2007b)
Today it is an important nesting ground for a number of (sea) bird species more than 43 species occur on the island. (ffrench, 2003) Little Tobago Island is one of the prime seabird sanctuaries in the Caribbean (Explore-Tobago, 2007).

2.4 Threats to the Environment

Unfortunately, habitat fragmentation and destruction, the over-exploitation of wildlife, competition with exotic species and the discharge of pollutants into the air, water and soil, pose serious anthropogenic threats to preservation of this rich biodiversity. (Kenny, 2000)
Human influences tend to reduce diversity, particular where they are intensive and long standing, but limited human activities can actually increase diversity. (Jeffrey A. McNeely, 1988)

Hunting & Poaching

Tobago has a hunting season which lasts 5 months, the Closed season is from March 1st, lasting until September 30th. No hunting, eating or possession of protected wildlife species including birds, is allowed. The species which are hunted most are; Armadillo, Iguana and the national bird of Tobago 'Cocrico', which has an ecotourism value. A serious concern is mentioned by Richard ffrench who is convinced that the current hunting behaviour will lead to an extinction of the Cocrico. (ffrench, 2003) . Due to hunting activities this species is hardly observed, hence it adapted to stay away from people. (Pers. Obs.)
The desire for wild meat harvest tends to fuel an increase in poaching activity, despite the valiant efforts by the government and the NGOs to promote conservation in the schools and through the local media. (ET, 2005)

Due to insufficient manpower in the forestry division, making sure that laws are being enforced is difficult, Tobago has 12 honorary game rangers and one game warden, to enforce law, only the game warden is allowed to carry a weapon. With regard to law enforcement, the current staffing the governmental Wildlife Section suggests a ratio of enforcement personnel to registered hunters of 1 : 913 on both islands (Joseph, 1999).

Unsustainable harvesting, over-hunting and poaching of terrestrial and marine species are leading to declining populations of game species and endangered sea-turtles and has become a significant problem. The perception between the given legal framework and the urgency of taking action by the government for enforcement makes the existing environmental legislation futile. The THA is taking initiatives to ensure that existing laws are enforced to improve the protection and conservation of wildlife. (interview, Patricia Turpin)

Another threat are pet keepers that catch wild birds illegally for the pet market (Joseph, 1999). Not much is known about involvement of the international market on this.

Soil Erosion

Housing developments, small scale farming, logging and excavations impact the soil and lead to increased erosion on Tobago. In Charlotteville land slides are a regular phenomenon in particular in the wet season. Along the road there are smaller land slides, especially along the new road to the village Lanse Fourmi. Some houses at Flag Staff Hill have been abandoned. In Charlotteville housing developments could be seen as the most critical factor in soil erosion issues along with natural events. Logging is only accepted with fallen dead trees in a small scale. There are no excavation activities. (PRDI, 2002)

Exotic Species

The former cash crop oriented CE was planted and managed as such. The only existing management plan from 1930, describes the usage of a broad scale of planted fruit trees from tropical Africa. (Turpin, 1929) It can be assumed that these alien plant species are still in the area and have the ability to disturb the natural ecology on Tobago. There is not much known about invasive alien fauna species, except for wild dogs and wild cats.

Other

Sewage contamination in the waters of the recreational beaches of Man-O-War Bay is a cause of considerable environmental concern. An ongoing water quality monitoring is needed to provide necessary information for designing appropriate management strategies. Both environments, terrestrial as well as marine sites are affected. Pollution of coastal waters due to sewage run-off, effluent discharge from yachts etc. is one of the factors with a negative impact on the coral reefs. The conversion of the remaining areas of coastal wetlands, which act as natural environmental buffers, is still ongoing.
(PRDI, 2005)

Another serious concern is garbage dumping behaviour. In abandoned areas, even in the forest old refrigerators can be found, plastic bags and bottles that have been left by the forestry workers show a non-existent awareness about environmental problems. (PRDI, 2002)

3 Methodology

This chapter deals with the methodology that is used for this research. At first, the used terminology and the research area in North Eastern Tobago, known as the CE is described, followed by an explanation of the fieldwork, the data collection and the data analysis.

3.1 Terminology

To make sure that this report is read like the authors meant it to be read an explanation of terms used in a research specific context for this report are given in this chapter.

Other terms that are subject to discussion concerning definitions can be found in annex I. In annex I, other used definitions in this report are described.

Zonation

The word zonation comes from the word zone. A definition provided by the online database www.wordnet.princeton.edu is: *a circumscribed region characterized by distinctive features.*

To get from zone to the meaning of zonation, the following definition has been used: distribution of regions divided in o specific zones caused by gradients of plants and animals or abiotic or biotic factors.

General information

There is a great variance in zonation of natural areas world wide. UNESCO has developed a zonation model called; the Man and the Biosphere (MAB), a zonation of that divides areas into three zones. In short: zonated areas consist of a core zone in which animals are preserved and land use is restricted to low impact research activities. The core zone is surrounded by a buffer zone, this is an area in which animals and humans coexist. Trails and minor roads can run through the area and even small scale housing for e.g. tourism is a possibility. Small scale use of the land for different activities, e.g. farming is allowed. The buffer zone is surrounded by the transition zone in which human activities are leading to the areas layout. Animals play a minor role in this zone. (UNESCO, 2007a)

The UNESCO has defined sharp demands to relative size of each of the three zones. These demands prevent small private owned parks and land of becoming a MAB reserve. Nevertheless the model of MAB can be adopted for zonation and adapted to the relative size of the area in which zonation takes place. (UNESCO, 2007a)

Key species

The word key species consists of two single words. ‘Key’ means in this context: An outline of the distinguishing characteristics of a group of organisms, used as a guide in identification.

The second word ‘species’ is biologically defined as: a single, distinct class of living creatures with features that distinguish it from others. A species is a group of individuals that can freely interbreed and produce fertile offspring with another individual of that group.

Two birds, for example a *Bananaquit* and an *Orange-Winged Parrot*, are two different species and can therefore not interbreed. Species can mostly be differentiated by appearance characteristics. Nevertheless there are species that seem to be one species but are not able to produce fertile offspring. With these species an identification based on individuals' genetic composition is needed.
Key species were identified in this project as a value for ecotourism activities and as an indicator for important habitats.

General information
Key species are species selected from a species list, which was compiled during a preliminary biodiversity assessment. Species are assigned with a key species status due to several factors; beauty, peculiarity, endemism, affection, scientific interest and/or rarity of occurrence. To become a key species they have to comply with at least 3 of the mentioned factors.
The key species list was not developed by the researchers alone, experts e.g., professors, the landowner and tourists were asked for their opinion. A combination of the different opinions resulted in a list of 15 species which are for this research defined as key species. The complete list can be found in chapter two '*Flora and Fauna'*.

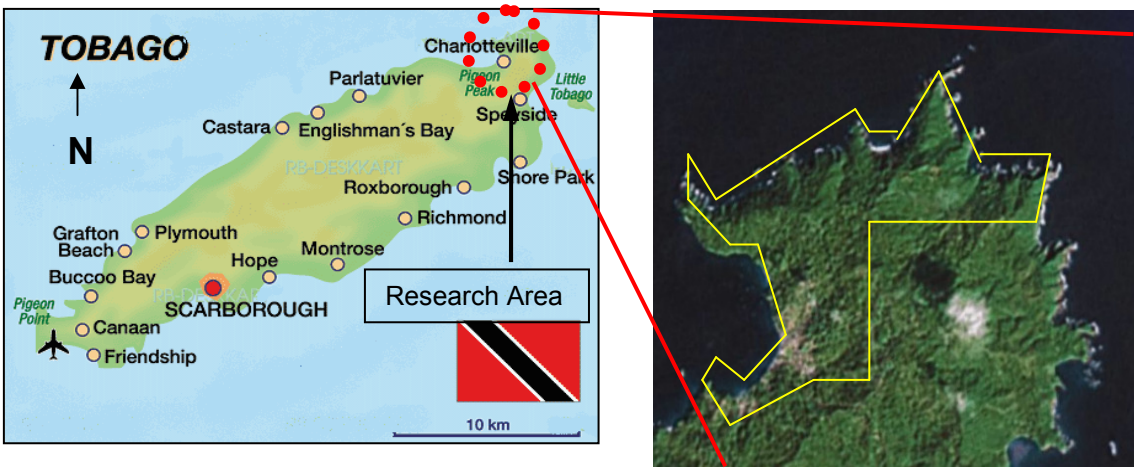
Mapping

There are many definitions for the word mapping. The one used for this research is: *The process of making a map, usually drawing a map showing the topographical features of an area.*
Deviations that can occur in mapping, or map-making depends on the data collection and processing methods.

General information
During the map making process of this research, mapping was defined to taking GPS data at locations which are of importance for the research.
A map of the area was already available; this 30 year old map contained only area features as streams and incomplete elevation data. GPS data was taken at recognisable markers, for example at rivers, with which the old map was digitised by using a geo-referencing tool in ArcGIS. Information could be added to this digitised map, as forest types, trails and borders.

3.2 Research area

Charlotteville is the most northern village of Tobago and lays on the North East coast of the island. It is the islands third most important town, even though with 283 households it only has about 1000 people. (Witt, 2006) The population is mixed but predominantly of African descent (BBC, 2007). It is seen as a laid back fishing village. Formerly established as a village to house the plantation workers it is surrounded by the CE and the ocean. (De-Light & Thomas, 2005)
The figures 4&5 show the location of the estate and an approximate border of the estate area.



1:400.000 Source: www.welt-atlas.de 1:80.000 Source: Google Earth

Fig. 4 Location of study area on Tobago (left)
Fig. 5 Border of the Research Area in yellow (right)

The estate is a former cacao plantation and used to be the main provider of labour for the people of the village. Since the fall of cacao prices, keeping a cacao plantation running was no longer profitable and the cacao plantation was abandoned. The main activity shifted to fishing and Charlotteville provides about 50% of the island with fish. (De-Light & Thomas, 2005)
Charlotteville has a long history of being the major fishing village in Tobago. Currently 100 persons and 50 boats are involved in fishing. This sector is having a considerable growth rate. In 1991 60 persons and 30 boats were involved in this sector. Further growth is being slowed down due to inadequate and lacking storage facilities. (PRDI, 2002)

The area around the village is considered the study area, located on the North East of Tobago (see Fig. 3&4). The land area is about 400 ha, according to Mrs. Turpin, the landowner. There are different vegetation structures to be found on the estate, it consists of a great variety of biotopes; lowland rain forest, littoral woodland, seasonal deciduous vegetation and montane rain forest. (Beard, 1944) The vegetation is disturbed by pasture fields and a large number of cacao trees which still produce fruits. The area is hilly with steep elevations and inclines connected to the Caribbean Sea with bays, beaches and coral reefs (pers. obs.).
The Tobago development plan describes the area as an underdeveloped area surrounding the small fisherman village of Charlotteville. (PRDI, 2005).
Still it is disturbed by activities as residential development, small scale logging, and there are roads in various states (personal interview with Mrs. Turpin).

Accessibility

The village can be reached by one main road; a second road is under construction. There are two possibilities to enter the forests of the CE. The commonly used entrance is a tar road through the village, becoming a broad trail as soon it passes the last houses (pers. obs.) This trail is maintained by the government and is swiped approximately every 4 months to prevent overgrowing (pers.com. Turpin). This main trail through the estate has 5 junctions that branch of in smaller trails which are privately maintained. The estate area used to be better accessible but since a

hurricane in 2001, trails have been inaccessible due to fallen trees. Many trails have been overgrown ever since (Comeau, Potter, & Roberts, 2006).
The total length of accessible trails is approximately 8 km, the main trail length is about 3,7 km.
The estate can be visited without permission of the owner, a guide is not required. It is forbidden to manipulate flora and fauna by the owner

Current Management of the Estate

There is no management of the estate. (Interview Patricia Turpin) Individually licensed loggers are allowed to harvest dead tree trunks (ITTO, 2005). The main trail "cow ridge" runs through the forest area of the estate and is maintained by the government every four months (Interview, Patricia Turpin). An area of 45 ha is reserved for the development of an ecotourism project in the South West (Krumpe, 2005).

Future Perspective

The idea of the land use plan for the CE is to manage parts of the area in accordance with the Man and Biosphere Reserve concept of the UNSECO e.g. zoning and land use plan. Parts of the estate must be managed in accordance with the biological value, e.g. areas with a high biological value must be assigned as a reserve and simultaneously allow ecotourism activities.
The nature reserve concept means preservation and management of the natural vegetation in the area outside the reserve with enrichment plantings (see annex I for explanation) in areas where the flora seems impoverished. Such areas consist of areas were trees have been cut or cleared in the past and grasses and shrubs have been grown back. Wildlife is planned to become legally protected by an inquired application for state lands. For populations that have declined in the past years below the numbers of viable population animals need to be reintroduced into the population. For this conservation project, more research is needed.
The last idea of this zoning includes also a conversion of parts of the estate into residential areas to allow the growth of the town.
Current ecotourism project planning incorporates the reinstallation of a part of the estate into former glory for tourists to get the old fashioned plantation experience. (Krumpe, 2005) Another development project is the installation of a butterfly breeding unit with two goals: the exploitation of valuable butterflies and for tourism attraction possibilities. (Interview with Patricia Turpin)

3.3 Research Approach

To answer the main research question stated in paragraph 1.3, the methodology describes the data gathering methods and analysis per sub-question. The logical sequence of the sub-questions is maintained.

The following overall methodological research (MRA) approach is chosen, see Fig.6. The current step will be marked in this very figure and shown during the methodological steps referred as MRA:

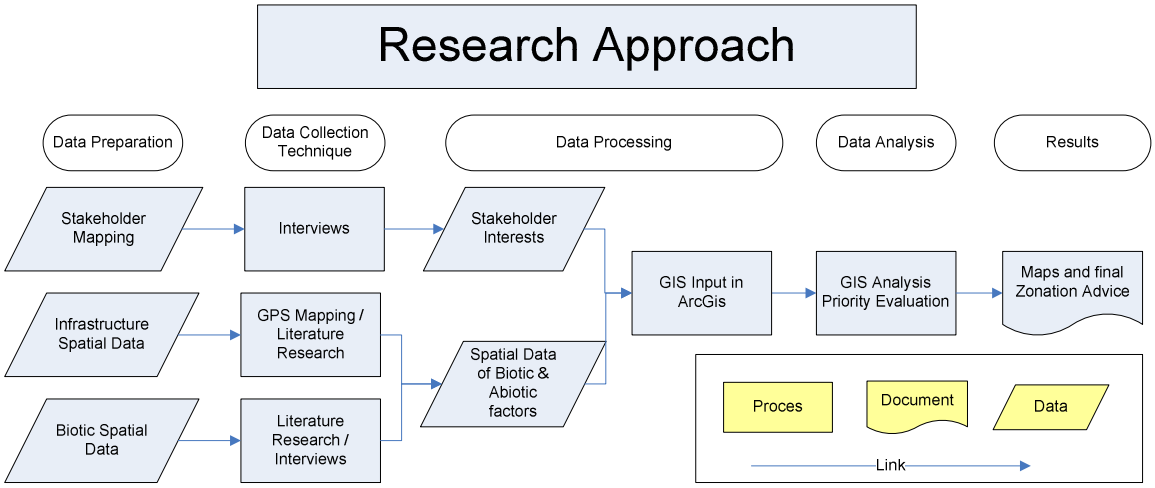


Fig. 6 Schematized Methodological Research Approach (MRA)

The sub questions are divided into 4 groups. The first two sub-questions will give answers on the stakeholders and their wishes and concerns about land use, ecotourism and development. This is done using an interview. At first, all stakeholders that could play a role are shown in a table. In a distribution matrix the relative power share on a zonation-decision is demonstrated. Finally land wishes of the most important stakeholders are brought into spatial data into ArcGIS.

The second group gives answer on infrastructure features of the CE: the location of the Estate, the residential area, the former plantation border, roads, trails and stream locations are determined. The main data collection technique is based on mapping and literature research. All data is translated into spatial data into ArcGIS.

The third group answers the questions about biotic factors: vegetation and key species distribution. The data for the answers is collected conducting informal interviews and literature research. Key species data is used from a biodiversity assessment that was conducted as preliminary step for the evaluation of the area. Species and vegetation information is progressed into spatial data in ArcGIS.

After having gathered all spatial data in ArcGIS, an evaluation is done. With a Multi Criteria Analysis (MCA), the processed maps are weighed with MAB criteria on their importance for a zonation advice. These are weighed in a scoring table which gives answer to the question, which maps are more important than others. Based on this result the maps are processed to a final map, showing the area that is considered to be most important for protective measures and ecotourism value.
The next paragraphs contain the data collection-, preparation- and analysis methods.

3.4 Data Collection Methods

The data that is to be collected is based on a general interview of the stake holding parties, a comprehensive literature study on general information about Tobago, its flora and fauna, Charlotteville and characteristics of the CE. Additional data is gathered by mapping the area with an emphasis on roads, trails and residential area in the CE. The results of a preliminary field study on the presence of a particular group of terrestrial fauna species referred as key species (see terminology) complete the data gathering methods. New data is created during the process of GIS map analysis.

The collection methods are introduced by a theoretical background, which are intended for readers who are not familiar with the topic. After this introductory part the used research methodology and techniques are described. For the mentioned data input into ArcGIS, see paragraph *3.5 Data Preparation*.

3.4.1 Stakeholder related questions

1. Sub-question

Who are the main stakeholders?

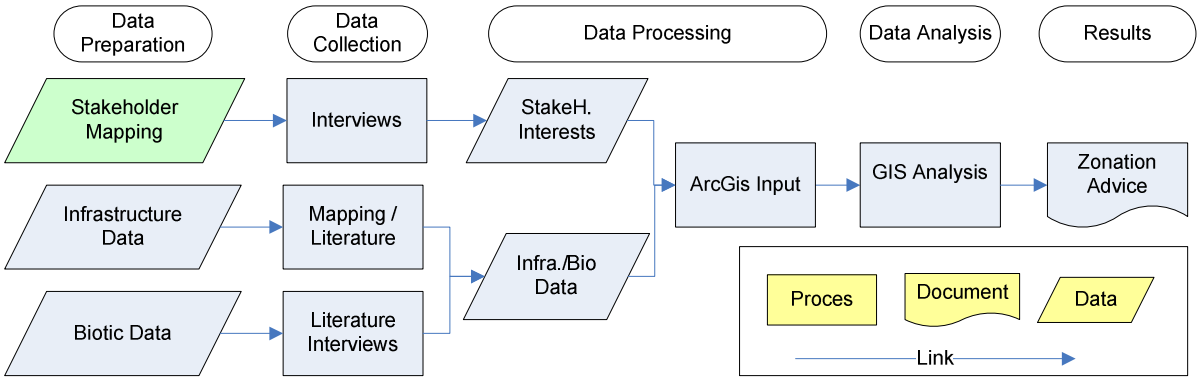


Fig. 7 Step I of the MRA, Mapping Data of Stakeholders

For the answer of this question a stakeholder distribution matrix will be used.

Mapping Stakeholders - Theory and background

A successful zonation approach involves the local communities to associate with the natural environment by which both must benefit together with the management plan (Borrini-Feyerabend, 1997).

As it is described by Varvasovszky et. al. (H. Varvasovszky, 2000), “Stakeholder analysis is an approach, a tool or set of tools for generating knowledge about actors – individuals and organizations – so as to understand their behaviour, intentions, interrelations and interests; and for assessing the influences and resources they bring to bear on decision-making or implementation processes.”

Two major differences between stakeholders can be assigned as internal/external (i, e) viewpoints and direct of indirect (d, id) stakeholders. External stakeholders comprise of all actors that can exert influence on the use of the CE while internal stakeholders have this power without exception. The category direct or indirect describes the direct influence e.g. by direct use while the government for example

can show their power in providing a legal foundation. Both categories can work in any combination and are not linked to a specific combination. (Feuerstein, 1986)

For an overall benefit, attitudes, wishes and concerns must be known to the group of developers to guarantee a broad satisfaction of the most important stakeholders. As being the largest group of directly depending party, the local people of the Charlotteville community play a major role.

Design used
In this study it is simply used as a tool to get an overall idea of the possibly involved parties and their approximate position for a future implementation of the management plan. The approach refers on the future use of the area, which will be mainly focussed on sustainable ecotourism activities.

The stakeholders in this study are identified during the literature study and the interviews and categorized according to their role in the development process, their use of the area and their position concerning nature protection. To give an overview, the information will be put into a table and a power distribution matrix.

2. Sub-question
What are wishes and concerns of the most important stake holding parties about land use, ecotourism and development?

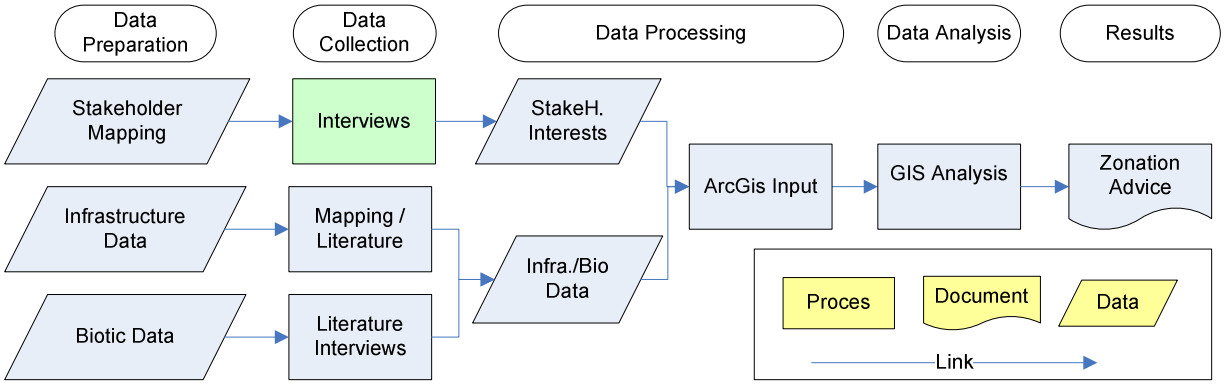


Fig. 8 Step II of the MRA, Collecting Interview Data

To answer the second sub-question an interview has to be developed.

Conducting Interviews - Theory and Background
Interviews are an often used tool to gather information about peoples' knowledge, attitudes and behaviours. This survey is an impartial way of collecting information from a sample of people that represents a population. (Feuerstein, 1986; Gibbs, Hunter, & Sterling, 1998; Rugh, 1992)
Personal stakeholder opinion about an issue plays an important role in how policy and management decisions are made and whether people are willing to support these decisions. People who are directly or indirectly affected by a management option – are critical in developing a final management strategy.
The first step to design an interview is to define what kind of information you want and what is done with the results. Once one has decided which information is necessary, one has to identify who needs to be interviewed.

The tone and the scope of an interview can influence the result. It should be the highest priority to choose for an unbiased and balanced question design. When one answer is obviously a better choice than another, it is obvious that the result can partly be projected; this is in particular true for emotional charged terms.
When interviewing people from a different culture and when this difference is obvious, people can tend to give answers that are socially more accepted than their true opinion.
The interview design can obtain two kinds of questions: close-ended or open-ended. The difference between these two is that with the first predetermined choices are given while open ended questions give space for an open answer. To gather information about more complex topics, the questions become more complicated and difficult to answer. Therefore answer choices should be clear. In general the interview design should start with the general questions continuing to the more specific ones. (Feuerstein, 1986; Gibbs, Hunter, & Sterling, 1998; Rugh, 1992)

A compete open question interview was not functional for interviewing people on the street because of time restriction. Therefore a second interview was developed in cooperation with Aljoscha Wothke, director of Eco-Project Ltd. Questions in this interview were formulated to get a general idea of the community's perception on tourism development, ecotourism, nature conservation and land use. Background for the community interview was an earlier held interview, Charlotteville May 2006, about tourism and the perception of an eco/agro tourism project (Witt, 2006). The new interview completed or added missing information about land use, ecotourism and nature protection to represent ideas of both stakeholders.

Design used
The main stakeholder interview has questions with an open character to give the responder the opportunity to give comprehensive answers. The community interview is a mixture of open and closed answer possibilities.

18 questions are asked, 9 yes or no, 5 open, 3 1-10 point scale for evaluation and 1 multiple choice. The interviews are conducted in the first two weeks of December 2006 in Charlotteville. The interviewed persons are chosen randomly out of Charlotteville inhabitants, while it is tried to cover different age groups, sexes and occupations to get a representative impression. The number of 40 interviews represents approximately 5% of the adult population. 35 out of 40 interviews are carried out by the authors, 5 are hold by a local person. This is done to find out if answers to interview questions are similar for a foreign interviewer and a local interviewer.

The results of the interview are stored in Excel tables and will be analysed as diagrams to become a descriptive part of the study. The most significant data is given in the general overview of Charlotteville; the less significant is described in the text or attached in the annex.

The results are not intended to be used statistically. They show a tendency of the local attitudes, complaints and ideas on how developmental planning, nature protection and land use are perceived and should be adjusted on key priorities that are of major concern. The results of the interview supply together with governmental development plans and the biological date the framework of the current situation in

Charlotteville. The interview is done as a compulsory part of the assignment. The interview part with spatial information on preferences of specific sites is translated into interest maps in ArcGIS. This is done for the landowner as well as for the community.

3.4.2 Infrastructure related questions

3.-7. Sub-question
What are the borders of the Estate?
What is the village border / residential area?
Where are roads and trails in the area?
Where are streams in the area?
What is the former plantation area?

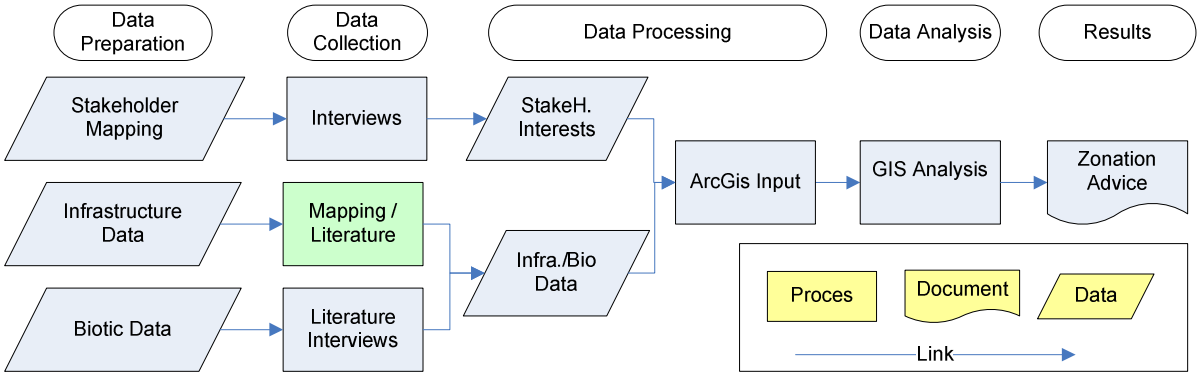


Fig. 9 Step III of the MRA, Collecting Mapping Data on Infrastructure

These questions about infrastructural data are answered combining a sound literature research, field work with GPS mapping and interviews with the landowner and local people.

Information Sources

Literature Study
For the literature study, available information of the landowner, respectively Charlotteville Estates Ltd. was compiled. Additionally an investigation on literature was done in the local library of Charlotteville as well as in the library of the NGO Environment Tobago (ET).

Informal Interviews
Informal interviews with locals, especially local guides and the owner of Charlotteville Estates Ltd. gave answers on missing information. No specific interviews were developed for this part of the study.

GPS Mapping of Roads, Trails and Residential Area
Due to the lack of recent maps and GIS data of the CE in Northern Tobago, a comprehensive GPS mapping of the village boundaries, roads and trails was done for the development of a GIS map.

The Mapping Area
The CE and some parts of the Estate that do not belong to the estate were mapped. The roads, trails and residential area on the Estate were mapped as well

Using a Mapping Technique
The data is taken with a GPS device, a Garmin Etrex, 12 channel GPS. To get familiar with the instrument; one day of practice is done before the mapping takes place. An accuracy of +/- 10 m is the minimum value for a point positioning. If conditions allow a better measurement, a 3m precise positioning is done. The accuracy of the measurement is simultaneously displayed during the measurement. If conditions are worse, due to bad weather or dense vegetation a new measurement is taken at the next closest spot or under better weather conditions.
The GPS data points for roads and trails are taken according to one of the three conditions:

- end of a road/trail
- turn of a road/trail
- approximate 200 meter distance points from the last measurement on a straight road/trail

Additionally some of the GPS points are assigned as spots that can be found back on the map to conduct a geo reference with a map that was digitized (see geo reference).
The chosen coordinate system is UTM/UPS. Trinidad and Tobago falls into the UTM/UPS square number 20, which is important to create a final raster layout for geographical references.
The GPS data is saved manually in an Excel database (see Table 3). For every road and trail an own excel table is created for an easy data input into ArcGIS (v. 9.1).

Excel File Example
TABLE 3 EXAMPLE OF DATA STORAGE IN EXCEL

Station Street to Small Super		
20 P	**UTM**	**Description**
767685	1252958	Cross Springstreet/Station Street to Health Center
767714	1252907	Station Street (New Street) / Book Street
767709	1252808	Station Cross School Street
767705	1252701	Sheep Shed
767474	1252721	Small Supermarkt Crossing

3.4.3 Biotic factor related questions

8.-11. Sub-question
Which vegetation types are present in the area?
Which area of the estate is covered by which vegetation?
Which key species can be found where?
Where are key species hot spots?

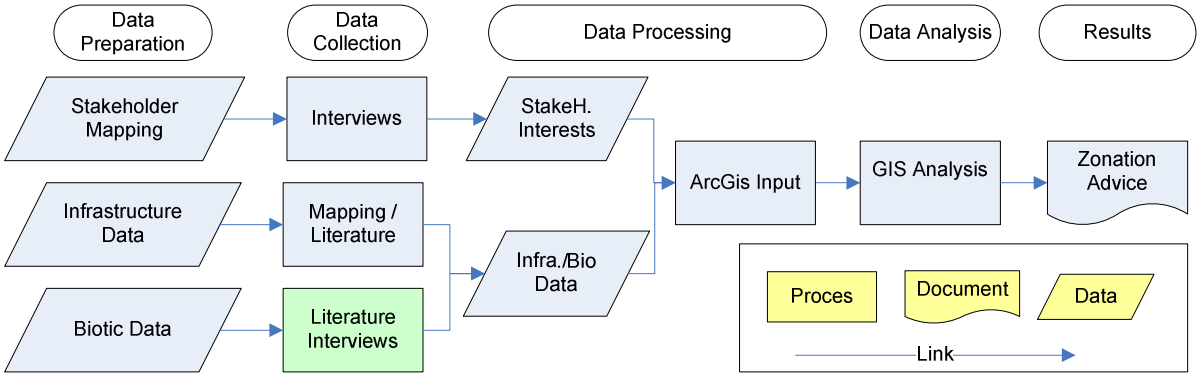


Fig. 10 Step IV of the MRA – Collecting Biological Data

Key Species Data - Background and Theory
Any census of terrestrial fauna should examine birds, mammals, amphibians and reptiles. Ideally vertebrate fauna often comprise 90-95% of an area of all described species. (Thomas & Thomas, 1991)
But a thorough invertebrate census of the whole invertebrate fauna is unrealistic; one can select particular groups that might serve as biodiversity indicators of others. (Kremen, 1994; Noss, 1990)

Amphibians are extremely poor dispersers owing to their physiological needs to stay near wet areas. In particular many song birds change behaviour in a fragmented ecosystem and nest on edge environments where they are subject to an increased level of predation. Conservation of the species diversity within natural areas depends on an adequate assessment of the area's flora and fauna composition. The decision on how to manage a natural area must be based on biological information. (Gibbs, Hunter, & Sterling, 1998)

Design used
For the biotic data the data collection is done by literature study and field work investigation. For the vegetation data, existing data about vegetation distribution was gathered from literature. In combination with data about the CE's land use history, 2 main vegetation types were later calculated in ArcGIS. One area was formerly covered for plantation use and one part that was not commercially used and assigned as a game reserve. The different vegetation types present in the area are used descriptive. This answers sub question 8 and 9.

For the key species data the results of a preliminary conducted study on the biodiversity of Charlotteville was used. The key species data was gathered and manually put into digital information for ArcGIS (see paragraph 3.5, Data Preparation).

3.4.4 Evaluation related question

12. Which priorities must be set for the zonation approach based on the gathered data and MAB criteria?

Theory and Background

With increasing problem complexity, an evaluation tool becomes an essential item to maintain a clear arrangement of playing factors. A Multi Criteria Analysis (MCA) is a tool, that supports a decision making process. Information is provided for an array of selected items to determine the ideal required approach state and therefore the achievement of particular solutions. A MCA outcome can result in complete order of alternatives from the best case to the least desirable. The basis of this tool is a two dimensional score board. On one axis the table shows all alternatives and on the other the chosen criteria for the evaluation are stated. The table is than filled with the scores that are addressed to the different items in compliance with the criteria. Criteria can also be weighed with different factors, when they are not of the same relevance. The appointed scores are summed together and presented in a total score. Depending on the designer's choice, a low or high score is addressed as highest or lowest priority.
(Sharifi, van Herwijnen et al. 2002)

Design used

The MCA is done to prioritize zonation aspects and will be based on the spatial data that was found during the investigation. This means that the created maps are weighed in this scoreboard with translated MAB criteria. Thus, the evaluation involves an assessment of the attributes of the 5 indicated areas: stakeholder interest area, disturbed area, watersheds, key species hotspots and pristine area. To weigh all different areas, criteria have to be defined in order to determine a priority-order for the zonation approach.
Criteria will be chosen and translated to weigh the areas on conservation, development and logistic aspects, since they are the basis of the MAB concept. Altogether the result will be presented in a score table that will be explained.

3.5 Data Preparation

Working with ArcGIS - Theory and Background

The GPS data points are processed as point features. For example species locations are processed as point features as well as the geo reference coordinates. For road- and trail-GPS-data-points, a new feature is created based on point shape files. The new feature translates manually the points into poly-lines. For the guarantee of the logical sequence and composition of this infrastructure information, a handmade map sketch was created during the mapping in which the interconnections of different roads and trails are incorporated.
In this study only 2 dimensional polygon shapes are used to represent surface areas. Polygon shape files are created as surface area placeholders. For examples the area of the village is produced in a polygon. Besides this, multi-polygons are used for surface features that are not connected with each other e.g. pristine forest or pasture areas. (Ormsby, et. al. 2004)

In ArcGIS the layer sequence in the table of contents shows all layers of a map that have been introduced to a particular map composition. The sequence of the layers determines the visualization.

Three tool functions of ArcGIS are the basis for the calculations and the creation of new spatial data.

- *Buffer*
- *Intersect*
- U*nion*

The *buffer* function simply creates an individually defined buffer area around a chosen feature e.g. key species are buffered to visualize a certain area importance for different species.
The *intersect* function is an overlay procedure. Two spatial features are overlaid and the common surface area is than created as a new layer e.g. the calculation of the estate area that doesn't belong to the former plantation area. The result an intersected surface area which represents the assumed undisturbed area on the CE.
The *union* tool combines two layers and unifies two layer surfaces to a new polygon layer.

Conducting a Geo Referencing in ArcGIS
For the digital map processing a geo reference is needed. A geo reference fits a digital map with the gathered data to the correct scale and position. A total of three points ensure a precise geo reference. Five spots were taken, to guarantee a precise geo reference. (Ormsby et. al. 2004)
The geo reference spots include the most southern part of the Man-O-War Beach, the spot where Bigualla River connects with the Sea, the end of the stream at Pirates Bay Beach which comes from the valley at the stairs, the most Northern tip of the CE that is closest to the Islands of St. Giles and the spot where Big River ends up in the Man-O-War Bay (see Fig. 11).
These GPS spots were chosen due to their ability for precise recognition later on a map and their durability in terms of landscape changes. The streams are situated in deep valleys or in artificial canals in the village, where on a short time base no major changes of stream locations can take place. This durability is the same for the most Northern tip and the most southern part of the Man-O-War Bay beach which ends in rocky cliffs with a rough volcanic origin as Hardy described 1982 in his Tobago Biogeography as Tobago's typical landscape feature.

In Fig.11, the GPS Geo Reference Points are shown as crosses. The points are dispersed over the whole area and suffice the conditions of a precise Geo Reference. In general these conditions are described as choosing at least three points, which are located within three different directions with a sufficient distance to each other. For example, three points on the Pirate's Bay Beach would lead to a much more imprecise geo reference than the chosen points.

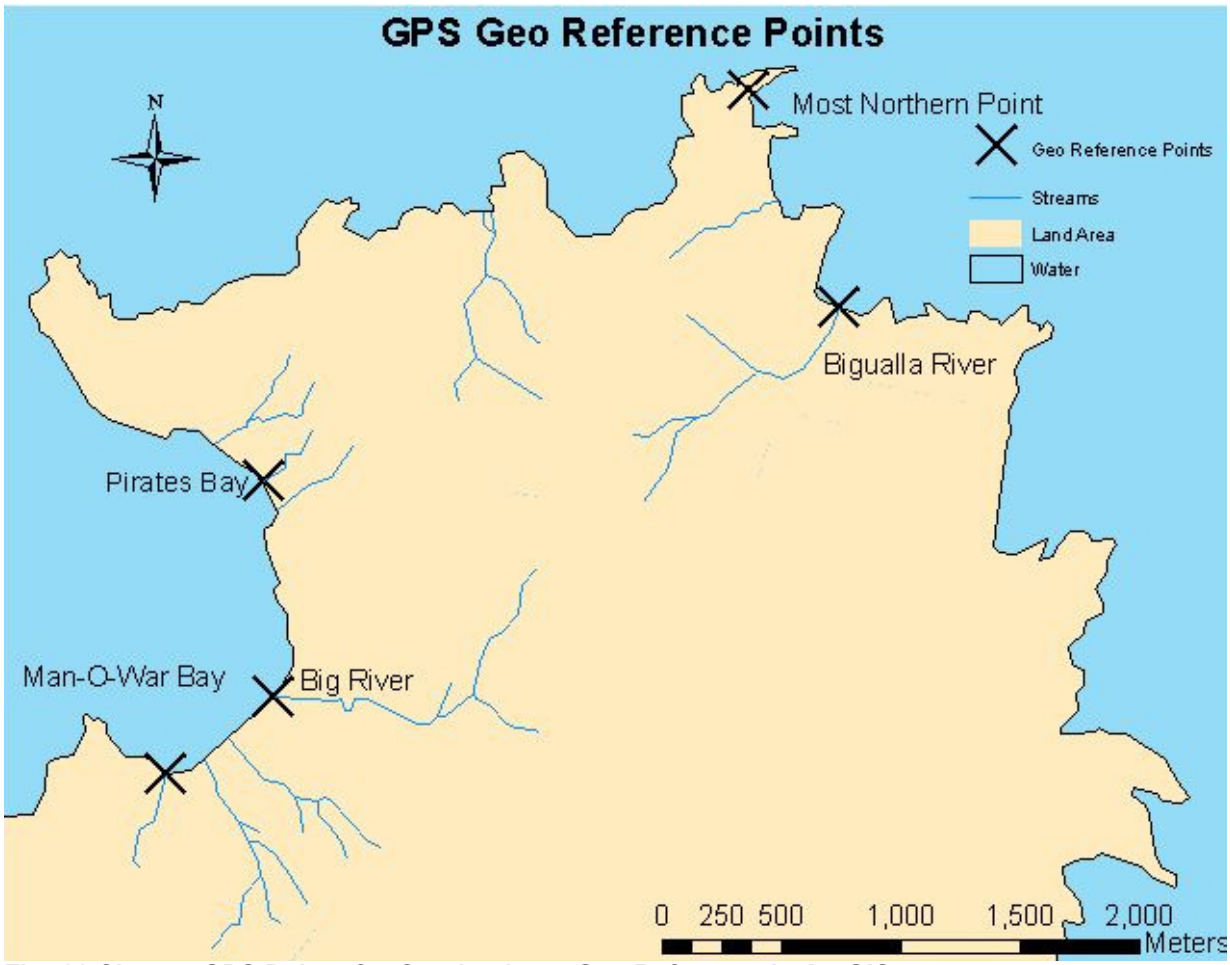


Fig. 11 Chosen GPS Points for Conducting a Geo Reference in ArcGIS
(map is based on Charles Turpin's map 'Jacamar Reserve')

3.6 Data Analysis

In this paragraph the analysis of the collected data is described. The logical sequence of the sub-questions is maintained.

3.6.1 Stakeholder Analysis

Stakeholder related questions

1. *Who are the main stakeholders?*

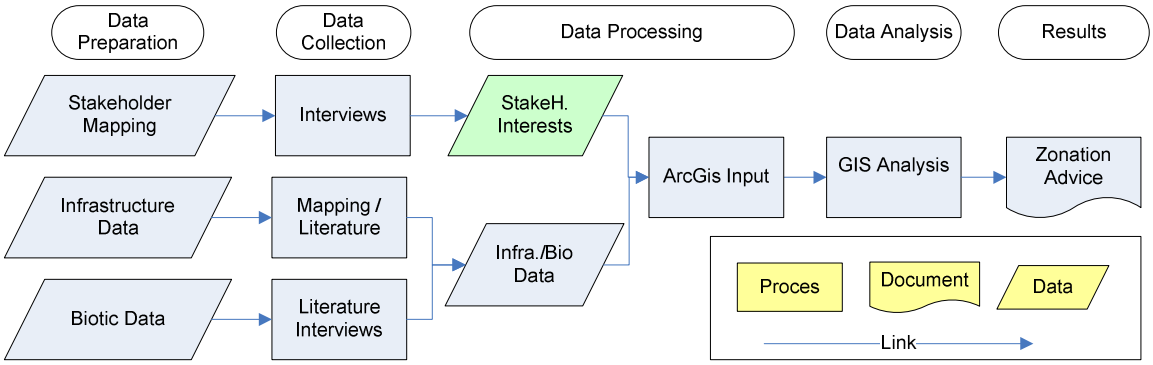


Fig. 12 Step V of the MRA – Processing Stakeholders and their Interests

All parties are evaluated with an emphasis on their power and interest on the whole situation and digested in a distribution matrix.

When considering a stakeholder analysis the whole of stakeholders are summarized into one overview. The priorities are determined by Charlotteville Estates Ltd., since the area is private state land and as long as the local laws are respected, the landowner stays the main and only decision maker. In consultancy with the landowner the most important stakeholders are chosen and integrated into the study.

2. *What are wishes and concerns of the most important stake holding parties about land use, ecotourism and development?*

The results from the interviews are compiled in an Excel file. The data analysis is restricted on percentage statements of the total number of given answers in text form or diagrams. The spatial information about area protection is taken into ArcGIS manually to represent the interests of the interviewed group. Data Analysis in ArcGIS.

Infrastructure related questions

3. *What are the borders of the Estate?*
4. *What is the village border / residential area?*
5. *Where are roads and trails in the area?*
6. *Where are streams in the area?*
7. *What is the former plantation area?*

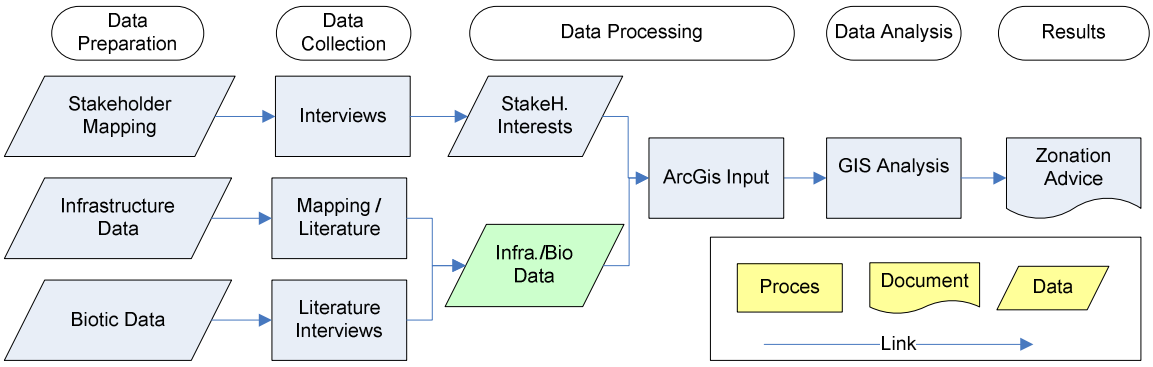


Fig. 13 Step VI of the MRA – Processing Infrastructure & Biological Data

All information is produced in digital form in ArcGIS into layer files. A geographical map that was provided by Charlotteville Estate Ltd. was digitized and processed to provide the basis of coastal and stream data. The map in Fig. 7 shows the outlines of the North-Eastern coastline of Tobago and the most important streams in the CE. With the roads in the village, the approximate village boundaries were determined. The chosen scale is 1: 33.000, to get a maximum resolution on a DIN A4 page. Together with information that was received during literature studies and personal interviews, the boundaries of the research area was given and digitized by using several older maps that were provided by Charlotteville Estates Ltd. A compromise of all information has lead to the boundaries that are handled in this report. The streams and the coast are acknowledged with the geo reference technique (see Conducting a Geo Reference in ArcGIS, page 28) and are based on the map of Charles Turpin.

The borders of the Estate, the residential / village area, roads, trails ,streams and the former plantation area were digitized manually.

Biotic factor related questions

8. Which vegetation types are present in the area?
9. Which area of the estate is covered by which vegetation?
10. Which key species can be found where?
11. Where are key species hot spots?

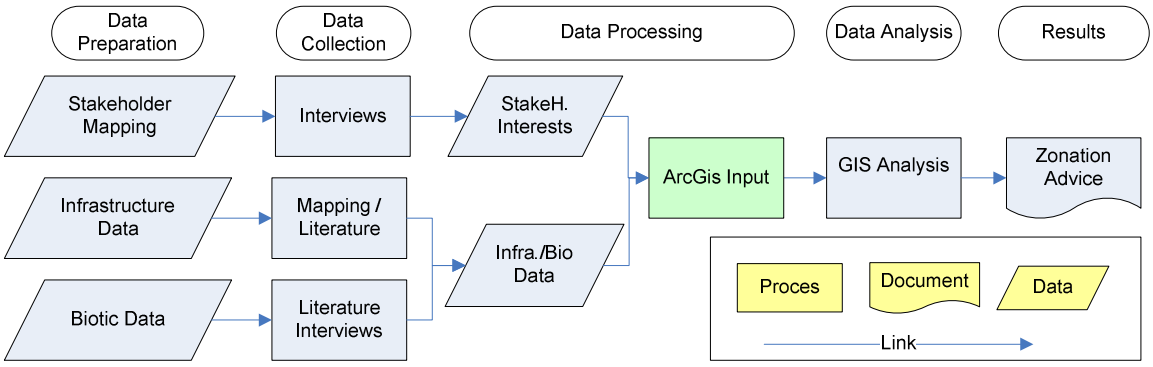


Fig. 14 Step VII of the MRA – Processing Data into ArcGIS

Vegetation types and key species distribution are digitized manually based on Beards vegetation publication (1946). The four vegetation types in North East Tobago are addressed separate layers in ArcGIS The spatial data of the plantation borders can now be used to intersect the layer of the total estate size to result in the surface which was not once plantation area and can be assumed to have a pristine vegetation composition. This new pristine vegetation part of the estate is now

intersected with the four vegetation types that are given by Beard which are again produced in 4 separate layers, the current pristine vegetation types within the estate.

For the process in ArcGIS see Fig. 15 on page 33, Processing Vegetation Data.

Processing Vegetation Data an overview

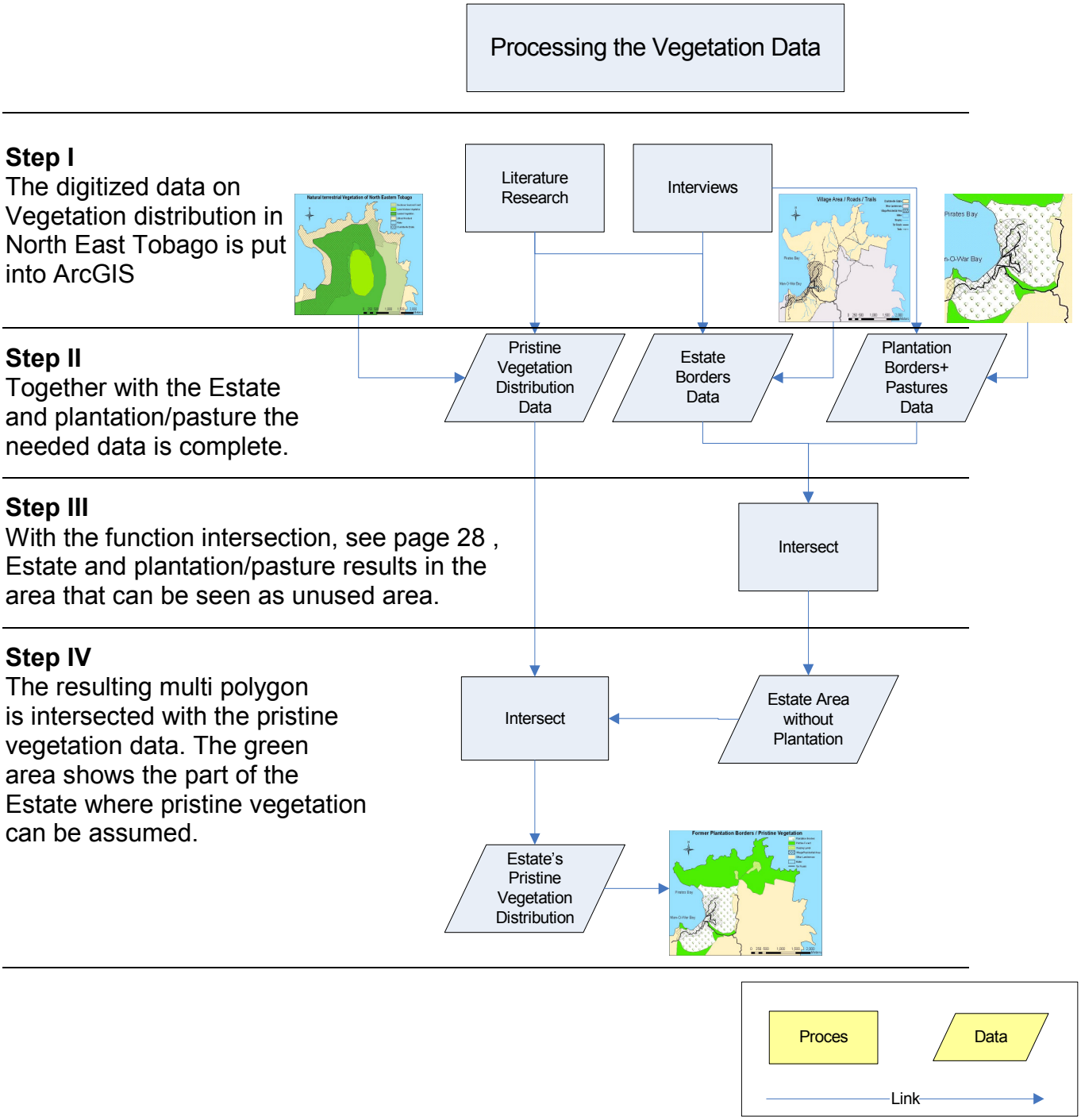


Fig. 15 Steps for Vegetation Data Input into ArcGIS

Processing Key Species Data

While the vegetation types are separately assigned with its own layer, the key species have been grouped into 4 classes to determine key species hotspots.

The four following classifications are chosen to fulfil requirements of different species.

- A 150 meter buffer range for endemic and/or rare bird species
- A 100 meter buffer range for endemic and/or rare species amphibian and reptile species habitat
- A 50 meter buffer range for endemic and/or ecotourism interesting species with a high mobility and migrating behaviour pattern.
- A 25 meter buffer range for species that are common, but have a high ecotourism value

TABLE 4 KEY SPECIES WITH 150 M BUFFER RANGE FOR ENDEMIC AND/OR RARE BIRDS.

Key Species	English Name	Status
8 Asio clamator	Striped Owl	Rare Endemic
9 Chiroxiphia pareola	Blue-backed Manakin	Rare Endemic
10 Cyanerpes cyaneus	Red-legged Honeycreeper	Rare
14 Nyctibius griseus	Common Potoo	Rare
15 Trogon collaris	Collared Trogon	Rare

These rare and endemic species in Table 4 were not found regularly. Two of them, Collared Trogon and Striped Owl could only be found once. (Klomp & Prinz, 2006) They have in common, a high requirement on their habitat, a specific feeding source or that they depend on undisturbed areas with primary forest. (ffrench, 2003) Based on the data that is available, it is chosen to assign a 150 meter buffer for every sight recording as an indicator of a high valuable habitat. Nevertheless more research should be done on this particular species to acknowledge or redefine locations that could be indicated as spots with a high potential biological value.

TABLE 5 KEY SPECIES WITH 100 M BUFFER RANGE FOR ENDEMIC AMPHIBIAN AND REPTILE SPECIES

Key Species	English Name	Status
1 Eleutherodactylus charlottevillensis	No English Name Given	Endemic, Rare
2 Mannophryne olmonae	Bloody Bay Poisoned Frog	Endemic, Endangered
3 Erythrolamprus ocellatus	Tobago False Coral	Endemic, Rare
5 Gonatodes ocellatus	Ocellated gecko	Endemic, Rare

All species in Table 5 are endemic to Tobago. The two frogs were only found at stream areas. The Tobago False Coral snake is becoming rarer according to herpetologist Hans Boos (Boos, 2001). The two found specimen were road kills. The ocellated gecko was not found in large numbers during the biodiversity assessment and is endemic to Tobago. (Murphy, 1997) Due to the amphibians low mobile behaviour and dependence on fresh water resource a buffer of 100 meter is chosen. This guarantees for amphibians a 200 meter stream area that will be buffered. There is nothing known about gecko numbers of this species. It was rare during the census and endemic on Tobago. The same goes for the Tobago False Coral snake. While the gecko is site depending, there is nothing known about territorial behaviour of the

snake. Their occurrence on a particular location is assumed as an indicator for good habitat parameters. For both a 100 meter buffer is addressed as a buffer.

TABLE 6 KEY SPECIES WITH 50 M BUFFER RANGE FOR ENDEMIC AND/OR ECOTOURISM SPECIES

Key Species	**English Name**	**Status**
4 Mastigodryas boddaerti dunni	Machete Couesse	Endemic sub-species
6 Caligo teucer	Cacao Mort Bleu	Common
7Anthracothorax nigricollis	Black-throated Mango	Common
11 Florisuga mellivora	White-necked Jacobin	Common

A 50 meter buffer range for the butterfly Cacao Mort Bleu and snake species Machete Couesse is chosen due to the species fast migrating behaviour in Table 6. The two hummingbird species were found close to a residential area and are therefore not classified as species that depend on pristine undisturbed vegetation. Nevertheless spots where species have been found should be considered as indicator for valuable sites.

TABLE 7 KEY SPECIES WITH 25 M BUFFER RANGE FOR COMMON SPECIES WITH AN ECOTOURISM VALUE

Key Species	**English Name**	**Status**
12 Galbula ruficauda	Rufous-tailed Jacamar	Common
13 Glaucis hirsuta	Rufous-breasted Hermit	Common

A 25 meter buffer range for Hermit species and Jacamars is chosen for these common bird species in Table 7. The Jacamar is depending on sandy banks for breeding which can be found along the roads and trails and is highly territorial. (ffrench, 1976) The rufous-breasted hermit is found on many locations. A specific habitat restriction with this particular species is difficult, especially due to the fact that hummingbirds adapt to dry and wet seasons in their territorial behaviour. (Hilty, 2003)

Conform to their class values of 25m, 50m, 100m and 150m buffer zones are created and overlaid. The sites with overlaying species buffers that show more than 3 key species in its range is than assigned with a 500 meter range and defined as the most valuable key species area. These buffer areas on the estate are than later assigned as a high priority area.

In Fig.16 processing of the key species data shows the approach in ArcGIS to determine key species hotspots.

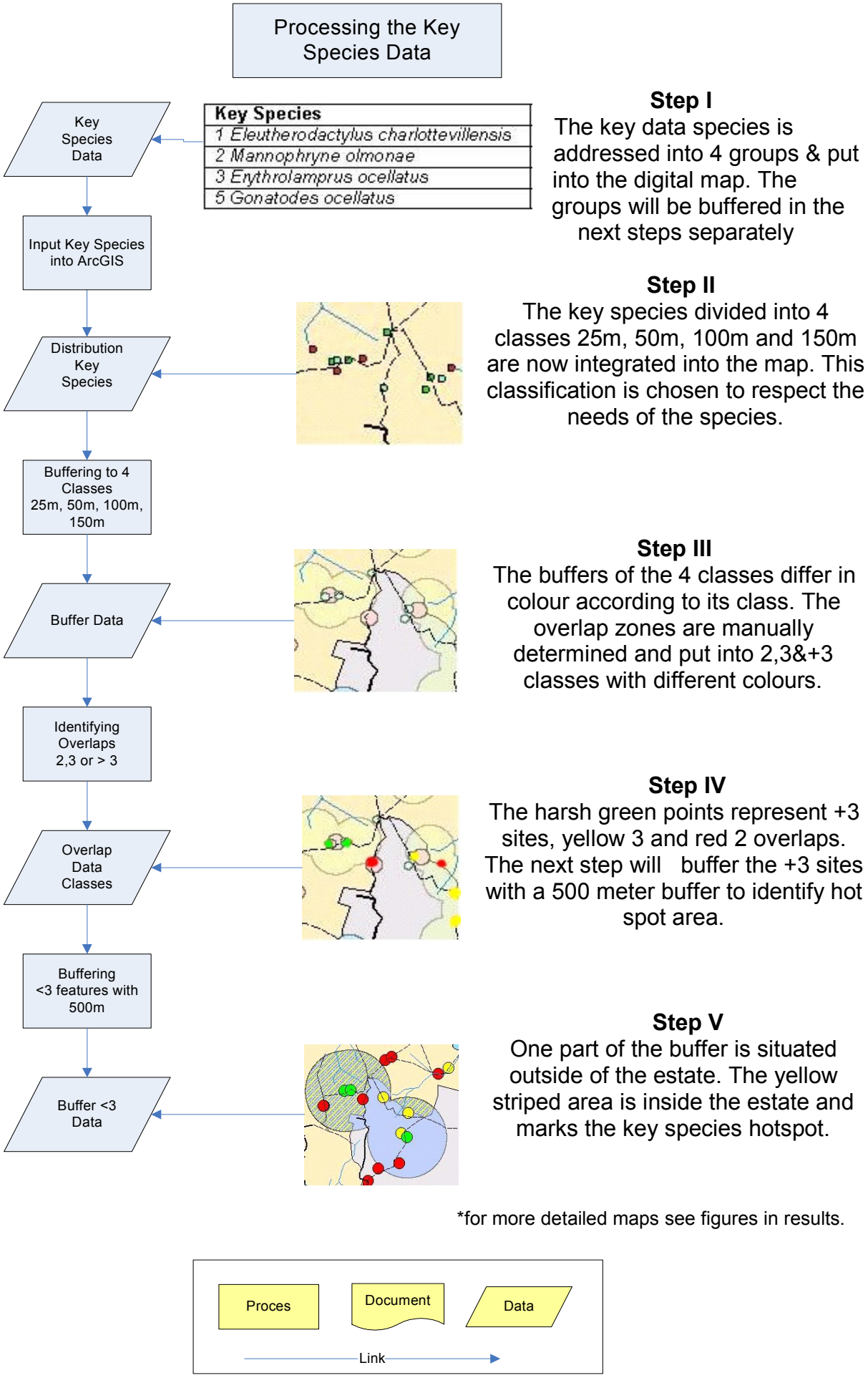


Fig. 16 Steps for Key species data input

3.6.2 Multi Criteria Analysis

Evaluation related question

12. *Which priorities must be set for the zonation approach based on the gathered data and MAB criteria?*

The following information concerning UNESCO, Biosphere Reserves and MAB is gathered from the official UNESCO website, (UNESCO, 2007b), MAB related information is gathered from (UNESCO, 2007a) and further exploration of the UNESCO website.
An elaborate version of the text in this chapter/paragraph can be found in annex II.

The MAB concept as criteria for an area analysis
As stated in the goal, the desire of the landowner is to incorporate a zoning of the estate in accordance with UNESCO's man and the biosphere as a tool for management activities. To do so understanding of the MAB concept is vital.
First of al the MAB is restricted to biosphere reserves part of UNESCO. All these reserves have in common their general lay out, they have a protected core area, a buffer zone surrounding the core area and a transition zone surrounding the buffer zone. These reserves share besides their layout, their sheer large size.
The relative small size of the Charlotteville estate, only 400 hectares, rules out adapting the original concept due to size. The desire for adopting the concept lies within the functions of MAB.
Biosphere reserves have three basic functions;

1. a conservation function, to contribute to the conservation of ecosystems, species and genetic variation;
2. a development function, to foster economic and human development which is socio-culturally and ecologically sustainable and;
3. a logistic function - to provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development.

If these functions can be realised within the Charlotteville estate, they could result in:

- a reduce of biodiversity loss,
- an improve of livelihoods for the local community
- an enhanced local perception of environmental sustainability
- increase of performed scientific research

To create a feasible zonation, dividing the estate into areas, core, buffer or transition area, it is necessary to evaluate the different area types present at the Charlotteville estate. A problem arises when the model of biosphere reserves is required for analysis. The concept of zoning remains the same but models of biosphere reserves are as numerous as the number of biosphere reserves themselves. Interpreting the biosphere reserve concept means incorporating the definition: *areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use.*

To create an evaluation in compliance to the definition and the functions of MAB the following criteria are selected to be in line with the MAB concept;

- the areas conservation value
- the developing potential
- research suitability

The remaining aspect of an area has to comply to the assigned status as suitable for ecotourism development by the stake holding parties. The stakeholders are important in this case because, one stake holding party owns the estate and the other, the local community, has to provide support in the tourism development process.

The areas conservation value

The value for conservation of an area is translated and determined by two aspects:

- animal key species presence and
- pristine vegetation presence.

Animal key species

The number of animal key species present in an area defines its conservation value. Information on key species is based on research performed by Klomp & Prinz in 2006 as preliminary work. The conservation value due to presence of key species is defined by two factors, the total number of key species and the number of different key species. A conversion table in which scaled groups are created to assign a value to an area with a certain number of key species provides an answer to the valuation problem. The conversion table used is created for this research.
The conversion of total species is based on the highest number of species found in an area on the estate, in this case 20 species in one area. This number is automatically assigned with the highest possible value. The analysis uses a scale of 1 to 5. Classes in the table are defined by dividing the highest number of found key species by 5. E.g. 20 found key species / 5 classes = 4 species, resulting in 4 species per class.
See Table 8 for conversion of the different areas key species.

TABLE 8 CONVERSION TABLE TO CONVERT TOTAL KEY SPECIES NUMBER TO VALUES FORTHE MCA

N total key species	Value
1-4	1
5-8	2
9-12	3
13-16	4
17-20	5

To prevent high densities of one single key species in an area to have a positive impact on the outcome of the analysis, areas are also evaluated by the numbers of different key species present. The number of different key species is also converted into values usable in the MCA. The maximum of 15 different key species is automatically the highest number of different key species an area can contain because only 15 key species are assigned, page 12, table 2. The conversion to usable criteria values is performed by dividing key species presence numbers into 5 scales. This scale analysis results in 3 key species per value step. Table 9 shows the 5 classes and the number of different animals an area has to contain to gain a value accordingly.
This is the same conversion method used as with total key species.

TABLE 9 ADDRESSING DIFFERENT KEY SPECIES NUMBERS TO A VALUE FOR THE MCA

N different key species	Value
1-3	1
4-6	2
7-9	3
10-12	4
13-15	5

The amounts for total key species and different key species are based on the data from Fig.25, Key species distribution, and displayed in Table 10. Conversion of these total and different numbers is performed by using conversion Tables 8 and 9.

TABLE 10 KEY SPECIES NUMBERS USED FOR CONVERSION FROM INDICES VALUE TO MCA VALUES

Mapped area	total N key species	N different key species
Land owner interest	12	7 (4, 6, 8, 9, 10, 12, 13*)
Community interest	13	7 (4, 6, 8, 9, 10, 12, 13*)
Pristine area	20	8 (2, 4, 5, ,6, 9, 10, 12, 13*)
Plantation	12	6 (1, 3, 6, 9, 12, 13*)
Village	4	4 (4, 6, 7, 12*)
Streams	4	4 (1, 2, 5, 6*)
Key species hotspots	13	7 (4, 6, 8, 9, 10, 12, 13*)

*****the numbers between brackets, ( ), in column, *N different key species*, refer to the numbers each different key species has been given in Table 2, E.g. 6 = *Caligo teucer*.

Pristine vegetation
The state of the vegetation is defined by Beard in 1946. The term pristine reflects to areas in which human impacts on vegetation are nonexistent or low. This could also be entitled as natural vegetation. Human impacts or human disturbance is entitled as a negative impact. The findings of Beard are supplemented with findings concerning vegetation status by Klomp & Prinz (2006). Table 11 visualises the state of the vegetation. The used scale goes from 0% to 100% pristine. For an area to be 100% pristine is virtually impossible. Pristine would then be; no human influence whatsoever, now and in the past, therefore small disturbance with a maximum of 20%, or i.e. 80% pristine, is still evaluated with the highest value possible.
The areas pristine state percentage is based upon the findings of Beard (1946). Due to the age of these data, a complementation by personal findings of Klomp & Prinz (2006) on present vegetation disturbance has been made during their field research and the assumed pristine vegetation is given as a percentage range.

TABLE 11 PRISTINE VEGETATION PERCENTAGES COMVERTED FROM INDICES VALUE TO MCA VALUES

Mapped area	**Pristine vegetation coverage**
Land owner interest	21-40%
Community interest	61-80%
Pristine area	81-100%
Village	0-20%
Plantation	0-20%
Streams	41-60%
Key species hotspots	61-80%

Mapped areas of the CE with their approximate pristine vegetation coverage percentage.

The conversion Table 12, converts the pristine coverage percentages of the areas into values suitable for the MCA. These values have been chosen for this research only. The more pristine vegetation coverage an area has the more valuable the area is for ecotourism and conservation. Simultaneously lacking pristine vegetation is less suitable for the mentioned activities and less favourable for most key species which adds to a lower score.

TABLE 12 THE USED VALUES IN THE MCA BY CONVERSION OF PRISTINE VEGETATION COVERAGE.

Pristine Vegetation Coverage	**Value**
0 -20%	1
21-40 %	2
41-60 %	3
61-80 %	4
81-100 %	5

The developing potential
As stated in the MAB concept, a certain level of development is required in an area for improvement of livelihoods, for an increase in environmental sustainability and potential research. These developments need to be sustainable and therefore must have a low impact. Developing activities might be: an improvement of trails through the estate, a small research station or an educational facility. The state of the area defined by the second criteria is leading for suitability of development. A pristine, natural state is preferred and has to be maintained as much as possible.

Development potential is therefore based on the vegetation structure, and works vice versa to the conservation value. A pristine area is unsuitable and therefore scores lower than disturbed areas. For ecotourism and research related activities, a site needs to be in a more natural state. The combination of both conditions results in the following table:

TABLE 13 PRISTINE VEGETATION COVERAGE, FOR THE MCA BASED ON ITS DEVELOPING POTENTIAL

Pristine Vegetation Coverage	Value
0 -20%	3
21-40 %	5
41-60 %	4
61-80 %	2
81-100 %	1

Research suitability

Research on ecosystems, in both flora and fauna is a continuing process. The lack of recent data concerning these topics in Tobago e.g. vegetation research dating back to 1946 and butterfly research from 1968, make it a plausible location for new research. Research might become an important development factor in the area. Sites which potentially have research preference gain a higher score during the analysis. The suitability of an area is calculated by combining three factors, key species, vegetation structure and trails.

The relative number key species **(n total + n different / 2)** in an area is divided by the length of the areas available trails in km. A higher relative key species-density of the different mapped areas represents a higher suitability for future research.

TABLE 14 THE LENGTH OF AVAILABLE ROADS & TRAILS PRESENT IN THE DIFFERENT AREAS OF THE CE.

Area	Road/trail length per area
Land owner interest	2350 m
Community interest	3500 m
Pristine area	4500 m
Village	4100 m
Plantation	2400 m
Streams	750 m
Key species hotspots	2700 m

TABLE 15 RELATIVE KEY SPECIES DENSITY, BASED ON N RELATIVE KEY SPECIES/ KM TRAIL

Criteria Maps	N Relative key species	Length trails km	Relative key species density
Land owner interest	9,5	2,35	4,0
Community interest	10	3,50	2,9
Pristine area	14	4,50	3,1
Village	4	4,10	1,0
Plantation	9	2,40	3,8
Streams	4	0,75	5,3
Key species hotspots	10	2,70	3,7

The formula for Relative key species is
(N different key + N total key species) / 2

The relative key species density is indicative for the suitability of an area for research purposes. The areas with the highest relative density represent the highest value due to high species numbers per area. Relative key species density number is the same as the areas research suitability value.

With the resulting MCA the created maps can be weighed for the determination of a high priority area, which finish the results.

4 Results

In this chapter the resulting data is presented. In the beginning the interview results are described and summarized. With the interview results, the spatial questions are answered and put into map information produced in ArcGIS (v.9.1). The sub-questions are stated and answered with an explanation of the outcome.

4.1 Stakeholder Analysis

On the next page you see the main stakeholders that play the decisive role in the decision making process of the zonation. Together with other stakeholders they are sorted by their influence that could play a role later in the later ecotourism development. The THA for example gives the legal frame for developments. As long as Charlotteville Estates Ltd. designs their development plans according to this framework the government can not influence a zonation management.

Stakeholder distribution matrix

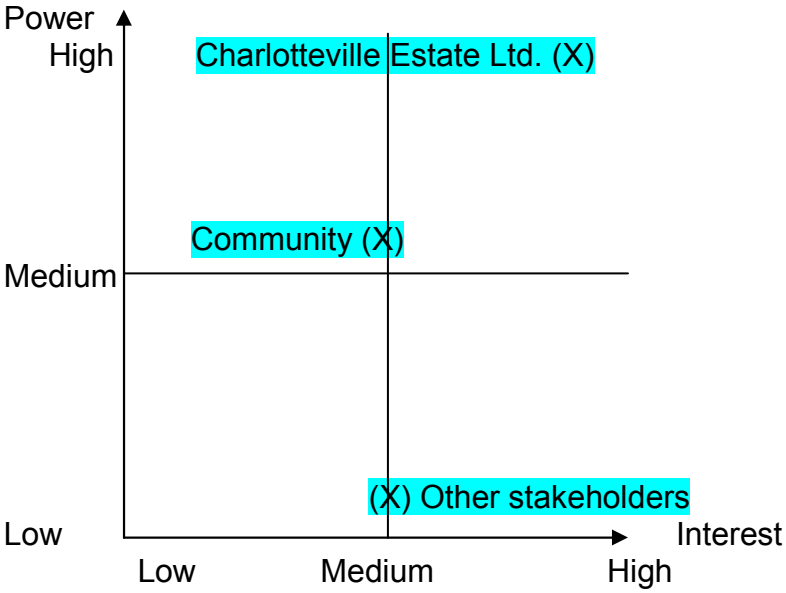


Fig. 17 Stakeholder Distribution Matrix

As stated by the assigning company, the focus had to be on the landowner, in this case Charlotteville Estate Ltd. and the Community of Charlotteville. The influence and interest of other stakeholders that were mapped at first are not of interest for an evaluation, since they do not influence a zonation decision. Nevertheless they could play a role in the implementation process of an updated management plan.

TABLE 16 STAKEHOLDER ATTRIBUTES CONCERNING LAND USE IN CHARLOTTEVILLE

Sorted by their influence on the zonation decision

Stakeholders Internal, i External, e Direct, d Indirect, id*	Characteristics Involvement in Land use	Interest in Land Use	Kind of Power	Position	Influence on party
Main Stakeholders					
Charlotteville Estate Ltd. (i, d)	Owner, Manager and final decision maker	Conservation top priority with sustainable profit oriented operations **High**	High (formal & material)	Supportive	**High**
Local Community (e, d)	Engagement for village development	Fair resource usage, Protecting of the Village facilities and needs **High**	High-Medium (formal & informal)	50 / 50	**medium**
Other Stakeholders					
THA (e, id)	Providing Legal Framework	Giving Developmental Guidelines **High**	High (formal & material)	Supportive	**Low**
SPCFCS (e, d)	Farmer Organisation for agric-use of the Gardens in the area & project developer	Sustainable use of the land with benefits and incentives for agricultural use **High**	High-Medium (formal & informal)	50 / 50	**Low**
Hunters Association (e, d)	Hunting during hunting season	Ensure Hunting Access **High - Medium**	Medium (formal & informal)	inactive	**Low**
Tourists (e, id)	Recreational Pressure	Maintain Natural Beauty **Medium**	Medium (material)	inactive	**Low**
Researchers (i, id)	Data for Management	Not essential **Medium**	Low-Medium (material)	inactive	**Low**
Economic Operators (e, d)	Not directly participating, but user	No contribution **Low**	Medium (informal & material)	inactive	**Low**
NGO Environment Tobago (i, d)	Not directly participating	Interest in Sustainable Developments **Medium**	Medium (informal)	50 / 50	**Low**

*see Data Collechton Methods for theoretical background

4.2 Interviews

In total 41 interviews were conducted in the last week of November 2006. 40 community members and the owner of the Charlotteville estate were interviewed. See appendix V for; gender, age class and occupation of the community interviewees.

For a successful ecotourism project, visions about important terms and future perspectives need to be in agreement with the stake holding parties. This interview was held to compare the opinion of the landowner and the opinion of the community and to get a general impression of the desired ecotourism project location and the attitude towards an ecotourism project.
The information required focuses on: development, eco-tourism and nature conservation. The interview questions can be found in annex III and IV.
A combined elaboration of the interview results is stated in the following paragraph.

Development
The rate of development and the opinion about this is leading for potential ecotourism development in Charlotteville. When the landowner and the community were asked about present development and responsibility for this the outcome revealed that present development is low and the overall opinion about this is poor, on a scale of 1 to 10 the average mark was 5,5. For improvement the community looks at itself and at the government (23 and 17 of N=40). On the other hand, the landowner feels responsible for development of estate property only. She thinks that the government is not providing the community with enough information about development and the community is not aware of the possibilities it has for development.

Ecotourism
The main stakeholder was asked about ecotourism in an open question. According to Patricia Turpin eco tourism means: *ecotourism is tourism based on ecology it takes into account the environment and its biodiversity*.
The remark she stated is that the term ecotourism is broadly used for presenting projects as environmental friendly all over the world. On Tobago it is primarily used as an advertising gimmick.

The community members where asked the same question but in a different lay out. The question presented eight possible features of ecotourism. Every interviewee could point out terms which describe features of ecotourism most, in which one feature was the minimum and three the maximum. N=40, the 40 people assigned in total 92 features, on average 2.3 features each.
The outcome is presented in the bar diagram in fig. 18. The bars represent the number of times each feature is chosen.

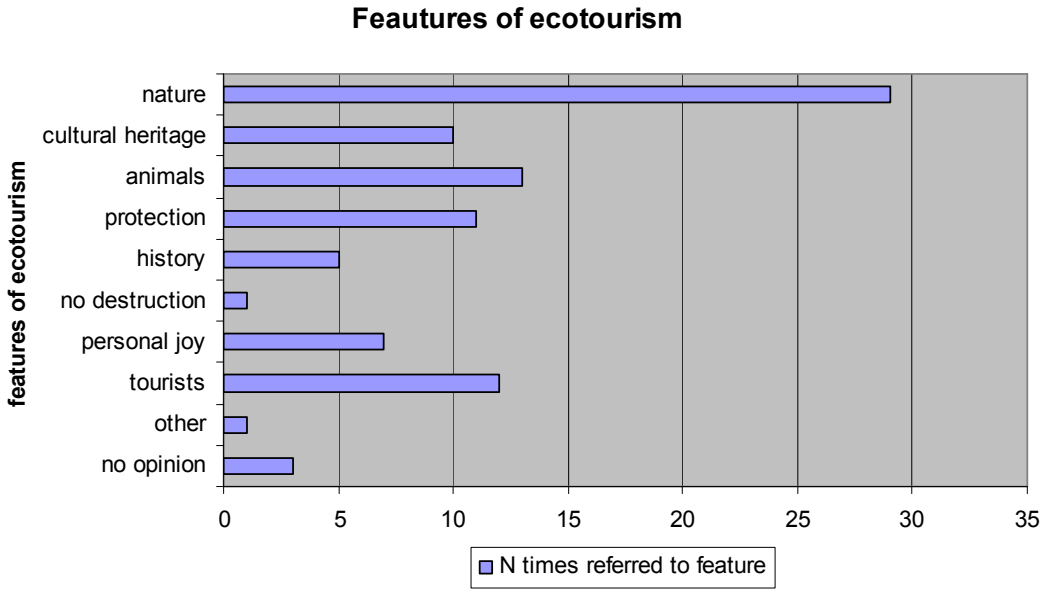


Fig. 18 Distribution of features that have been stated by community members as "Ecotourism" features. N=40

For an ecotourism project to be successful the factor of cooperation within the community is important. Questions on tourism and project perception need to be answered.
Almost everyone agreed to see more tourists in Charlotteville, only one interviewee replied: the current number of tourists is enough for the village (restaurant owner, 54yr). Support for an ecotourism project is high, 82,5 % (N=40) of the community thinks that such a project will attract more tourists to the village. The landowner is less positive. It is expected that a project in Charlotteville succeeds or falls by marketing and advertisement.

The bar diagram in Fig. 19 represents the opinion of local people concerning animal classes and their idea of the tourist point of view. To chose multiple animal classes is possible N=40.

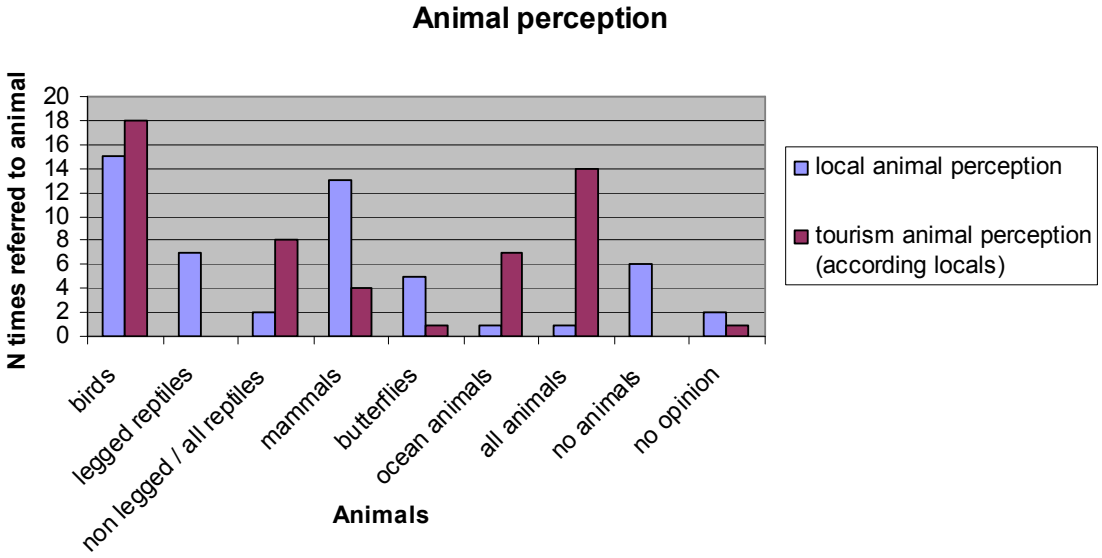


Fig. 19 Perception of animals by local community and tourism perception on animals according to local community. N=40

Conservation

Possible effects of an ecotourism project are according to Patricia Turpin two folded. Due to the current land use of the estate, entitled as “non managed due to lack of manpower” and other threats as; not enough game wardens to cover the areas on the island/estate which have biological value and to enforce law, the sewage pollution, logging and bad agricultural practices.
Ecotourism can provide the money and therefore the possibility for manpower or awareness to change these problems. But if tourism roams freely without a controlling factor, it can become a more destructive then constructive factor.
To prevent overexploitation but to fulfil the need of the village and the Estate to attract more tourists a wildlife reserve and an integrated ecotourism project are a possible solution.

An ecotourism project must according to Patricia Turpin comply to the following requirements:

- it should be a sustainable project which encourages growth of wildlife numbers and aids the conservation of flora and fauna
- A project must have local employees eg. guides, and should be educational for both tourists and local residents
- The tourism group favoured, the educational tourism group, representing students and researchers

A large segment of the community shares the perception of Patricia Turpin on possible positive effects of ecotourism, out of N=40 only three interviewees were negative about the conservation possibilities provided by tourism. One interviewee stated that*: we are not destroying the forest it’s the foreign people who do it.* (construction builder, 37yr).

The present day usage of the estate of small scale agriculture, logging of fallen trees and illegal hunting is partly preserved by the community. When people were asked whether they like to see parts of the forest as a wildlife reserve or as an ecotourism project area, the response was predominantly positive: 36 persons (90%) were in favour for assigning a part of the forest as an ecotourism area in which hunting and small scale logging was allowed for some time during the year. A wildlife reserve in which no logging or hunting was allowed was welcomed less positive, but still 72,5% was in favour of such an initiative. The only problem foreseen by many people was that due to the ban on hunting in such an area, poaching was expected and others said that "*people should always be allowed to hunt".*
As an indication everyone was asked to point out on a map or mention a specific site of the area in which according them was most suitable for ecotourism. Patricia Turpin likes to see the ridges and the water streams protected/conserved and the community want to focus the attention to the flagstaff hill section of the area, Pirate's Bay and the Northern costal forest part.

Summarised; it is the belief of Patricia Turpin that ecotourism could benefit the community financially and that the environment benefits due to growth in environmental awareness resulting in an increase of nature conservation.

4.3 GIS Results

The first four spatial research questions about infrastructure can be put together into one map.

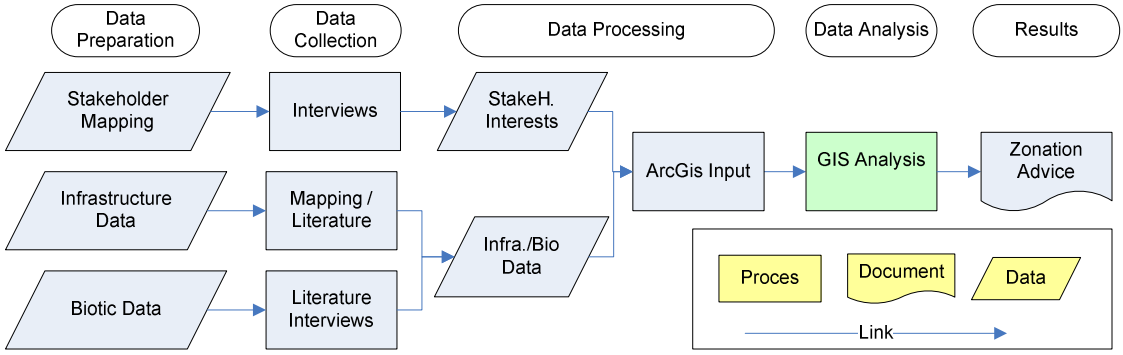


Fig. 20 Step VIII of the MRA – Conducting Spatial Analysis in ArcGIS

The roads, trails and village locations in Fig.21, were taken with GPS mapping. The position of the streams and coast is based on a map of Charles Turpin and are digitized by using a geo reference (see Geo Reference, Methodology).

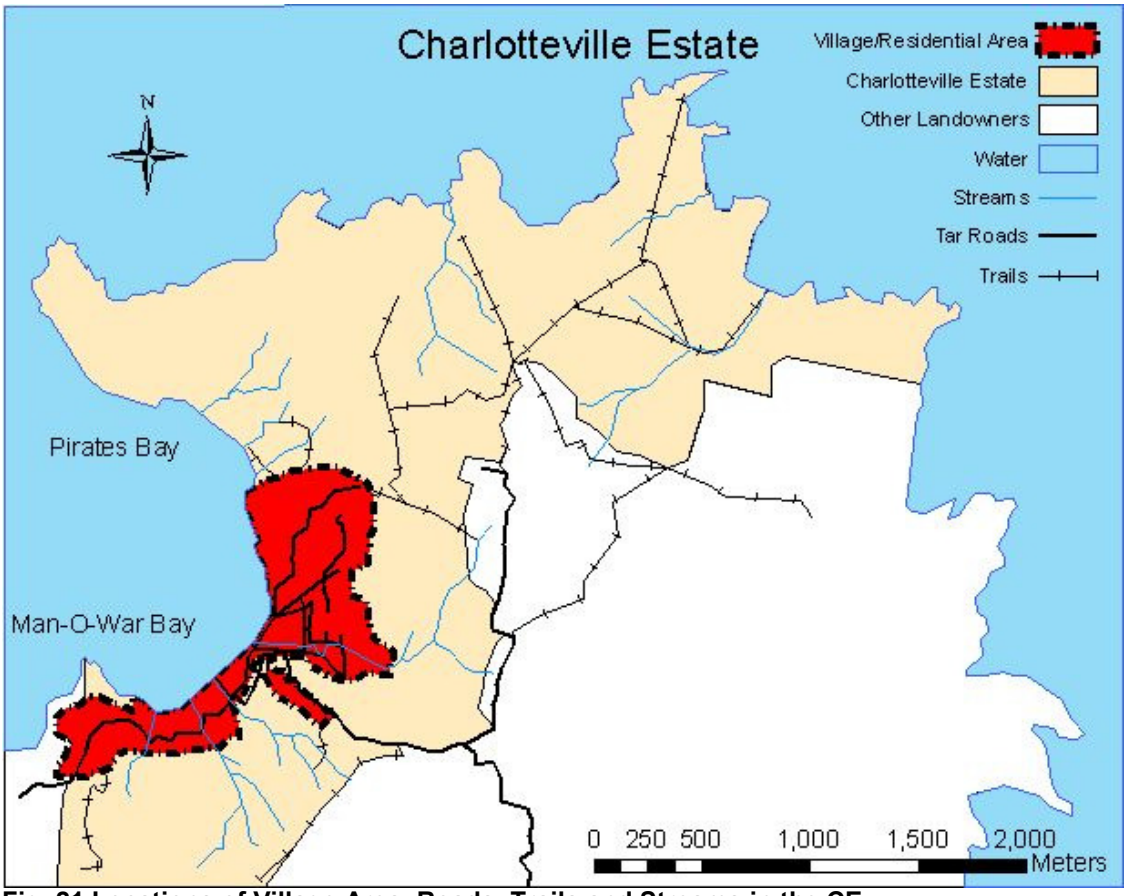


Fig. 21 Locations of Village Area, Roads, Trails and Streams in the CE
(map is based on Charles Turpin's map 'Jacamar Reserve')

The next question to be answered was to determine the area that was covered by the former cocoa plantation.

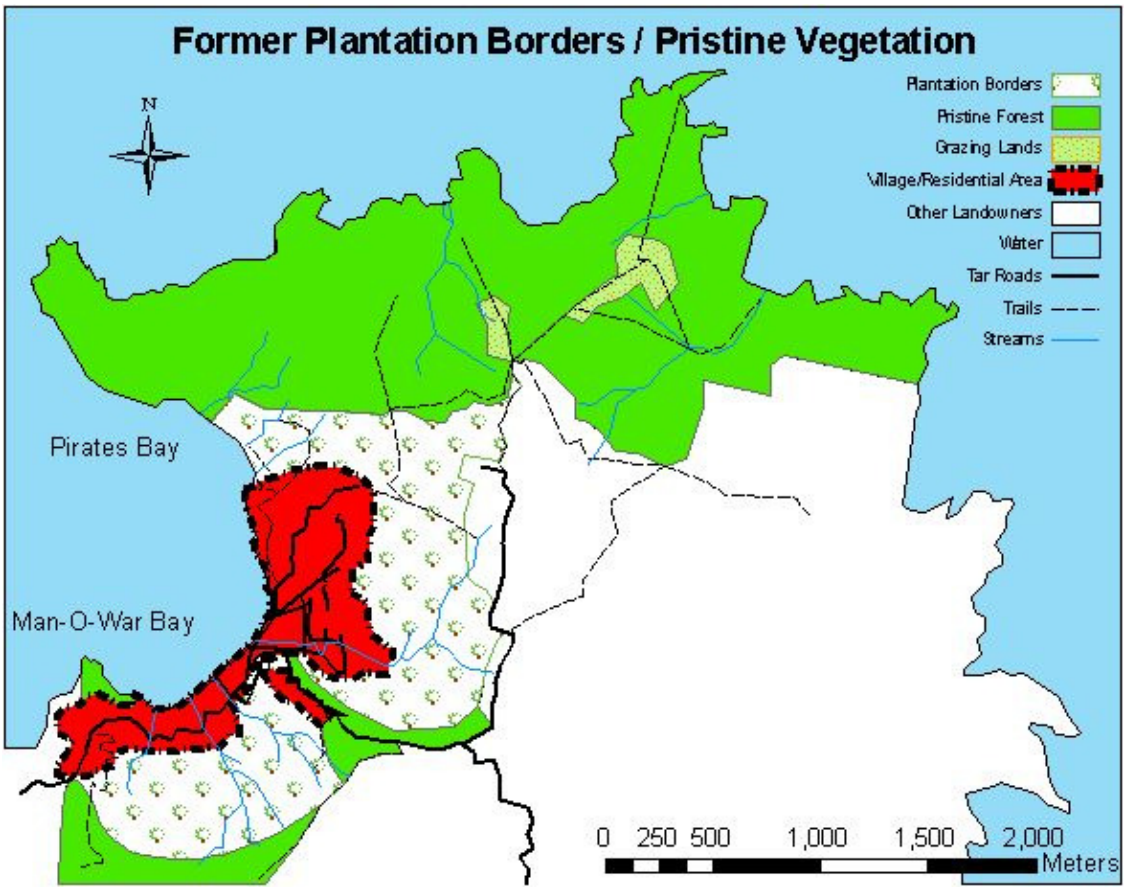


Fig. 22 Assumed Former Plantation Borders and Pristine Vegetation in the CE
(based on Ceryl Turpin, 1929 & Interviews, map is based on Charles Turpin's map 'Jacamar Reserve')

The plantation borders in Fig.22 are shown in white with tree icon coverage. It shows the assumed plantation extent. Patches within the plantation area can show still untouched vegetation. A couple of pasture fields are in the very centre of the northern part and were located during mapping procedure of the forest trails. Here, two farmers breed cattle in a small number of about 20 cows that are held on grass and shrub lands using an extensive technique. The shown village area is confirmed by different maps. One of them was taken from Charlotteville Estates Ltd., the other is provided by the PRDI as a part of the North Eastern Tobago Development Plan. The rest of the CE is covered by assumed pristine vegetation.

The only existing flora assessment of Tobago was published in 1944 by Beard. His findings are the starting to define which vegetation types can be found in the estate area. With this information the present vegetation types in the area can be shown? (Fig.23)

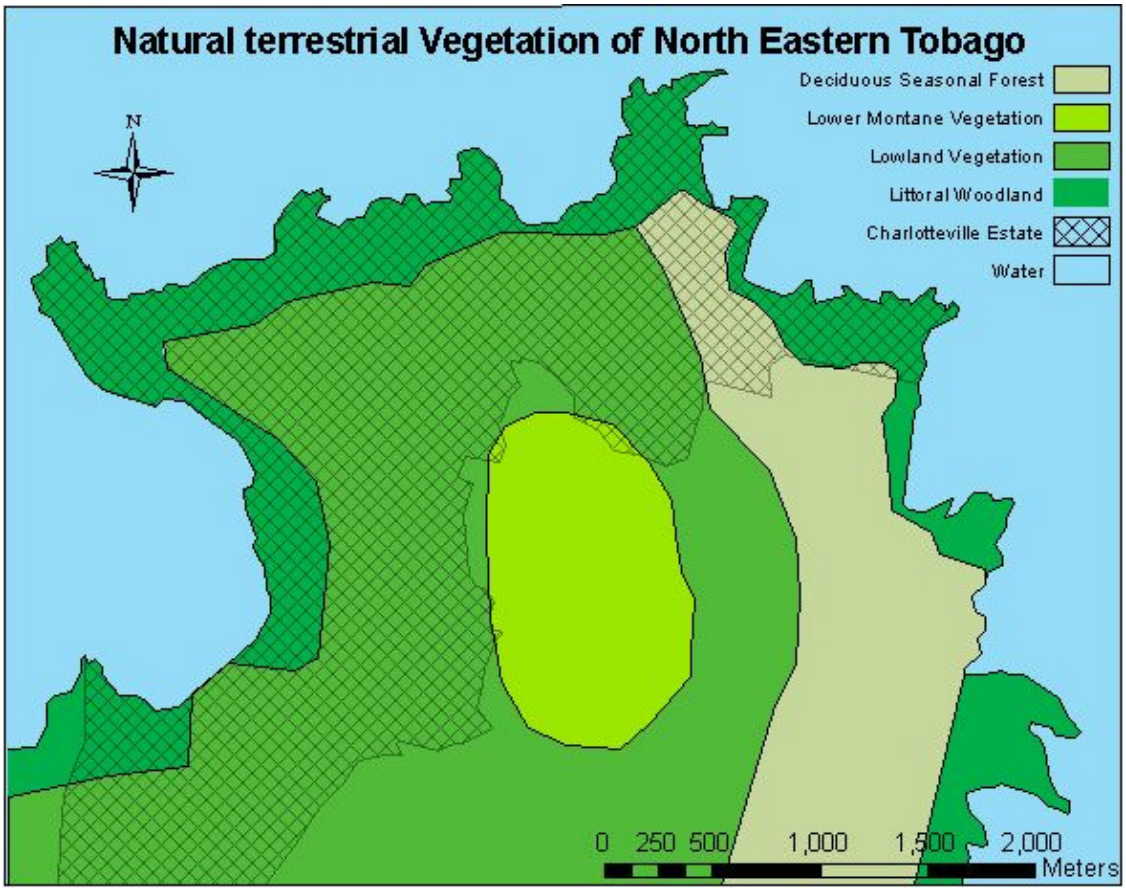


Fig. 23 The natural terrestrial Vegetation of North Eastern Tobago
(based on Beard, 1946, map is based on Charles Turpin's map 'Jacamar Reserve')

Two vegetation types dominate North Eastern Tobago: Lowland vegetation and littoral woodland. A small fragment is covered lower montane vegetation in the centre and a stripe of deciduous seasonal forest.

Combining this data with the former plantation defines the *area of the estate that is covered by which vegetation. (Fig.24)*

Figure 24 shows the composition of the pristine forest coverage belonging to the research area. Littoral woodland together with lower montane vegetation are responsible for the largest share of the surface. A lesser part of seasonal deciduous forest vegetation is followed by a negligible coverage of lower montane vegetation. The grazing fields are shown as unnatural disturbed vegetation together with the former plantation extents.

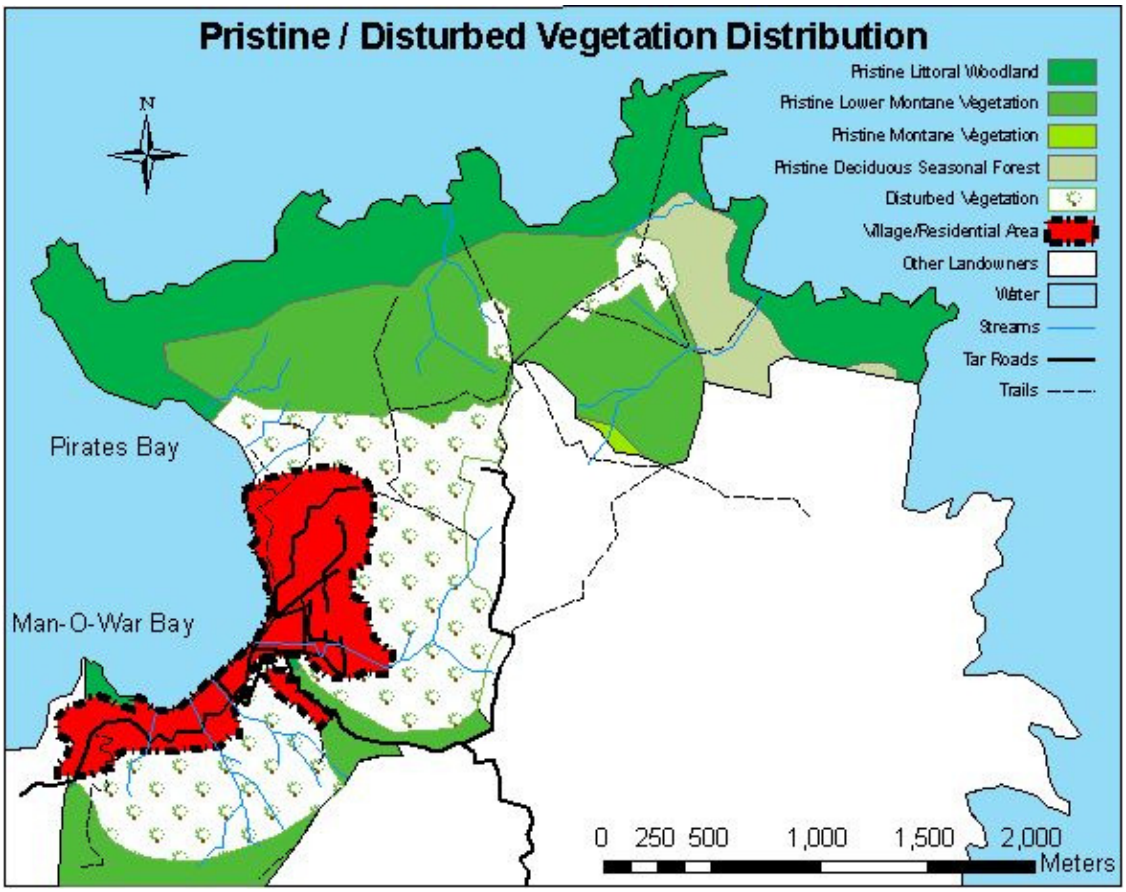


Fig. 24 Pristine and Disturbed Vegetation Distribution in the CE
(Borders are Based on Ceryl Turpin, 1929 & Interviews, map is based on Charles Turpin's map 'Jacamar Reserve')

After the determination of the vegetation types in the estate, the basic data for one of the zoning approaches is now available for further data processing. To accomplish the date of the two other zonation approaches, key species and stakeholder interests.

The next steps illustrate the description of key species distribution and specifying the hot spot areas. With the biodiversity assessment that was done prior to the thesis investigation the needed data only needs to be digitized. The GPS data of the locations were key species were found were processed into ArcGIS using Excel tables. The different key species have indices from 1-15, see Fig.25.

For assigning the numbers 1-15 to species, see page 12, table 2.

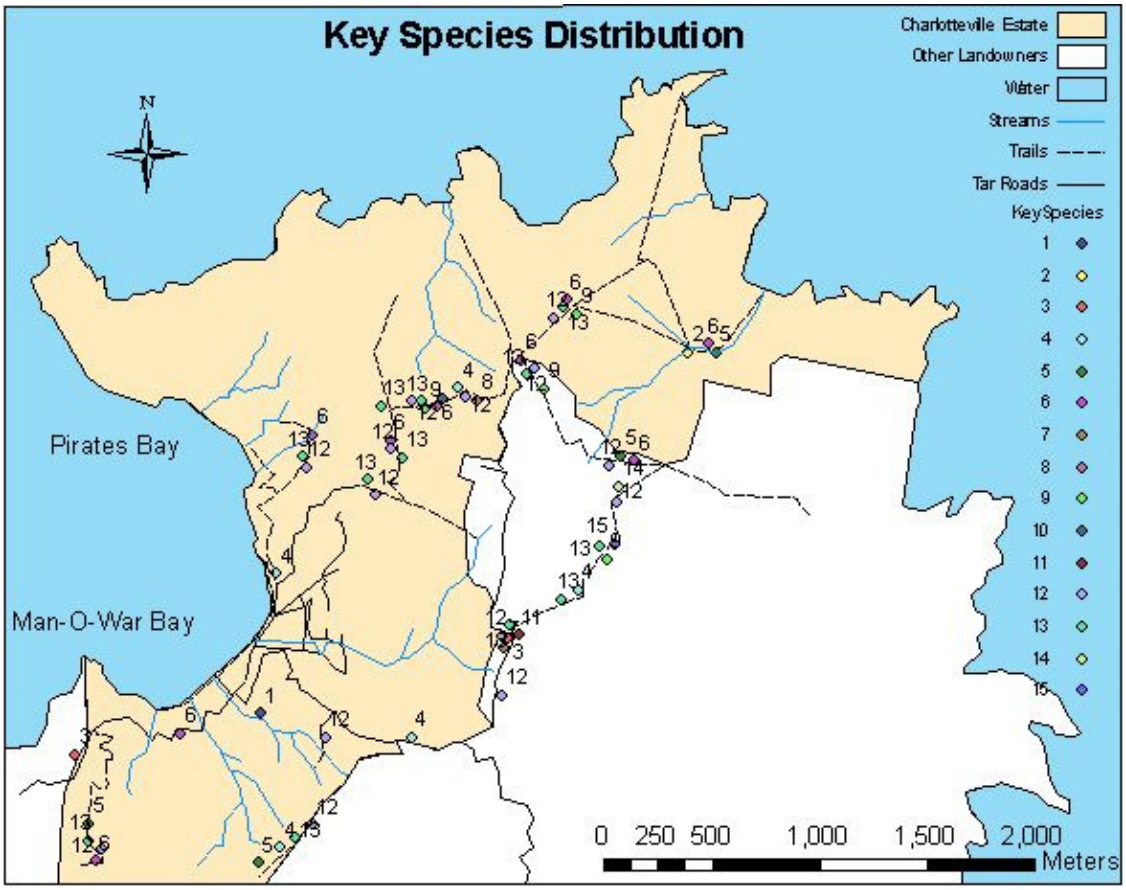


Fig. 25 Key Species Distribution in the CE with Indices
(Borders are Based on Ceryl Turpin, 1929 & Interviews, map is based on Charles Turpin's map 'Jacamar Reserve, key Species Source Klomp&Prinz 2006')

The different key species were clustered into 4 groups to facilitate a determination of key species hotspots.

With this the following key species locations can be addressed on the map. (Fig.26)

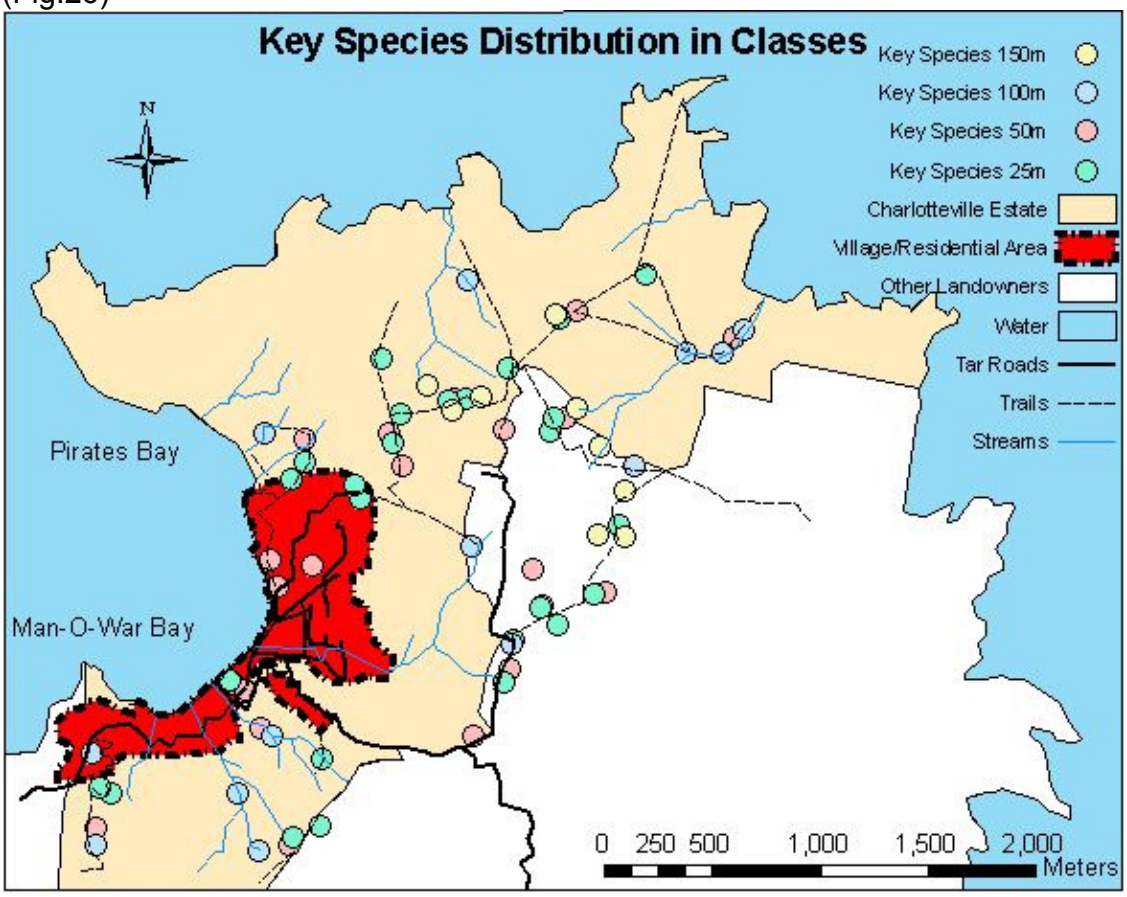


Fig. 26 Map with Key Species Distribution in North Eastern Tobago
(key species locations are based on Klomp & Prinz, 2006, map is based on Charles Turpin's map 'Jacamar Reserve')

The 15 different key species were put into 4 classes with different buffer parameters and are illustrated in four different colours. One key species location represents the single or multiple observation of a key species. The classification is done to determine hotspots, answering the next research question.

With three extra procedures (see fig. 16, page 36) the key species hotspots are determined. The first step is to activate the buffers of the 4 different key species groups *(Fig.27)*

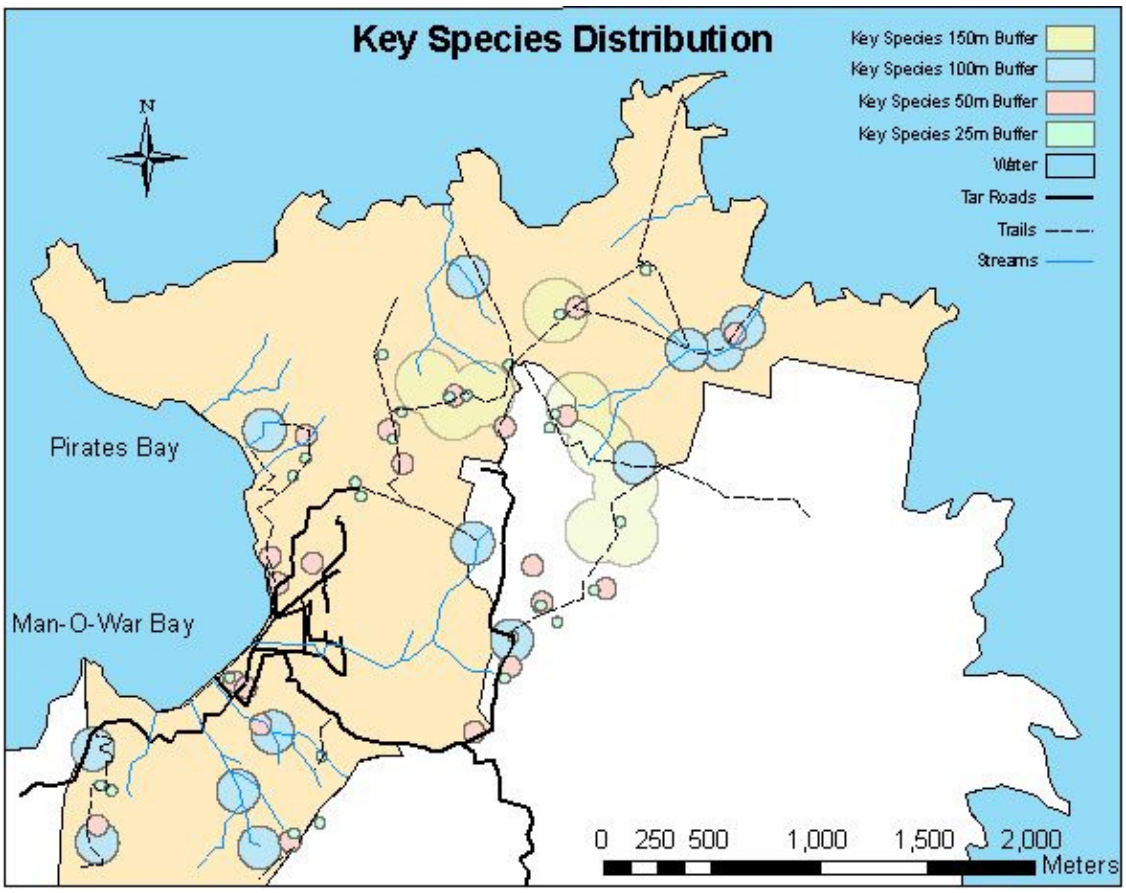


Fig. 27 Key Species Classes with Activated Buffers
(map is based on Charles Turpin's map 'Jacamar Reserve', key species locations are based on Klomp & Prinz, 2006)

Now the different key species buffers, ranging from 25, 50, 100 and 150 meter visible in the map. Locations of 2, 3 and +3 overlapping buffer-zones are determined and assigned and the centre of the intersections are unified as 2,3 or +3 buffer locations.

The next map describes the buffering of the +3 buffer locations. These were chosen as indicators for suitable key species habitats. With defining a range of 500 meters around the +3 buffer locations a circular surface area is created which is cut by the layer describing the area of the other landowners.

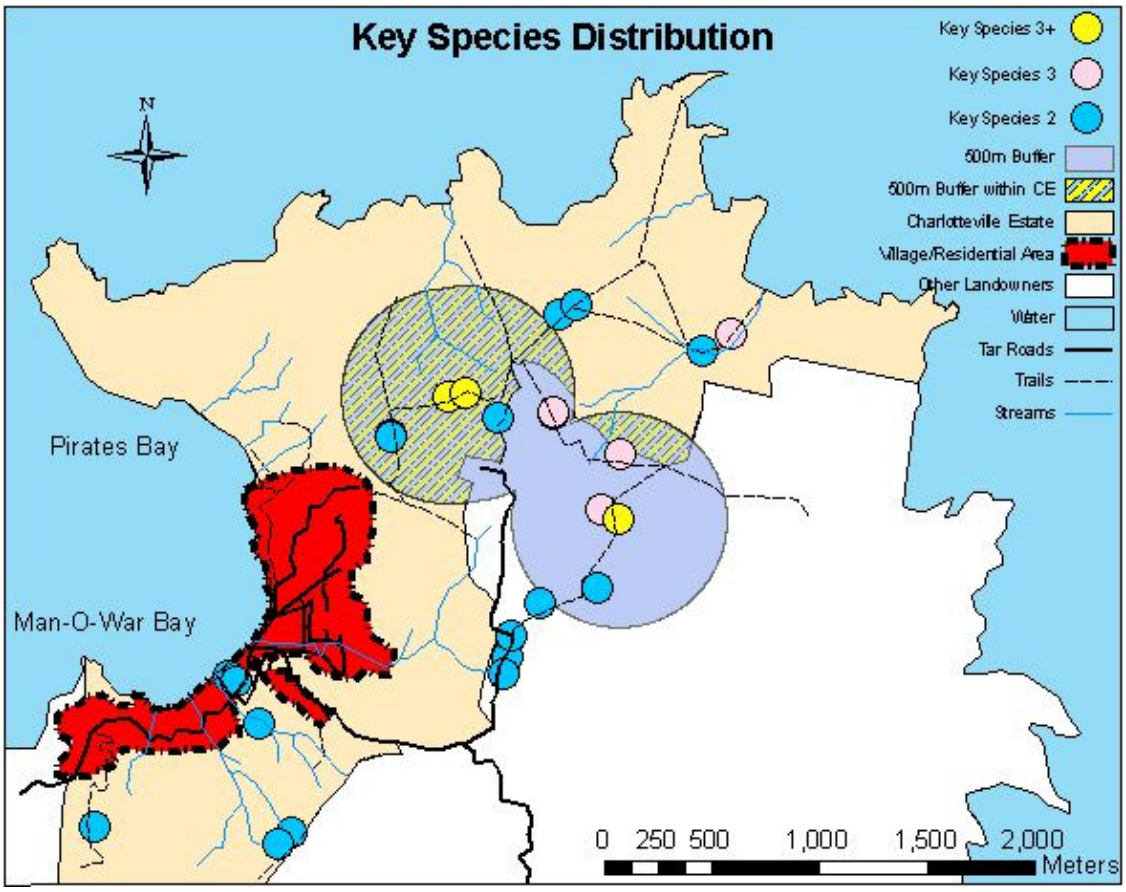


Fig. 28 Hot Spots of Key Species Distribution
(based on key species locations by Klomp & Prinz, 2006, map is based on Charles Turpin's map 'Jacamar Reserve')

There is a higher occurrence of key species at two sites (Fig.28). One of the cores is located in the estate whereas the other finds its centre about 1 km outside to the South East (green dots). A range of 500 meters around these key species hot spots are taken as a measure to assign the most valuable area for protection according to their presence. Within the range, 3 of the four spots where 3 key species were found are covered, while two are situated right to the border of the estate and the other close to the centre outside the estate.
The main trail runs though no estate lands, where close to the estate border a high number of key species were observed. To respect these findings, these found key species were taken into account. One of the green +3 buffer-locations is situated in the lower right to the other two. With its buffer it buffers additional to the other two +3 buffer-locations a smaller part North to its location (striped area).

Zonations can be done by choosing different management priorities. In case of a restriction in biological data about an area, all existing data should be weighed and taken into account, respectively new fieldwork should be done to solve the lacking data.

4.4 MCA Results

The resulting MCA tests the maps on their suitability for an area zonation by criteria that have been translated from UNESCO's MAB concept. This is visualised in Table 17.

TABLE 17 MCA RESULT OF MAP SUITABILITY IN ACCORDANCE WITH MAB CRITERIA

MAB Criteria	Conservation value	Development & Logistic value

Criteria / Areas/ Maps	Total key species value	Different key species value	Vegetation value	Developing potential	Research suitability	Total score
Land owner interest	3	3	2	5	4	**17**
Community interest	4	3	4	2	3	16
Pristine area	5	3	5	1	3	**17**
Village	1	2	1	3	1	8
Plantation	3	2	1	3	4	13
Streams	1	2	3	4	5	15
Key species hotspots	4	3	4	2	4	**17**

The score values range from 5, the highest possible value, to 1, the lowest value. **Each criteria** has the same weight factor.

Explanatory for this analysis is that the area with the highest total score has the highest value for ecotourism and preservation. This area deserves highest attention during the zonation process.

The first prominent fact is, that the same total score is given to three different areas. These areas, respectively the landowners interest, pristine areas and the key species hotspots, are the dominant factors for creating the zonation map. The small difference with the areas representing: the community's interest, stream flows and even the plantation, result in an incorporation during the

zonation if possible. The village area has the lowest score and is therefore not seen as an area in which the ecotourism or protection is necessary.

With the score table results of the MCA 5 maps seem to be equally important while differing only in two points. Paragraph 4.5 will explain further about the map process.

4.5 Zonation Approach

The gathered data is now analyzed and combined together. The three approaches of **stakeholder interests**, **pristine area, stream areas** and **key species hotspots** are combined (see Fig.29). The stakeholder interests represented in the maps of the landowner and the community will be unified to one Unified Interest map. With this map, intersections will be done separately, with the key species hotspot map and the pristine vegetation map. The resulting intersections are unified with the stream buffer areas and are addressed to become a high priority area for a final zonation advice. The disturbed area map as well as the village map was not taken into account for the determination of the high priority area.
The next resulting maps show the steps and interim results that are described in Fig.29 and lead to the high priority area that will be the basis for a zonation advice.

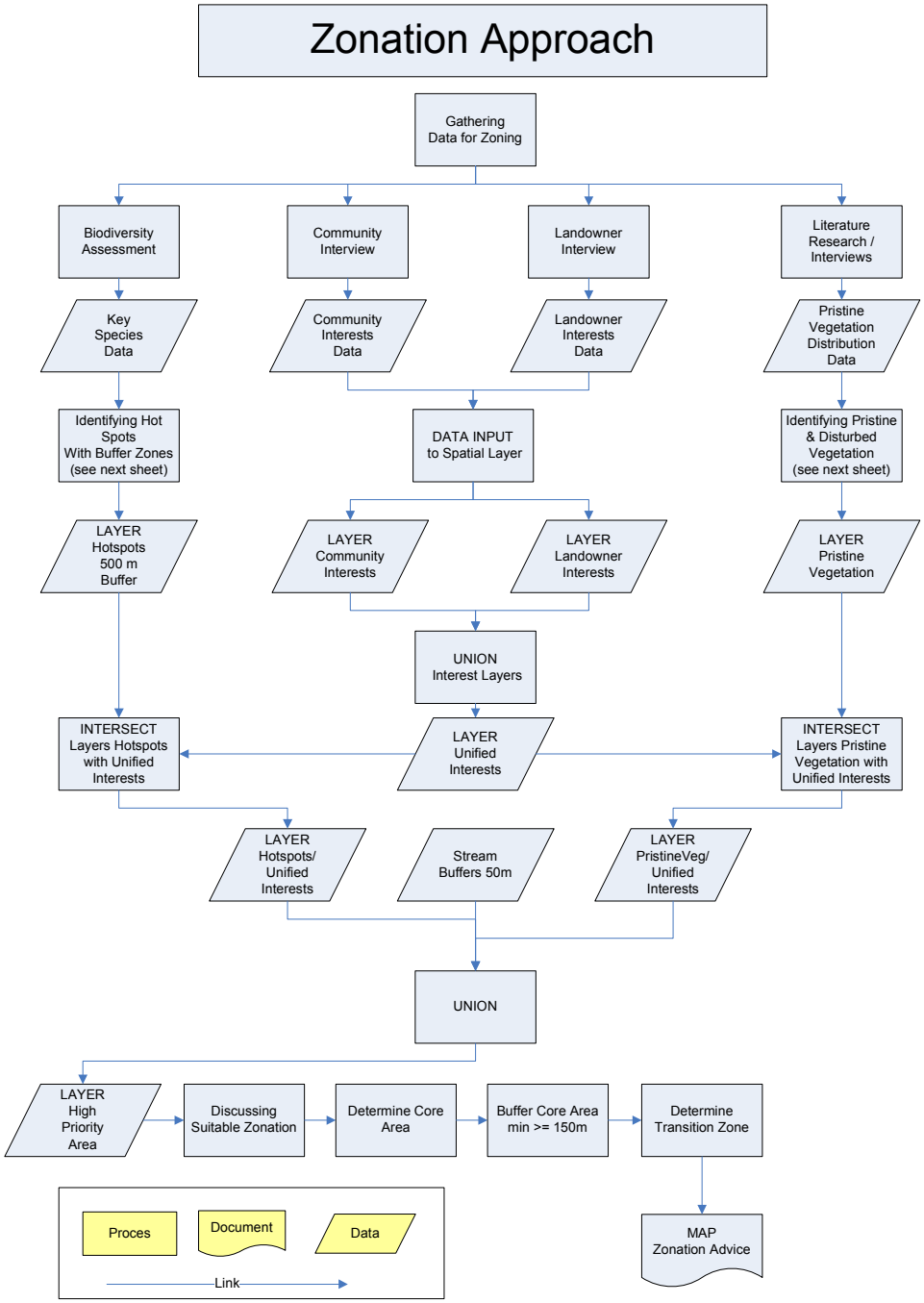


Fig. 29 Zonation Approach to a Map with High Priority Area.

Community Interests

Fig.30 shows the resulting area that was described during the interviews by the community as favoured areas for a protective status.

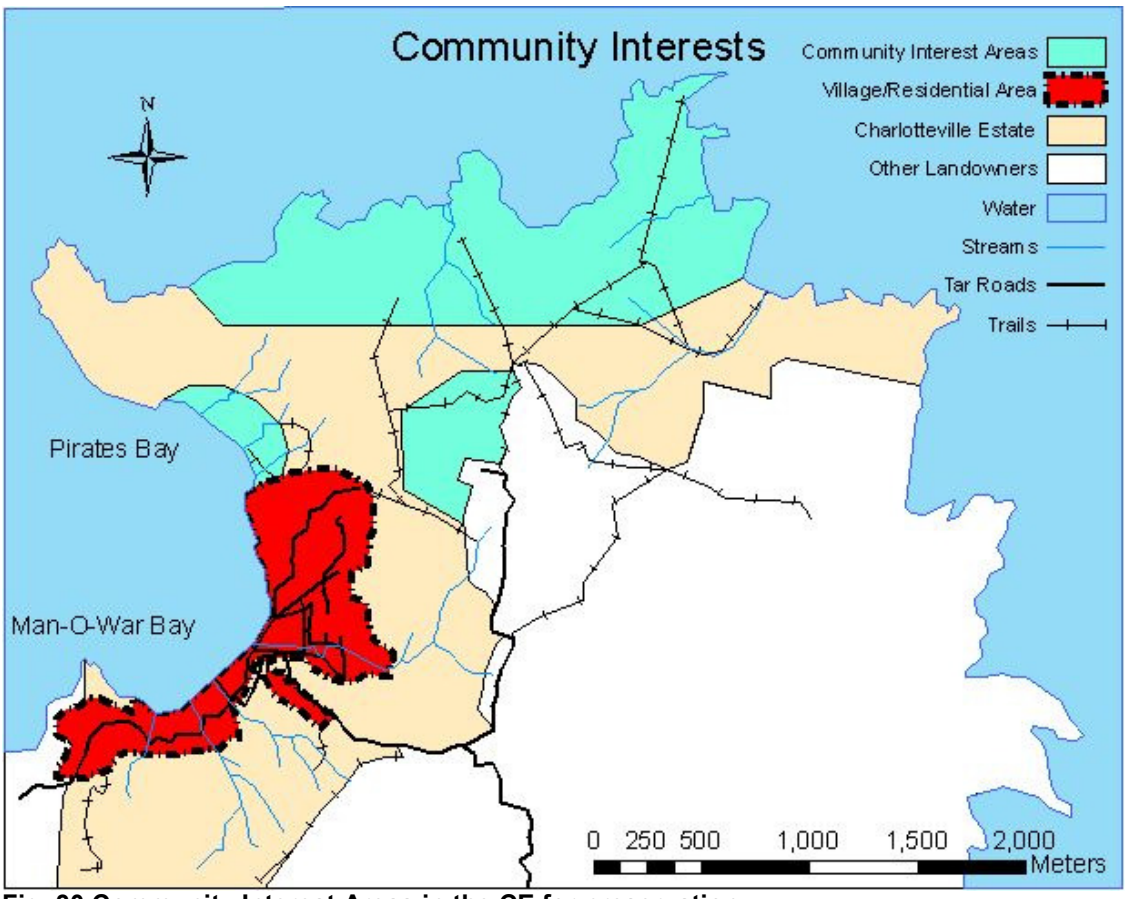


Fig. 30 Community Interest Areas in the CE for preservation
(map is based on Charles Turpin's map 'Jacamar Reserve', Community Interests based on the conducted Interview)

The striped regions in Fig.30, are the sites, where Charlotteville citizens tended to give a favour for protection and ecotourism activities. Pirate's Bay Beach, Flagstaff Hill and the costal forests to the most Northern point were mentioned. They will be combined with the landowner's interest area to reflect both stakeholders interest areas in one map.

Landowner Interests

This map (Fig. 30) shows the landowner priorities for protecting specific landscape features in the Estate. The ridge areas are concentrated in the centre and continue beyond estate lands. It was stated that the protection of the ridges is chosen, due to the fact that here a high number of species is expected. The ridges are taken also from a map that was provided by Charlotteville Estates Ltd. created by Charles Turpin. The approximate ridge locations were drawn into the map Fig.31.

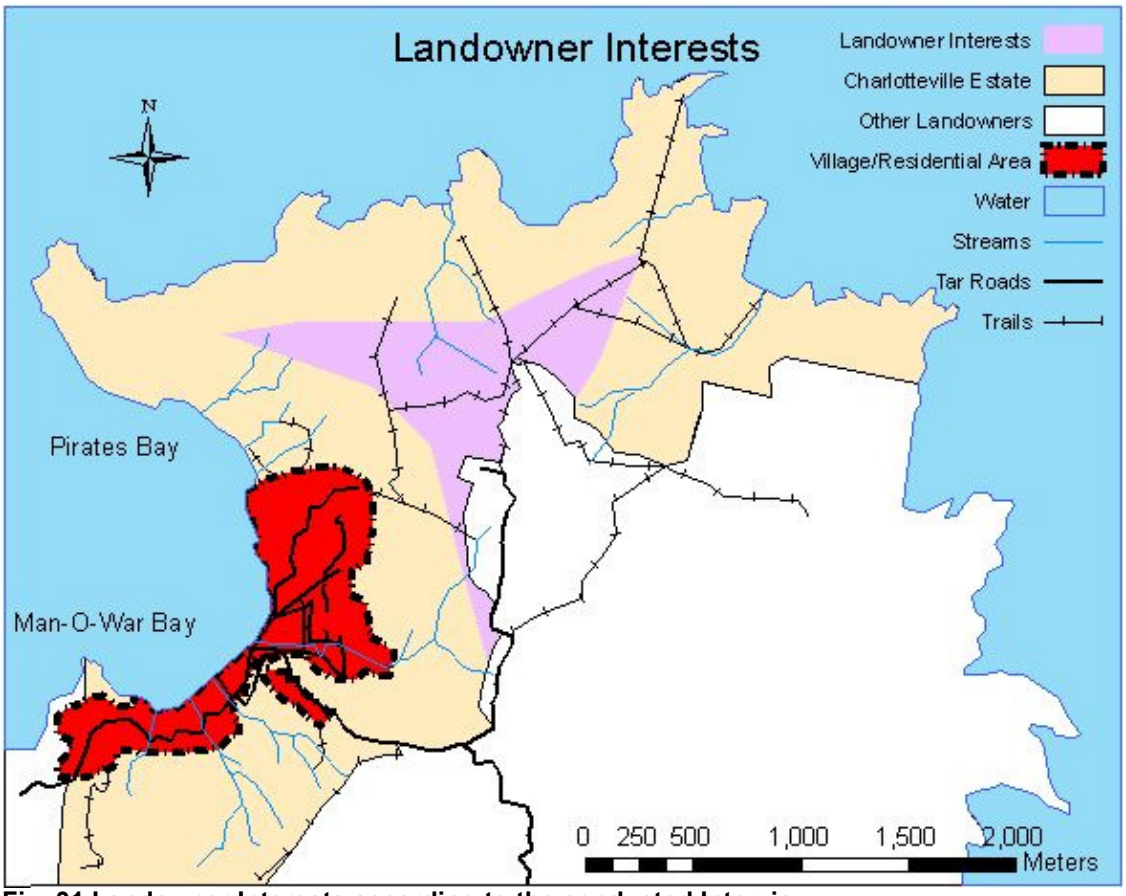


Fig. 31 Landowner Interests according to the conducted Interview
(map is based on Charles Turpin's map 'Jacamar Reserve')

Unified Interests

As the third zonation step, the interests of the landowner and the community are combined. This means that both areas are added to prevent the disregard of one of the parties. Thus both interests are represented (see Fig.32).

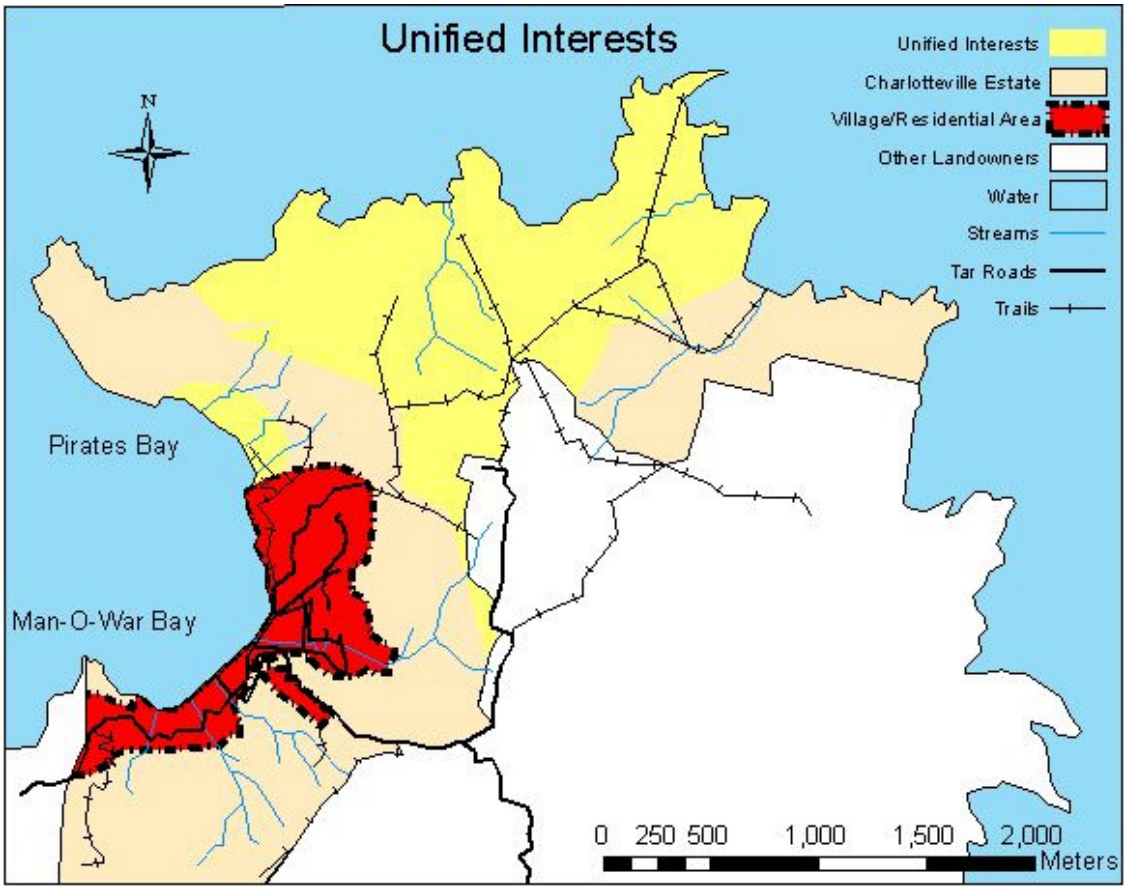


Fig. 32 Unified Interests as a Combined Interest Surface of the Stakeholders
(map is based on Charles Turpin's map 'Jacamar Reserve', Interests are based on the interviews)

The next steps include the intersection of hot spots with the combined interests and the intersection of pristine vegetation with interests. These two intersections will be combined with the stream areas to a final coverage.
As a consequence, the area of the resulting high priority cover will be partly based on the intersection with both biological data: key species hotspot and pristine vegetation intersections.

Key Species Hotspots and Interests

The map in Fig.33 shows the intersection of key species hotspots and unified interest map into a green coverage.

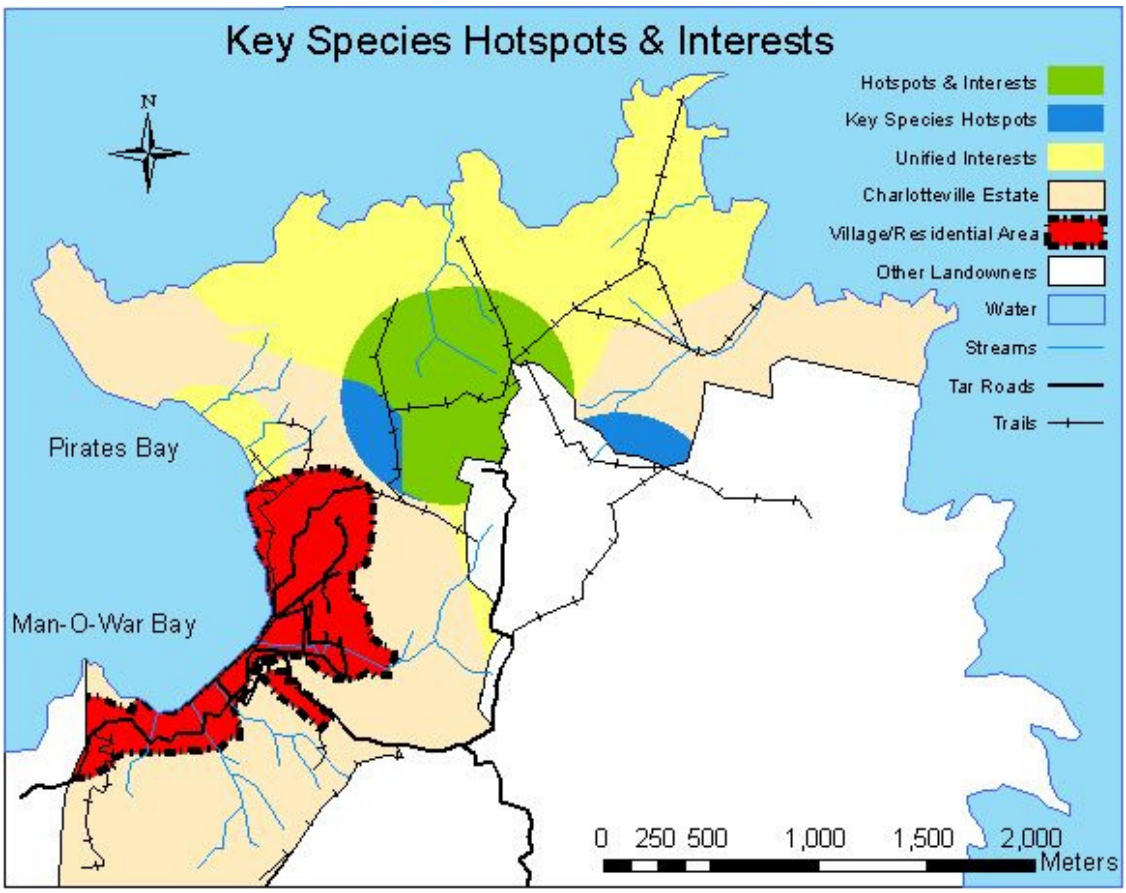


Fig. 33 The Determined Key Species Hotspots (fig.28) & Unified Interests (fig.33)
(map is based on Charles Turpin's map 'Jacamar Reserve')

The intersection area of key species hot spots and unified interests is determined to become a high priority area since it is covered by two important zonation maps.

Pristine Area

The map Fig.34 illustrates the combination of pristine vegetation and unified interests in an intersection.

The tree images visualise the intersection area. This is the potential high priority area. All other green area without tree coverage is not prioritized to become a high priority area, since it represents the same area of two important maps.

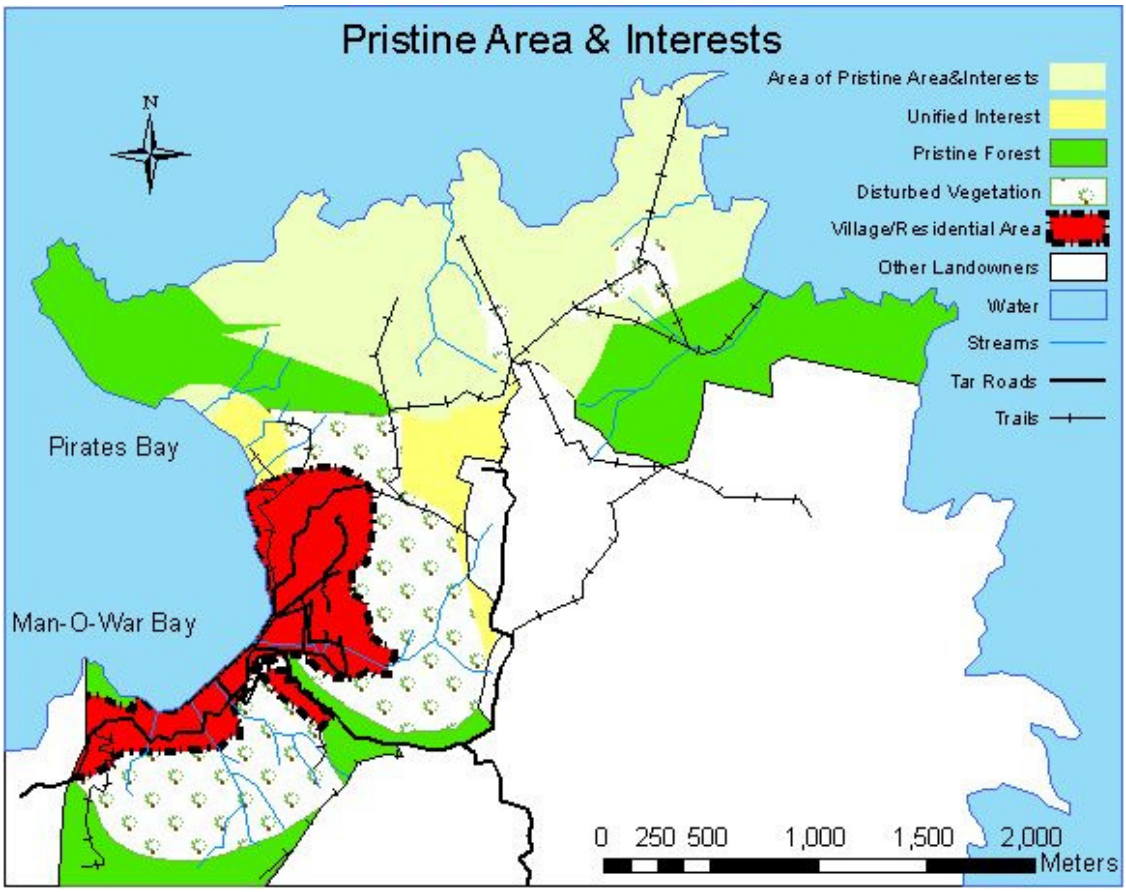


Fig. 34 Assumed Pristine Area in the CE & Unified Interests of the Stakeholders
(map is based on Charles Turpin's map 'Jacamar Reserve')

Streams

As described by McNeely et. al., one important feature in a forest ecosystem is confined to rivers and streams providing flora and fauna with a permanent source of water and nutrients. Streams are also essential as natural drains during the wet season. (Richards, 1996)

Streams in the CE are usually small in size and are distributed over the whole estate. Some of them run through the village and a natural flow is restricted by a concrete canal. To prevent soil erosion, watersheds should be given space and be excluded from developments as required by the landowner Patricia Turpin. For this a 50 meter buffer zone is chosen to guarantee the vital functions of the stream system as shown in Fig. 35.

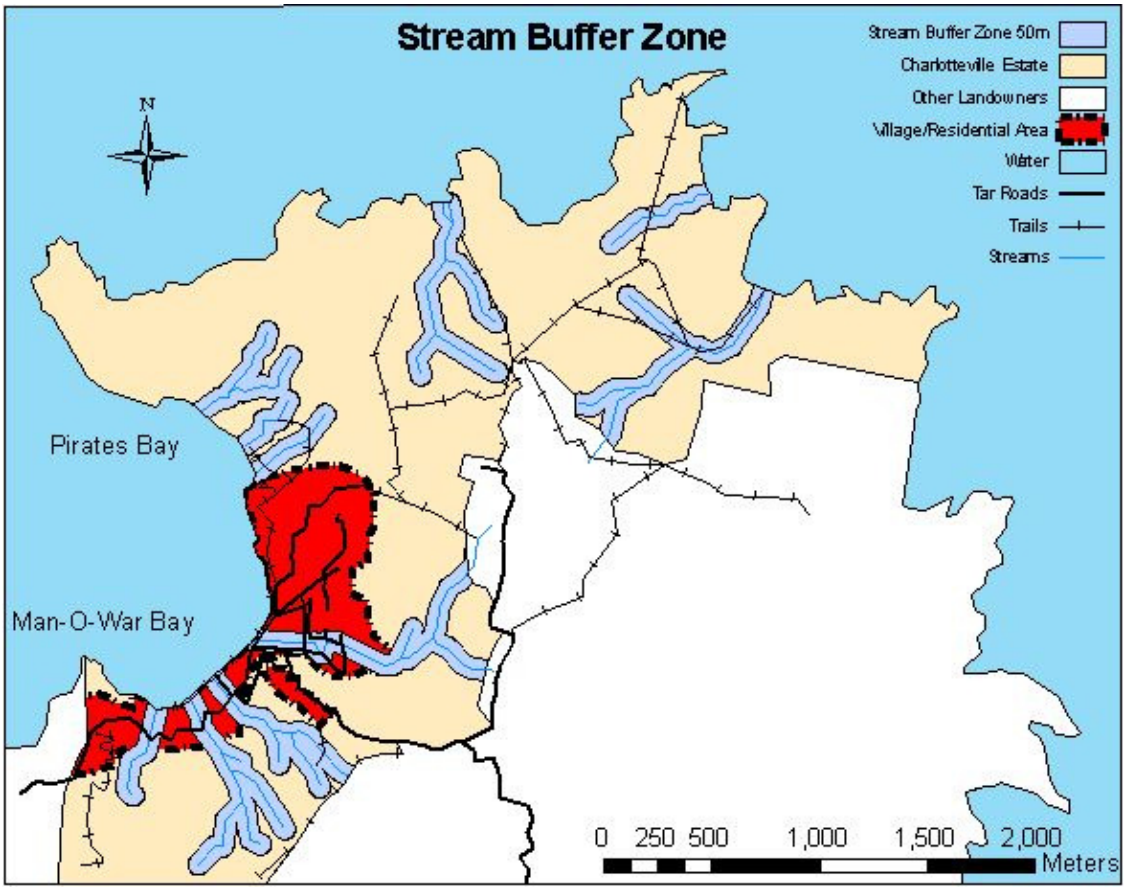


Fig. 35 Streams with a Buffer Zone of 50 m in the CE
(map is based on Charles Turpin's map 'Jacamar Reserve')

The stream buffer zones are combined with the other determined intersections of pristine areas/key species hot spots areas with unified interests. The stream buffer is added to these intersections to define the high priority area.

After conducting all steps of the zonation approach a final prioritized area can be created. The next paragraph presents the resulting high priority area.

4.6 High Priority Area

With the last step of the zonation approach, a high priority area can be addressed based on the outcome of the criteria analysis. In which high priority is an area being suitable for nature conservation or i.o.w. as a core area in of the MAB reserve concept.

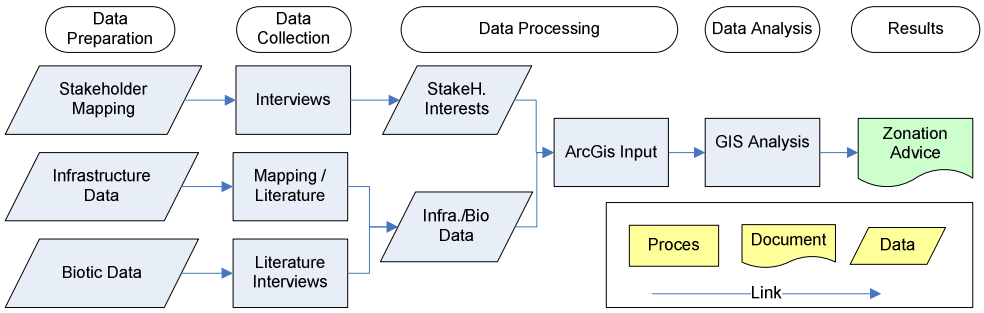


Fig. 36 Step IX of the MRA – Adressing Zonation Discussing the High Priority Area

The map, Fig. 37, is a combination, or union, of both intersection areas plus the stream buffers. Together it becomes the area of high priority.

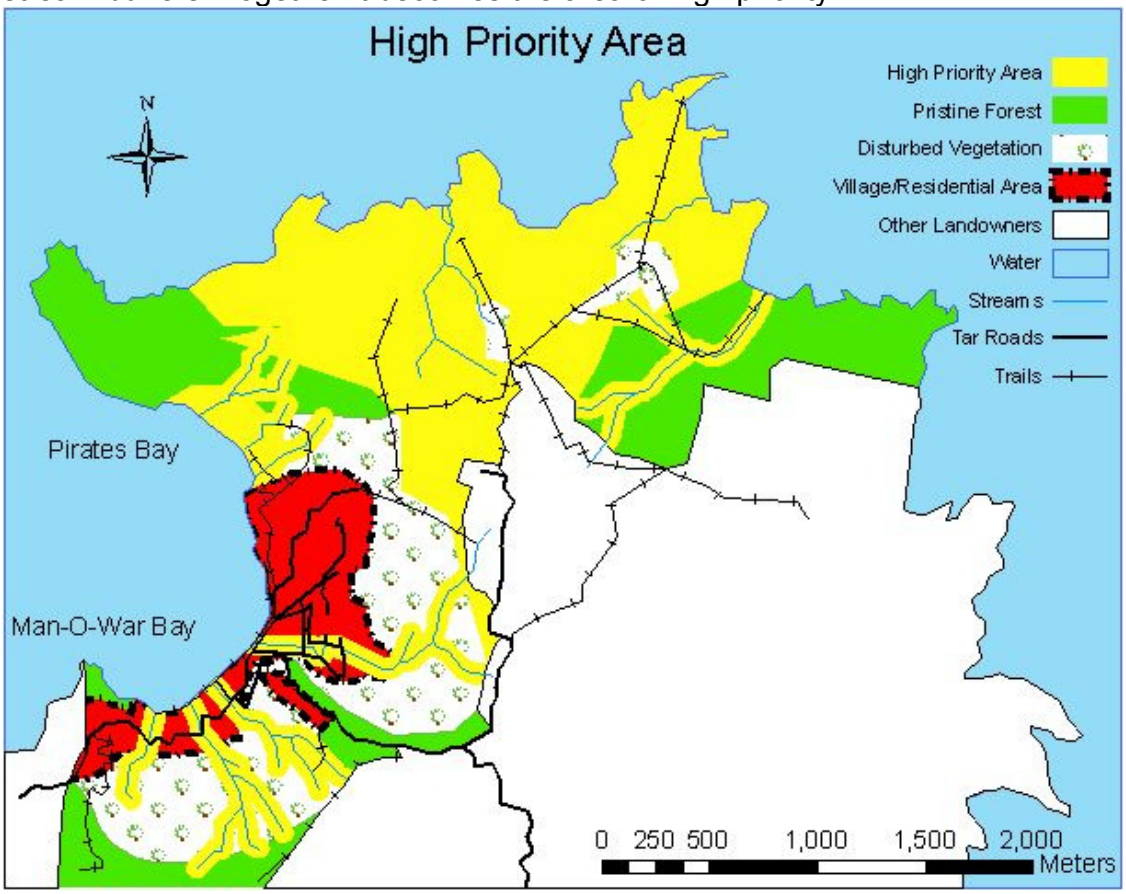


Fig. 37 Calculated High Priority Area as Potential Core Zone Area
(map is based on Charles Turpin's map 'Jacamar Reserve')

The yellow area is the area which needs the highest management attention for nature conservation, ecotourism potential due to the presence of key species and a protective status. It shares both stakeholder interests, contains key species hotspots, buffered stream areas and is covered for the biggest part by pristine vegetation. While a large connected part is situated in the North of the CE, smaller fragments can be seen in the West, and South, including Pirates Bay and the Buffer zones along streams on the CE.

This outcome is the basis for a final zonation. In the next chapter, conclusion, short, summarizing answers will be given on the sub-questions. While all visual results are already presented in the results, it will be necessary to look back at these figures. The high priority area will be object of discussion in Chapter 6.

5 Conclusion

The conclusion gives short and direct answers on the defined sub-questions. The conclusions respect the logical sequence of the methodology and are answered separately.

Stakeholder related questions

1. Who are the main stakeholders?

The main stakeholder, Charlotteville Estates Ltd., is the landowner who is free to decide about the future of the estate. The assignment gave the restrictions to consider the community of Charlotteville as the other only stakeholder. A more complex differentiation of stake holding parties was not preferred. Therefore not was chosen not to do an elaborate stakeholder analysis.

This restricts the stakeholders to two parties:
Main stakeholders: Charlotteville Estates Ltd.
Community of Charlotteville

2. What are wishes and concerns of the most important stake holding parties about land use, ecotourism and development?

The second sub-question, the answers in the interviews by both the Charlotteville Estates Ltd. and the community of Charlotteville, can be summarized as:

Wishes

- More Tourists
- More Ecotourism
- More Development activities
- More Environmental Awareness

Expectations

- Financial Benefits
- Ecotourism Projects will attract more tourists
- Marketing and Advertisements for Projects are needed

Attitudes

- Locals have a different preference for certain animals than tourists
- A consumptive role with edible animals is prevalent
- Local people are generally strong religious believers

Attitudes towards a Nature Reserve

- Locals are in general positive, as long as a usage is guaranteed
- A smaller group agreed that a part for only ecotourism activities can be reserved

Proposed Areas with Protection Need

- Charlotteville Estates Ltd.
  - Ridges
  - Watersheds
- Community
  - Pirates Bay
  - Flag Staff Hill
  - Northern Part of the Forest

Infrastructure related questions

3. What are the borders of the Estate?
As seen in Fig.21 the borders of the Estate are determined approximately with older maps and the information provided by the landowner. This border is used for all following maps.

4. What is the village border / residential area?
In Fig.21 the village border/residential area is shown. It consists of the village and a smaller inhabited location South East comprising of 2 buildings with gardens.

5. Where are roads and trails in the area?
Roads are marked with a clear black line and are especially present in the village and as the main road running East (see Fig.21). The trails are distributed over the whole area. Some connect to the roads, but the most origin in the deeper forest areas. Nevertheless the quality of the trails covers a large array, a differentiation of trail types is not visualized.

6. Where are streams in the area?
Streams are found approximately evenly distributed all over the Estate, see Fig.21.

7. What is the former plantation area?
The assumed former plantation area buffers the village some hundred meters in all directions, except the Sea. It is narrowed to the Pirate's Bay beach in the North, Flag Staff Hill in the East and Pigeon Hill Road in the South West (see Fig.22)

Biotic factor related questions

8. Which vegetation types are present in the area?
The findings by Beard (1946) are converted into spatial data, see Fig.23. Four vegetation types are present: littoral woodland, lowland forest, seasonal deciduous forest and lower montane forest.

9. Which area of the estate is covered by which vegetationtype?

Two vegetation types are prevalent in the CE: littoral woodland and lowland forest, see Fig.24. Seasonal deciduous forest is situated in the North East at Flagstaff Hill. A negligible part of lower montane forest is situated on Flagstaff Hill.

10. Which key species can be found where?
The findings of Klomp & Prinz (2006) are converted into spatial data on the map with assigned indices by them (see Fig.25).

11. Where are key species hot spots?
Key species hotspots were calculated and found around the Flagstaff Hill Area. With a 500 meter buffer it covers a circular area and is narrowed in the South East by other landowners (see Fig.28).

Evaluation related question

12. Which priorities must be set for the zonation approach based on the gathered data and MAB criteria?

To determine priorities, the different maps were weighed according to MAB criteria which can be found in the MCA (see Table 17). The conservation-, development- and logistic-value, which are framework criteria of the MAB concept are used for this evaluation.
The pristine area map, the Key species hotspots area map and the landowner interest area map score all 17 points, the highest score. With respectively 16 and 15 points, the community interest area map and the stream map area score a second and third place. The village area map and the disturbed area map have 8 and respectively 13 points, a lower score. With this result the priorities can be defined. The zonation approach is based according on the outcome values in the MCA. These different important areas are unified into one map. The stakeholders interest areas are joined together and are separately intersected with the pristine area and the key species hotspots. This resulting into two new areas, which can than be joined together with the stream area to define a high priority area as potential zone for protection, ecotourism development and conservation.

6 Discussion

During the research many assumptions have been made in accordance with data gathered from books and by personal opinion. Motivation, analysis and discussion about these assumptions can be found in this chapter.

6.1 Justification of Research Methods

Literature research

Literature research was performed before, during and after the research period. Before the actual research started literature research was performed to produce a sound foundation for the upcoming field research. Data was gathered on topics as zonation principles, land use/natural area management, ecotourism and Tobago. The Tobago topic extended from flora and fauna to socio economic related information. Information was gathered at the libraries of the Christelijke Hogeschool Nederland and Van Hall Larenstein. Gathered data was than complemented with information from sources available on the internet.
During the research, data was collected at the library of the NGO *Environment Tobago*, this involved gathering data on topics as vegetation types, estate boundaries, development plans and species information.
To complete the literature research a research was done on zonation advice and usage of ArcGIS on the internet, websites of UNESCO and ESRI, and an ArcGIS course was followed at the Rijks Universiteit Groningen (see Spatial Analysis). Overall this process was needed to be provided with correct and sufficient information.

Interview

The first interview held was an open question interview with the landowner. This interview was held in November 2006, after this initial interview with Patricia Turpin, the need for information about the community's perception on tourism development, ecotourism, nature conservation and land use arose.

The open question interview was not functional for interviewing people on the street because of a general time restriction. Therefore a second interview was developed in cooperation with Aljoscha Wothke, the director of Eco-Project Ltd. Questions in this interview were formulated to get a general idea of the communities perception on tourism development, ecotourism, nature conservation and land use. Background for the community interview was an earlier held interview in Charlotteville, in May 2006, about tourism and the perception of an eco/agro tourism project (Witt, 2006). The new interview completed or added missing information about land use, ecotourism and nature protection to represent ideas of both stakeholders.

Spatial Analysis
The overall process includes the digitizing of the analogue data into digital data on a platform (ArcGIS) suitable for data processing. Supervisors advised to use ArcGIS version 9.1 from ESRI.

6.2 Results discussion

Interviews
The outcome of the interviews gave a positive reflection to the idea of starting an ecotourism project. According to Patricia Turpin an overall positive influence can be the result of the ecotourism project. But the success of such a project depends on marketing and the attitude of the community towards such a project (Borrini-Feyerabend 1997). The community interview gave the impression that the community seems willing to comply and provide help in the process because they expect financial benefits for both the village and personally.

The interview gave the researchers an idea of what stakeholders expect from an ecotourism project, the overall positive reply might be too positive. Probably fewer individuals will benefit than is expected by the interviewees. This will automatically result in a more negative perspective if an ecotourism project is initiated.
It seems that the start of an ecotourism project can rely on support of the community but instituting an area in which usage of nature is reduced to null will have many difficulties while executing (Gibbs et.al., 1998). The earlier mentioned problems with law enforcement and lack of manpower are supplemented by personal conversations during the research period. The outcome of the interview doesn't correspond entirely to what people have said in preliminary and later held conversations. These conversations were personal and did not have an interview layout.
5 interviews were held by a villager to minimize a potential bias due to being foreign and a minority (seen as a white tourist). A comparison of the interview results showed that there was no obvious difference between outcome of authors held and local interviewer held results. (Houtkoop-Steenstra, 2000)

Local perception on animals could be a factor of disturbance for the success of an ecotourism project, if this differs significant from visitor animal perception, which it does. When the community was asked to state which animals they like to see and which animals their think tourists like to see the difference became obvious. A possible problem is therefore recognised and solutions can be prepared, if it has a negative influence on the both tourist as local community member.

The overall positive reply to tourism and an ecotourism project can partly be explained by the community's personal gain. 60%, of N=40, replied that they think that more tourist and a tourism project will bring personal financial benefit.

As stated in the Tobago development plan (2004) tourism is known for it's huge positive impact on local peoples financial status. As stated in the introduction, entire Tobago is for a huge part depending on tourism related income and the village of Charlotteville is according to its inhabitants no exception to this.

Map making

The map making process was subject to most assumptions. Nevertheless as this being an advising report final borders for a zonation can differ from this recommendation.

The precise borders of the CE and the plantation are unknown. The management plan of the year 1929 by Ceryl Turpin gave insufficient information about the precise borders. Some of the old landmarks are lost and the existing plantation map is roughly sketched. The plantation was used until 1990, together with village developments and hurricane devastations major changes have taken place. Combining observations during mapping activities, the information of guides and the information of the landowner lead to the shape in Fig.21 and Fig.22.

Data was gathered in the library of environment Tobago, but this was not always up to date. The most recent data was used, but if data was scarce, older dated sources were subject to map making. The oldest map used was a 1970 detailed map of the estate by C. Turpin which included indications of height and land features. This was the map which gave an overview of the land. Coastal lines and stream formations were taken over from these maps and could be acknowledged by GPS point measurements.

Other maps which were subject to possible changes, were maps with vegetation types and coverage. During time, spent in the field, changes or differences in vegetation were observed but these are small and fragmented plots. Technical difficulties in incorporating these small plots resulted in a neglecting of the possible changes.

MCA related discussion

The gathered data by a field study on key species, roads and trails and literature research on vegetation, in other words, collecting all available data, lead the way to criteria used. E.g. this research has not focussed on costs or field data concerning vegetation. These factors can therefore not be a factor during the discussion and analysis. The (non)available information on these topics had to be taken for granted.

The criteria used for this analysis are guided by the MAB concept. Due to the variance in MAB concept, strictly defined criteria are not available. Except for area size, which is a factor the Charlotteville estate does not comply to. Criteria are therefore restricted to functions of the MAB concept only. The three functions of MAB were leading during the criteria definition process. Doing so resulted in a crucial role of these functions in the outcome of the analysis. Which was required to zonate the area to be in comply with the MAB concept. Functions shapes the zonation lay out.

Key Species
The preliminary preformed research provides extensive information on key species. Key species are not the only animals interesting for ecotourism, research or even both. The choice to stick to 15 species only was a necessary adaptation to keep overview during the zonation making, incorporating all species findings of 244, would have been resulted in a non functional map in which no zonation would be feasible. This is partly due to the ecotourism value of even the most common species which than would have been added to the 15 key species. The preliminary research, A Biodiversity Assessment in Tobago, by Klomp & Prinz 2006, explains how the selection of key species has been made and can be discussed separately. Fact is that all endemic and rare species that were found are taken into account and into the list.

The given value to key species presence is restricted only to finding locations. This restriction resulted in a loss of N total key species, not all species were found on the estate, some were found just off the estate area. If a key species is present just off the estate, the chance that its home range stretches into the estate is possible. This home range is not restricted to the one or two individual animals found but also incorporates an assumed lager population of which the individuals are part of. This fact is not taken into account during the analysis because it leaves to much space for assumptions. The available data could not provide answers on these questions.

Research Suitability
The research suitability is based upon relative key species presence per km. Assumed is that a high key species density indicates a high overall species presence. More species present do not necessarily result in more attraction for research purposes. But more species present could also mean a higher uncertainty level about species presence. Tobago is a small island on with a general lack of biological research, based on the lack of scientific reports concerning research and personal observation. Personal conversation with Patricia Turpin also revealed that Prof. Dave Hardy from the Smithsonian Institute, has performed research in the last 5 years but hasn't published a report as just yet. His findings revealed a new species of frog, 2 newly discovered spider species and some plants. This indicates a high value for future research and all the more reason to protect and preserve as much as possible.

Vegetation
A general lack concerning data on vegetation types and vegetation state makes it hard to predict the exact value of the data used concerning these two topics. Research based on Flora only should be performed and the outcome used to make the analysis more valuable. The large percentage array during scale formulating, steps of 20%, have been made to cover plausible vegetation changes and to incorporate a value of assumption.

Stream Findings

The stream and pristine area (key) species presence is probably higher than the outcome of the research indicates. The trails used to cover the pristine area and the streams followed, only covers a small percentage of the entire pristine/stream area. Creating new trails was not permitted by the landowner and besides this, to much time consuming due to dense vegetation and steep elevations/inclines. Expected is that more species, possible even previous unknown species can be found if this area is subject to future research.

MAB Concept
The high priority addressing of the area is based on UNESCO's MAB concept. This concept has strict guidelines for the different zones in both order of appearance and size. During the zonation of the CE, these guidelines were not taken into account. Only the three functions and the three layer zone approach of the concept have been used.

First of all the size of zones in the MAB concept is beyond the size of the CE. The circular layout of MAB restricts zoning in the area significantly and is therefore not functional. The unique location of the Estate bordering the ocean is there for used as a fence. The border to the ocean is a natural inaccessible landscape feature. This natural presence gives the advantage of not requiring a buffer zone and transition zone around the entire high priority area.

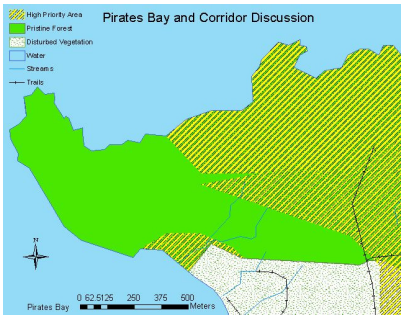
The buffer zone area is relatively small compared to the core and the transition zone. This zone is needed to be incorporated as its name implies as a buffer. Preventing high impact usage to border low usage is an improvement for the well being of the animals. The sheer relative small size of present animals: birds and reptiles, in the estate, require a smaller zone as it is needed for bigger mammals, e.g. primates or large herbivores, would have needed. This is due to relative small territory size and fleeing behaviour once disturbed. Short after disruptions animals tend to return e.g. birds. The MAB concept differs from this due to the large size animals inhabiting the MAB Reserves in comparison to the small size animals inhabiting the Charlotteville Estate.

The high priority area is not only defined by; pristine, key species hotspot, stream area or as stakeholder interest area. Not obvious displayed in the map is the 500 meter buffer around the hotspot areas required for the preservation of present territories. The 500 meter buffer is initiated after gaining information from several authors, Boos 2001, ffrench 2003, Hardy 1982 and Thomas 1991.

The buffer of 500 meters around hotspots is also initiated to make sure that animals at present have enough space to be viable. Negative aspect of this viability is that it is probably short term due to the relative small size, only 500 meters, of the buffered area. This needs to be monitored and probably areas need to be connected, therefore complementary research is required. The researchers, cannot prove this by their own research, required information on this topic could not be obtained due to time restriction.

High Priority Area Characteristics

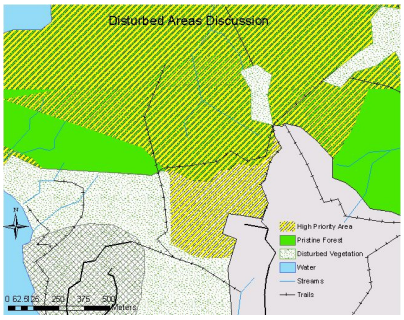
The following figures are a visualisation of discussion points that occur during the high priority area defining process. This visualisation is performed by enlarging some parts of the final map, together with a brief description on how the areas have been incorporated or excluded within/from the high priority area.



Western Incision & Pirate's Bay
There are two locations for discussion. The small scar like corridor that was created during the process should be interconnected to close the high priority area.

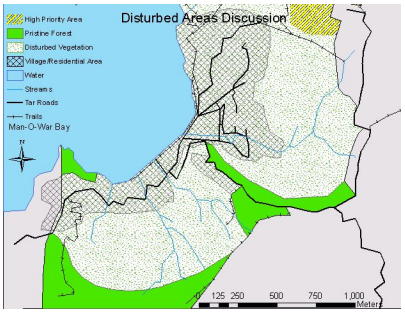
The small fragment at Pirates Bay has to be excluded from its high priority attribute. It should go under transition zone criteria.

Fig. 38 Western Incision & Pirate's Bay



Former Plantation Cover
A small fragment of the high priority area is on former plantation area. A transition zone has the potential to attract other species and in this way to increase species numbers. This area should be included in the core area zone. It offers as a transition zone a contribution to the habitat diversity.

Fig. 39 Former Plantation Cover



Small Clustered Pristine Forest in the South
The small fragments of pristine forest in the South shouldn't go under a core zone criterion. This would make the core zone one clustered composition, which is not manageable. Due to their location they are difficult to use, mostly on steep elevations it is excluded from developments. This could be the reason why they are still in this condition.

Fig. 40 Small Clustered Forest

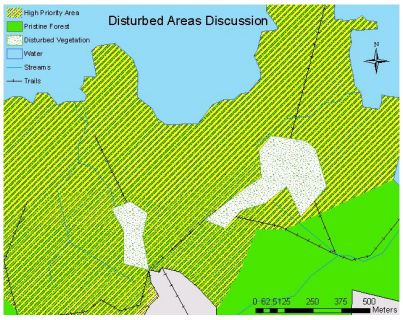


Fig. 41 Pasture Fields

Pasture Fields within the Core Zone

The two pasture field within the core area are excluded from the core criteria. These fields are extensively used for cattle breeding in a small number. This has not an impact on the surrounding vegetation and even creates an interesting and viable vegetation type that is maintained naturally by the process of grazing. Therefore it is advised not to change this situation. But an extension should prevented.

Fig. 42 Stream Buffers

Stream Buffers

Stream areas were buffered with a 50 m criterion and were addressed to become high priority areas at first. Since their clustered distribution over the whole CE, they offer a poor suitability as a potential core zone area and are not functional for an effective management. The streams that are not situated in the Northern large cover are excluded from a final core area feature. The management of the streams should be managed separated from the core zone area.

High Priority Area to a Final Zonation

The high priority area represents together with the restriction of sites in the discussion, a good compromise of all zonation approaches. It combines the interests of the community and the landowner. Key species hotspots are integrated with a high percentage of their original cover. The largest part of pristine vegetation is incorporated into one connected zone. A clustered zone in small fragments with the same surface would have disadvantages in comparison with a connected area. Two streams are located within and only a smaller part of the main trail runs through it. Two pasture fields are located within the high priority area. This is not considered to be a problem as long as it present size remains within its borders and usage is not intensified. A number of 20 cows provide a natural grazing of the fields and hence creating a transition zone within the pristine vegetation, differs from the transition zone of the MAB. Transition zones are known for their ability to increase species numbers and the diversity of an area.

A buffer zone should encircle the high priority area with a minimum distance of 150 meters. In dense tropical vegetation, this ensures that the high priority area is protected from disturbances.

The area shows suitable attributes for a future management with land divided into zones. After having discussed particular site features to be included or excluded as high priority area, the next Chapter shows the core zone area that is addressed for the final zonation and given as a recommendation.

Recommendations

With all information resulting from the discussion of the high priority area a zonation advice can be given, see Fig.43.
The dark green area now reflects the core area. Around this core zone, a 150 m buffer (lighter green) was chosen to prevent disturbance effects and to ensure that there is no core area used by accidence. Furthermore the buffer zone in the East is extended to buffer the valley of the Bigualla River with an extra 100 meter buffer zone. This is added as measurement to protect the watershed from developments and maintain the habitat for found key species. With two medium sized streams and one smaller one, three water sources guarantee a supply with water during the year.
The lightest green area represents the transition zone in which developments are possible. Especially, this is interesting for the area around the village which is objective for village developments. The North Western and North Eastern part, momentarily not included in the core zone (yet), a biodiversity evaluation on flora and fauna should be first conducted before it undergoes developments.
Overall accessibility can be evaluated as medium. There is only one main trail of good quality, called the ‘Cow Ridge’ which can be used by car, but ends at some point where a land slide has occurred. The rest of the trails are only accessible by foot and are hard to recognize as such. The lack of activities at these trails creates the risk of overgrowing. Overgrown trails are inaccessible and are useless for ecotourism activities. Maintenance is therefore required, but needs to be managed, the natural state of the area needs to be maintained.

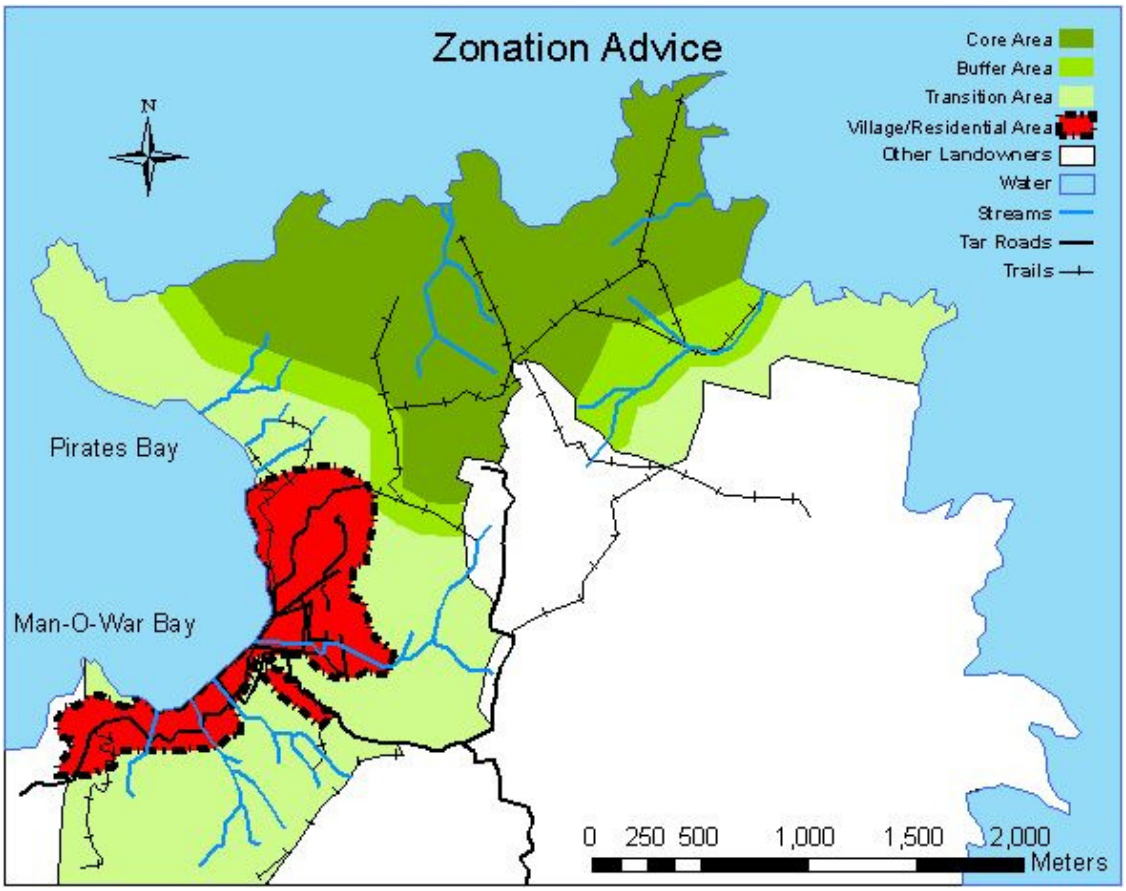


Fig. 43 Zonation Advice for the CE with Core-, Buffer- and Transition Zone
(map is based on Charles Turpin's "Jacamar Reserve Map")

Further Recommendations

Streams
Since all streams have been excluded from the Core Zone except for those which are situated within, a policy should be taken into the policy of the area for a particular management of stream areas without the core area.
Corridor
The most Southern Point of the buffer could be extended to the road to create a wildlife corridor in which an exchange of wildlife with the rest of the island could be made possible.
Research
More research including monitoring on Flora and Fauna is necessary to examine biological developments e.g. observations on key species can provide useful information as an indicator. It can further be used to complement information on biogeography in Charlotteville and should be used as a development advising tool. A systematic vegetation plotting should be done on the whole Estate to update Beard's findings from 1946 for a potential redefinition and refinement of zone borders..

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Maps

Figure 1
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Figure 2
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Annex I Terminology

Agro tourism
Agrotourism is a tourism experience in which hospitality is offered on farms, this includes the opportunity to assist with farming tasks during the visit and to learn about farming activities.

ArcGIS
A GIS (Geo Information System) program to develop and process geographic maps digitally.

Buffer Zone
This is a zone that buffers the core zone from the transition zone. Her usage is allowed on a low impact scale.

Biodiversity
Biodiversity is the number and variety of organisms, animals, plants, fungi, and micro organisms, and ecosystems within a particular habitat in a region.
Or:
Biodiversity is a broad term in ecology, encompassing the diversity of living organisms, including genetic diversity, diversity of form, origin and the natural systems in which organisms exist. The term is used interchangeably. (Kenny, 2000)
In this paper this term refers to the variety and number of different terrestrial animal species of birds, reptiles, amphibians, spiders and butterflies on Tobago with an emphasis on northern Tobago, the forests around Charlotteville.

Core Area
This surface area describes the most important part of a natural area. It is bufferd by a buffer zone to prevent disturbances. The only allowed activity in this zone is scientific research.

Eco tourism
Two definitions are chosen which represent the range of ecotourism in the context of the study.
Ecotourism is responsible travel to natural areas that conserves the environment and improves the well-being of local people. (Eco Tourism Society, 1991)

It is also defined by Honey (1991) in his book *Ecotourism and Sustainable Development, Who owns Paradise?* as travel to fragile pristine and usually protected areas that strives to be low impact and small scale. It helps educate the traveler; provides funds for conservation; directly benefits the economic development of local communities and fosters respect for different cultures and human rights.

Eco-tourism must comply to the following 6 aspects; (Honey, 1999)

- involves travel to natural areas
- minimizes impact
- builds environmental awareness
- provides direct financial benefits to conservation
- provides direct financial benefits and empowerment for local people
- respects local culture

Enrichment planting
Enrichment planting is planting of local or traditional plant species in areas were species impoverished is the case due to human activities species.

High Priority Area
Area that is chosen to covers all important sites for conservation and ecotourism issues in the CE. It is the basis surface that is later discussed and redefined to a core zone area for the final zonation.

Hotspots
Hotspots are areas on the estate were species can be found in numbers which are above the average. They are also areas where an above average number of key species occur, independent of regular species numbers.

Interest Maps
These maps are made to visualize the interests of the stakeholders for a particular site protection. Both interest maps are later unified to a Unified Interest map.

Intersections
This function in ArcGIS cuts the surface of two maps with the same coverage into a new map-layer.

Key Species Hotspots
These are spots, where 5 or more key species in a radius of 100 meters were found during the biodiversity assessment of the CE. (Klomp & Prinz, 2006)

Low impact
Low impact is a term used to identify practices with minimal actual or apparent changes to an area.

MAB concept
the Man and Biosphere Reserve idea used as a guideline for the land use management plan of the area without becoming part of a man and biosphere reserve. It includes the use of the concept of the Man and Biosphere Reserve program during the compilation of the management plan of the area. For additional information have a look at annex II.

Sustainable
An ecosystem condition in which biodiversity, re-newability, and resource productivity are maintained over time, in which present needs are met without compromising those of future generations. Maintaining in the same or creating a better condition for the future.

Transition Zone
A surface area of that encircles the buffer zone. Here developments and a wise use of the local resources take place. It is mostly found in directly vicinity of villages.

Unified Interest Maps
This map combines the interest areas for protection of both stakeholders into one single map.

Annex II UNESCO's man and biosphere reserve

UNESCO's Man and the Biosphere Programme (MAB)

The Man and the Biosphere Programme (MAB), proposes an interdisciplinary research agenda and capacity building aiming to improve the relationship of people with their environment globally. Launched in the early 1970s, it notably targets the ecological, social and economic dimensions of biodiversity loss and the reduction of this loss. It uses its World Network of Biosphere Reserves as vehicles for knowledge-sharing, research and monitoring, education and training, and participatory decision-making.

Background
MAB was launched in 1970 and initiated work in 14 Project areas covering different ecosystem types from mountains to the sea, from rural to urban systems, as well more social aspects such as environmental perception. The MAB governing body, the International Co-ordinating Council of the Man and the Biosphere (MAB) Programme, usually referred to as the MAB Council or ICC, consists of 34 Member States elected by UNESCO's biennial General Conference. In between meetings, the authority of the ICC is delegated to **its Bureau**, whose members are nominated from each of UNESCO's geopolitical regions.
MAB's work over the years has concentrated on the development of the World Network of Biosphere Reserves (WNBR).
The biosphere reserve concept was developed initially in 1974 and was substantially revised in 1995 with the adoption by the UNESCO General Conference of the Statutory Framework and the Seville Strategy for Biosphere Reserves. Today, with more than 480 sites in over 100 countries, the WNBR provides context-specific opportunities to combine scientific knowledge and governance modalities to:

- Reduce biodiversity loss
- Improve livelihoods
- Enhance social, economic and cultural conditions for environmental sustainability
- Thus contributing to the pursuit of the Millennium Development Goals, in particular MDG 7 on environmental sustainability

Biosphere reserves can also serve as learning and demonstration sites in the framework of the United Nations Decade of Education for Sustainable Development (DESD).

Approach (Extract from UNESCO's Draft Programme 2006-2007)
"The General Conference authorizes the Director-General […] to implement the corresponding plan of action in the ecological sciences […], in order to:

- Contribute to minimizing biodiversity loss through the use of ecological and biodiversity sciences in policy- and decision-making;
- Promote environmental sustainability through the World Network of Biosphere Reserves;
- Enhance the linkages between cultural and biological diversity, jointly with [Major Programme IV- Culture]"
-

Main line of action 1: Minimizing biodiversity loss through research and capacity-building for ecosystem management

Focus will be on a broad-based interdisciplinary research agenda with respect to the ecological, social and economic dimensions of biodiversity loss and its reduction. Capacity-building will be key […], including the development of a network of learning centres for integrated ecosystem management and through South-South cooperation. In Africa, the regional postgraduate school in Kinshasa, Congo DR, will serve as the principal node for this network.

Efforts will be made to promote interdisciplinary and multi-sector approaches to sustainable development in higher education and in-service training institutions, particularly in post-conflict countries.

State-of-the-art synthesis will be undertaken and new research initiatives on arid lands and humid tropics will be launched, capping 50 years (2006) of UNESCO's involvement in these areas.

- Research, training and education related to biodiversity loss and global assessments
- Urban systems, carbon economies and ecosystem management for biodiversity use
- Research, training and ecosystem management of drylands and mountains
- Research and ecosystem management in coastal areas and humid tropics and South-South cooperation for capacity-building

Main line of action 2: Biosphere reserves - promoting environmental sustainability

Emphasis will be placed on linkages between biodiversity conservation and socio-economic development in specific biosphere reserve contexts. The WNBR and its regional networks will be used as vehicles for knowledge-sharing and exchange of experience, research and monitoring, education and training, and testing of participatory decision-making, thereby contributing to the emergence of "quality economies" and to conflict prevention.

- Establishing new biosphere reserves and transboundary biosphere reserves
- Strengthening of knowledge base on environmental sustainability - including the Great Apes Survival Project (GRASP), and the Biosphere Reserve Integrated Monitoring (BRIM) programme
- Using biosphere reserves as platform for conflict prevention
- Statutory meetings and MAB Young Scientists Award Scheme
- Supporting regional and thematic MAB networks

Main line of action 3: Enhancing linkages between cultural and biological diversity

Cultural landscapes and sacred sites will receive special attention and allow to learn about biological and cultural diversity interactions. Special attention will be given to biosphere reserves and World Heritage sites.

Establishing a knowledge base on cultural practices fostering local-level sustainable use of biodiversity in biosphere reserves

Local and indigenous knowledge as a basis for equitable biodiversity governance in Small Island Developing States

Raising awareness of the role of sacred natural sites, cultural landscapes and intangible heritage in ecosystem management and sustainable use of biodiversity

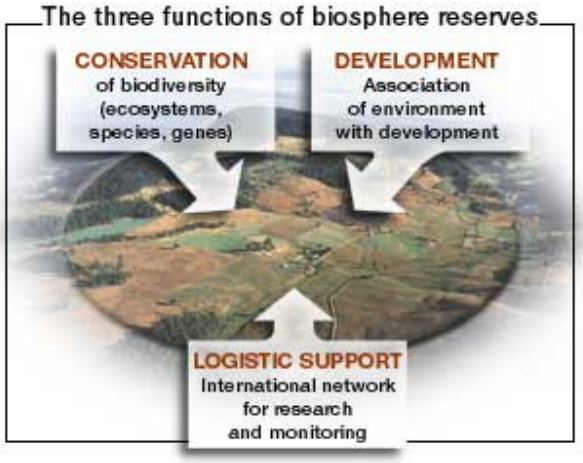
What is a Biosphere Reserve?

Biosphere reserves are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognized, nominated by national governments and remain under sovereign jurisdiction of the states where they are located. Biosphere reserves serve in some ways as 'living laboratories' for testing out and demonstrating integrated management of land, water and biodiversity. Collectively, biosphere reserves form a World Network. Within this network, exchanges of information, experience and personnel are facilitated. There are over 480 biosphere reserves in over 100 countries.

What are the functions of biosphere reserves?

Each biosphere reserve is intended to fulfil 3 basic functions, which are complementary and mutually reinforcing:

- a conservation function - to contribute to the conservation of landscapes, ecosystems, species and genetic variation;
- a development function - to foster economic and human development which is socio-culturally and ecologically sustainable;
- a logistic function - to provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development.



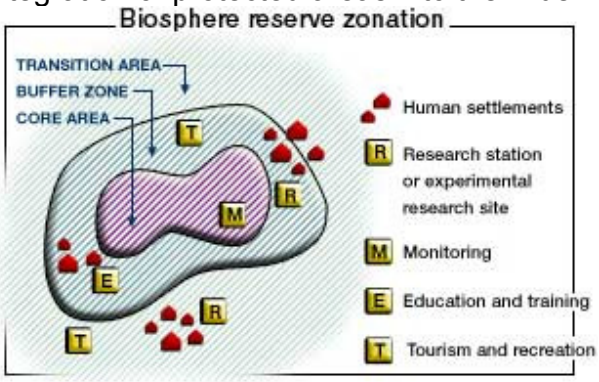
Visualisation of the three functions of biosphere reserves

What are the biosphere reserve zones?

Biosphere reserves are organized into 3 interrelated zones:

- the core area
- the buffer zone
- the transition area

Only the core area requires legal protection and hence can correspond to an existing protected area such as nature reserve or a national park. This zonation scheme is applied in many different ways in the real world to accommodate geographical conditions, socio-cultural settings, available legal protection measures and local constraints. This flexibility can be used creatively and is one of the strongest points of the biosphere reserve concept, facilitating the integration of protected areas into the wider landscape.



Schematised biosphere reserve zonation

What are the benefits of biosphere reserves?

The biosphere reserve concept can be used as a framework to guide and reinforce projects to enhance people's livelihoods and ensure environmental sustainability. UNESCO recognition can serve to highlight and reward such individual efforts. Designation of a site as a biosphere reserve can raise awareness among local people, citizens and government authorities on environmental and development issues. It can help attract additional funding from different sources. At the national level, biosphere reserves can serve as pilot sites or "learning places" to explore and demonstrate approaches to conservation and sustainable development, providing lessons which can be applied elsewhere. In addition, they are a concrete means for countries to implement Agenda 21, the Convention on Biological Diversity (for example the Ecosystem Approach), many Millennium Development Goals (for example on environmental sustainability), and the UN Decade of Education for Sustainable Development. In the case of large natural areas which straddle national boundaries, transboundary biosphere reserves can be established jointly by the countries concerned, testifying to long term cooperative efforts.

Who is in charge?

UNESCO does not require any change in law or ownership: each biosphere reserve has its own system of governance to ensure its meets its functions and objectives. The management system of a biosphere reserve needs to be open, evolving and adaptive in order for the local community to better respond to external political, economic and social pressures, which would affect the ecological and cultural values of the area. Hence it is necessary to set up an appropriate governance mechanism, for instance a committee or board, to plan and co-ordinate all the activities of all the actors concerned, each within their own mandate and competence. Usually a biosphere reserve coordinator is named as the contact person for all matters dealing with the biosphere reserve.
(UNESCO, 2007a, , 2007b)

Annex III Community Interview

Interview for citizens of Charlotteville, Tobago.

Introduction by Jasper and Sebastian, including Biodiversity study and thesis for the Van Hall University.

Gender: Male / Female; Age Class: 16-21/22-29/30-39/40-49/50-59/60-69/70-79; Occupation:_____

1.	Are you supporting a club/society/party that has influence on the development of Cville?	Yes / No, Which?
2.	Would you like to participate in such club/society/party to influence the development of Cville?	Yes / No
3.	Do you have the feeling that you are being informed sufficiently about ongoing projects considering developments in Cville?	Neg 1 – 10 Pos
4.	Are you satisfied with the tourism development in Charlotteville?	Neg 1 – 10 Pos
5.	Do you feel responsible for the tourism development of Charlotteville?	Yes / No
6.	What are features of eco/nature tourism to you? Name max 3.	Open

(Nature, cultural heritage, animals, protection, history, no destruction, personal joy, tourists, others?-> which?)

7.	Would you like to see more eco/nature tourists in Charlotteville?	Yes / No
8.	Do you think establishing eco/nature tourism in Charlotteville will attract more tourists?	Yes / No
9.	Do you think eco/nature tourism will benefit you financially?	Yes / No
10.	Which wild animals in Charlotteville do you like to see most?	Open
11.	Which wild animals do you think eco tourists like to see most?	Open
12.	What do you think about the general land use of Charlottesville's surrounding forests?	Neg / Pos / Neu
13.	Would protecting the forest be an improvement, if yes which measures should be taken? Max 3.	Open
14.	Do you think eco/nature tourism could help to protect the forest in Charlotteville?	Yes / No
15.	What are the biggest dangers for the forest in Charlotteville? Name max 3.	Open
16.	Do you think it's good to have some parts of the forest as a reserve for wildlife only?	Yes / No
17.	Do you think it's good to have some parts of the forest for eco/nature tourism purposes only?	Yes / No
18.	Which part would you like to see protected according to you? Why? Map! Choose one or more.	Open

Do you have any remarks/comments/etc.?

Annex IV Main Stakeholder Interview

1. What means eco tourism to you?
2. Do you feel responsible for the tourism development of Charlotteville? In which way?
3. Would you like to see more eco tourists in Charlotteville?
4. Do you think establishing (more) eco tourism in Charlotteville will attract more tourists?
5. What kind of ecotourism projects would you like to see developed? Which not?
6. Do you think the community's level of information about tourism development is sufficient? Why.
7. Do you think the community's level of involvement is sufficient in the development of Charlotteville and surrounding?
8. What do you think about the land use of Charlottesville's surrounding forests? Why?
9. What are the biggest dangers for the environment in Charlotteville?
10. Would protecting the forest be an improvement, if yes which measures should be taken?
11. Do you think ecotourism will help to protect the environment in Charlotteville? Why?
12. Do you think it's good to have some parts of the forest as a reserve for wildlife and or ecotourism only? Why?
13. Which part would you like to see protected/most important/used for ecotourism according to you? Why?
    Map!
14. Do you have any other personal ideas/remarks/comments or wishes about ecotourism development in Charlotteville?

Annex V Community interview participants

person	gender	age class	occupation
1	female	22-29	librarian
2	female	40-49	teacher
3	female	22-29	bartender
4	female	22-29	receptionist
5	female	50-59	shop owner
6	female	30-39	shop worker
7	male	40-49	bird guide
8	female	30-39	housewife
9	female	16-21	student
10	male	50-59	senior
11	male	40-49	police officer
12	male	40-49	builder
13	female	30-39	waitress
14	male	40-49	restaurant owner
15	female	40-49	restaurant owner
16	female	40-49	health officer
17	male	22-29	health officer
18	male	16-21	student
19	male	50-59	shop owner / farmer
20	male	30-39	guard
21	male	60-69	retired labourer
22	female	50-59	housewife
23	male	30-39	tourism handyman
24	male	60-69	retired fisherman
25	male	30-39	entertainer
26	female	22-29	receptionist
27	male	30-39	construction builder
28	male	50-59	gardener/farmer
29	female	22-29	receptionist
30	female	30-39	bartender
31	male	60-69	fisherman
32	male	22-29	fisherman
33	female	22-29	housewife
34	male	22-29	fisherman
35	male	70-79	retired fisherman
36	female	16-22	student
37	male	16-22	fisherman
38	female	50-59	housewife
39	female	30-39	unemployed
40	male	40-49	teacher

Annex VI Background Information

History
Trinidad and Tobago was discovered in 1498, by the explorer Christopher Columbus. In reality, the islands were already occupied by the indigenous Amerindian tribes, the Arawaks and the Caribs.
Trinidad remained in the hands of the Spanish from the 15th Century until the British captured it in 1797, it became a British colony in 1802.
Tobago has a more turbulent past, the native Amerindian tribes had to defend themselves against European forces from the late 1500's. Before it a became British colony by decreed in 1814, it was ruled and taken over 31 times by European powers, including the Spanish, Dutch, French, Courlanders and British. In 1889 the British Crown enjoined the islands administratively together.
Trinidad and Tobago achieved independence from England in 1962 and became the Republic of Trinidad and Tobago in 1976. (T&T-Government, 2007e)

Political Situation
Trinidad and Tobago is a presidential republic. The Tobago House of Assembly (THA) is responsible for administrative governance within Tobago. The THA is empowered to "do all such acts and take all such steps as may be necessary for or incidental to the exercise of its powers or for the discharge of its duties". (T&T-Government, 2007c)

The THA is the main employer in Tobago. After a period of radical economic adjustment under IMF and World Bank supervision, the government economic policy is well in line with prevailing market principles: trade liberalisation, open market-driven economy, rationalisation of the public sector, promotion of private enterprise and foreign investment, and development of exports and tourism. (T&T-Government, 2007b)

Economy
Tobago is not a development country in the classical sense. Trinidad and Tobago is one of the wealthiest countries in the Caribbean, thanks to the exploitation of its large reserves of oil and gas, which dominates its economy. Inhabited mostly by people of African and Indian descent, the two-island state enjoys a per capita income well above the average for Latin America. (BBC, 2007)
In the list of countries of the world sorted by their Gross Domestic Product per capita (GDP, nominal) describing the value of all final goods and services produced within a nation in a given year, divided by the average population for the same year, it ranks on the 42nd position before the Czech Republic (Wikipedia, 2007a). While Trinidad has earned a reputation as an excellent investment site for international businesses (Wikipedia, 2007b). Tobago instead is depending for a major part on its tourism income. Natural resources are primarily the forest that once covered the whole island (CIA-Factbook, 2007).

Tourism

Tobago is for a major part depending on tourism as the main source of income. Many new opportunities await exploitation in Tobago's tourism industry, of these eco-tourism is the most important, since it will open doors to most other doors of tourism. (PRDI, 2002)

Being classified as the "Ecotourism Destination of the year 2003" by the World Tourism Organization, the government, tour operators, tourists and local businesses depending on the tourism industry have high expectations. Trinidad's and Tobago's potential for ecotourism development is now widely recognized according to the Caribbean Tourism Organization (CTO).

To ensure a positive effect of this valuation for the island community, sound management of natural resources must be coordinated for the maintenance and benefit for the islands future. (PRDI, 2005) To ensure a positive effect of this valuation for the island community, sound management of natural resources must be coordinated for the maintenance and benefit for the islands future. (PRDI, 2005)

As a relatively new destination for the international tourism market it is described as a major attraction for the eco tourist. The natural resources and environmental sector play a significant in the continuing development in Tobago. Tobago's best known natural resource is its forest resource. Over the last decade the tourism sector has enjoyed significant growth due to this resource. During the period 1995 to 2000, the accommodation capacity increased with 60% in Tobago. The fast growth rate is depending most on small establishments as bed & breakfasts and guesthouses and investments are mostly private. Tobago has approximately 50% of the 4300 rooms available for tourists on entire Trinidad and Tobago. (PRDI, 1998)

Large parts of Tobago are former plantation estates dating back to the colonial time around 1700. (Turpin, 1929) Most of the land on Tobago's estates has remained fallow for many decades (PRDI 2002). Because of the international trend towards healthier lifestyles and the search by tourists for a more enriching experience than sea sun and sand (Honey, M. 1999), the abandoned estates now present many opportunities for tourism (T&T-Government, 2007b).

The first opportunity lies in Tobago's beauty in flora and fauna, Tobago has a rich natural supply of a wide variety of exotic tropical fruits, herbs, fauna and marine resources. Tourism growth potential clearly lies within Tobago's beauty tranquillity and environmental friendliness. These can be cultivated and used in developing a very profitable tourism sector (PRDI, 2002).

Efforts have to be intensified to market Tobago as the primary tourism region of the nation. These efforts should focus on targeting the Northeast coast of Tobago as a tourism destination (PRDI, 2002).