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A Biodiversity Assessment in Tobago

A Species census of the Charlotteville Estate
in preparation of the development of a management plan

Submitted by:
Jasper Klomp & Sebastian Prinz

7th January 2007

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This research is done as an internship to acquire the Bachelor Degree Bachelor of Wildlife Management at the University of Applied Sciences Van Hall Larenstein, Leeuwarden, The Netherlands

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List of Abbreviations

CV	Charlotteville
CSFCS	Charlotteville / Speyside Farmers' Cooperative Society Ltd.
IUCN	International Union for Conservation of Nature
NGO	Non governmental organisation
T&T	Trinidad and Tobago
THA	Tobago House of Assembly
WTO	World Tourism Organization

List of Tables and Figures

Acknowledgements

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. Especially Roy and Lakkan, who have been our guides, the president, Mr. Greville Nickolson and the members of the Charlotteville/Speyside Farmers Cooperative Society as an enthusiast audience for our presentation.

Further we would to thank Mrs. Pat Turpin for the provision of accommodation, material and useful information as well as to the staff of Man-O-War Bay Cottages.

Additionally, the authors would like to express their gratitude to their supervisor Mr. Aljoscha Wothke, the director of Eco-project Ltd. and simultaneously to Mr. Martijn Weterings our supervisor of the Van Hall Larenstein Institute, who all supported the work and preparation of this research eagerly.

Summary

This report is based upon field research performed to analyse the potential of the Charlotteville Estate, Tobago, for an eco-tourism project based upon presence of animal species which are possibly interesting for eco-tourism activities called Key Species. The research performed from 26th of July – 7th of November took more than 52 days of fieldwork in which species of amphibians, birds, butterflies, reptiles and spiders were observed, identified and analysed for eco-tourism value. The research consisted of line transects with point counts supplemented by systematic searching, during different parts of the day. An other main objective was mapping of the research area by GPS to assign different species to regions of the estate. The research was completed by interviews with specialists e.g. professor Star of the Zoology Department of the University of the West Indies, Trinidad, concerning their opinion about valuable species for further research.

During the research over 200 different species were found and 15 species were assigned as key species.

The data collected will be used for the development of a management/policy plan, for the development of eco-tourism activities on the estate.

Introduction

This report contains common used terminology e.g. biodiversity. These terms are used in a specific research context, the definitions and explanations can be found in Annex II.

Research on the variety of life on earth was and is a constant, still ongoing process of passionate scientists all over the world. Combining the number and variety of different species of a habitat to a restricted area, the word biodiversity became common in biology sciences as a tool to measure and describe this phenomenon. Depending on the context the meaning can differ from describing the diversity of one or more animal classes e.g. birds and reptiles, differences in genetics and life forms but also the whole spectrum of the flora and fauna community of a specific biotope in different topographical, geographical or other restrictions that are imaginable.

While species numbers are not equally distributed on earth a general increase in biodiversity from the poles upwards to the tropics described as a bump in biosphere can be measured. This phenomenon isn't seen in cold-blooded animals (ectotherm) only, but also in warm blooded-animals such as birds and mammals (endotherm) (Attenborough, 1989).

Tropical rainforests cover only 7% of land surface on earth but contain at least 60% or probably even more than 90% of all animal and plant life. They are by far the richest terrestrial ecosystem. (Arthur, 1991)

Tropical rainforests show a species diversity which is high in comparison to individual species numbers. Most animals in tropical rainforests are insects smaller than 3 mm, so despite the high species richness it's ore difficult to observe animals of larger size in comparison with forests of moderate temperatures. Tropical rainforests are also the only biotope in which some higher taxonomic species are present e.g. primates. Despite the extent of scientific research in tropical rainforests, there is still a lot unknown. We only know 3% -

5% of the organisms that are part of this ecosystem. According to the lack of knowledge on many aspects, further research is of interest to all involved, especially doing research on mapping species distribution and species presence on earth. (Hoogmoedt, 1992)

South America is home to a number of unique animal groups which are found nowhere else. Some groups are represented on other continents but this resemblance is only based on similarity in appearance e.g. toothless mammals, bird species, reptiles and amphibians. Remarkably is the appearance of prehensile tails confined to tree dwelling species, mostly mammals. This adaptation is barely evolved in species in other parts of the world.

South America is home to approximately 3000 bird species. This is 30% of the total known bird species in the world. In Venezuela there are approximately 1300 bird species recorded, this covers 44% of all South American bird species (Hoogmoedt, 1992).

As many as 44% of all species of vascular plants and 35% of all species in four vertebrate groups are confined to 25 ‘biodiversity hotspots’ comprising only 1,4% of the land surface of the Earth. (Myers, 2000) One of the worlds hotspots defined by Myers, are the Caribbean Islands containing endemic plants and vertebrate species while retaining only 11.3% of its primary vegetation.

Lying on the edge of the continental shelf of South America, Tobago is a commonplace to observe that its flora and fauna are essentially continental rather than Antillean (Hardy, 1982). Because of this close proximity with land bridges existing as recently as 14,000 years ago, flora and fauna is rich and varied (Comeau, Potter, & Roberts, 2006). Typical for islands, it shows characteristics such as species impoverishment and only small fragments of these Neotropical islands are systematically explored. (Hoogmoedt, 1992)

There is a major problem of recent and reliable documentation on species presence for Trinidad and Tobago. Vertebrate fauna is well-known for example; the arachnids on the other hand are poorly documented. The problem is particularly difficult in the case of terrestrial fauna. This probably reflects the personal interests of investigators who, over years, have studied the fauna (Kenny, 2000).

Furthermore species occurrence in literature, especially for fauna on Tobago is not recent and e.g. still enlists lots of observations even from the 19th and beginning 20th century that haven't been confirmed since then. Hurricane Flora in 1963 damaged much of the rain forest (Niddrie, 1980) and apparently had the effect of causing an increase in populations of certain birds, while causing a marked decrease in population of others (ffrench, 1976). Due to the lack of research in general, the number of present terrestrial animal species in the research area is unknown.

Fact is that the terrestrial fauna is dominated by the avifauna, since birds are the dominant terrestrial vertebrate fauna of South America. Vertebrate fauna on Trinidad and Tobago is for mammals 15%, birds 62,6%, reptiles 10,5%, amphibians 4,5% and freshwater fish 7,4%. (Kenny, 2000)

Endemic species are automatically of high interest. Their occurrences are restricted to one single place in the world, the island of Tobago, and thus are enlisted as critically endangered according to the lists of endangered species of the IUCN. There are some indigenous species on Tobago e.g. the Tobago False Coral Snake, or Red Snake *Erythrolamprus ocellatus*. (Boos, 2001)

The outcome of the census was analysed and a key animal species list was compiled in cooperation with Eco-Project-ltd., the Smithsonian Institute and with advice of the University of the West Indies, Trindidad. These key animal species function as species that are of interest for further research activities and the ability to attract tourists. The special ability of these species in terms of e.g. beauty, peculiarity, endemism, affection, scientific interest and/or rarity of occurrence, can be used and marketed for ecotourism project developments in the Charlotteville Estate.

Thus key animal species represent the nature value of the area for the community of Charlotteville, the Charlotteville and Speyside Farmer Cooperative, the land owner Mrs. Turpin, the Non Governmental Organization (NGO):

Environmental Tobago (ET) and The Tobago House of Assembly (THA) representing Tobago's government.

Purpose of study

This research was done by order of the Van Hall Larenstein Institute, part of the Wageningen University, in Leeuwarden, the Netherlands and the 'Charlotteville and Speyside Farmers' Cooperative Society Ltd.'.

The research goal of this research was to determine the presence of key animal species in the Charlotteville Estate, Tobago.

The term "key animal species" describes in this context a group of selected species that play a vital role in attracting tourists. The special ability of these species i.e. in terms of; beauty, peculiarity, endemism, affection, scientific interest and/or rarity of occurrence, can be used and marketed for ecotourism project developments in the Charlotteville Estate. The research focused on different animal species: birds, reptiles, amphibians, spiders and butterflies (see annex ???). Some interesting species of other classes that have been found accidentally during the research are also taken into account and have been added. The outcome of the census was analysed and the key animal species were compiled and listed in cooperation with Eco-Project Ltd. and the Smithsonian institution.

The resulting data contributes to the ongoing development of a management plan for the Charlotteville Estate. Furthermore it supports a possible use for future research or sustainable eco/agro tourism issues.

Research questions

Main research question

‘Which key animal species occur where in the designated research area, Charlotteville Estate, Tobago, W.I.?’

Sub questions

‘Which animal species are present in the research area?’

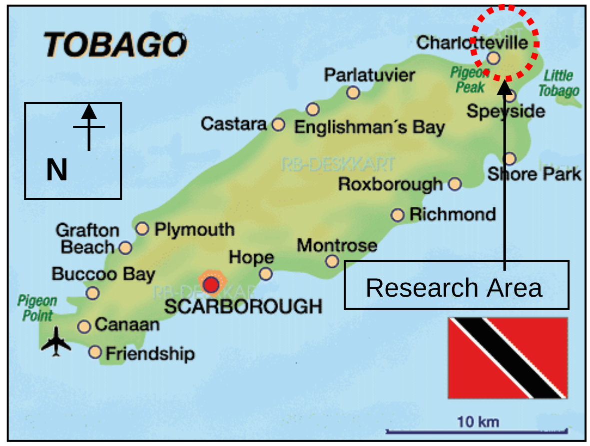
‘Are there any areas present with high/low (key) animal species diversity?’

‘Which key animal species are present in the research area?’

Methods

Study Area

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



Source: http://www.worldatlas.com

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 kilometres long and 10 kilometres wide. (see fig. 2) The counted population in 2000 comprised 54,084 inhabitants. (THA, 2006)

The close vicinity of Trinidad and Tobago to the coast of Venezuela (11 km) results in a high similarity of species in accordance with MacArthur & Wilson's island Biogeography (1967).

Tobago is for a large part covered with secondary tropical rainforest some parts contain primary rainforest e.g. Little Tobago and owns the first tropical rainforest reserve in the western hemisphere (WTO, 2004).

The dominant feature of the island is the Main Ridge, running like a backbone along the northern part of the island and reaching a height of 1890 feet, though there is no well-defined peak. This is formed of metamorphic rocks of sedimentary origin. It 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 mostly now in the Main Ridge Forest, forming less than one quarter of the island's area (ffrench, 2003).

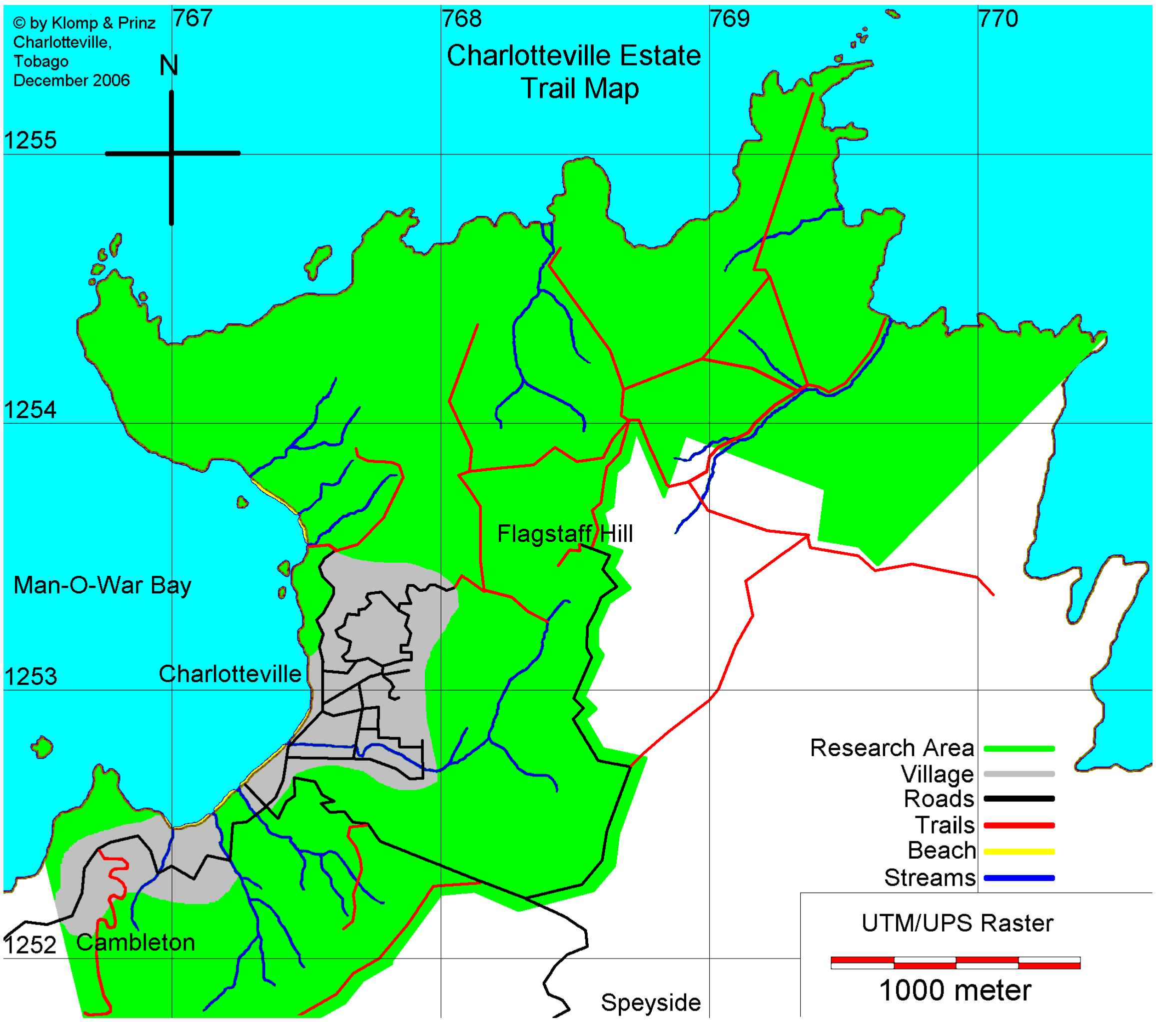


Fig. 3 Map of Charlotteville and Surrounding Estate

The study area is located on the northeast of Tobago (see Figure 2 & 3). The private owned land by Charlotteville Estates Ltd. is about 400 ha. This former cacao plantation is abandoned about 20 years ago and left for nature to take over again. Traces of the plantation history are found in big parts in the hereditary form of remaining cacao trees. In general it can be thus classified as secondary forest. The northern parts adjacent to the sea are mainly untouched, inaccessible and are still pristine forest. Besides the cacao trees/fields it consists of a great variety of biotopes; especially consisting of littoral woodland, lower montane forest, lowlands, a smaller part of deciduous seasonal forest vegetation in a hilly surrounding with steep elevations, adjacent bay harbours and coral reefs. Activities at the moment are logging of dead trees, small scale gardening and some pastures for cattle. Hunting is allowed during the hunting season from October until December, but is probably all year round, due to a lack of game wardens to enforce the regulations. Furthermore it is disturbed by village activities as residential development, a small number of homesteads and roads in various states. The area surrounding the small fisherman village of Charlotteville comprises 283 households and the total population counts 992 people (PRDI, 2005). Former terrestrial research was done by Smithsonian Institute on freshwater fish, reptiles and other vertebrates. (Hardy, 1982)

Census methods

Materials

The following list of material shows the equipment used during the research.

- GPS, Garmin etrex, 12 Channel GPS
- Silva Field Compass
- Camera, Pentax WP 5 MegaPixel, 3 x optical Zoom
- Camera Panasonic FZ 20, 5,2 MegaPixel, 12 x optical Zoom, Lens 36-432
- Binocular, 7 x 25 Bushnell, 10 x 30 Meade, 10x 50 Noname
- Species related literature identification/information (see literature)
- Other field materials
    - Snake hook
    - Tongs/pinchers
    - Linen sacks
    - Gloves
    - Butterfly net, self made, diameter net 60 cm, pole 150 cm
    - Plastic box with lid (several)

The full range of habitats and altitudes present in a research area should be covered by trails used. Slight variations are important, transition zones are known to show high species richness. Habitat breaks and changes in habitat such as ridges and valley bottoms are good areas to focus the census on. The same *applies to streams and forest edges which are well known to attract animals and some provide easier viewing. Many species depend on restricted habitats and it is therefore important to locate and record such restricted habitats with GPS coordinates.* (Bibby, Jones, & Marsden, 1998)

The first step of the research was mapping the different trails present at the Charlotteville Estate. The first two weeks were spent on preliminary location sighting to find a suitable mix of transects and point locations for a representative census. This was done from 26th of July – 9th of August 2006, with the aid of two local farmers/guides who work in the forest. After this period the search for trails continued but was a minor priority activity. The whole range of trails en point count locations can be found in fig. 4, *point counts*.

The second step was an inventory of animal species which was done from 10th of August – 7th of November. The data collected resulted in a listing of animal species present, from which a key animals species list could be compiled, see annex V.

There were three data collection methods used during this research. Photo documentation was preferred by the client. Nevertheless documentation of some cryptic nocturnal species, but also day active species has been difficult or not possible, due to their hiding behaviour. As stated in the goals of this research, species diversity is to be determined; density numbers are of no interest. This had a major impact on the executed census techniques. Counting the same individual of a species for several times does not result in a bias in our data.

The census techniques used for our research:

- **Line transects**
- **Point counts**
- **Systematic searching**.
- **Road Kills**

Line Transects

Line transects were used to cover large proportions of the area to guarantee a comprehensive identification of key animal species. The lines used consisted of "natural" existing features in the area e.g. riverbeds and roads. Line transects were complemented by point counts. This was possible because point counts are similar in concept and theory to line transects according to (Bibby, Hill, Burgess, & Mustoe, 2000) and complement each other for the research aim.

The line transects and point counts were used for all species groups that were determined as part of the research. The last method was active searching for animal species at sites with high probabilities of sighting for a particular species. The active searching was done on reptile, amphibian, butterfly and arachnid species at species-specific habitat sites to discover cryptic and skulking species.

Line transects were highly suitable for more mobile, conspicuous species which 'flush' easily. (Bibby, Jones, & Marsden, 1998) But the disadvantage of line transects was the identification of species due to continuous moving while simultaneously disturbing shy species by emitting walking noises e.g. cracking branches. (Sutherland, 2004) To solve this, point counts were used in which the observer is completely focussed on animals and their habitat. With this it was likely to detect the cryptic and skulking species.

The largest disadvantage of point counts is the relative large amount time spent travelling between two survey points. Sutherland (2004) gives a description to solve this problem, to reduce the negative effect on research time, the point counts were located on line transects and were selected on 6 different vegetation types (forest area, shrub area, shore/coastal, cacao tree area, pasture area, and residential garden area). This had the advantage of filling the gap of "no observations" while relocating to the next point count position and enlarges the researched area significantly. The number of transects therefore was adjusted with the number of point counts.

Line transects were undertaken by observers moving along a fixed route (see fig. 4) recording all animals seen on either side of the route. Lines were appointed to the area depending on present vegetation, facilities, existing paths, stream beds etc., only these were used during the research. Clearance and continued use of new man made trails would have been too time consuming and would have impacted the surrounding vegetation. The total length of transects was about 11 km but some transects are one way. This combined with several streams, which were not covered by or on a line transect, being followed up and downstream, adds an additional 5 km and makes it of a total length of 16 km. Different vegetation types and heights were included automatically within the line transects. Walking speed ranged from 1-2 $^{km}/_{h}$. Counts were taken to infinite distance.

Point counts

The choice of positioning points was based upon vegetation types as a guideline. Each type had approximately the same amount of points in accordance with the relative presence.

E.g. on a total of 20 points and 2 types of vegetation with 80% respectively 20% presence results in a point division of 16 and 4 points in the different types.

To get an overall impression of species in the different habitats and the suitable locations, 23 different point count locations were possible on the Charlotteville estate. The number of point count locations in the different vegetation types is as follows: forest 6 locations, shrub 6 locations, shore/coastal 3 locations, cacao tree 2 locations, pasture 4 locations, and residential garden 2 locations, as indicated on the map in fig. 4. The points have been chosen with a minimum sensible distance of 200 meters from each other. The points were visited when the line transect was being used but not always used as such. This resulted in a regular visitation of the locations, but those were not always used for point count activities. As described by Sutherland (2004) there are differences in activity periods in different species. This results in the need to be at one point at different times a day. To cover point counts and transects at different times of the day, planning was made in such a way, that each point count location was visited three times during morning (6am-10am), noon (10am-15pm) and evening (15pm -18pm) to complement the day counts, each point count location was visited once during the night (18pm-23pm).

Point counts took 15 minutes each and the counting started immediately. Normally a settling down period of about 5 minutes is taken into account with point counts but this was neglected to make sure new species observed within the first 5 "settling down" minutes where recorded as well , after 10 to 15 minutes the probability of detecting new species became lower.

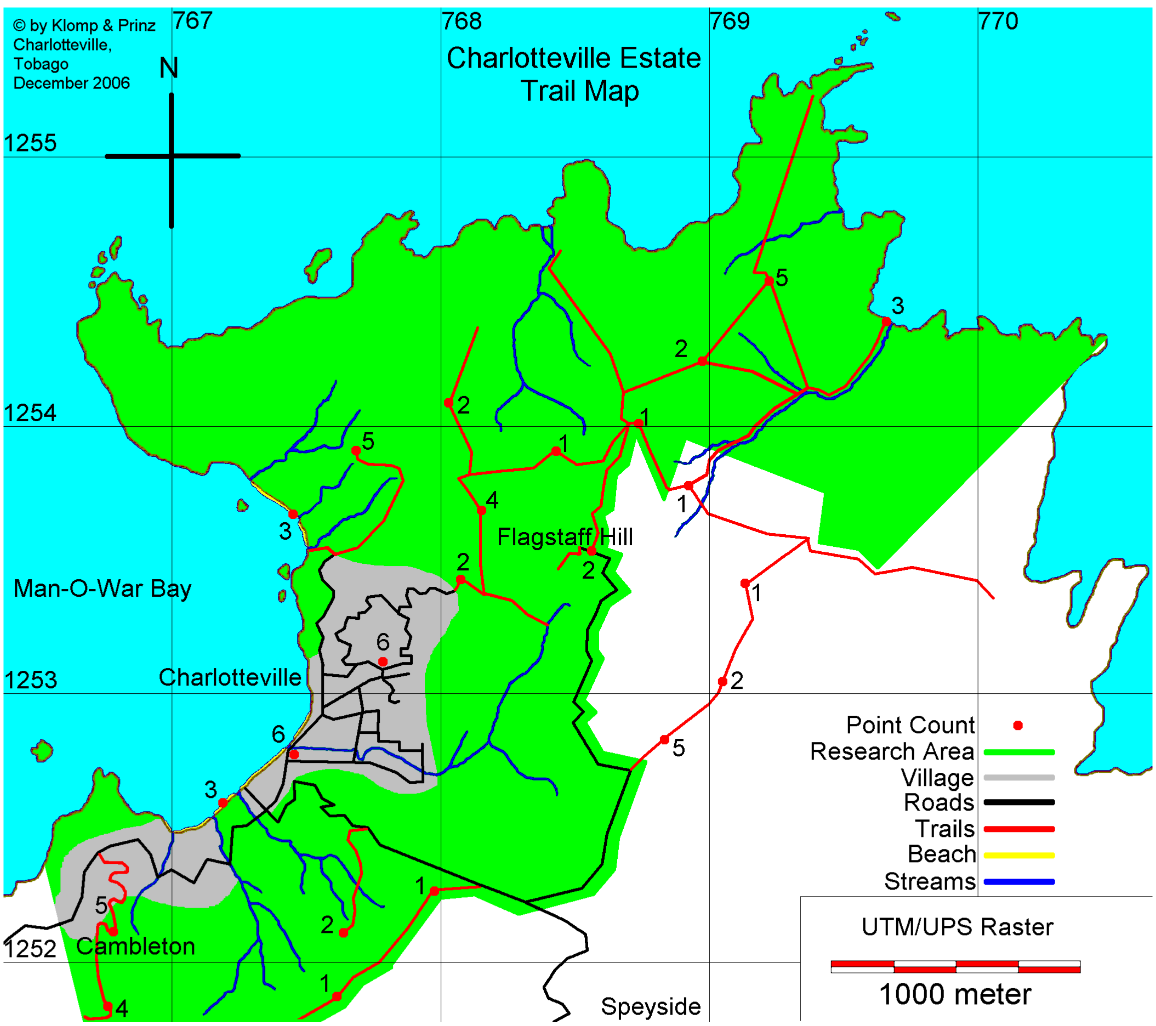


Fig. 4 Trail Map with Point Count Locations

Systematic searching

Systematic searching took place at locations where species could be expected, according to a compiled species list of all species that are described for the whole of Tobago. During this type of census one or more of the same habitat-specific species were searched for at the same time e.g. butterflies and reptiles that prefer riversides and were searched at a riverside simultaneously. Systematic searching included searching at all places where species could potentially be hiding.

Road Kills

Road kill searching took place whenever walking was necessary on traffic roads and was done in addition to the normal census activities two times a week with a flashlight. The road at night had a length of approximately 7-8 km. All specimens that were new and not found earlier during the research pictures were taken for identification or the specimens were collected.

The different animal groups on which the census was focused consisted of birds, butterflies, reptiles, amphibians and spiders. For an overview of time spent on the different classes see fig. 7 results / time spent during research.

Bird Census Methods

Line transects and point counts.

Bird detection was two way, in the beginning, viewing was the most used identification tool but after practice birdsong identification was being used as well. Nevertheless viewing was preferred because photographs were required.

To detect bird species on Charlotteville Estate 23 point count locations connected by transects were used. Each transect and point count location were visited at least 5 times, for more details concerning use see *transects* and *point counts*. Transects and points counts were conducted by two persons. The average walking speed was 1,5 $^{km}/_{h}$, the estimated walking time was 4-6 hours resulting in

6-9 km of transect walking per observation day. Add to these the visitation of 4 point count sites per day to get to 5-7 hours of sampling a day.

Butterfly Census Methods

Line transects and systematic searching.

Butterflies were mostly observed during dry, sunny and wind still weather conditions often referred as “butterfly weather”.

The line transects were undertaken by two observers recording butterflies seen at a range of 5 m to both sides, 10 m to the front and 5 m above the transect. If photographic evidence could not be taken the butterfly was captured by netting and the butterfly was brought immediately into a plastic box. This was pure for the photo documentation to be taken more easily. If this was still unsuccessful the butterfly was killed with a maximum of 1 individual per species.

The transects used were the same as for birds. The different habitat types on the transects were completed by systematic searching on roadsides and in wild gardens e.g. overgrown places in town with herbs and wild flowers. The walking speed remained the same as in bird observations, 1-2 $^{km}/_{h}$, including stops for netting as advised by McGavin (1997).

Every butterfly species detected and or caught was photo documented from sides, both upper- and underside.

Reptile and amphibian Census Methods

Line transects and systematic searching.

Reptiles and amphibians were mainly searched for while walking transects and being discovered by their fleeing behaviour. Most species are camouflaged and maintain immobile until danger gets close. If the researchers got to close, the animals tried to get away. This behaviour was the most common way for spotting. For amphibians the emitted sounds by males was also a good locating tool, but due to the required photographic material not always functional. To get the required material, reptiles and amphibians were caught photographed and released.

The methods used for capturing:

- **Hand capturing (including net and snake hook)**
- **Cornering**

Hand capturing was done by the researchers if possible. There are no venomous snake species on Tobago so no precaution measurements were needed to be taken. Both reptiles and amphibians were caught bare hand or with the use of a snake hook or the “butterfly net”. If handled reptiles were fixed at the head to prevent biting and supported under the abdomen. Amphibians were fixed by holding the rear legs.

Cornering was done on smaller specimens only. The animal was cornered by placing hands around the animal creating a barrier it wouldn’t cross or by lifting the rock/log the animal was sitting on. This way the animal needn’t to be touched and photos could still be taken.

Photo’s were taken from the head, the whole body and if possible the abdomen.

Potential search locations for systematic searching were:

1. **On the ground**
2. **Below the ground, holes buried under litter**
3. **In trees, shrubs and bushes**
4. **Under stones and logs**
5. **Near water, streams, pools**

The systematic search was done on all different animals in these two classes; due to lack of scientific information about animal habitat preferences this was required to cover the whole array.

Spider Census Methods

Systematic searching while doing line transects.

E.g. Charlotteville Estate is home to tarantula species and the crab hunting spider. Tarantulas are mainly found in the forest inside little holes and under stones and the crab hunting spider dwells at river banks.

This example shows that spiders inhabit different niches. Therefore, arachnids are searched for at many different locations and are not restricted to well defined habitats. The spiders found, will be photographed from the upper and if possible from the under side.

Results

The conducted research has had **3 main activities** to get answers to the research questions; **1 mapping of the area, 2 field work/census and 3 time spent processing the collected data**. These 3 activities combined represent 90% of the total research time. The total time spent on the research is 664 hours per researcher. For a detailed overview of the activities see annex III.

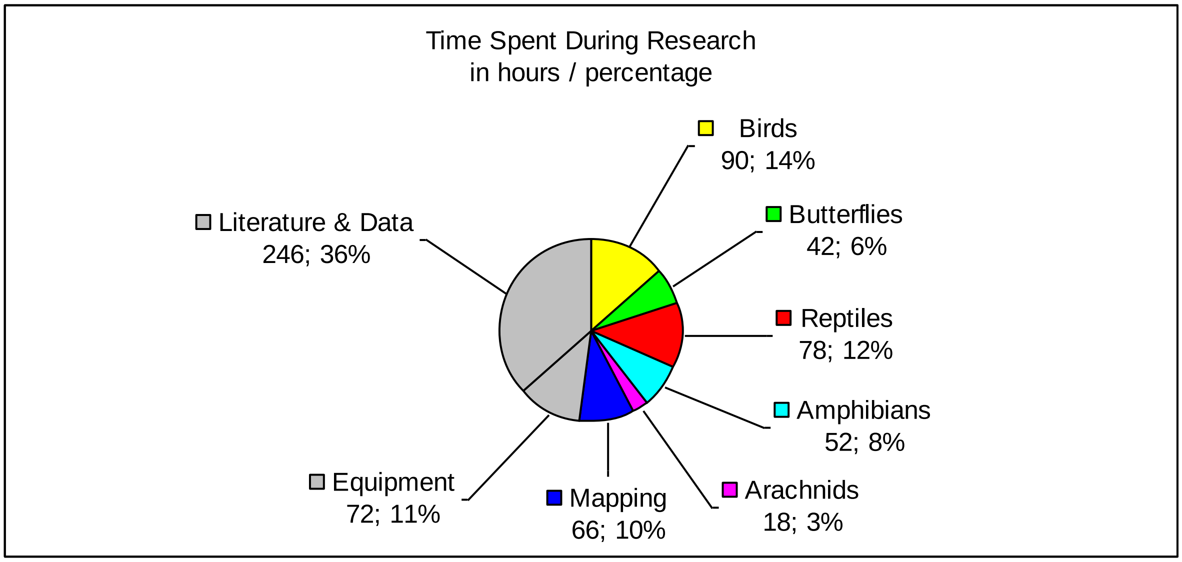


Fig. 5 Detailed Time Distribution on Different Activities

Fig. 5 shows the distribution of the spent time during the research. The animal classes represent the percentage of the field census. During mapping, work was done in the beginning to get acquainted with the area, the trails by developing a map and also the searching techniques. The species that could be found in this preliminary work were recorded too. Equipment activities consist of e.g. buying, repairing and all other technical problems that had to be solved. Literature and Data includes the identifying of species and digitizing the gathered data.

The time spent during the research divided into 8 hour days, gives the following overview in fig. 6 of days spent on the activities.

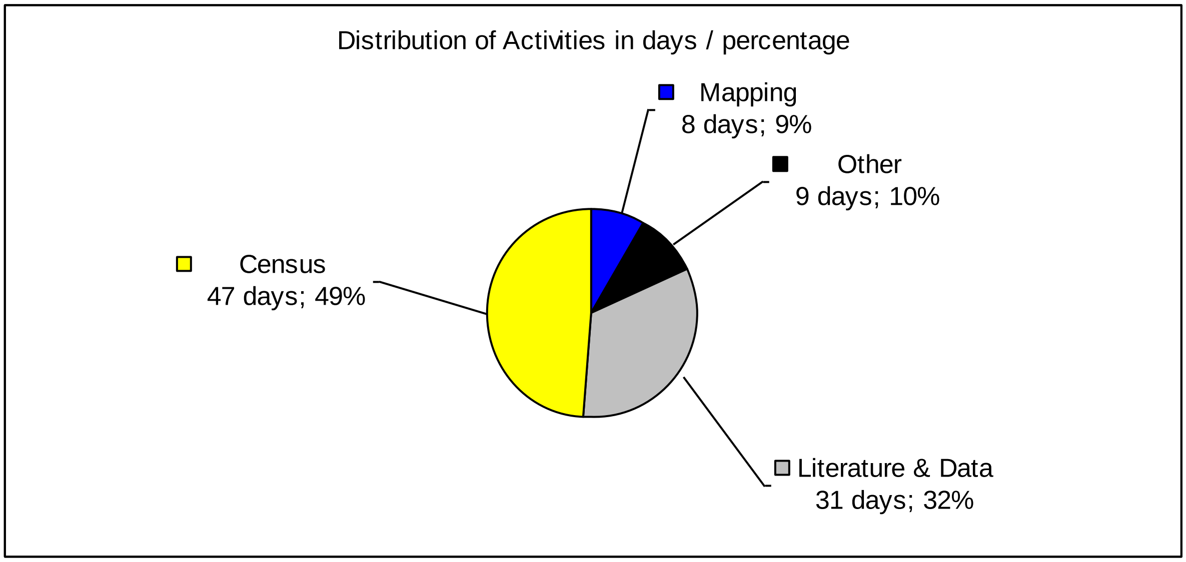


Fig. 6 Time Distribution on Main Research Activities

The time spent during the research divided to the species groups, gives the following overview of hours spent on the different groups in fig. 7.

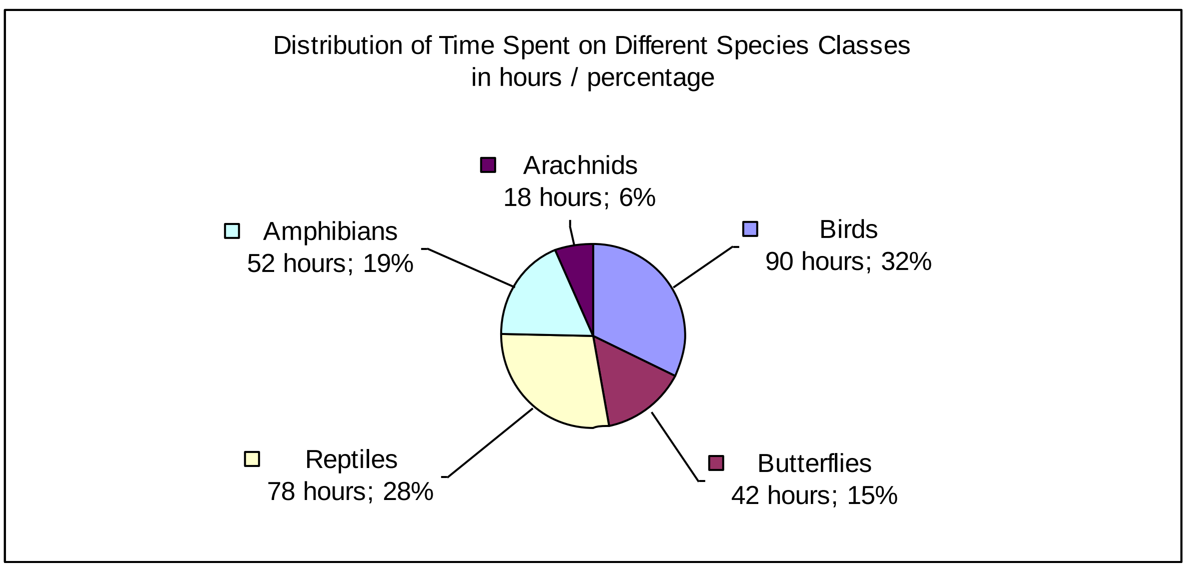


Fig. 7 Census Time Distribution on Animal Classes

The research questions are divided in 3 sub-questions and 1 main question, to answer the main question; the 3 sub-questions need to be answered first.

Animal species presence

To answer this question the survey with line transects, point counts and systematic searching was being performed. A total of 52 days was spent to census the area for species presence. The description of this census can be found in chapter *Methods*.

All animal groups the census was focussed on have had census days in which each group was specifically surveyed/searched for. The time spent on the various groups is divided as described below and shown in fig. 8. The time percentage per group is birds 32%, butterflies 15%, reptiles 28%, amphibians 19% and arachnids 6%.

The outcome in total species number is 238 species. The numbers per species group are; 82 bird species, 41 butterfly species, 22 reptile species, 9 amphibian species, 23 arachnid species and 61 other species.

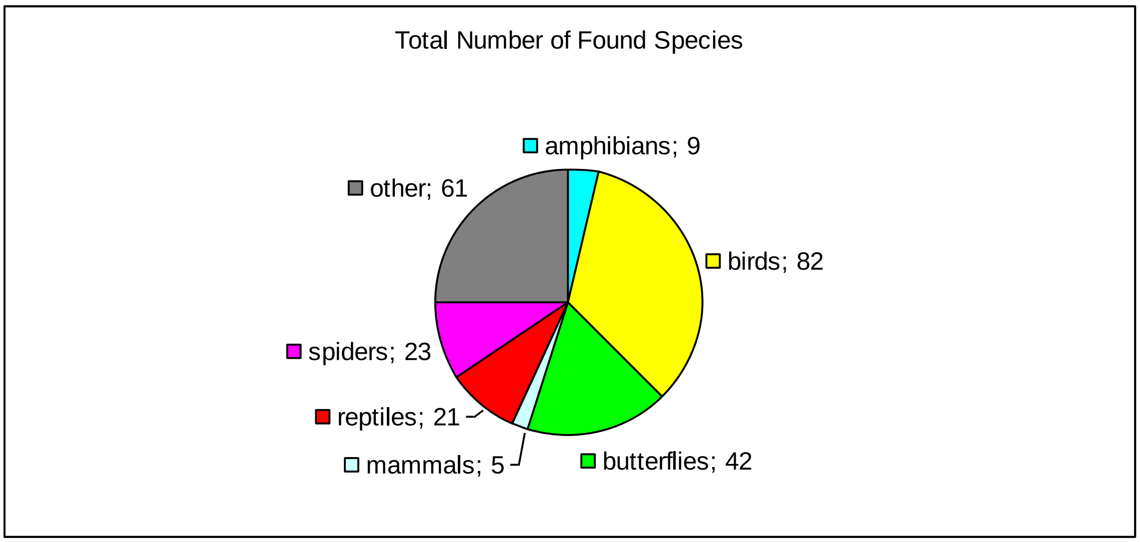


Fig. 8 Total Number of Found Species in Animal Classes

The names of the different species can be found in annex IV and the photos taken during the research can be found on the CD in the cover of the report.

Areas with high/low species diversity

The extensive fieldwork provided a staggering amount of information about the different animals present but also about whereabouts of animals in the research area. The animals found during the research were mapped on a large scale map (1:7500) which was later digitised (see fig. 3). Because of the research activities focused on trails and point count locations most animals were found along these locations. The systematic search gave some additional information about locations with higher numbers but was less often performed and thus gave little information compared to the others in total numbers of found species.

The research area is divided into square kilometres by a grid, see fig. 10. This grid is divided into quarters to get areas of 10.000 m^2. Four of these quarters were assigned to show areas with very high presence of found species. This choice was made to show only the most promising areas where species have been found. The 4 quarters are chosen to show a spot with its direct surrounding and is assigned as a '*hot spot'* in terms of found species numbers, see fig. 11. A scale for diversity in different species was used to determine in which diversity group areas are classified. The scale for diversity in terms of species numbers can be found in the table below.

The animals noted during the research were assigned to grids and once sighted the animal was considered present at that specific location, even if it was only seen once the presence status was positive. One of the criteria was sufficient to address it's diversity status. The distribution can be seen in the following map, see fig. 10.

Diversity Status	Species numbers present	Key species numbers present
1 Very low	0-3	0
2 Low	3-6	1
3 Average	6-10	2
4 Above average	10-15	3
5 High	15-20	4
6 Very high	20-99	5 - 15

Fig. 9 Numbers used for site diversity calculation

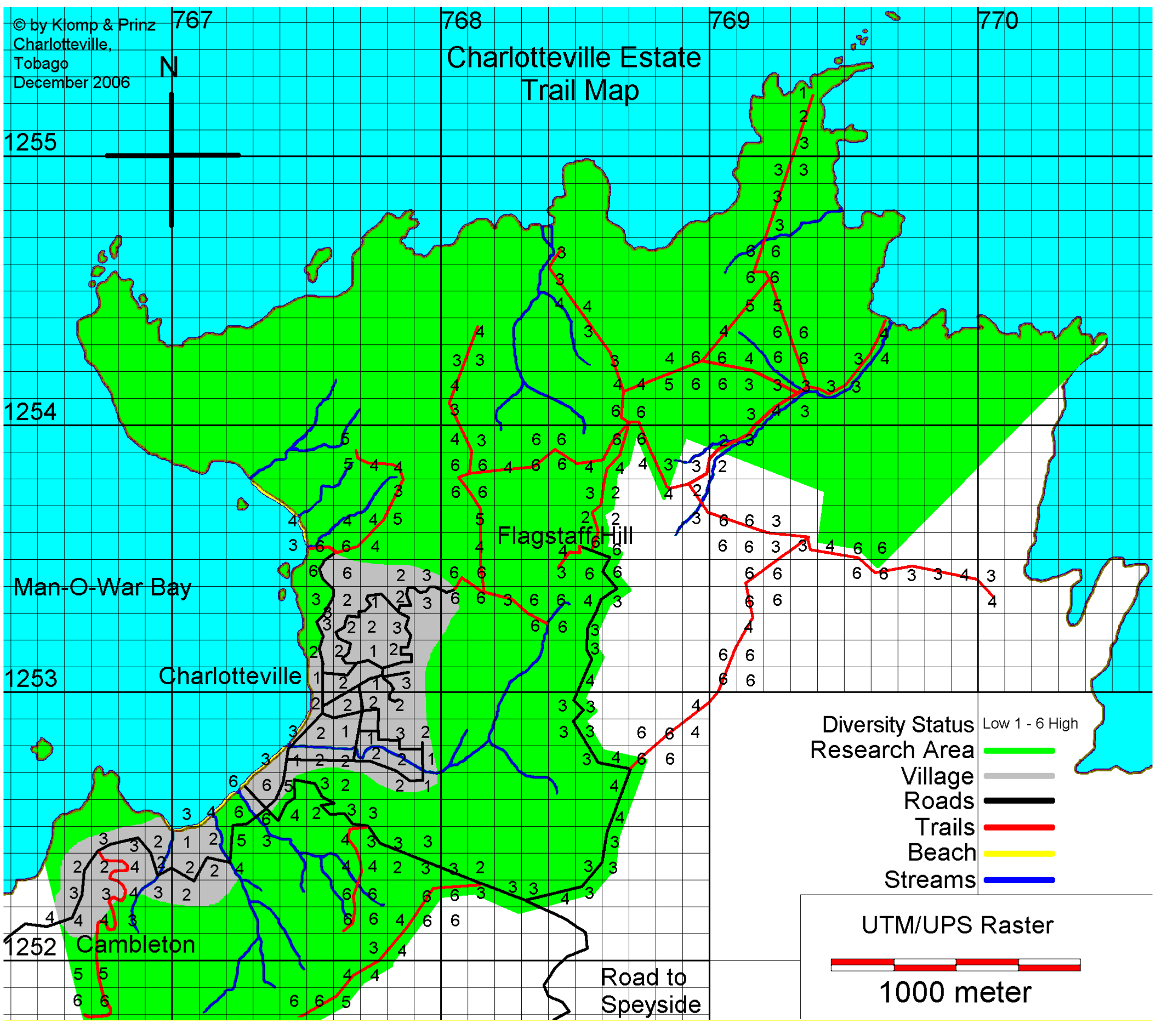


Fig. 10 Distribution of assigned diversity status

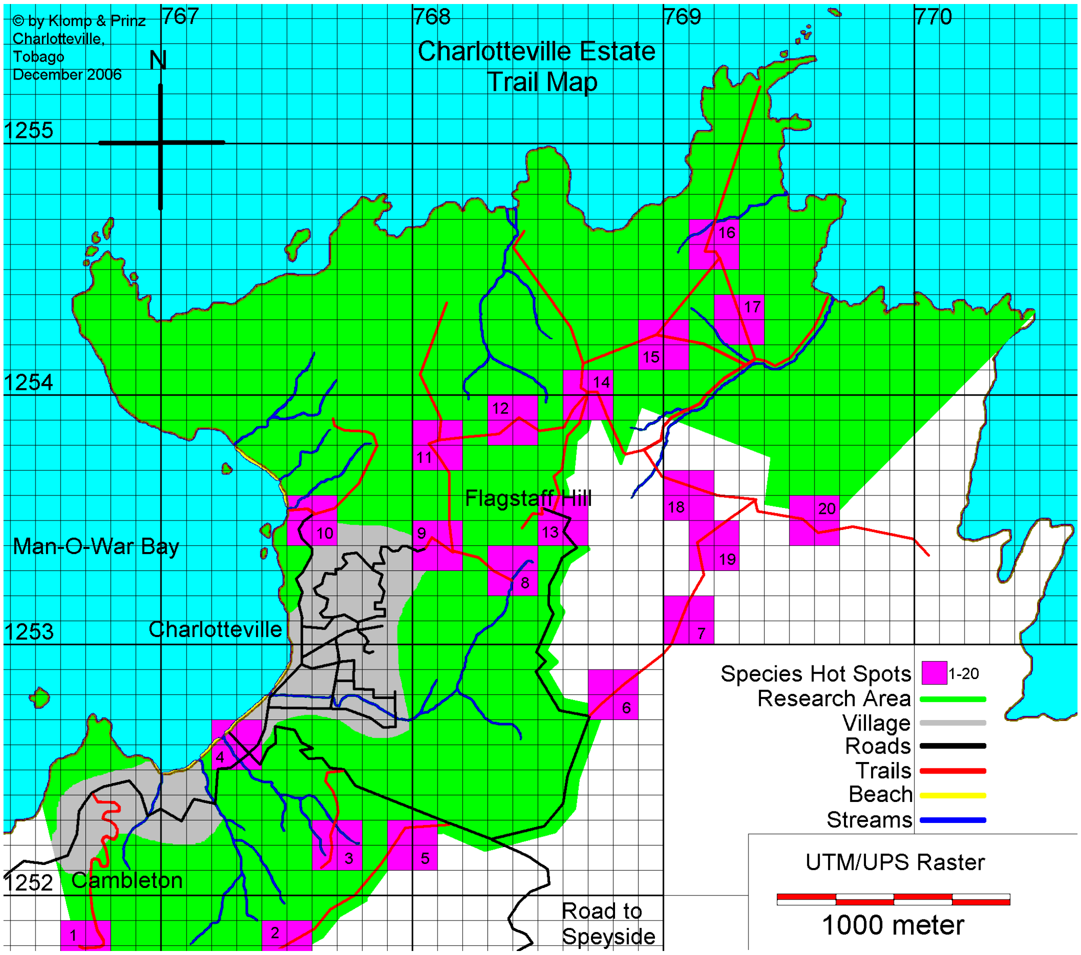


Fig. 11 Map with Spots from 1-20 show high numbers of found species

The pink marked areas show the areas with the highest number of found species.

Key animal species Presence

To answer this question the following actions were performed. The species found during the field research, were all listed and then analysed to note their possible key species status which means interesting for; tourism in general, scientific tourism e.g. researchers and students, or having value in any kind eg. protected species.

To get an overall impression of the status of the possible key species the list was compiled in cooperation with A. Wothke director of Eco-project Ltd., professor D. Hardy of the Smithsonian Institute, professor E. Star of the university of the West Indies, P. Turpin owner of the area, 5 random chosen tourists and the opinion of the researchers self.

The outcome of the questioning of the mentioned persons is as follows;

- Wothke; birds and butterflies which are appealing due to beauty
- Hardy; reptiles, two snake species and a skink specimen, all endemic
- Star; insects, more information in general about the species is required
- Turpin; all animals which could potentially attract more eco-tourists
- Tourists; all animals, rare, endemic, beautiful or any form of appealing
- Researchers; butterflies, reptiles, amphibians, spiders and other insects, the lack of information about several species makes all animals potentially valuable and amongst these groups are many appealing species.

The key animal species analysis can be found in annex IV. This annex provides the scientific name, the local or common name and explains the grounds for being a key specimen.

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

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

Fig. 12 List of Key Species

The animals noted during the research and their Key Species status confirmed were given extra attention during the process of map making and were drawn into a map to get an overall view of key species status. By keeping record of the key species and the location they were found a map with combined data of key species and locations could be made. As shown in the map below, some key species cover larger areas then others. The animals confined to smaller areas could be considered more attractive due to the lack of species abundance in larger areas, but presence in smaller areas brings along that only a small number of these can be found. Knowing where to look for which animal or having a chance to find one, spotting doesn't become a certainty even though there is a map available. But a map with information about key species is a valuable source of information for both tourists and researchers see fig. 13.

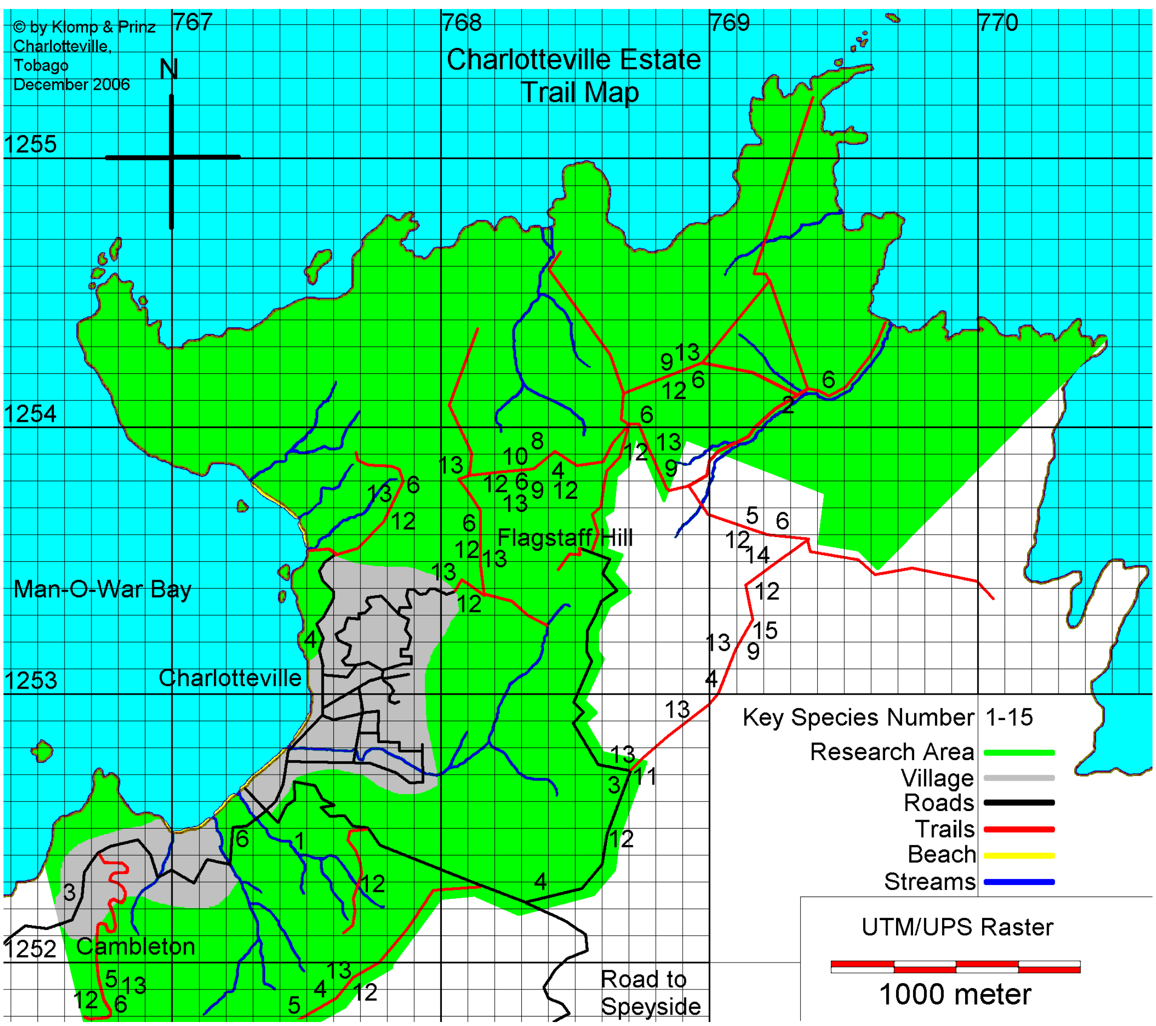


Fig. 13 Map with Key Species Distribution

There is evidence that around Flagstaff Hill are a lot of key species while in the village hardly any key species could be found. Stream beds seem to attract only a small number of classified key species. The same phenomenon is to be seen at road sites.

Discussion

The framework, the techniques of gathering the data in means of conducting research as well as the consistency of the presented results are a point of discussion.

Time restriction

The effective research time was from the 27th of July until the 7th of November. This covers a time period of 3 full months: August, September and October. A total of 8 days mapping were also part of the census. 50% of mapping, an equivalent of 4 days, is therefore added to the total census time. These numbers of days are covering only three months of the year, for the bigger part the raining season so no data was gathered during the specific dry season in which blooming flowers attract butterflies. A large number of birds are linked to the dry season as their mating season in which detection work can be considered to be easier. If you look at the discovery curves (see annex V) there are definitely still more species that can be discovered that could be valuable key species. And even in the last days new species were discovered, which makes it difficult to give a definitive answer on total numbers of present species.

Covering of the research area

The approach was to cover different habitats, vegetation types and heights as good as possible to get a representative image of the research area in its whole. Nevertheless the North-Western tip trails in particular became inaccessible due to a Hurricane two years earlier. Steep edges to the waterfront were also not possible to cover, increasing the risk of getting injured without the necessary equipment and experience. It was compromised to choose for the most promising trails and sites to find in the short time of three months a large number of animal species. By this choice of subjective evaluation, inaccessible parts and the short period of mapping there will be habitats that have been neglected during the research.

Expertise of the researchers

First of all the tropics are not only overwhelming with its lush evergreen rainforests but also strain on the physical fitness when working in this unused climate. For the inexperienced researcher that hasn't been to the tropics, it took some days/weeks to get used to tropical sounds and odours of flora and fauna. Walks longer than six hours were hardly possible restricted by ones ability to focus and concentrate on the sounds and movements of the environment. The non existent prior experience of conducting fieldwork in this new environment lead to constantly advising and changing research behaviour, adjusting census techniques, improving the skills of searching, finding and identifying species. Another weighing factor was the lack of knowledge of the research area.

Census techniques

In the beginning the search of a specific animal group was addressed as a day's objective. Some species are happen to be found more by coincidence than by active searching. As a general code of conduct, attention to all animal classes was a necessity when walking in the forest A general lack of acquaintance with census techniques and recognizing tropical unknown species, made days more efficient the longer the research took the more one got used to the environment.

Days of snake search were often not successful. A day combination to watch out for similar or a broader spectrum of animal groups was more advisable and successful. A change of specific searching in the end especially under leaf covered grounds brought up new species of the reptile group.

For butterflies, catching was often the only possibility to get a decent photograph for identification. A lot more butterflies were spotted but couldn't be caught due to their fast movement or impossibility of direct access. Another unexpected factor was the spontaneous loss of flowering trail edges that had been cut down by the government for maintaining the roads. The butterflies that were attracted to these spots migrated to other places that were hardly accessible and made a butterfly census more difficult to conduct affecting the resulting data.

Searching for birds was quite similar to bird observation in Europe. A slow movement with a lot of patience brought the best result. The better and the more one gets to know of all the bird species, the more skulking and inconspicuous species were discovered. There are a handful of these birds that couldn't be determined due their hiding behaviour. Point counts worked very well in combination with transects. A more specific search for some other species was not conducted due to the difficult spotting conditions in the deeper forest.

Amphibians were found especially at streams or on wet days in the vegetation. Some frogs in deep vegetation couldn't get caught nor photographs taken.

Spiders were surprisingly found in the night when some of them show a good eye reflecting ability. All other spiders were taken during daily walks for other animal groups.

At many spots with a dense canopy it was impossible to take GPS data. Instead for every specimen found, it was decided to give an area code on a map for the key species that has been found.

Animal behaviour

Performing research on live animals always brings in a factor of uncertainty due to their ability to be moving around. This uncertainty only grows whilst conducting research on animals in the wild. The animal groups focussed on are all mobile animals which are able to walk, fly or crawl and are possibly restricted to certain territories. Due to the fact that hunting is executed during the hunting season and (small scale) poaching happens year round, animals have the tendency to be shy. This makes spotting more difficult and animals which are hunted are reluctant to reveal themselves to humans. If the research area is compared to a place with similar vegetation structure, but different due to a ban on hunting and no confirmed poaching, the animals are more spotted during getting "away activities" then would be without this disturbance.

In many other species it's just natural behaviour to be skulking.

Other Shortcomings

These factors were expected as well as unexpected and have influenced the result. In general one can say that there is a restriction in resources that are the decisive key to the best solution. A lack of budget, time and people gave the framework for the data gathering. Some equipment e.g. the butterfly net had to be made and was not an item of brought equipment. Reliable information of the area itself, with reliable and actual maps was hardly available. No recent research data could be given on animal groups as butterflies, amphibians, spiders and bird data is getting of age. A lack of competent guides has also been a big disaster in the beginning. There are a few people that know some parts of the area that were willing to work for/with us. Some on the other hand pretended to know but were not a great help except in making up our budget. Imprecise information about the borders of the Charlotteville Estate made it difficult to cover the correct edges of the area. Altogether lacking reliable information or receiving the wrong data was a key issue that was time and budget consuming. In addition, technical issues e.g. extending flight tickets and changing the accommodation for several times had a time reducing effect.

Key Species Classification

The classification was done by different kind of people, tourists, researchers and local people. In general one can say that this choice is highly subjective but is a compromise to have a clear and distinct number of animals which can play a vital role concerning conservation of the area as well as science and ecotourism development in Charlotteville.

Diversity Classification

Diversity classification can be influenced by all factors described in the discussion. It is done to get an impression for all potential stakeholders for sites and areas to expect high or low species diversity. Furthermore it can give a guideline for further research or area use. It can be expected that this data is not absolute reliable and will be more accurate with a resumption of this first global species diversity assessment.

Assumptions

- Not al key species are defined to small niches or are uncommon. Species can be key due to beauty and be present in large numbers. The Bananaquit (*Coereba flaveola*) is a good example of this, the species is very abundant, absolutely not shy, a good singer and is beautiful coloured. The species is easily attracted to cottages and apartments with fruits and sugar and is therefore a key species. To attract tourists.
- All animals can be considered beautiful, by different people or just by the differences in opinion, mainly based on personal perspectives. With the analysis for animals to key species one of the criteria is on beauty, this is beauty is based upon the opinion of the researcher and the tourists interviewed.

Conclusion

The aim of the research was to get an overall idea about species richness of the area and the goal was to find and locate key species which are interesting for future eco tourism activities. During the weeks spent in the field executing research many different species of different classes were found. During the research the knowledge and skills of the researchers have improved and the results became better as time passed. Some aspects of the research have been changed during the research to get a more detailed result. The time spent gave a staggering amount of 243 species of which some are highly suitable for attracting tourists in both the classical eco tourism point of view and the research related tourism. The potential value of classes found can be described to both tourists and researchers which are appointed below.

Some of the classes are already well documented, but the existing data is somewhat aged and other classes are poorly documented with data collected more than 35 years ago or no data collected at all.

Especially available data on spiders and butterflies can be called poor. This lack of data gave some problems concerning the confirmation in whether or not a specimen is a key species, but this makes them highly interesting for future research. Knowing that butterflies are also very interesting in appearance and lifecycle for tourists makes them valuable for an eco tourism project. The butterflies represent a big group of the potential useful species.

Birds are a class which is more often used as eco tourist attracters and the estate has a potential valuable resource of species in this range as well. Some endemic (sub)species have been found and there are many beautiful coloured or singing species which you can see and enjoy. For future research this class is less interesting but more for tourists.

Reptiles and amphibians are classes which are home to species which are attractive (appearance and behaviour) and also harbour some endemic species, on which debate about status is still ongoing and more information is required. These classes are often clustered, this clustering is also done here because these species attract a certain kind of tourists and the information about them needs to be improved which makes them a good source for research related tourism.

In general one can say that the Charlotteville Estate is home to many different species, some of these species can be found nowhere else but others are quite common in the Caribbean or South America. The less common species are mostly poorly addressed in literature which makes them interesting for future research, on the other hand other well known, pretty, common species are interesting for visitors who just want to enjoy the fauna of Tobago. In total 15 species were appointed as key species with potential value to attract and satisfy needs of tourists and researchers.

Annex

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II Definitions

Biodiversity: the number and variety of organisms, animals, plants, fungi, and microorganisms, and ecosystems within a particular habitat in a region.
Or:
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 confers 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.

Key animal: animal species of main importance for ecotourism development at Charlotteville Estate.
"key animal species" describes in this context a group of selected species that play a vital role in attracting tourists. The special ability of these species i.e. in terms of e.g. beauty, peculiarity, endemism, affection and/or rarity of occurrence, can be used and marketed for ecotourism project developments in the Charlotteville Estate.

Other species: Species which are not represented in the species classes we conducted our research on: birds, butterflies, reptiles, amphibians and arachnids.

Species diversity: the number and variety of species found in a given area in a region.

Species richness: the number of species present in an area.

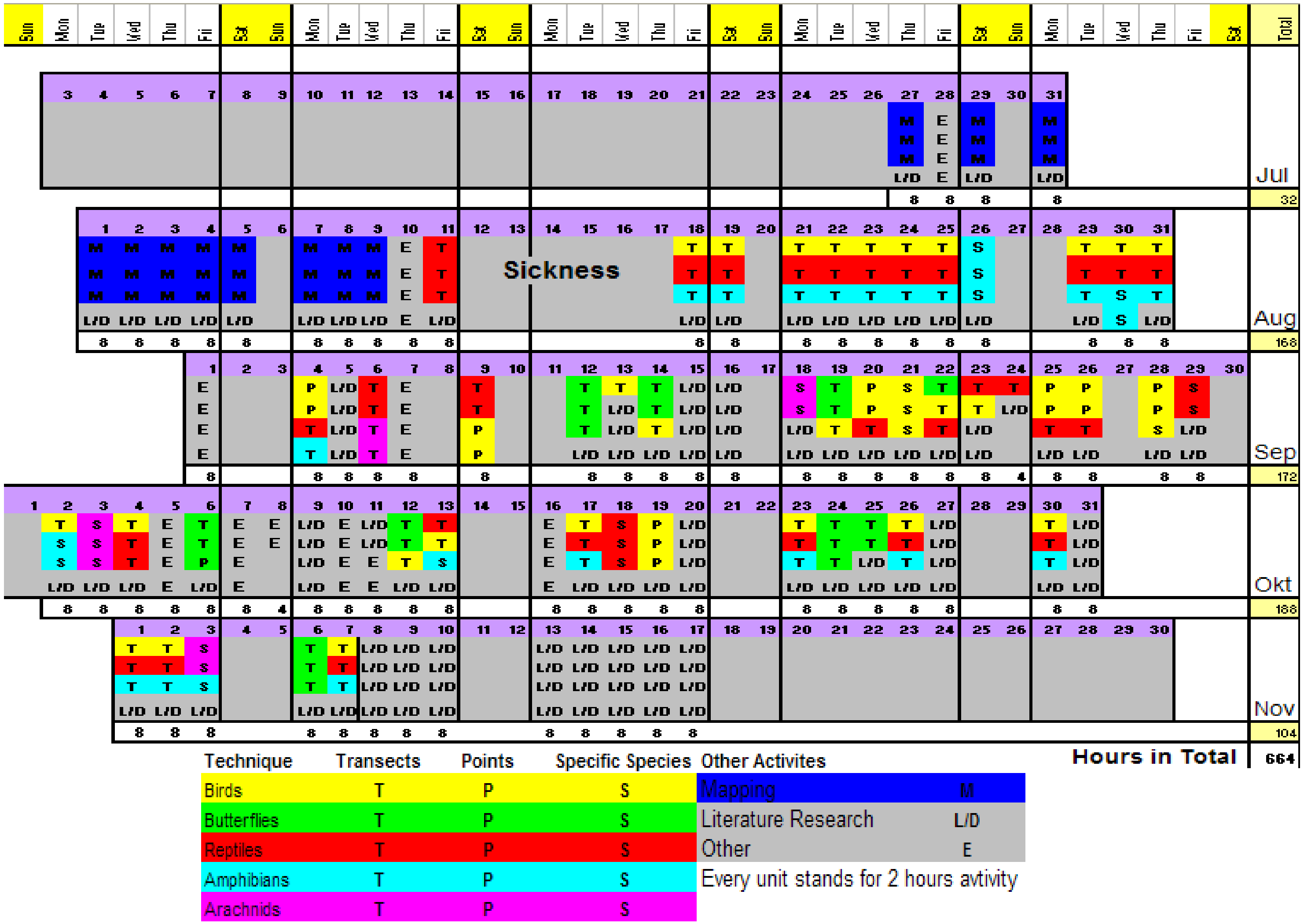
Secondary Forest

Forest that has been degraded by significant human activity, such as extraction of timber, or which has regenerated after cultivation or other disturbance. It is widespread and extremely varied in form. It forms depends on what was there originally, what has been extracted, what may have colonised, land use, fires, squatting and soil erosion. Left long enough, secondary forest reverts to something close to original primary forest. It tends to have a diverse fauna, comparable with evergreen forest. (Kenny, 2000)

Vegetation types: certain specific vegetation features of a biotope. The plants of an area or a region

III Time Schedule Research Activities

Fig. 14 Overview Research Activites in days



IV Found Animal Species

Species in yellow were classified as **key species**
Classification was done according to 5 aspects: ***B****eauty*, ***P****eculiarity*, ***E****ndemism*, ***R****arity* and ***S****cientific Interest*.

	Species	English/Local Name	B	P	E	R	S
Spiders**	*Argiopa Argentata*	Orb Weaver		x			x
	Gasteracantha cancriformes	Spiny Orb Weaver		x			x
	Nephila clavipes	Golden Silk Spider		x			x
	Santinezia serratobialis			x			x
	Tarrantula spp.	Tarrantula		x	?		x
Mammals	*Saccopteryx spp.*	White-lined Sac-winged Bats					
	Tonatia bidens	Round eared Bat					
		Red Squirrel	x				
		Agouti	x	x		x	
		Fruit Bat		x			
		Rodent-Mouse					
Amphibians	*Bufo marinus*	Crapaud					
	Eleutherodactylus charlottevillensis		x	x	x	x	x
	Flectonotus fitzgeraldi		x	x			x
	Hyla crepitans	Flying frog		x			
	Leptodactylus fuscus	Whistling frog					
	Leptodactylus validus						
	Mannophryne olmonae	Bloody Bay Poisoned Frog	x	x	x	x	x
	Phrynohyas venulosa		x	x			
	Physalaemus pustulosus	Coong-la, canal frog, pung-la-la		x			
Snakes	*Boa constrictor constrictor*	Macajuel, Boa Constrictor					
	Corallus ruschenbergerii	Cascabel Dormillon, Tree Boa					
	Erythrolamprus ocellatus	Tobago False Coral, Red Snake	x	x	x	x	x
	Liophis melanotus nesos	Beh Belle Chemin, Doctor Snake	x				
	Leptodeira annulata ashmeadi	False Mapipire					
	Ninia atrata	Ring Neck Snake, Coffee snake	x	x		x	
	Sibon nebulata nebulata	Clouded Snake					
	Leptophis ahaetulla coeruleodorsus	Lora, Parrot Snake	x				
	Mastigodryas boddaerti dunni	Machete Couesse		x	x	x	x
	Oxybelis aeneus	Horsewhip				x	
	Spilotes pullatus pullatus	Tigre, Tigro		x			
Lizards	*Ameiva ameiva*	Common ground lizard, zandolie	x				
	Anolis richardii	Gumangala, Richard's anole					
	Bachia flavescens			x	x	x	x
	Cnemidophorus lemniscatus	Striped runner, foot-shaker	x				
	Gonatodes ocellatus	Ocellated gecko	x	x	x	x	x
	Gonatodes vittatus vittatus	White-banded gecko, streak lizard	x	x		x	
	Hemidactylus mabouia	Twenty-four hours					
	Iguana iguana	Guana, lesard, iguana	x				
	Mabuya bistriata	Trinidad skink, bronze skink					
	Polychrus marmoratus	Many-coloured tree lizard, slow lizard	x	x			x
Butterflies*	*Anartia amathea*	Red Anartia	x				

	Appias druscilla	Florida White					
	Battus polydamus	Gold Rim	x				
	Biblis hyperia	Red Rim	x				
	Caligo teucer	Cacao Mort Bleu	x	x			x
	Calycopis beon	Dusty Blue Hairstreak					
	Colobura dirce	Mosaic	x			x	
	Dryas iulia	Flambeau	x			x	
	Dynamine theseus	Blue-tinted Handkerchief	x				
	Euptychia hermes	Family Satyridae					
	Euptychia libye	Ringlet	x				
	Euptychia themis	Ringlet					
	Eurema albula						
	Eurema venusta	Little Yellowie					
	Haeliconius melpomene	Postman	x				
	Junonia evarete	Caribbean Buckeye					
	Leptotes cassius	Cassius Bleu					
	Lymnas iarbas	Underleaf	x	x			
	Mestra hypermestra cana	Grey Handkerchief					
	Nymula calyce	Brown&cream Nymula					
	Phoebis sennae	The Common Yellow					
	Pyrgus oileus	Tropical Chequered Skipper					
	Taygetis echo	Night					
	Urania leilus	White-tailed Page	x	x		x	
Birds	*Actitis macularia*	Spotted Sandpiper					
	Amazilia tobaci	Copper-rumped Hummingbird	x	x			
	Amazona amazonica	Orange-winged Parrot	x	x			
	Anous stolidus	Brown Noddy, Noddy Tern					
	Anthracothorax nigricollis	Black-throated Mango	x	x			x
	Asio clamator	Striped Owl	x	x	x	x	x
	Bubulcus ibis	Cattle Egret					
	Buteo brachyurus	Short-tailed Hawk					
	Buteogallus anthracinus	Common Black Hawk					
	Buteogallus urubitinga	Great Black Hawk					
	Butorides striatus	Green-backed Heron, Green Heron					
	Calidris mauri	Western Sandpiper					
	Caprimulgus cayennensis	White-tailed Nightjar		x			
	Catoptrophorus semipalmatus	Willet					
	Ceryle alcyon	Belted Kingfisher		x			
	Chaetura brachyura	Short-tailed Swift					
	Charadrius collaris	Collored Plover					
	Charadrius semipalmatus	Semipalmated Plover					
	Chiroxiphia pareola	Blue-backed Manakin	x	x	x	x	x
	Cnemotriccus fuscatus	Fuscous Flycatcher					
	Coccyzus americanus	Yellow-billed Cuckoo				x	
	Coereba flaveola	Bananaquit	x				
	Columba cayennensis	Pale-vented Pigeon					
	Columbina talpacoti	Rufous-winged Dove					
	Crotophaga ani	Smooth-billed Ani		x			
	Cyanerpes cyaneus	Red-legged Honeycreeper	x	x		x	
	Dendroica petechia	Yellow Warbler	x				

Egretta tricolor	Tricolored Heron				
Elaenia flavogaster	Yellow-bellied Elaenia				
Euphonia violacea	Violaceous Euphonia				
Florisuga mellivora	White-necked Jacobin	x	x		x
Formicivora grisea	White-fringed Antwren	x			
Forpus passerinus	Green-rumped Parrotlet	x	x		x
Fregata magnificens	Magnificent Frigatebird, Man-o-War	x	x		
Galbula ruficauda	Rufous-tailed Jacamar	x	x		
Geothlypis trichas	Common Yellowthroat				
Glaucis hirsuta	Rufous-breasted Hermit	x	x		
Larus atricilla	Laughing Gull				
Leptotila verreauxi	White-tipped Dove				
Limnodromus griseus	Short-billed Dowitcher				
Melanerpes rubricapillus	Red-crowned Woodpecker				
Mimus gilvus	Tropical Mockingbird				
Mionectes oleaginea	Ochre-bellied Flycatcher				
Molothrus bonariensis	Shiny Cowbird				
Momotus momota	Blue-crowned Motmot	x	x		
Myiarchus tyrannulus	Brown-crested Flycatcher				
Myiodynastes maculatus	Streaked Flycatcher				
Nyctanassa violacea	Yellow-crowned Night-Heron		x		
Nyctibius griseus	Common Potoo	x	x		x
Ortalis ruficauda	Rufous-vented Chacalaca, Cocrico	x	x	x	
Parula pitiayumi	Tropical Parula	x			
Pelecanus occidentalis	Brown Pelican		x		
Phaethon aethereus	Boatswain Bird, Booby		x		
Progne dominicensis	Caribbean Martin				
Psarocolius decumanus	Crested Oropendola	x	x		
Puffinus lherminieri	Dusky Shearwater				
Quiscalus lugubris	Carib Grackle		x		
Sclerurus albigularis	Gray-throated Leaftosser				
Seiurus noveboracensis	Northern Waterthrush	x			
Sterna anaethetus	Bridled Tern		x		
Sterna sandvicensis	Sandwich Tern		x		
Sula leucogaster	Brown Booby		x		
Sula sula	Red footed Booby		x		
Tachyphonus rufus	White-lined Tanager				
Thamnophilus doliatus	Barred Antshrike				
Thraupis episcopus	Blue-gray Tanager	x	x		
Thraupis palmarum	Palm Tanager	x			
Thryothorus rutilus	Rufous-breasted Wren	x			
Tiaris bicolor	Black-faced Grassquit				
Tolmomyias flaviventris	Yellow-breasted Flycatcher				
Tringa flavipes	Lesser Yellowlegs				
Troglodytes aedon	House Wren	x			
Trogon collaris	Collared Trogon	x	x		x
Turdus nudigensis	Bare-eyed Thrush				
Tyrannus dominicensis	Gray Kingbird				
Tyrannus melancholicus	Tropical Kingbird				
Tyto alba	Barn Owl		x		

	Vanellus chilensis	Southern Lapwing		x
	Veniliornis kirkii	Red-rumped Woodpecker		
	Volatinia jacarina	Blue-black Grassquit		
	Xiphorhynchus susurrans	Cacoa Woodcreeper		
	Zenaida auriculata	Eared Dove		
Other*	Bostra sp.	Stick insect	x	x
	Cerabycidae sp.	Longhorn Beetle	x	
	Chalcolepidius porcatus	Click Beetle		x
	Curculionidae sp.	Weevil		x
	Diplopoda sp.	Millipede	x	x
	Ectatomma tuberculatum	Ant Species		
	Hemiptera, Heteroptera sp.	Bug Species		
	Lampyridae sp.	Firefly	x	
	Pachycondyla crassinoda	Ant Species		
	Passalidae	Bessbug		
	Passalidae sp.	Phoretic Mites		
	Platyhelminthes sp.	Flatworm		x
	Polybia rejecta	Social Wasp		
	Polyplacophora so.	Chiton		
	Sceliphron figulus	Sphecid Wasp		
	Stagmatoptera septemtrionalis	Praying Mantis	x	x
	Xylocopa sp.	Carpenter Bee	x	x

* 17 *species* more of *butterflies* were found but couldn't be identified.

** 19 more *spider species* of spiders were found but couldn't be identified.

*** An additional number of 45 *other species* were found. Most of them are insects. Photographic evidence on the cd-rom.

V Species Discovery Curves

The frequency of adding new species to a list declines with time. At the start of the fieldwork every species recorded was new and as time spent in the field increases, less new species were recorded, except for butterflies. By recording dates at which new species are found together with its number of new found species, a simple analysis can be used. Such an analysis can result in a species discovery curve.

Another method of predicting the species richness of a site is to plot the number of species of new species recorded for each unit of survey effort against the logarithm of the cumulative number of species recorded prior to that unit of effort. A linear relationship is consequently expected. Where the line of best fit crossed the X-axis an estimate can be obtained of the total number of species present. (Bibby, Jones, & Marsden, 1998)

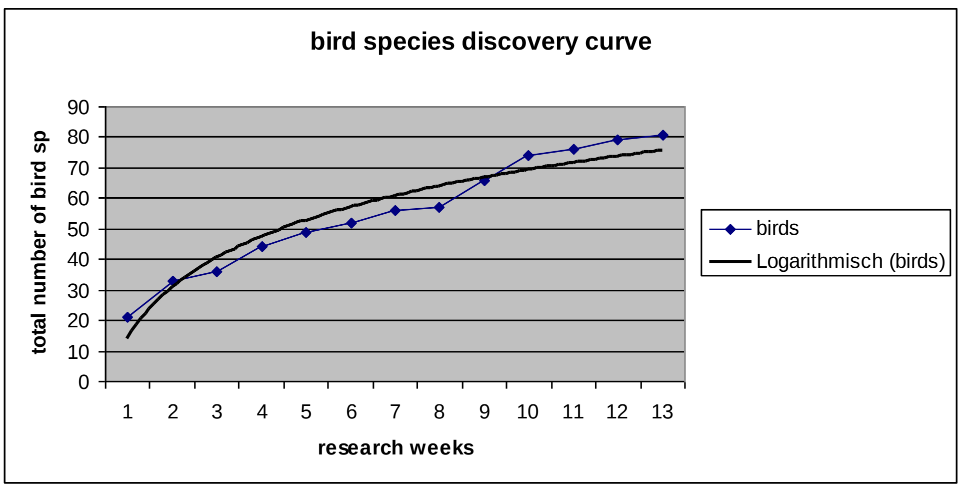


Fig. 15 Bird Species Discovery Curve

In fig. 15, bird discovery has an obvious bulge between week 8 and 10 is observed. This can be explained probably due to improved searching techniques and behavior by the authors. In general this is the most confirming curve of all. There is except the bulge a nice similarity in the shapes. More birds on a small scale can be expected to be found by extending the research time.

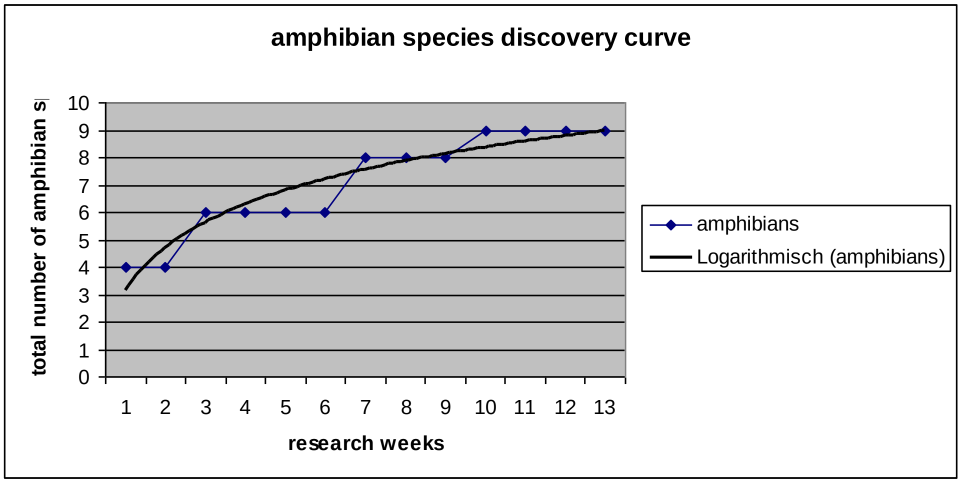


Fig. 16 Amphibian Species Discovery Curve

Several bumps make this amphibian curve not representative (fig. 16). There is no conclusion possible from this graph. 9 out of 17 species were found. How many species more can be expected can't be answered.

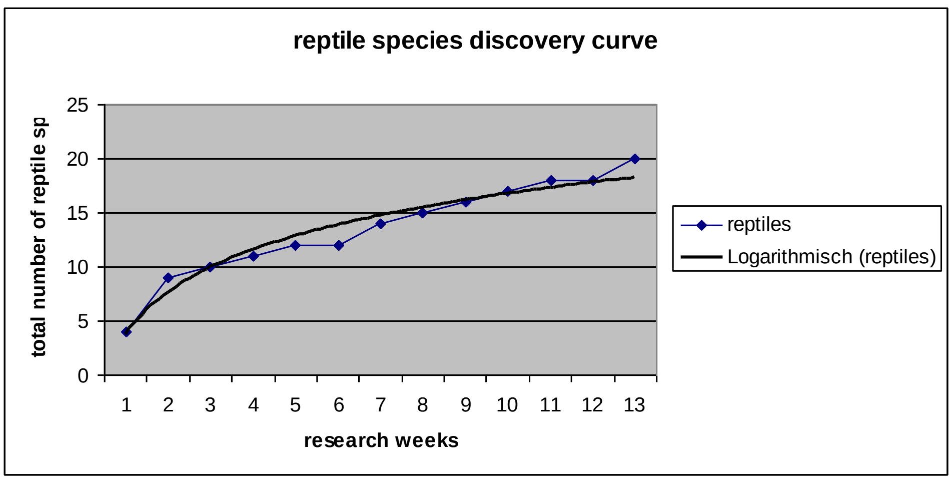


Fig. 17 Reptile Species Discovery Curve

Reptiles were found until the last few days where even 3 new snake species were discovered. The curve in fig. 17 is not reliable. More intensive research will possibly reveal even more species.

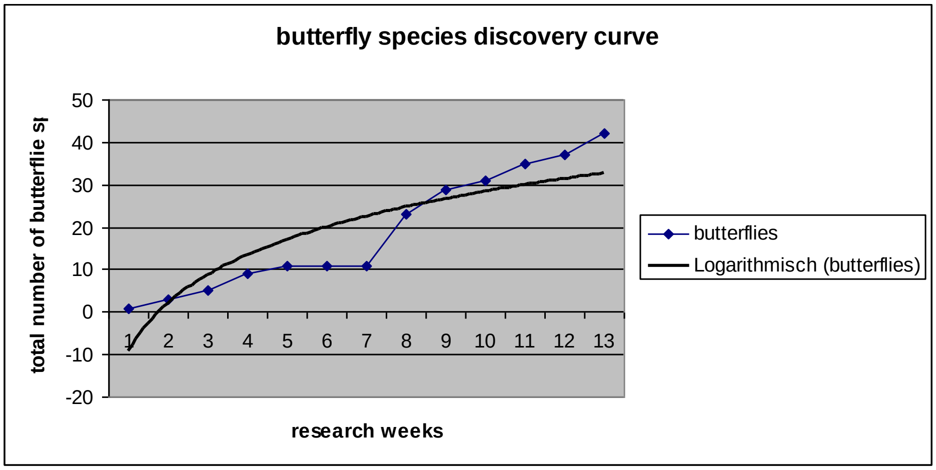


Fig. 18 Butterfly Species Discovery Curve

This butterfly curve (fig. 18) is of no use at all. According to old literature references there are supposed to be 400 different species of butterflies on the whole of Tobago. Only a small portion was found. Depending on the weather conditions of the wet season and the researcher's expertise as well a good portion of coincidence brought up a constantly increasing curve.

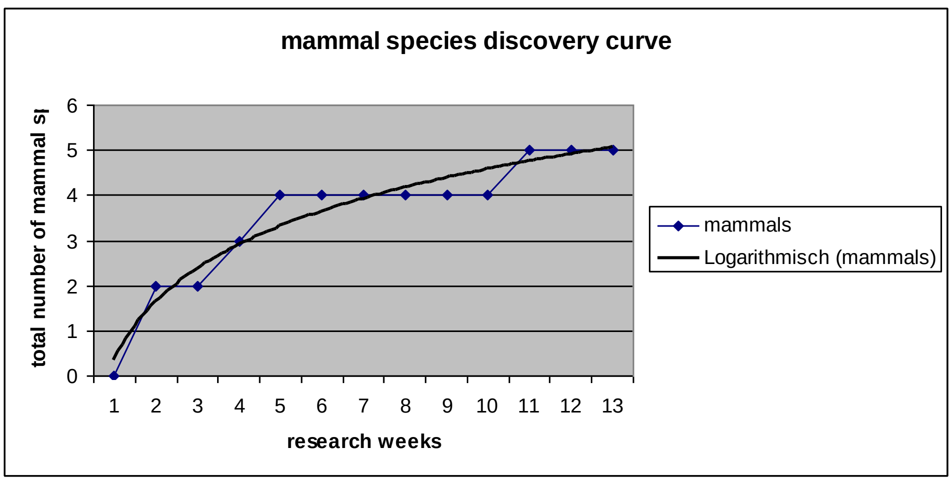


Fig. 19 Mammal Species Discovery Curve

The mammals in fig. 19 that were found are a side-result of the research. Some bat species, a unidentified rodent and an agouti could be found without being integrated in the active searching of the research. Therefore this curve has no bigger value.

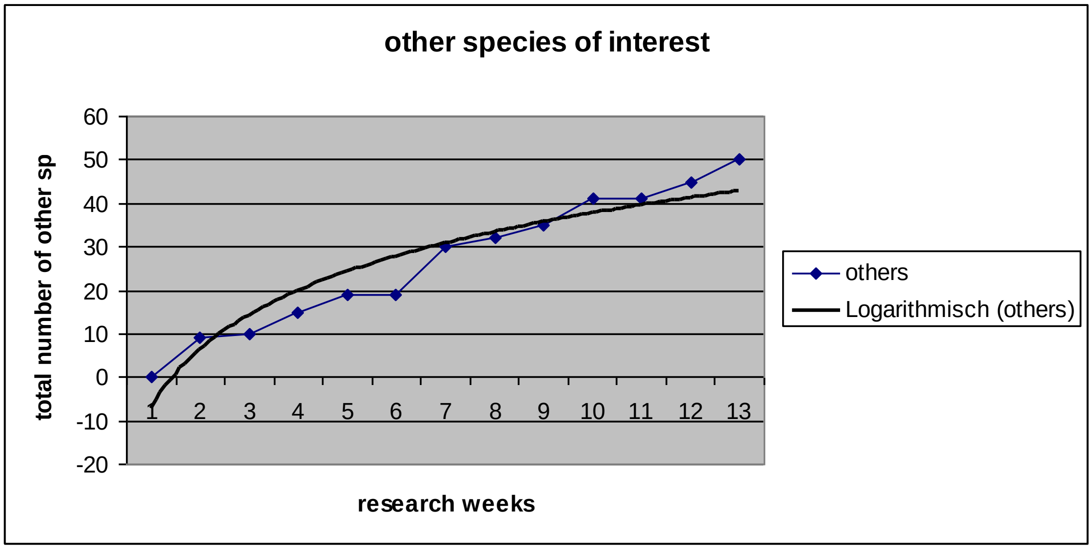


Fig. 20 Other Species of Interest

All species found besides during the research activities were also been archived. As a matter of fact only a small portion could be identified, due to a lack of specialists and resources. Some of them will be interesting for tourists for example too. The curve in fig. 20 shows no good resemblance that would allow a conclusion of a total number. Only obvious species were taken or skulking species that were revealed during the search for other species.