Cusuco National Park, Honduras

Ecology of a Meso-American cloud forest

2007 field report

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Contents

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Executive summary

Cusuco National Park in Honduras is a montane forest of exceptional conservation significance. The park, situated in the Meso-American hotspot, is a remarkable example of an increasingly threatened habitat and supports populations of many cloud forest specialist species including several which are endemic to Cusuco (found nowhere else on earth). The biological diversity of this park is considerable and includes 270 bird species, 93 reptiles and amphibians, 35 bat species and charismatic large mammals such as the mantled howler monkey and Baird's tapir. Although the core zone of the park remains relatively undisturbed the buffer zone is increasingly threatened by human activities, especially coffee production, land clearance and logging. Operation Wallacea have conducted surveys in Cusuco since 2004 documenting the biodiversity of the park and exploring mechanisms for effectively conserving this ecosystem.

Major achievements of the 2007 field season included the completion of habitat surveys in 114 sample sites, a task which would have been impossible without the assistance of general volunteers from 21 schools in the UK, USA and Canada. Another highlight was the number of new records for the park and undescribed species. This year our herpetology team found several species of *Craugastor* frogs which are all new records for the park and some may be undescribed species. Among the 18 new bird species recorded in Cusuco in 2007 the most notable were the Rufous-browed wren, mountain pygmy owl and potentially the Honduran emerald hummingbird, although this record awaits confirmation.

The genetics team had a particularly successful year and demonstrated that it is possible to extract DNA from a range of tissues in all taxonomic groups tested and that even in field conditions with no refrigeration facilities and limited power, simple genetic techniques using customised reagents can be used to examine patterns of genetic diversity using Inter Simple Sequence Repeats (ISSRs).

This season we refined techniques for sampling reptiles and amphibians, small mammals and bats and are confident of the rigour of the long-term monitoring programmes for all the groups that are studied in the park. In 2007 we have placed a greater emphasis on using data from the field surveys to generate indicators for monitoring the state of the park. We believe that our biodiversity data sets now provide unambiguous evidence of the importance of Cusuco, essential to our efforts to leverage funding for conservation.

During the 2007 field season data management was greatly improved by the use of a single custom database and all spatial data relating to the park was brought together into a GIS and made available on the internet. These developments will allow us to synthesise data from all science teams more easily than before, permit more powerful spatial analysis to be performed and facilitate the science teams' preparations for the 2008 season.

Our academics are now analysing data from the season and we await a number of high impact publications. Nineteen students collected data for their dissertations, made very valuable contributions to the survey teams' work , made good progress in data analysis and left Honduras having shared their results over two days of lively presentations.

The Operation Wallacea social scientists once again worked in two buffer zones villages Buenos Aires and Santo Tomas. They conducted a large number of questionnaire-led interviews that collected standardised data invaluable for developing baseline socio-economic indicators that can be used to monitor the effects of conservation policies on livelihoods in future. This team also pioneered some unique participatory methods that gave real insights into what makes these communities tick. We are pleased to report that in 2008 provision of many services upon which the Operation Wallacea programme depends including catering, transport and camp management will be contracted to a newly formed logistics company based in Buenos Aires which will provide even more secure income to this community.

Threats to the park show no signs of diminishing. Our teams found evidence of recent forest clearance and hunting. Conservation measures, in particular effective management of the park by full time staff including rangers is essential to ensure the integrity of the park in order that viable populations of key species are able to persist. By working with a diverse range of partners in Honduras and internationally, Operation Wallacea is striving to put into place sustainable streams of income which will permit effective conservation of the park. To this end, many of our scientists worked together to identify non-timber forest products (NTFPs) that could potentially be sustainably harvested including mimbre palm, capuca palm and micropropagated orchids.

Our team of scientists in Cusuco this year were incredibly dedicated and enthusiastic. The many positive comments from general volunteers, research assistants and dissertation students are testament to this. We would like to thank everyone who has assisted the Operation Wallacea survey teams this year by so generously sharing knowledge, resources and time. We are particularly grateful for the hospitality of the people of Buenos Aires and Santo Tomas for their generous hospitality. We look forward to returning in 2008.

Introduction

Operation Wallacea is an international conservation research organisation specialising in tropical forest and coral reef ecology and conservation. The University of Nottingham is a leading research-intensive university in the UK. The two organisations work together to manage a programme of research in the Parque Nacional Cusuco (PNC) in Honduras. The overall aim of this research programme is to inform the effective conservation management of this important tropical montane forest and cloud forest.

Research each year is concentrated into a two-month period in July and August each year. Science staff afre contracted to lead scientific projects in Cusuco National Park and social science research in the communities within the park. Our science staff are drawn largely from Universities in the UK, Ireland, USA and Canada, but also from Honduras, Belgium, Australia, Colmbia, Mexico, Ecuador and other countries. School students and undergraduates from the UK, Ireland, Canada and the USA pay to join expeditions and participate in the research projects whilst gaining experience of working in a tropical environment and an understanding of various survey techniques and forest ecology. Some students collect data to be used in their undergraduate dissertations. Students provide the funding that supports scientific work and the necessary logistics to safely work in the forest.

Scientific research is co-ordinated by the senior scientists: Dr Richard Field from the University of Nottingham, Peter Long from the University of Bath and Dr Fiona Helmsley-Flint and by two PhD students doing fieldwork in Cusuco: Jose Nunez-Miño (University of Oxford) and Sophie Hall (University of Liverpool). Jose's PhD addreeses whether cross-taxon congruence of several groups in PNC allows groups such as dung beetles to be reliably used as indicators of other groups. Sophie's PhD concerns the impact of development, in the broadest sense, on the livelihoods of people living in PNC. Sophie co-ordinates all social science research in Cusuco. Alex Tozer has overall responsibility for the entire programme in Honduras.

The aims of the expedition in 2007 were:

- Documenting the diversity, abundance and distribution of animals and plants in Cusuco.
- Studying the ecology of a range of important organisms
- Monitoring habitats, dung-beetles, butterflies and moths, jewel scarab beetles, reptiles and amphibians, birds, small mammals, bats and large mammals.
- Investigating the social and economic structure of the villages Buenos Aires and Santo Tomas to inform plans for sustainable development in PNC.

This season our scientists also pursued a number of additional projects on the community ecology of invertebrates in bromeliads, patterns of genetic diversity in Liquidamber trees and behavioural ecology of mantled howler monkeys at Rancho Manacal, just outside the park. We also collected ground-truth data to classify remote-sensed images, made a key to the five species of tree-fern in the park, sampled solitary bees and bracket fungi to send to specialist taxonomists and for the first time ever supported a student dissertation on forensic entomology using three dead pigs.

A key objective of our research is to leverage funding to resource the conservation of PNC. Progress was made this year on a grant application to the Global Environment Facility (GEF) of the World Bank, informed by the results of biodiversity and social science research since 2006.

In delivering our scientific aims we also intend to give the students on which the entire programme depends the best possible learning experience. Fortunately the diversity of science teams investigating all major taxonomic groups, plus a genetics team and a canopy access team together with a programme of evening lectures and seminars with visiting academics and the enthusiasm of all staff ensured that the students felt that their contributions were valued and learned useful skills whilst experiencing living and working in a tropical forest.

The new access road to Santo Tomas associated with the hydroelectric scheme made access easier and the Western camps, first opened in 2006, worked well this season. 2007 was the last year in which the site at Parasio valley was used by Operation Wallacea. In this season, for the first time, we offered the opportunity for students to learn about conservation genetics in the field which proved a very popular option. Also in 2007, Jose Nunez-Miño, Kathy Slater and Justin Hines strengthened our collaborations with a number of organisation in Honduras including a private university, Tegucigalpa zoo,micro-credit charity CARITAS, DIMA and COHDEFOR.

This report outlines the physical geography of the park, the spatial sampling framework for studying biodiversity, the methods used to study each group and how data, including spatial dat, were managed. We present summary results from each team, and species lists are presented in the appendixes. We also interpret the results to understand the state of Cusuco and identify some research and management priorities for the future.

Further information about research in previous years, publications arising from the research programmes in PNC and student dissertations are archived on the Operation Wallacea website www.opwall.com.

The students and scientists learnt a lot from working in PNC this summer. We have collected much valuable data and have greatly enjoyed meeting the people of Buenos Aires and Santo Tomas.

Cusuco National Park

Cusuco National Park is a 23,400ha protected area in the Merendon mountains of northwest Honduras. The park ranges from just above sea level in the west to 2425m in the centre. Cusuco encompasses several major habit types including semi-arid pine forest, moist pine forest, moist broadleaf forest and dwarf forest (bosque enaño) at elevations above 2000m.

The park is part of the Meso-American biodiversity hotspot (Conservation International 2006), a region characterised by exceptional species richness. Cusuco also has great diversity of habitats and high beta diversity in many groups due to the large elevational gradients in the park.

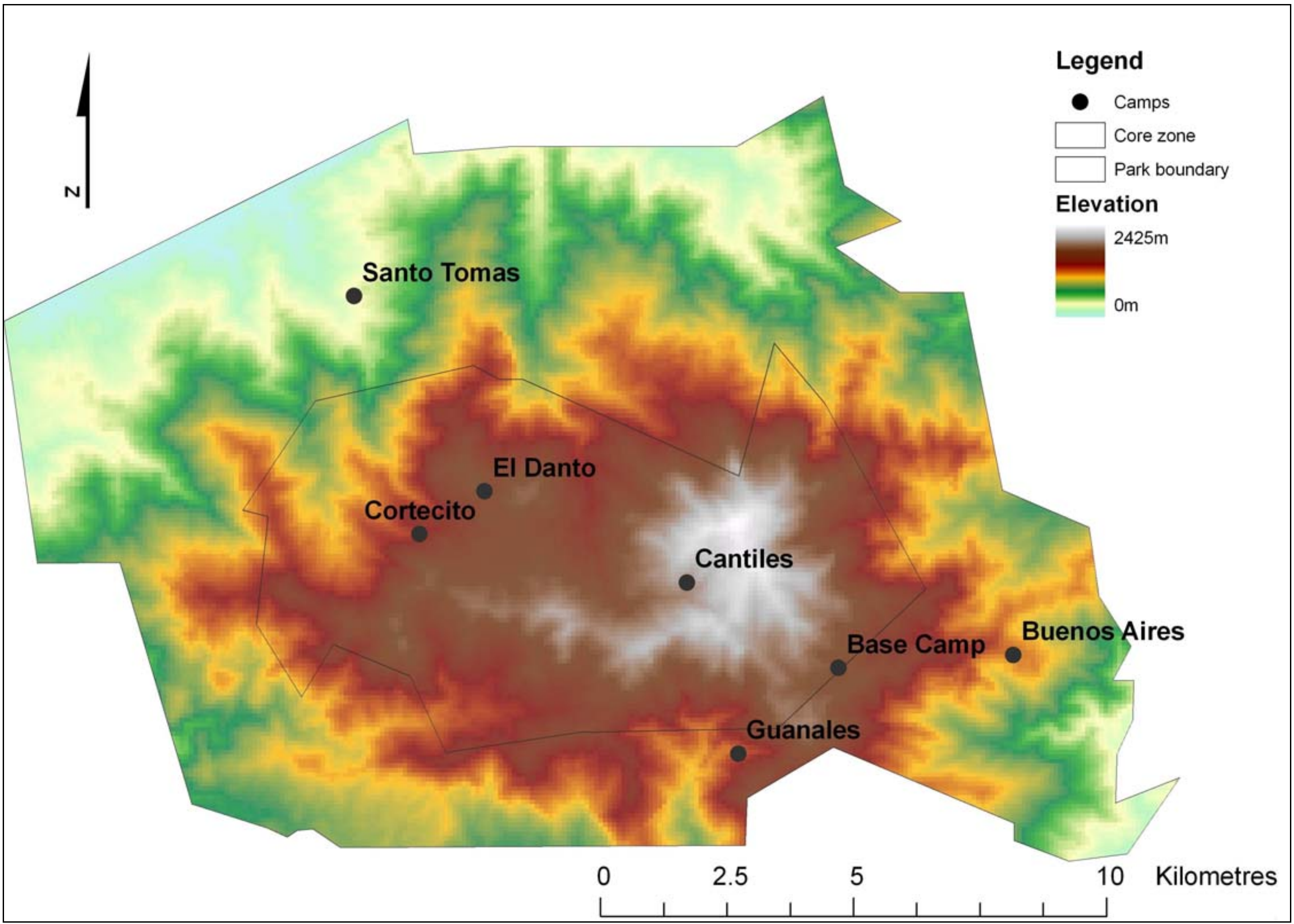

Figure 1. Digital elevation model at 90m resolution of Cusuco National park derived from Shuttle Radar Topography Mission (SRTM) showing main camps and the boundary of the core zone of the protected area. The source of this data was the global land cover facility url: http://www.landcover.org

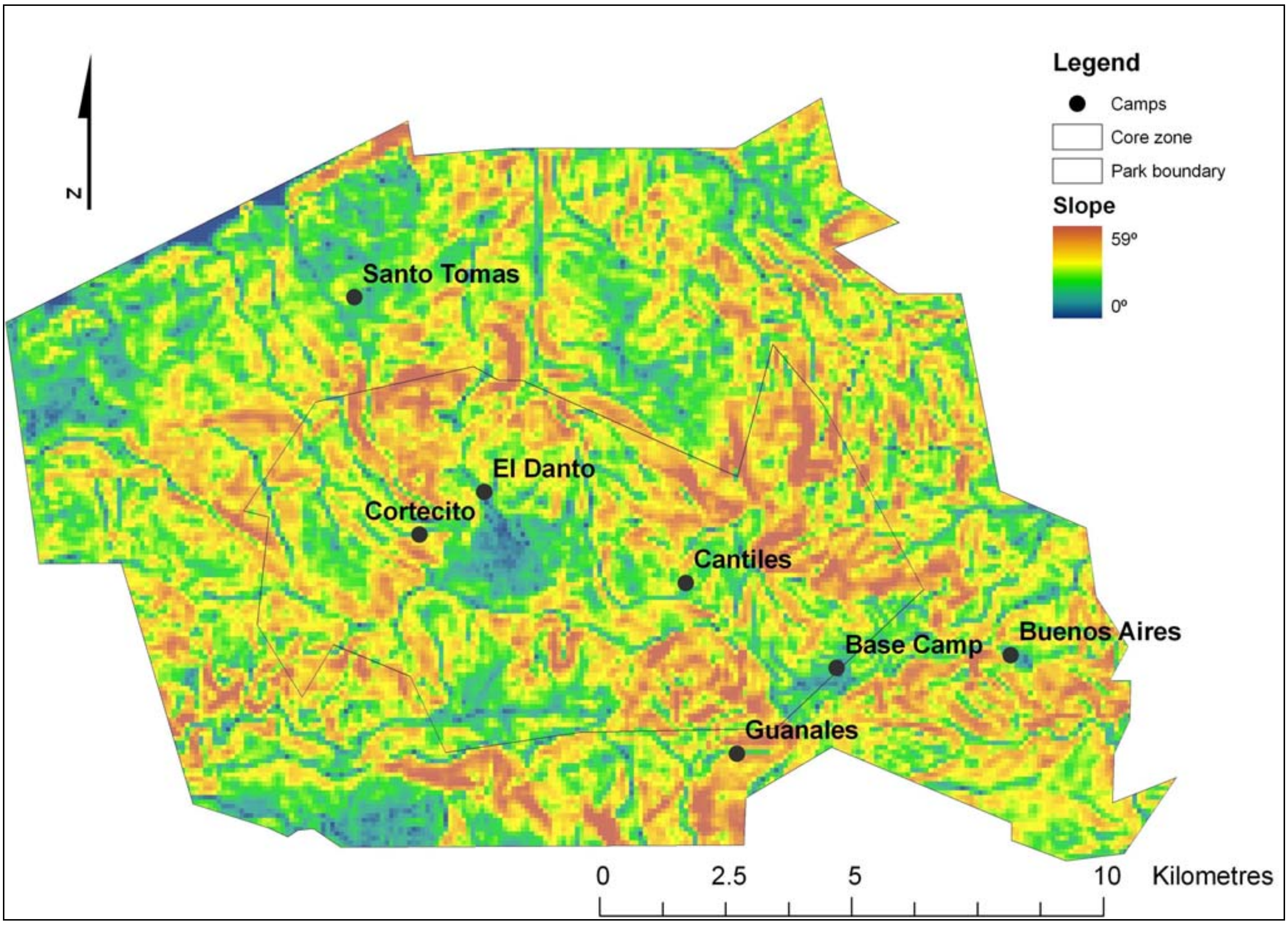

Figure 2. Slopes in Cusuco derived from a digital elevation model at 90m resolution

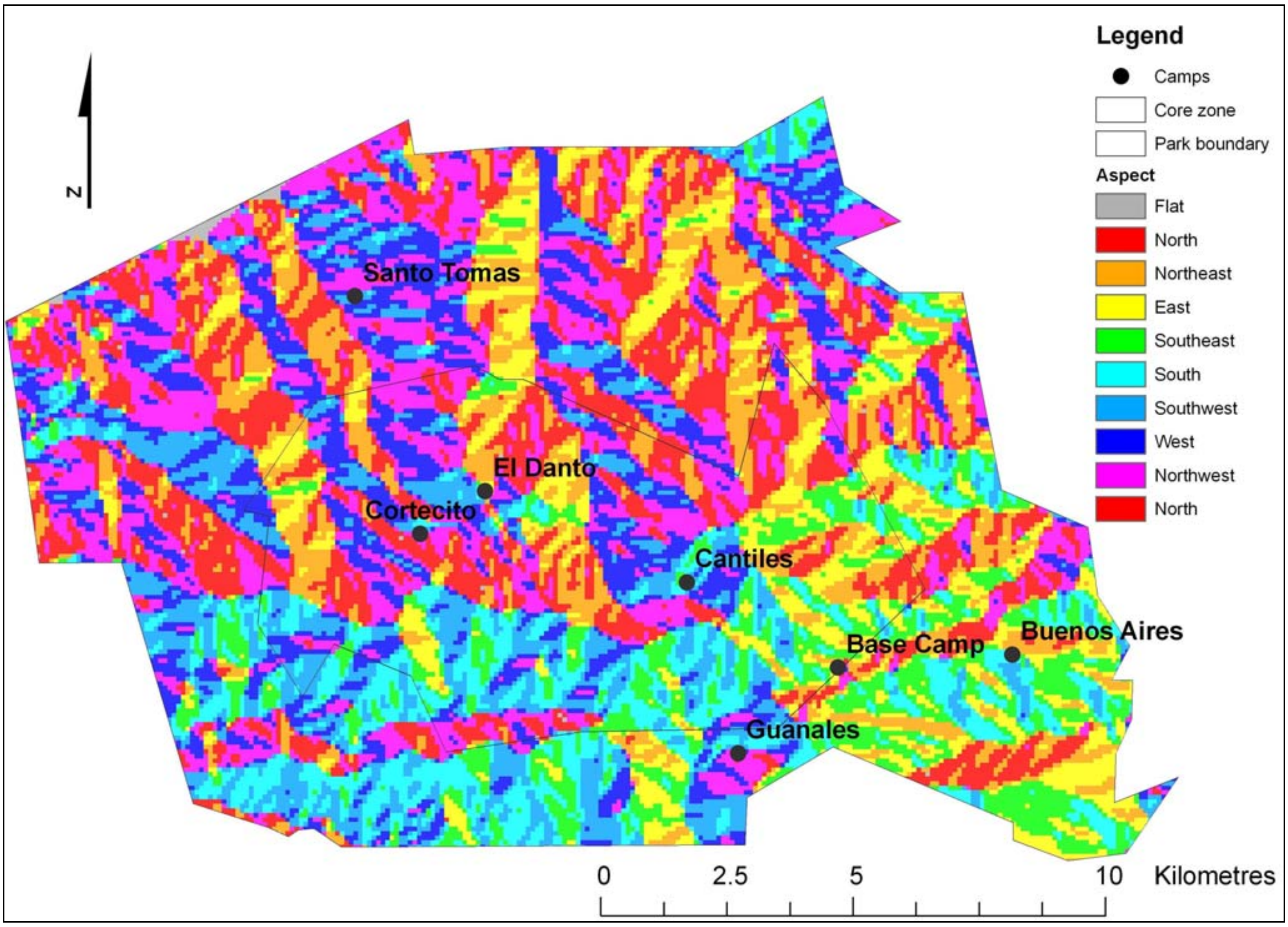

Figure 3. Aspect in Cusuco derived from a digital elevation model at 90m resolution

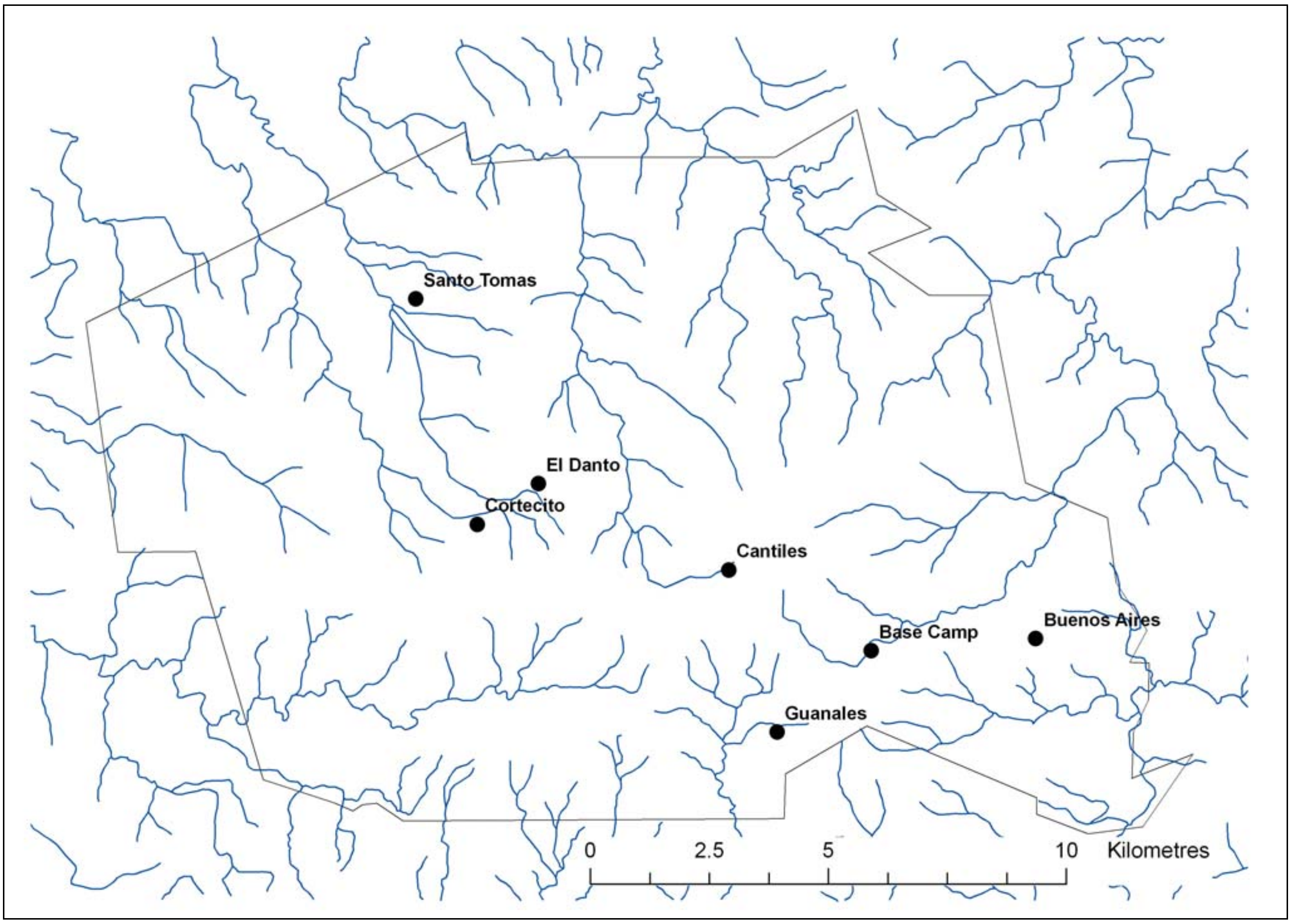

Figure 4. Streams in Cusuco National Park

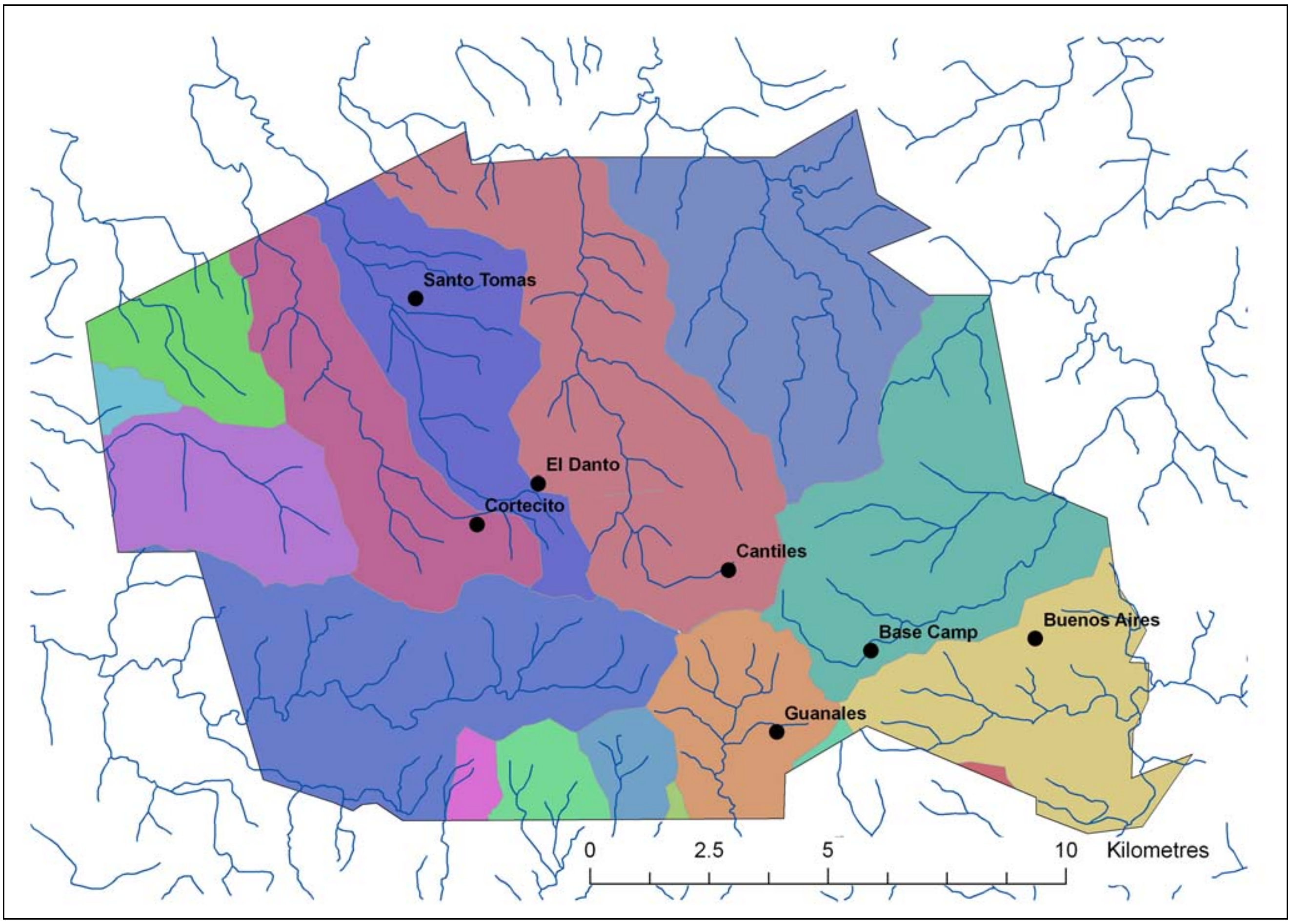

Figure 5. Streams and drainage basins in Cusuco National Park

Spatial data

Topographical maps
Cusuco National park is represented in four sheets of IGN 1:50000 series E752 produced using aerial photos acquired in 1970 (Instituto Geográfico Nacional 1986).
2562 I – Cuyamel San Pedro Sula
2562 II – Valle de Naco
2562 III – Quimistan
2562 IV - Cuyamelito

These maps are available from Instituto Geográfico Nacional in Tegucigalpa, Honduras and Omni Resources in the USA. There is no supplier in the UK.

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www.omnimap.com/catalog/int/honduras.htm

These maps have been scanned, mosaiced together, georeferenced and partially digitised. The maps will be made available to Operation Wallacea scientists on request as a high-resolution geotiff, as a set of shapefiles digitised from the maps and as a digital elevation model. The hard copies of the maps have been deposited in the Operation Wallacea UK office.

Remote sensed data
The most useful collection of remote sensed images of Cusuco is a collection of Landsat scenes acquired between 1987 and 2006 in WRD-2 p018r049 and p019r049 (Figure 7). These have been orthorectified and extensively pre-processed to compensate for atmospheric effects and standardise radiance. In 2003 the scan-line corrector on Landsat 7 failed. In order to obtain a high quality image of the park in 2006 we used several scenes acquired within a two week window in two WRS-2 footprints and a gap-fill procedure and then mosaiced both scenes together. Please see appendix 6 for further details.

We also have a single SPOT scene acquired on 02-Feb-2007 as well as several Ikonos scenes which offer partial coverage of the park. This season IGN also provided us with a small number of aerial photos taken in 1994 covering approximately half of the park. These are hard-copy prints, held by Jose Nunez-Miño. They contain no spatial reference and our view is that they are not very useful.

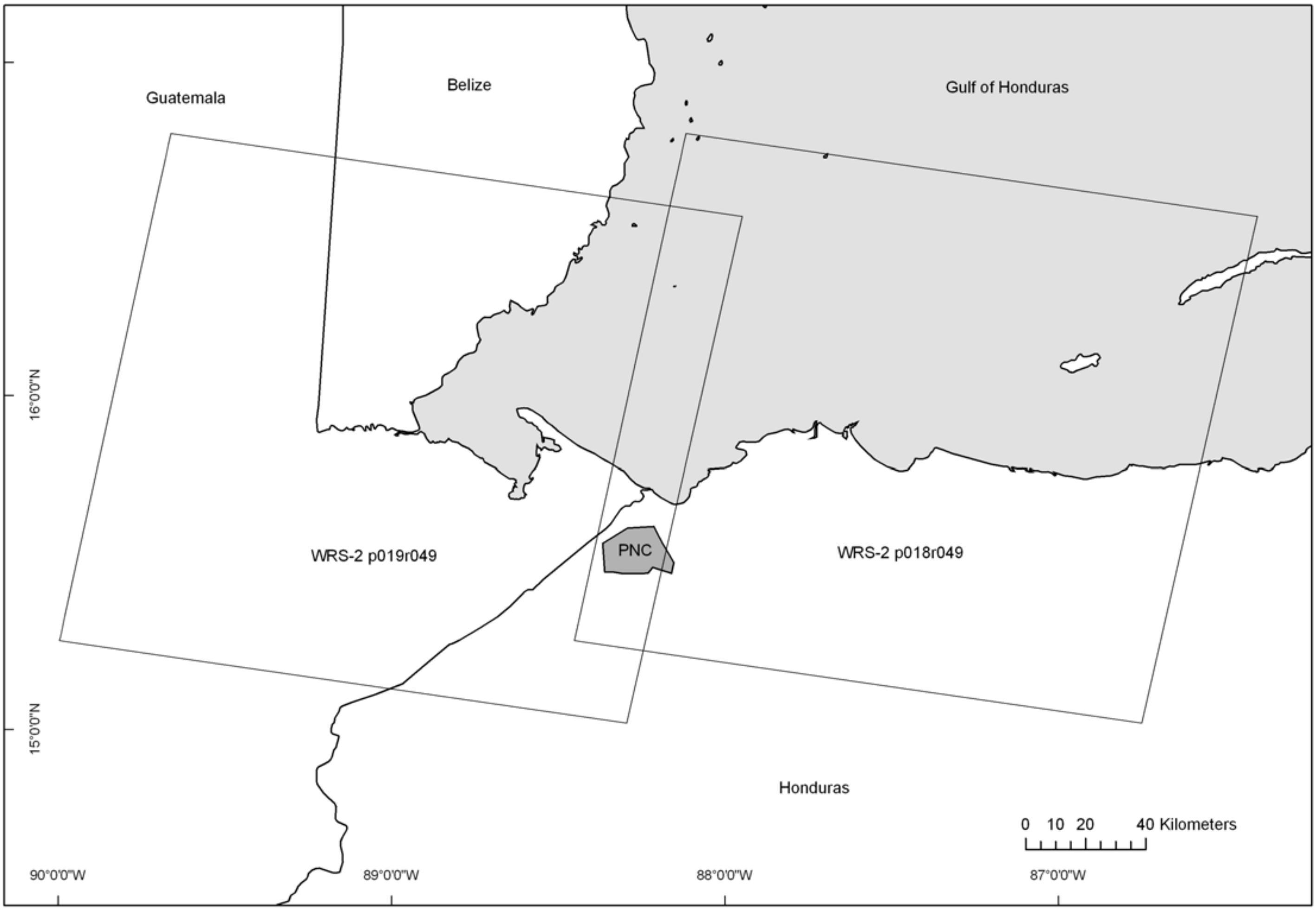

Figure 7. Cusuco National Park is almost completely within the overlap between two Landsat WRS-2 footprints. This offers an opportunity to exploit freely available archived cloud-free Landsat scenes from both footprints for change analysis and allows us to circumvent the problems associated with the loss of the Landsat 7 scan line corrector in 2003 by gap-fill and mosaicing using scenes collected in the same week from both footprints to obtain a 2006 image.

Spatial sampling framework

Seven camps were used in Cusuco in 2007: Buenos Aires (BA), Base Camp (BC), Cantiles (CA), Cortecito (CO), Danto (DA), Guanales (GU) and Santo Tomas (ST) At each camp, four transects have been laid and sample sites have been marked at intervals of at least 200m along the transect. Transects were designed to access a stratified random set of sample sites with respect to elevation and different habitat types and for an approximately equal number of sites to be located in the core and buffer zones of the park. Howvever, transect routes and sample site locations were constrained by topography and safety considerations.

One sample site on each transect was selected as representative of the surrounding forest and designated the main site. The other sites on the transect are then known as subsidiary sites.

At sample sites habitat structure data was collected, plant specimens collected (not in 2007), dung beetles, jewel scarabs beetles, butterflies and moths trapped,bird point counts took place, pitfall trapping and opportunistic searches for reptiles and amphibians were conducted.

Bird mist netting and bat mist netting took place in areas adjacent to transects, but not usually in sample sites. Small mammal traps were set along transects, as sample sites were too disturbed. Large mammal monitoring was independent of the sample sites.

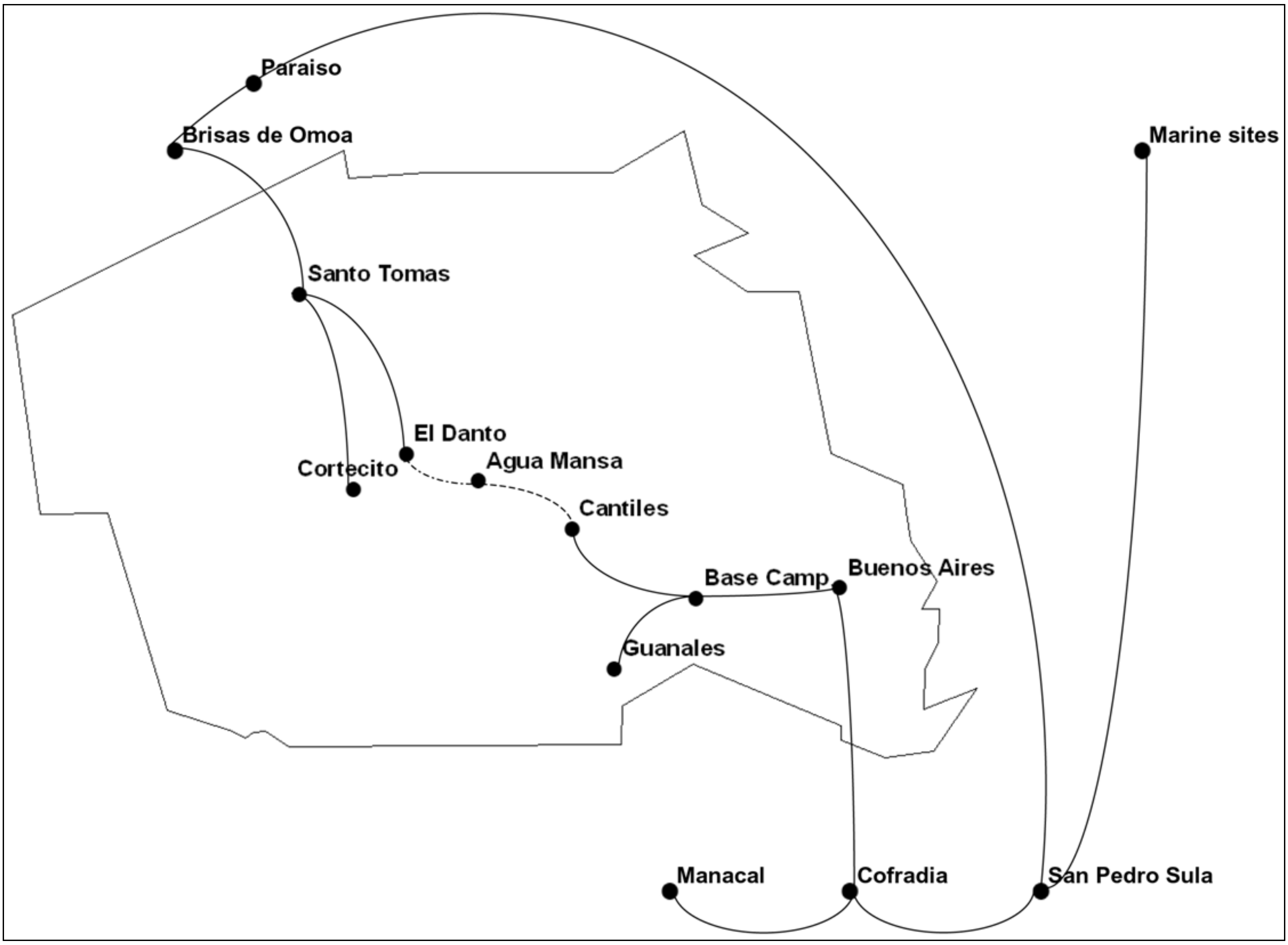

Figure 8. Topology of Cusuco camps: Buenos Aires, Base camp, Guanales, Cantiles, Santo Tomas, Cortecito and El Danto; Temporary camp: Agua Mansa; Additional forest research sites: Manacal, Paraiso; OpWall Honduras office: Cofradia; and transport interchange points: San Pedro Sula and Brisas de Omoa

Methods

<u>Habitat survey team</u>
Forest structure data were collected at all sample sites by teams of general surveyors led by a member of the habitat survey team. At each site, the teams mark a 20m*20m plot and lay two perpendicular tapes across the plot in a cross shape bisecting each edge and creating four 10m*10m plots. The team then divides into four groups. First, a position and disturbance group record position of the site with a GPS receiver, measure the slope and aspect of the plot and classify the plot by level of disturbance using the categories on the data collection form. This group also counts cut stumps and measures fallen trees. Second, a tree survey group tags all tree with a circumference at breast height >30cm, measured the circumference of all trees >15cm circumference at breast height and estimates the height of the four tallest trees in the plot using a clinometer. Third, a profiles group draws a plan profile for the whole 20m*20m plot on graph paper, marking the positions of all trees >30cm circumference at breast height. Finally, a vegetation cover group estimates canopy openness, counts vegetation intercepting 0.5m segments of a 3m pole positioned every 1m along the two bisecting tapes, estimates percentage ground cover b y bare rock, bare soil, leaf litter and vegetation and finally counts the number of woody saplings in 4 quadrants of 2m*2m randomly positioned in the plot.

Habitat survey data are used to characterise forest structure across the park, monitor human disturbance, relate to patterns of biodiversity dat collected by other groups and ground-truth satellite images.

<u>Invertebrate team</u>
The bulk of the work carried out by the terrestrial invertebrate team in Cusuco National Park in 2007 built on the work started in 2006. This concentrated on sampling three important components of the invertebrate fauna found in the park, namely: Dung beetles (Coleoptera: Scarabaidae: Scarabaeinae), Jewel Scarab Beetles (Coleoptera: Scarabidae: Scarabaeidae: Rutelinae) and Moths (Lepidoptera: Sphingidae, Saturnidae & Arctiniidae). Additionally a wider opportunistic sampling has taken place in order to ascertain a background reading of other invertebrate species found in the park. This is done in the knowledge that one of the few previous research studies in the area of invertebrate diversity of two insect families (Curculonidae & Staphylinidae) found a high level of not only country but single park endemics in many of the Honduran cloud forest national parks including Cusuco (Anderson & Ashe, 2000).

Two dissertation students also carried out research of their own. Julie MacDonald built and expanded on the work done preciously on butterflies by Jose Nunez-Mino (2004) in the Buenos Aires Area. Julie focused on the diversity and abundance of butterflies in forest fragments, forest edges and coffee plantations. Her results will be available once she has completed her undergraduate thesis at the University of Cambridge. Victoria Mort worked on a novel project looking at the succession of invertebrates colonising large mammal carcasses (pigs), her investigation will again be written up as her undergraduate thesis at the University of Glamorgan.

Unfortunately full analysis of the data for the dung beetles, jewel scarabs and moths requires the specimens collected to be sorted and identified. However to give an initial oversight of what results might be expected over the coming twelve months I will endeavour to share some of the information collected on dung beetles since this group has undoubtedly taken up the majority of our efforts. I will of course also touch on the other taxonomic groups that we looked into for the sake of completeness.

Dung beetles have an important functional role in forest ecosystems since they remove dung from the soil surface and in so doing aid the recycling of nutrients, aeration of soil, act as secondary seed dispersers, protect seeds buried in the dung from predation, compete or remove disease/pest organisms & promote mycorrhizal associations (Look in references contained within: Andresen, 2003; Horgan, 2005; Scheffler, 2005)

Jewel Scarabs are a charismatic invertebrate species and as such form an important known constituent of the invertebrate fauna of Cusuco National Park. The purpose of our work is to assess their overall distribution across the park this is done with two aspects in mind: to assess their potential as indicator species and the danger they may face because of the impact of unscrupulous collectors (many jewel scarabs have a high market value) and due to habitat loss.

Lepidoptera are an important component of the herbivore community found in tropical forests and as such the hold great potential as indicator species (Lawton *et al.*, 1998). The diversity of moths in particular is very high in Cusuco national park so our work has concentrated on three taxonomically well known families namely the Hawk, Saturnid & Arctid moths. The specimens collected in 2006 and 2007 will be identified over the coming months in order to asses the variation in their distribution and habitat association.

A total of seven camps were open in Cusuco National Park in 2007 (Buenos Aires, Base Camp, Guanales, Cantiles, El Danto, El Cortecito & Santo Tomas) which covered a diverse array of habitats at a range of altitudes. The last three were new camps in 2006. Each site has four transects (as set up in 2006) with a main site (50x50m) and up to seven subsidiary sites (20x20m) where sampling by all the taxonomic groups was carried out.

Three different methods of sampling for invertebrates were used: Light trapping, Flight intercept traps and Dung baited pit fall traps.

Light trapping was carried out using a 22/25W actinic moth trap with a safari net trap (see figure 1). The trap was run overnight at main sites where this was possible for logistic reasons (i.e. fears of theft of equipment including battery) otherwise it was manned for as many hours as possible. The trap was rotated between sites at a minimum of every other day. All Saturnidae, Sphingidae and Arctinidae moths found in the trap or within a 2m radius were collected and stored in labelled glassine envelopes (date, moth family, sample number, site, trap method and collectors name). All non lepidopterans were stored in similarly labelled (date, site, trap method and collectors name) whirl-pak bags (M-Tech Diagnostics Ltd http://www.m-techmicro.com) with 70% alcohol.

Flight Intercept traps were also run is as many main sites as possible. Traps were set up by having saturated salt solution or diluted (50:50) coolant (Ethyl glycol) in the trays. Samples were collected every four days by passing all the liquid through a sieve and putting the insects in a whirl-pak with 70% alcohol. Each bag was labelled with (date, site, trap method and collectors name).

Dung baited traps were run at each main and subsidiary sites. Traps consisted of two 16oz plastic cups (one inside the other) dug into the ground with their lip flush with the ground surface. A small (approx. 20g) of fresh horse dung wrapped in cheese cloth was tied onto a stick and placed across the plastic cup (Figure 2). Traps were emptied every four days in the same way as flight intercept traps. Bait other than Horse dung was also used occasionally in order to obtain a better picture of overall dung beetle diversity (i.e. to note species not collected through horse dung baited traps). This other bait was namely human dung and, when available, fresh Howler Monkey or Tapir Dung collected from the forest.

Bromeliad associated invertebrates team

Plant-held water bodies (phytotelmata) are a common occurrence in tropical rainforests and other humid habitats with a high average yearly precipitation. A particular subset of phytotelmata are the Bromeliaceae. Bromeliads are epiphytic plants geographically restricted to the Americas, from Florida to Chili with one exception; *Pitcarnia feliciana* occurring in tropical rainforest in West Africa. Unless other plant held water bodies such as tree holes, bamboo internodes and many others, bromeliads are true microcosms. Benzing (1986) classified bromeliads as `animal assisted saprophytes`. Organic material collected in the bromeliads, mostly from botanic origin, but including dead organisms, is shredded by macro-invertebrates and further decomposed by micro-organisms. Released nutrients are absorbed by the bases of the leafs which form the tank (Richardson 1999, Kitching 2000). Tank bromeliads are interesting habitats to study deep ecological questions. The small size and occurrence of bromeliads in high densities ensures easy manipulation and gathering of data. The small communities nonetheless have a high richness of species providing enough resolution to tackle a wide range of subjects. The current drawback on using bromeliads for ecological research is the limited knowledge of the occurring species. A good knowledge of the occurring species and the ecology of these species is essential to tackle deep ecological questions and approach conservation issues. Bromeliads are a well established part of the forest in the national park Cusuco. On the long run, a well documented survey of the occurring (aquatic) bromeliad fauna in National Park Cusuco will open the way to an extremely interesting study system and might shed some light on the value of these habitats for the whole forest.

The recorded species richness of aquatic invertebrates follows the observation of high species richness in previous studies on macroinvertebrate communities in bromeliads (see for instance Richardson 1999, Mestre et al. 2001). Interesting is the presence of permanent residents in the bromeliads. Permanent residents have a passive dispersal and require vectors (e.g. amphibians) for their distribution. Ostracods are recorded to survive gut passage of amphibians (Lopez et al. 2002) and tree frogs and snakes are found to have several ostracods and annelids attached to their skin (Lopez et al. 1999). The pelagic cladoceran (*Ceriodaphnia laticaudata*) recorded in the bromeliads in National Park Cusuco last year is an unusual inhabitant. Other Cladocera recorded from bromeliads are a Chydorid (*Alona bromelicola*) in Nicaragua and a Daphniidae (*Daphnia ambigua*) in Jamaica. The reason for the limited occurrence of pelagic cladocerans most probably resides in the limited dispersal capacities. Daphniidae are passive dispersers with no physical grasping possibility (opposed to Ostracoda and Chydoridae?) or no external protection (opposed to Ostracoda and Chydoridae) to survive gut passage. The highly specialised passive dispersers are only present in long established and mature bromeliad communities and forests and probably are highly sensitive to disturbance of the bromeliad visiting amphibians and the surrounding forest.

This year we further gathered baseline information on the aquatic invertebrate communities and focused on the role of the bromeliad placement for the community structure by sampling bromeliads with special attention for the diversity of the permanent residents in the bromeliads. We additionally performed a colonisation experiment with artificial bromeliads (plastic cups) and different treatments mainly to test the presence of vertical dispersal through flooding of higher growing bromeliads.

Study sites

Sampling was done from the 12th of July to 22nd of august 2007. In total 60 bromeliads were processed from 6 sites in around Basecamp (3 sites), Cortesito (2 sites), Elven forest near Cantilles (1 site) and Danto (1 site). At each site 6 “large” bromeliads of *Tillandsia guatemalensis* (or a species with a similar tank structure) were collected.

Bromeliad collection and processing
To minimize variation for analyses, we aimed at collecting bromeliads from a single species (*Tillandsia guatemalensis*) in broadleaf forest and only tree attached specimens. No bromeliads were collected from the ground. Before the actual collection of the bromeliad, we measured the height on the tree, size of the plant, water collecting capacity, light intensity, exposure to direct rainfall and the regional richness of bromeliads. Height on the tree was measured from the attachment point on the tree to the ground level in centimeters, size of the plant was the height measured from the root of the plant to the top of the new leaves in the centre of the plant, water collecting capacity was the widest distance measured between the highest points of opposite leaves (from were the water will be guided to the central tank), light intensity and exposure to direct precipitation is recorded on a scale from 0 to 10 with 0 being absence of direct light or rain, the number of bromeliads in four size classes (small, medium, large and mega) were recorded on the same tree (below and above) and in a two meter radius. Consequently the bromeliad was carefully collected in a bucket to obtain all water and transported back to the camp, core diameter, water content, number of leaves, weight of the washed leaves and weight of the detritus in the bromeliad were recorded. The root of the bromeliad was removed and the core diameter was measured, the volume of the water was measured in centilitres, consequently the leaves were removed one by one and rinsed in a bucket, numbers of leaves were counted and weighted. The organisms in the rinsed water were picked out using a white tray and stored in 70% ethanol. After all invertebrates were removed, the water was filtered on a 64 micrometer sieve to collect the detritus. Large debris were nmanually removed, excess water was squeezed out and the weight of detritus measured with a 100g PESOLA spring balance.

One stereo microscope was available and the reference collection made in 2006 was further adapted. We used “Introduction to Insects” (Borror`s & Delong 2006), An introduction to the aquatic insects of North America (Merritt & Cummins 1996) and “How to know the immature insects” (Chu & Cutkomp 1992) for preliminary identifications.

Colonisation experiment
To study the effect of the placement of a bromeliad on the colonisation and community structure, we performed an experiment with plastic cups serving as artificial bromeliads. We were in particular interested in the dispersal of the passive dispersers (Ostracoda and Cladocera) and used three different treatments and a control to determine the importance of zoochory (e.g. frogs) and vertical dispersal on a single tree through flooding of higher growing bromeliads. The control were artificial bromeliads attached to trees without bromeliads. The three treatments included artificial bromeliads attached to trees with several bromeliads to test the importance of flooding, artificial bromeliads attached to trees with several bromeliads but with a grid (mesh size of a square cm) to prevent large animals from entering and artificial bromeliads hanging from branches to prevent both inflow of water and the entering of large animals (e.g. frogs). For each treatment and the control we used four replica`s and we set up 15 clusters with a total of 240 cups. The plastic cups used as artificial bromeliads were semitransparent green drinking cups, attached to trees with rope. A small indentation was made in the tree to ameliorate the inflow of water in the cups. The setup was left for four weeks and thereafter checked for living organisms in a white tray. The setup of the cups was left until next year.

<u>Herpetology team</u>
A variety of techniques were employed in 2007 to maximize the frequency of herpetological encounters while also producing accurate data in a standardized fashion. The first and most effective method engaged this season was that of walking prescribed transect lines through a variety of habitats at a rate of 500 m/hr and recording all individuals sighted or captured during that time. Data was recorded for each individual, including factors such as identification, morphological observations and measurements, habitat notes, and the location along the transect where each individual was encountered. This location data will them be matched back to the nearest study site along the transect, with which the specimen will be associated. This technique is a significant improvement from the 2006 methodology, in which predetermined study sites along the transects were investigated rather than the transect lines themselves. As a result of the high level of disturbance incurred at the study sites after several weeks of intensive study by multiple taxonomic groups, the frequency of herpetological encounters was especially low while exploring these sites when compared to the “opportunistic” records of species sighted while traveling the transect lines to and from the study sites. This season showed a highly positive increase in productivity due to this change in methodology.

The second technique heavily employed this season was old-fashioned opportunistic surveys, an all-around efficient practice in herpetology. Searches were conducted both day and night in locations which appeared to be productive habitats for finding reptiles and amphibians. Examples include river walks, night walks in a variety of habitats, and any other productive-looking areas which might not have been visited whilst performing transect line surveys. Looking under rocks, breaking up dead logs, and raking through leaf litter are all effective practices. This technique proved very useful for two main reasons: (1) It proved to be the main source of data for species which are primarily nocturnal (of which Cusuco has many), (2) Many streams and rivers are crossed by the transect lines but are not followed; without searching these habitats, amphibian encounters would be much lower and the data less complete.

Lastly, the third technique used in an opportunistic fashion to encounter small, secretive fossorial species was pitfall trapping. An array of 4 plastic buckets were buried in the ground in a Y-shaped formation, with each of the three rays extending outwards at 120 degree angles. Plastic lining was used as fencing in 4m lengths, radiating outwards from the central bucket, the bottom of which was buried in substrate and supported vertically by sticks. One array was placed near each camp in a suitable habitat and checked daily.

Bird team
A total of 408 10 minute point counts were conducted along 28 transects across seven camps within the park, representing 68 hours of survey effort. At each site the point count was repeated three times. During a point count when a bird was sighted or heard the following data were recorded: species, number in group, method of observation, distance, habitat data. Additionally, cloud cover, rain and wind were each recorded on a five point scale.

The point count data was supplemented by 50 days of mist-netting with 200ft of net fvrom 0530-0830, representing a total of 150 netting hours spread across 25 sites in five camps. When birds were removed from mist nets they were identified to species, aged, sexed, morphometric measurements taken, their moult condition was scored and all bird were ringed, except hummingbirds. A large number of informal opportunistic sightings at all camps were also made.

Small mammal team
In 2007, the small mammal team operated the following transects: BA1, BA2, BA4, BC1, BC3, BC4, CA1, CA2, CA4, CO1, CO3, CO4, DA0, DA1, DA2, GU1, GU2, GU4, ST1, ST2 and ST3.

Trapping was conducted during July and August 2007. A standardized trap-line was used in each transect and consisted of 54 aluminium “Freya” wire-cage traps (320 x 173 x 140mm). Traps were placed approximately 30m apart in an approximately straight line on levelled ground and marked from 1-54 consecutively. Plastic bags, plastic sheeting (a.k.a. GLADWRAP®) or leaves were used as shelter from the rain. Surrounding leaf litter was placed inside for bedding. Traps were baited with a mixture of peanut butter, granola or oats, flour, honey and vanilla essence. Traps were checked in the morning and rebaited and reset as required.

Opportunistic cage traps were used to catch medium-sized mammals. Two wire cage traps (76 x 31 x 31cm) and one collapsible Tomahawk® wire cage trap (66 x 25 x 25cm) were placed opportunistically within each transect. Various baits were used according to the potential animals in the area which included ripe or green plantains, mango seeds, “ichosos” (forest fruit), offal and chicken.

The traps were baited as close to dusk as achievable and were checked early the next morning – it is important that the mammals were not in the traps for longer than is absolutely necessary. As a rule of thumb, we aimed for all traps to be empty and closed by 9am. Traps were not re-baited immediately, but baited and set as close to dusk as possible. Bedding (dry brown leaves – to offer refuge and insulation) was placed in the traps when they are set. A plastic cover or large leaves was used to provide a roof for the traps, to ensure that the animals had shelter from rain and shade from the sun.

Captured animals were uniquely marked by ear clippings for long term identification of the animal. Unfortunately, individuals captured from previous years cannot be identified and long term ecological and biological data is unattainable. Other means of unique marking can be performed, but the equipment necessary for such procedures were not available. Animals were then weighed, sexed, reproductive status noted (adult and juveniles) and morphometric data collected. Morphometric data included nose-anus, anus-tail (not noted if part of tail missing) and hind-foot. The trap number, date of capture and recapture, and fate (released or taken) of the animal (and comments if necessary) was recorded. The ear clipping was stored in 95% ethanol to preserve DNA for any future identification and/or population studies. Hair samples were collected to develop a reference hair library for future studies.

Trapping constraints and limitations for the 2007 survey:

- Time: In order to sample three transects from each site (22 total transects), multiple transects had to be run concurrently for five consecutive nights. Additionally, one day was needed to setup and another day to move from one transect or site to the other.
- Available traps: There were approximately 250 operational traps; however, they were easily damaged during transportation. Time was spent fixing traps at the beginning of the season and again while setting each transect.
- Adequacy of traps: traps were not appropriate for the terrain. The shutting mechanism was easily triggered by rain and obstructed by objects (plants, branches, leaf litter, etc.). Traps were bulky and hard to transport, many were broken or required repairs.

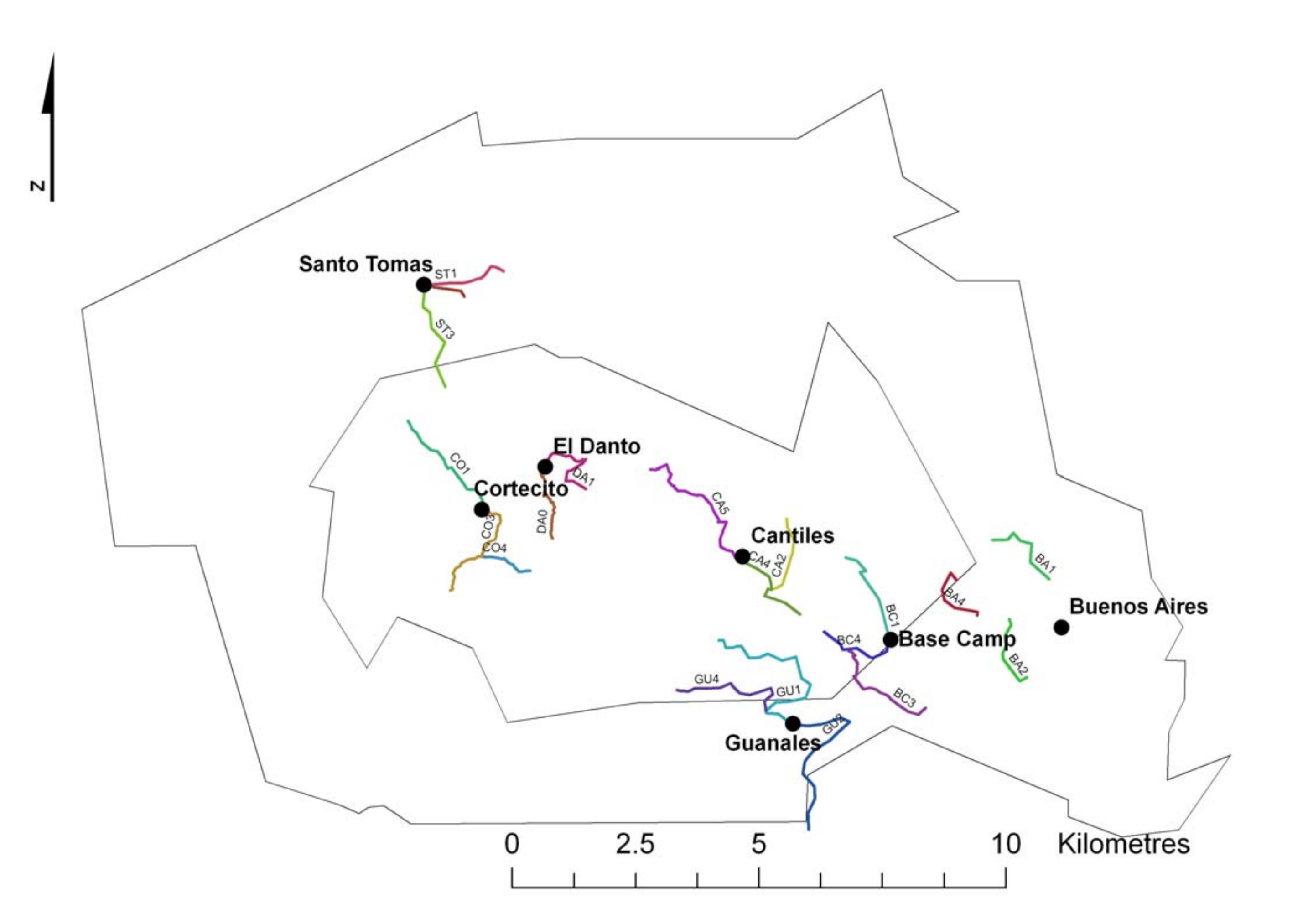

Figure 9. Transects sampled by the small mammal team in 2007

<u>Bat team</u>

Bat surveys were conducted between June and August of 2007 in 4 survey camps within the buffer zone and the core zone of the park with similar sampling efforts between sites. Bats were captured in the forest understorey with regular mist nets of different lengths (6, 9 and 12m X 2.5m). Netting was restricted to two transects per survey camp and around the 100m^2 main sampling sites but always intending to intersect flight paths to maximize capture success. Full moon and rainy nights were avoided. Captured bats were sexed, weighted and measured following standardized protocols (Jones 1996). Adults were distinguished from juveniles or sub-adults by the ossification of the epiphysis in the phalange. Field identification was based on Mammals of Central America (Read 1997), A Field Guide to the Bats of Costa Rica (Tim and LaVal 1998) and the key of the bats of México (Medellin et al. 1997).

Data analysis

Species richness was compared between the core zone and the buffer zone using rarefaction methods and calculating 95% confidence intervals (Moreno 2001; calculated with the software EcoSim Gotelli and Entsminger 2001). Same procedure was used to compare wetter and dryer camps, which would be the north slopes versus de south slopes of the CNP, respectively. To determine inventory completeness for the species ensemble (sensu Fauth at al. 1996) in Cusuco, as well as for the buffer and core zone, a non-parametric species richness estimator (Michaelis-Menten 1 Mean) was compared with a species accumulation curve to obtain a percentage of completeness (calculated with the software EstimateS Colwell 2005). The chosen species richness estimator has proved to be reliable of mobile organisms such as bats (Brose and Martinez, 2004). Randomizations for the estimations were set to 1000.

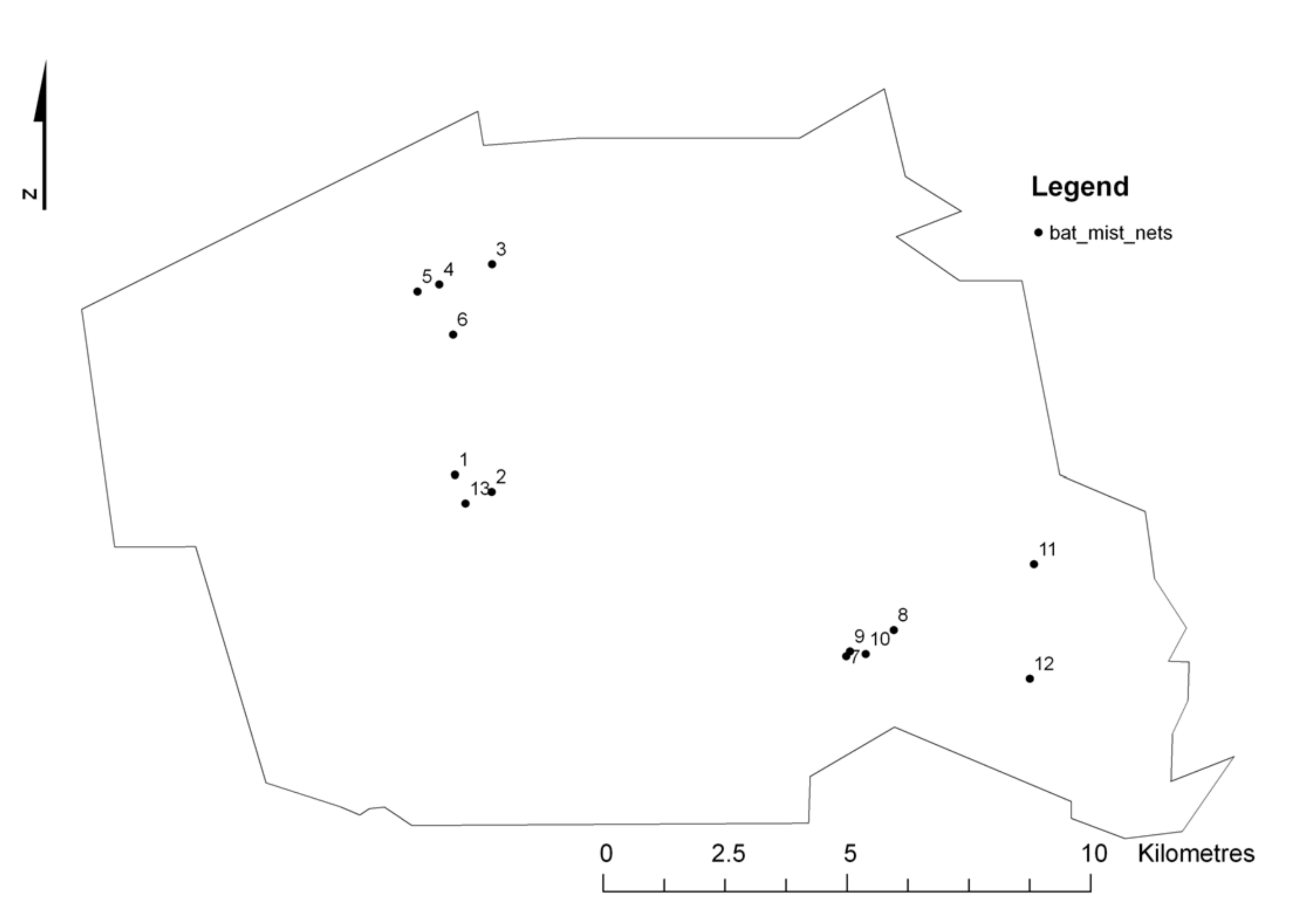

Figure 10. Bat mist net sites in 2007

Monkey team

Subjects and Study Site

The study was conducted at two sites, Parque Nacional Cusuco and Rancho Manacal. Parque Nacional Cusuco is located in the Merendon Mountain range in North West Honduras and consists of 23,440 acres including a buffer zone (15, 650 hectares) and a central core area (7,790 hectares). The park was created in 1987 and has been managed by Corporacion Hondurena de Desarollo Forestal (CODEFOR) in conjunction with other non-government organizations. There are three main forest types within the park: broadleaf, pine and dwarf forests with zones of transition, agriculture, shade coffee plantations and recently logged areas. Data were collected on three un-habituated troops of mantled howler monkeys observed in broadleaf forest locations in the core zone and buffer zone close to the south side of park. The first of the three troops contained one adult male, three adult females, one juvenile and two infants and was generally observed close to Transect 3 (Figure 1). The second troop contained two adult males, four adult females and two infants and was generally observed close to Transect 1 (Figure 1). The third troop contained 3 males, 6 adult females, 2 juveniles and three infants and was generally observed around the Quetzal trail

Rancho Manacal is a privately owned cattle ranch and sugar cane plantation located outside Cofradia, off the main highway to San Pedro Sula. The ranch is managed by Continental Ltd, which enforce a strict policy to ensure the protection of the primates within the property. There are five different troops of howler monkeys within the forest fragment at Rancho Manacal (Figure 2), of varied sizes and compositions (Table 1). Outside Rancho Manacal on the opposite side of the road is a small water purification plant run by a cooperative of local villagers called Gracias a Dios. The water purification plant is located within a long thin strip of forest that also houses a large number of howler monkeys in two separate groups (groups two and 6: Figure 2 and Table 1).

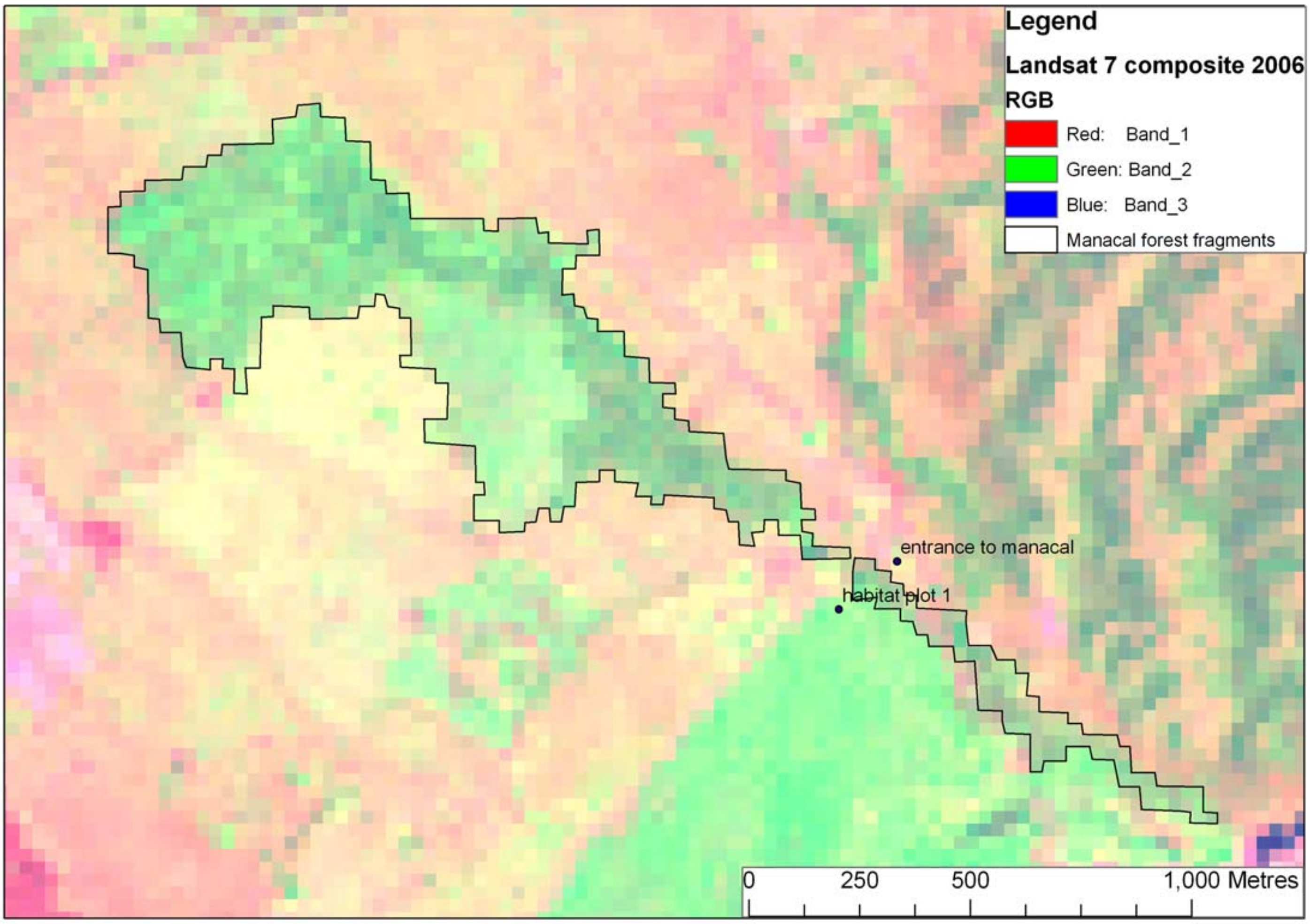

Figure 11. Rancho Manacal forest fragments digitised from a 7,4,2 Landsat composite acquired in 2006

Behavioural Data Collection

At Cusuco, daily attempts were made to locate at least one troop based on the direction of their morning vocalisations. Once located, the number of individuals present and age/sex distribution were recorded. The GPS position of the troop and the location in relation to the survey transects were also recorded once the troop had been encountered and at regular intervals during troop movements. At Manacal, groups were habituated and therefore easily located within minutes of arriving at the field site. Behavioural data collection at Manacal was centred on group one as each member of this group could be individually identified. Group one were observed daily for 6 hour periods either from 05.30 until 11.30 or from 11.30 until 17.30 and an equal number of morning and afternoon observations were conducted. The GPS location of the group was recorded throughout the day in order to assess home and day range.

Age-sex classification was based on Carpenter's (1934) criteria with some modifications from Glander (1980): Infants (<18 months), juvenile (18-48 months), adult female (>48 months), and adult male (>60 months). Adult males were defined by the presence of a white scrotum, large size relative to females with associated longer hair, the presence of beard giving the appearance of square shape to head. Males were also be identified by their loud vocalizations. Adult females were smaller than males, but larger than other age classes and were distinguished from males by the presence of nipples, the lacking of testicles and the potential presence of infants. Infants were defined as small sized with pelage of grey/brown/black, did not feed independently of their mothers and were carried by the mother when travelling between trees. When the group was stationary however, infants were observed to move freely with increasing tendency to play. Juveniles travelled independently from their mothers and were defined as slightly larger in size than infants, possibly with the beginnings of a distinguishable mantle.

Behavioural data was collected using instantaneous scan samples, at 10-minute intervals, noting the age/sex class of each individual in view, their corresponding behaviour and the plant/tree species being utilised. Each behavioural category was predefined in a behavioural ethogram (Table 2). When feeding, the type of food (mature leaves, young leaves, fruit and flowers) and corresponding plant species was recorded or samples taken for later identification if the plant species was unfamiliar. All occurrences of aggression, vocalisations and social events were recorded, noting the individuals IDs or age/sex class of the individuals involved and the context in which the event occurred. Habitat survey data were collected at 15 randomly located sites within Rancho Manacal and Gracias a Dios water station, recording the DBH of all tree with circumference over 30cm, canopy cover using canopy scopes, the height of the five tallest trees and the slope of the terrain using a clinometers, the number of cut stumps and fallen trees within the plot, the number of small trees <30cm in circumference, and the GPS location of the plot. For each tree over 30cm in circumference, the state of the tree (alive or dead), the presence or absence of bromeliads, and the presence or absence of fruit flowers and new growth were recorded. Similar habitat surveys were conducted at each of the sample sites along the transects at Guanales by the habitat assessment team.

Vocalisation Data Collection

Vocalisation data was collected using a Marantz PMD660 recorder, Sennheiser ME66 shotgun microphone and a support tripod on loan from the Windsor University, Canada, courtesy of Dr Dan Mennill. All occurrences of loud calls were recorded, noting the time of call (hh:mm:ss), the group size excluding infants, the origin of the call, the origin group number, the age/sex class of caller the number of callers, the location, number of different groups and number of callers from each group that responded to the original call, the context in which the calls were made, and the behavioural response of other individuals in the same or neighbouring troops. During the dawn chorus, the time and location of the first and last calling bout were recorded and as was the GPS location of each group during vocalisation bouts. The bioacoustic content of calls will be analysed in Canada at the bioacoustics lab at The University of Windsor.

Social science team

This field season the social science team was working with the communities that live and work within the buffer zone of Cusuco national park. To avoid the unnecessary repetition and questionnaire fatigue of previous years, the collection of comparable baseline data was achieved via a standardised household survey. The focus of the survey was basic demographics, livelihood activities, income, the impact of Operation Wallacea, land ownership and other livelihood activities. This was carried out the dissertation students and myself in three of the buffer zone communities: Buenos Aires, Guadalupe and Santo Tomas. Two dissertation students based in Santo Tomas undertook a household survey as well as semi-structured in-depth interviews. A similar pattern was followed in Buenos Aires where three dissertation students were based for 6 weeks. The research as a whole constitutes a varied methodological approach to understanding community dynamics, the changing role of women, the impact of Operation Wallacea on buffer zone communities, changes of land use in the buffer zone as well as the use of natural resources and existence of commodity chains and local food networks.

To avoid unnecessary repetition of interview questions that has been an issue in previous years, a survey of all the houses in Buenos Aires, Guadalupe and Santo Tomas was undertaken. This will be extended to other villages during my next period of fieldwork. Angel and Laura, based in Santo Tomas, where very little research has been undertaken up until this year, based their methodology on an ethnographic approach including semi structured interviews with people living in the community and detailed observation also completing the baseline survey in Santo Tomas to provide comparable data. Laura, focusing on how the land surrounding the community is used, also plotted farm land using GPS. Data which will be available soon. This will be undertaken in Buenos Aires in 2008.

In Buenos Aires, Holly and Katy also concentrated their methodology on an ethnographic approach, including semi-structured interviews, in addition to the baseline survey questions. As well as semi-structured interviews, they carried out a week of participatory group interviews with women from Buenos Aires, inspired by a methodology of ‘family portraits’. Using an imaginary family, created by the women they were working with in the community, they explored themes of how women work in the home, their hopes for the future, community organisation and how they think fair trade might affect their lives (Figure 12). Phil was researching the ways that Operation Wallacea is experienced in Buenos Aires, Guadalupe and Guanales jungle camp. He employed am ethnographic approach in addition to the household survey, including in-depth interviews and becoming involved with the community through games of football, finding his key informants among the guides and football team members.

All the research undertaken by social science students this year will help to inform how a project such as the fair trade plus scheme might work. In communities where people are often reluctant to work together and untrusting of new ideas, it is vital to find out how and where community spirit exists, and what affect the proposed scheme might have on the way women work and the ways commodities and resources are used and experienced in the community. Without knowing how this community could work together to police the forest themselves it is difficult to see how a scheme such as the one proposed might work. My own research, which has focused on the completion of the baseline survey this summer, will go on to explore community dynamics more deeply, researching how the fair trade scheme will be implemented, via the village co-operative and priority buying scheme suggested by Opwall and what impact these changing food networks will have on coffee production, local livelihoods, the use of natural resources, and the future of Cusuco.

Figure 12a. Participatory group interview in Buenos Aires

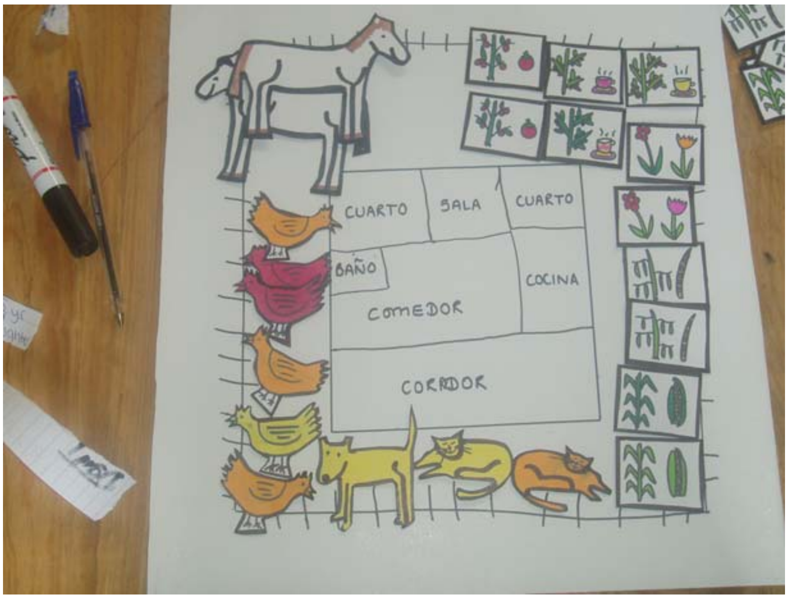

Figure 12b. Materials used to explore the concept of a 'proper' family

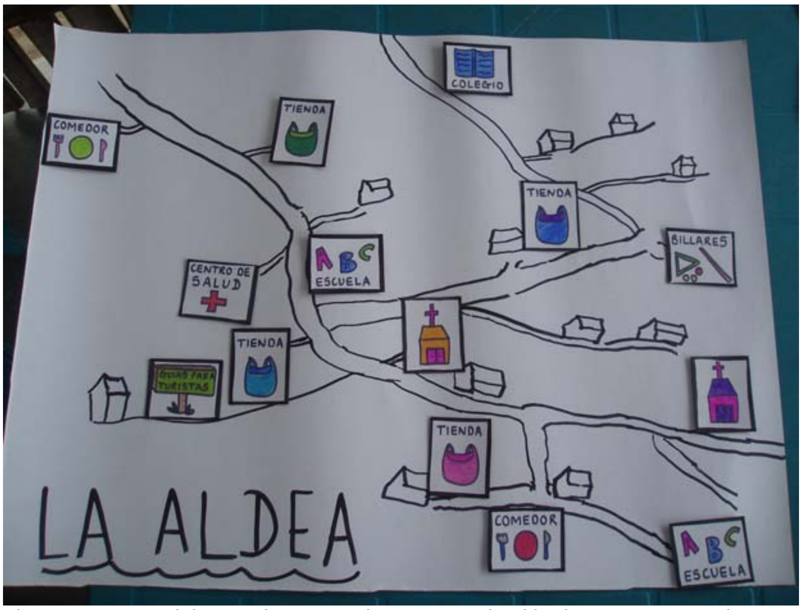

Figure 12c. A social map of Buenos Aires as perceived by focus group members

Data management

In the 2007 field season a single Access database was used to manage all data collected during biodiversity surveys in Cusuco. The database was designed around the spatial sampling framework such that tables describing sample sites were linked to tables describing habitat characteristics and biodiversity records. The data entry interface was designed following consultation with survey team leaders and was modified and added to during the season to meet analytical needs that arose. Fiona Helmsley-Flint took responsibility for the integrity of all data entered and ensured that all data collected by survey teams was entered by the end of the field season.

Operation Wallacea has appointed Jose Nunez-Miño as data manager for Cusuco National Park. All requests for access to survey data should be addressed to him in the first instance.

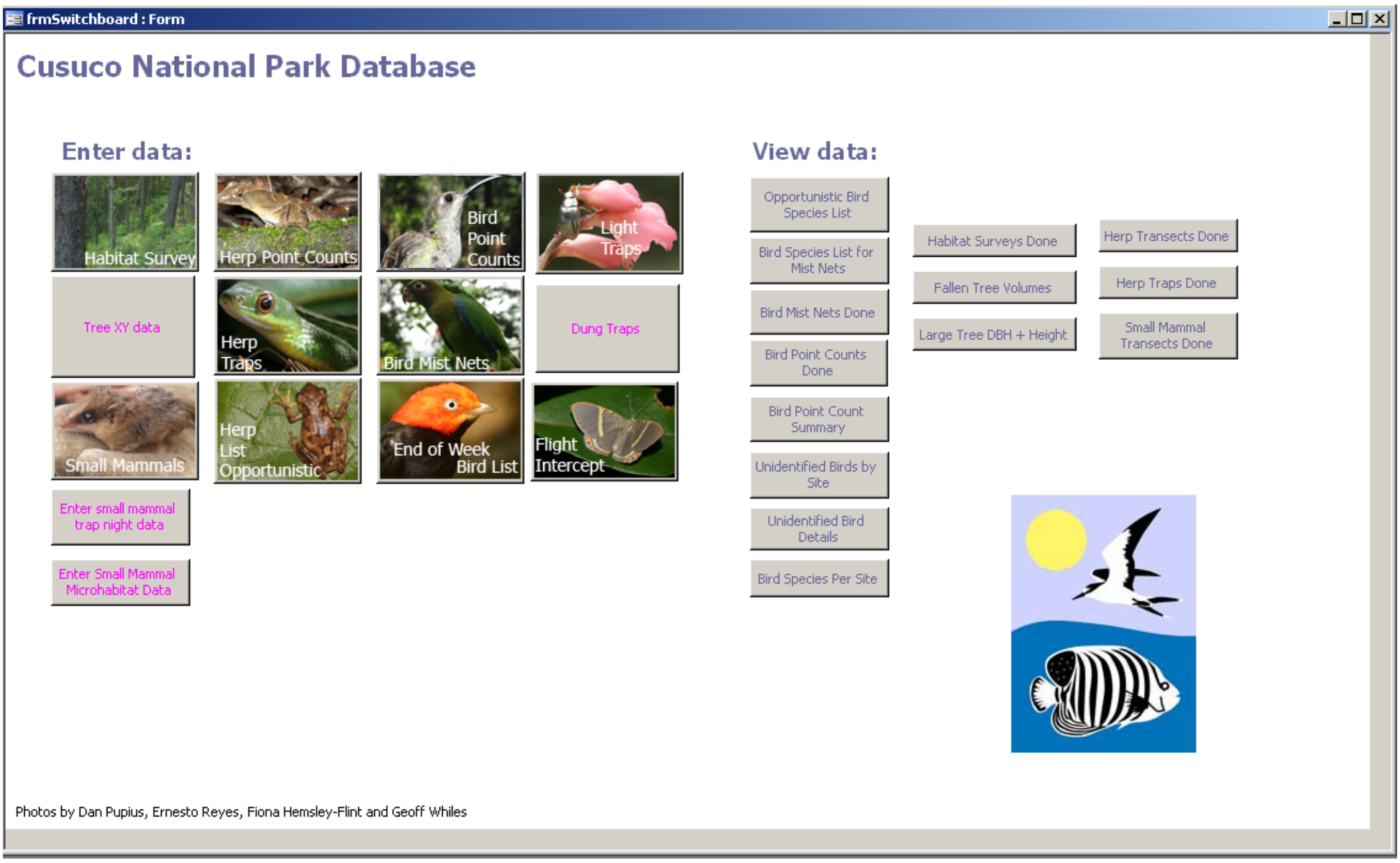

Figure 13. Screenshot of data entry interface of Cusuco National Park Database

Results

In this section we present results from each team working in PNC in 2007. For clarity, all species lists can be found in Appendix 5.

<u>Invertebrates (jewel scarabs, dung beetles, butterflies)</u>
Jose Nunez-Mino, Sara Beynon, Rebecca Eivers, Julie Gwendolin Zähringer, Lucy Ryan, Kalina Davies, Julie MacDonald and Victora Mort

The results presented here can only be preliminary since the large number of specimens collected before and during the Operation Wallacea research season will need to be sorted, identified and catalogued once they have been delivered to the Oxford University Natural History Museum (United Kingdom).

Dung Beetles:
For dung beetles alone a total of 6447 individuals were collected in 2006 which revealed a total twenty eight species overall (see attached appendix 1 for the 23 species identified from Main sites). For a more complete picture of the 2006 results please see the Operation Wallacea Science Programme (2007) available at: http://www.opwall.com/Library/Operation%20Wallacea%20Science%20Programme%202007.pdf.

The final total number of individual dung beetle specimens collected in 2007 is undoubtedly much higher than 2006 because we have had a much larger overall sampling effort. Additionally the data covers a far wider area than in 2006 since all 7 camps were sampled. Some Camps such as El Danto and Santo Tomas were sampled for the first time this year. The data should build and extend on that collected in 2006 in order to answer some interesting questions about distribution and abundance of this important functional group.

Initial observations of the samples seem to support some of the findings from 2006. For example, one small nocturnal tunnelling species (*Ateuchus near solisi* sp – this has recently been found to be a species complex of two subtly different species) which made up 66% of all individuals caught in 2006 was still the most common species found in samples overall. However, the fraction of the community that was made up of this species varied enormously with site. The species was almost never recorded around Buenos Aires while at Guanales (which is at approximately the same altitude) they made up between 88 to 95% of all individuals sampled.

Copris nubilosus (Kohlmann) (Figure 14), another nocturnal tunneler, which was recently described by Kohlmann (2003) was sampled in large numbers particularly around Base Camp where it dominated the dung beetle community in 2006. The collection of this species in Cusuco signifies a range extension for this species within Honduras.

Figure 14.*Copris nubilosus* pair (male foreground, female background). Photo: J.M. Nunez-Mino

Dichotomius satanas (Harold; Figure 15), yet another nocturnal tunneler, was the largest dung beetle species recorded in Cusuco National Park. Just like in 2006 it appears from initial observations that this species is most abundant in Buenos Aires although it was also recorded in large numbers in Santo Tomas.

Figure 15. *Dichotomius satanas* pair (Female left, Male right). Photo: J.M. Nunez-Mino

We also hope to have collected more specimens of a small dung beetle species that appears to be new to science (*Cryptocanthon* nov. *sp.*) in order to publish a full description at the earliest opportunity. Other new species may well present in the list we have for the park currently (Appendix 1).

Jewel Scarabs: All seven species found in the park (*Chrysina quetzalcoatli*, *C. karschi*, *C. spectabilis*, *C. cusuquensis, C. pastori*, *C. strassei* and *Platycoelia humeralis*) were recorded during the sampling in 2007. *C. cusuquensis* deserves special mention as it's a park endemic as does an unusual pink morph of *C. karschi* which was sampled near Base Camp

Moths: Saturnid and Arctid moths formed the vast majority of the individuals collected in 2007 with some unusual hawk moths also being collected.

Discussion and future work

Tropical dung beetles do not appear to specialise in their use and selection of dung resources in the tropics although they are generally associated with large vertebrate fauna (Hanski & Camberfort, 1991; Howden & Nealis, 1975; Larsen, Lopera & Forsyth, 2006). Furthermore they tend to be very habitat specific in tropical environments (Davis & Philips, 2005; Howden *et al.*, 1975; Klein, 1989; Nummelin & Hanski, 1989; Scheffler, 2005). Both of these characteristics makes them good candidates as overall biodiversity indicators. Analysis of the data collected in 2007 and 2006 will allow models to be created that will reflect the structure of dung beetle communities in relation both to different habitat characteristics and in relation to the diversity of other taxonomic groups.

Recent work by Novotny *et al.*(2007) has demonstrated that beta diversity of invertebrates appears to be remarkably low in tropical lowland forest ecosystems. In tropical montane cloud forests, such as Cusuco National Park, the situation is likely to be the complete opposite as habitat changes dramatically, along with associated fauna and forest structure, over relatively short spatial scales. The data collected by the invertebrate team along with all the other taxonomic teams and the habitat structure work will enable us to look at whether there is any cross taxonomic correlation that will enable us to identify the most effective set of indicator species for overall diversity.

Bromeliad associated invertebrates
Merlijn Jocqué, Jeroen Casteels, Ana Belan

Table 1. lists the preliminary recognized morpho-species in the reference collection at the end of this year and at this point contains 58 aquatic invertebrates. Most terrestrial organisms such as Aranea and Coleoptera (adults) are occasional vagrants of the bromeliads (only 1 or 2 collected specimens) and are not included in the reference collection. The Diptera larvae, in particular Culicidae, Chironomidae, Tipulidae and Syrphidae reached the highest species richness and abundances. This year we found an additional species of water flea (Cladocera), in a single bromeliad in Cortesito, Chydoridae, possibly *Alona bromelicola*, but identification has to be confirmed. We also observed the presence of eggs and tadpoles of treefrogs (*Hyla bromeliacia*) in some of the bromeliads and for the first time found a juvenile (as well as an adult) salamander (*Bolitoglossa diaphora*) in the bromeliads around Danto.

Table 1. The list of 58 morphospecies in the reference collection. A = adult, L = larvae.

Larger taxonomic group	Family	# sp.
Diptera	Culicidae (L)	6
	Syrphidae (L)	7
	Ceratopogonidae (L)	4
	Chironomidae (L)	4
	Tipulidae (L)	4
	Muscidae (L)	2
	Sciomyzidae (L)	2
	Canacidae (L)	1
	Psychodidae (L)	1
	Other (L)	8
Coleoptera		13
Hemiptera	Veliidae (A)	1
Turbellaria		1?
Crustacea	Daphniidae (A)	*Ceriodaphnia laticaudatus*
	Chydoridae (A)	*Alona bromelicola*?
	Cyprididae (A)	*Elpidium* sp.
	Cyprididae (A)	1
		58 species

What determines the aquatic invertebrate community structure in these bromeliads? Possible influencing factors are multiple, some of the more important are; broadleaf – pine forests, different bromeliad species, light intensity, possibilities for direct rain, regional bromeliad densities and the effect of altitude. As often several of these subjects are related and it is difficult to disentangle the individual effects. A logic effect would be that the potential number of species occurring in a bromeliad increases with a longer permanence of the water. Allowing species with a longer maturation time to grow adult and disperse before the habitat disappears. In this way all factors affecting the bromeliad water holding capacity also influence the aquatic communities. Another major aspect influencing species richness in communities is the productivity of the habitat. In these detritus based systems it might be interesting to check the relation between nutrients (nitrogen and phosphorus), algae densities (light influenced) and species richness and test the effect over different other categories. The basic question this year was focused around the placement of the bromeliads and the colonisation of the passive dispersers. The artificial bromeliads contained small amounts of Chironomidae (8 cups), Culicidae (6 cups) and other Diptera larvae in different treatments, not allowing for distinction between the treatments. The presence of *Ceriodaphnia laticaudata* (Cladocera) in four cups and 1 cup with an Ostracod all in artificial bromeliads hanging under other bromeliads, illustrates the presence of vertical dispersal on trees through flooding of bromeliads attached higher on the tree. The question remains how the Cladocera reach the higher bromeliads.

The composed reference collection at this moment has few definite species identifications and needs further attention. Adults should be reared to allow secure identifications, different growth stages should be collected and inserted in the reference collection, and potentially at the end a dichotomous identification key for the park could be prepared.

The aquatic invertebrate communities in the bromeliads in National Parc Cusuco have a high diversity and especially the presence of two species of water fleas and 2 species of seed shrimps is remarkable. The high diversity of passive dispersers indicates a long existing population of bromeliad communities in an undisturbed forest and illustrates the conservation value of the Cloud forest in Cusuco.

Next year we will further see into the nestedness of the bromeliad invertebrate communities and the role of the largest bromeliads as sources for surrounding bromeliads. Further attention will be given to the factors sustaining the presence of passive disperser populations in these habitats with a relatively short lifespan and the dispersal of invertebrates in general. At this point almost no information is available on the occurring bromeliad species, distribution and ecological preferences (light and water dependence) of the bromeliad species in the National Park Cusuco. This information would be most helpful for further studies of the invertebrate aquatic communities.

Reptiles and amphibians

Jonathan Kolby, Douglas Fraser, Anna Liner, Brian Crnobrna and Ileana Luque

Upon compilation of the data collected during the 2007 field season, we have herein increased the herpetofaunal inventory for Cusuco National Park from 83 species to 93 species. The identification of several problematic specimens are pending and may possibly increase this number. These specimens will be brought back to the United States for morphological and DNA analyses against museum standards for a definitive identification. The bulk of these uncertainties revolve around a group of rain frogs of the genus *Craugastor* (formerly *Eleutherodactylus*). An unusually high degree of variation has been observed in the field which seem to sometimes blur the distinction between species and at other times seems to cause the specimens to fall outside the boundaries of any species description in the literature. This may imply that there are less species than thought within Cusuco, but with an extremely high degree of variation, or that there are many more species than identified if examined at the molecular level. A third possibility is that there may be a high degree of hybridization occurring within the *Craugastor* of Cusuco and that a melting pot of genetics may be in play.

Of the significant new records for the park is a frog of the *Craugastor* group which was collected in Santo Thomas and El Cortecito. This frog is very likely *Craugastor coffeus*, a rare frog endemic to Honduras previously known only from a few specimens collected near Copan. Upon further confirmation, this is a very significant addition to the park's inventory, as well as a noteworthy range extension. In addition, the author of this report believes that the western side of the park may harbor a healthy population of *C. coffeus* and that they may be fairly abundant in that area.

A second specimen of a *Craugastor* frog collected in El *Cortecito* fits no published description of any member of its genus in Honduras. It is very likely a new record for Honduras, if not completely new to science. Several other *Craugastor* frogs collected in Santo Thomas are currently pending identification as well. Even without a name, these frogs are undoubtedly new records for the park at the very least.

This year's data also continues an observed trend of drastic elevational range extensions in addition to the usual geographic extensions. A snake recorded in Buenos Aires, *Scolecophis atrocinctus*, was previously only known from the southern pacific corner of Honduras, and from sea level to only 700m. Our record now spans the county to the Carribbean coast and up to an elevation of roughly 1200m. Two years previously, a similar elevational range extension was recorded for a Fer de Lance (*Bothrops asper*) in Guanales. The elevational aspect of range extensions encountered in Cusuco might be a factor worth examining more closely in the future. In addition, a snake specimen from El Cortecito in need of further ID confirmation appears to be *Sibon annulatus,* a species which ranges from Nicaragua south to Panama. This would be both new to the park, and new to Honduras.

In summary, the 2007 Herpetology Team was again very successful and continued to add a significant body of data to the growing herpetofaunal inventory of Cusuco National Park. The continued addition of species records to the park even after years of intensive research falls in line with a message delivered by the Herpetology Team of 2005 which stated that, "…a case for the perpetual protection of the habitats of this park can be made on the basis of the herpetofauna alone."

Discussion

The herpetofauna of Cusuco National Park displays an incredible diversity of species for a park of its small size. In addition, the park harbors at least 18 species endemic to Honduras and of those species, 11 are endemic to Cusuco alone (numbers are subject to change pending identification of problematic specimens). Despite this richness of diversity and the establishment of Cusuco as a national park in 1987, the preservation of Cusuco's herpetofauna remains at great risk. There remains a considerable amount of habitat disturbance within the park boundaries, such as cattle grazing and logging, which are a large concern on the western side of the park considering the discovery of *Craugastor coffeus*. That being said, it is of the opinion of the author of this report that currently the imminent threat to the park's herpetofauna is posed by wildlife diseases, most notably the amphibian chytrid fungus. This disease has the ability to devastate an environment like Cusuco, which harbors an isolated assemblage of rare and restricted amphibian species that are particularly vulnerable to decline. Chytrid fungus is the only wildlife disease that has proven to be the ultimate cause for the extinction of a species and several frog species in Cusuco, including ones endemic to Cusuco, are currently said to be experiencing dramatic population declines as per the IUCN RedList. During the 2007 season, the author of this report performed the first investigation for the detection of the amphibian chytrid fungus among the amphibians of Cusuco National Park. Data analysis will be carried out over the following months and it is very likely that additional study, collaborating with several science teams will be pursued in 2008.

Birds

Tom Martin, Ernesto Reyes, Wilf Simcox, Chris Hill, Martin Meads, Sarah Rustage

2007 has been another productive season for the ongoing Operation Wallacea ornithology survey of Cusuco National Park. A total of 408 ten minute point counts were conducted along 28 transects across 7 camps within the park, representing 65 hours of survey effort. The point count data was supplemented by 50 days of mist-netting with 200ft of net, representing a total of 150 netting hours spread across 25 sites in 5 camps. A large number of informal opportunistic sightings at all camps were also made. The combined methodologies of this year's survey resulted in the recording 198 species within the park.

18 of the 198 species recorded in Cusuco this season can be considered new sightings within the park. These new additions are displayed overleaf in table 2. Three of these new species were observed within the parks core zone, four in park edge locations and fifteen in the park buffer zone (Four species – Black Hawk Eagle, Band-tailed Pigeon, Ruddy Ground Dove and Green Kingfisher)were sighted in two sites). As with last year, the vast majority of new park additions were observed in the buffer zone, particularly in Santo Tomas. This is not unexpected as this is only the second year in which the low-lying areas (>1000m) of the West have been surveyed by ornithologists, and so more previously unrecorded species have been observed here than in the more extensively surveyed core and edge sites. These additions raise the avifaunal inventory for Cusuco National Park from 252 to 270 species (Brace 2007).

Most of the new additions to the park list are not unexpected. Indeed, it is believed several 'new' species observed this year (Crowned Woodnymph, Great Kiskadee and Common Yellowthroat) have actually been observed by Operation Wallacea observers in previous years, but their addition to the park list has been accidentally overlooked.

Several new additions for this year are worthy of comment. The Rufous-browed Wren is a significant addition to the park list as it is a range-restricted species that occurs only in the Northern Central American Highlands (Stattersfield *et al*. 1998). The sighting of a Mountain Pygmy Owl at circa 500m in Santo Tomas is also notable as Holwell and Webb (2005) describe this as a species of Central and Southern Honduras that rarely occurs below 1500m. However, this sighting was a reliable observation backed up by photographic evidence.

One final observation of potentially great importance was the capture in Santo Tomas of a hummingbird that could possibly be a specimen of the Honduran Emerald (*Amazilia luciae*). This observation was fairly ambiguous because of insufficient information at the time of capture and also because this species is thought to be found exclusively in dry thorn forest within the arid interior of the country (Holwell and Webb 2005; Birdlife International 2000) and so was not included on this year's list. However, if the species can be caught again and positively identified as *Amazilia luciae* (possibly by DNA testing) this would be extremely significant, as this is the only bird endemic to Honduras and is considered by the IUCN (2006) to be critically endangered due to its small population (<1000 individuals estimated) and small, decreasing known breeding area (currently only 3 sites totalling less than 12km^2) (Birdlife International 2000).

Table 2: Eighteen species additions to Cusuco National Park in systematic order (re: Clements 2000)

Common name	Scientific name	Park Core		Park Edge		Park Buffer	
		CN	EC	BC	GN	BA	ST
Black Hawk-Eagle	*Spizaetus tyrannus*		X				X
Orange-breasted Falcon	*Falco deiroleucus*					X	
Band-tailed Pigeon	*Patagioenas fasciata*	X		X			
Ruddy Quail-Dove	*Geotrygon montana*				X	X	
Mountain Pygmy-Owl	*Glaucidium gnoma*						X
Brown Violet-ear	*Colibri delphinae*					X	
Crowned Woodnymph	*Thalurania colombica*						X
Green Kingfisher	*Chloroceryle americana*					X	X
Scaly-throated Leaftosser	*Sclerurus guatemalensis*			X			
Streak-headed Woodcreeper	*Lepidocolaptes souleyetii*					X	
Sepia-capped Flycatcher	*Leptopogon amaurocephalus*						X
Great Kiskadee	*Pitangus sulphuratus*						X
Black-crowned Tityra	*Tityra inquisitor*					X	
Rufous-browed Wren	*Troglodytes rufociliatus*	X					
Tawny-crowned Greenlet	*Hylophilus ochraceiceps*						X
Blue-hooded Euphonia	*Euphonia elegantissima*			X			
Common Yellowthroat	*Geothlypis trichas*						X
Spot-breasted Oriole	*Icterus pectoralis*						X
	Totals	2	1	3	1	6	9
	TOTALS		3		4		15

<u>Small mammals</u>
Dario Riviera

A total of 465 individuals of 13 species were caught out of 4922.5 trap-nights. There was a total trapping effort of 5447 traps.

Table 3. Small mammal capture summary in 2007

Scientific name	Common name	No. of individuals	Previously caught (y/N)
Heteromys desmarestianus	Spiny pocket mouse	185	y
Peromyscus mexicanus	Mexican deer mouse	147	y
Scotinomys teguina	Alston's singing mouse	21	y
Nyctomys sumichrastu	Vesper rat	3	N
Reithrodontomys gracilis	Slender harvest mouse	1	y
Tylomys nudicaudus	Northern climbing rat	2	y
Oryzomys alfaroi group	Alfaro's rice rat	1	N
*Baiomys musculus**		1	N
Unknown		10	y
Mustela frenata	Long-tailed weasel	2	N
Tamandua mexicana	Northern tamandua (anteater)	1	N
Didelphis marsupialis	Common opossum	9	y
Marmosa mexicana	Mexican mouse opossum	6	y
Marmosa robinsoni	Robinsoni's mouse opossum	7	N
Total		387	

Peromyscus mexicanus and *Heteromys desmarestianus* were the two dominant species and were quite ubiquitous in the park. Together the two species represent 86% of the animals caught and were found in all the transects except for 4 and 2 respectively.

During the survey a concern arose between leaving traps open during the day. However, to fully elucidate all the small and medium sized mammals in the area, it is important to consider diurnal animals. The main concern is to catch non-target animals such as birds which may injure themselves and potentially die in traps. Providing bedding and sufficient food may be enough for mammals. Four birds, two brush finches and two doves, were caught in traps, but were released unharmed. A peregrine falcon was deliberately caught, as it had killed a rat already in a cage and to find out what animal had been eating it, we reset the trap and placed it inside a bigger trap to catch the raptor. The figures show the numbers of non-target animals were caught considering the trapping effort and the number of target animals caught. Two long-tailed weasels, *Mustela frenata*, and a Northern tamandua, *Tamandua mexicana*, were caught as a result of diurnal trapping.

Despite efforts to shelter traps from the rain and providing bedding in the form of surrounding leaf litter, there were 10 animals that died. Three of them lodged their muzzle in the wire caging of the traps of which two broke away the nose and front incisors and the other died while still stuck. There were a few animals lethargic, most likely from hypothermia during the night and splashing into the trap from heavy rain. It is imperative to minimize any loss of life. The figures illustrate the casualties considering the trapping effort and the number of animals caught.

Discussion

While this year we have trapped several species not trapped before in the park, there are many more species that are suspected of occurring. Little has been done to standardize a long term small mammal monitoring technique by which individual animals will be identified from year to year. Both transect, either as small lines through unique habitats (preferred) or as a constant line by which each trap is associated with ecological factors (i.e. microhabitat factors within 5 or 10 meter radius), or grid trapping should be considered to try to determine small mammal populations. Medium sized mammals have been vastly ignored. This requires multiples techniques and longer periods of trapping within greater areas, something that current methodology does not allow. However, transect trapping can sample both small and medium sized mammals better than grid trapping. Many animals in the park are arboreal, and adequate trapping techniques are not available. Identifying canopy corridors and fruiting trees might allow for opportunistic sampling of arboreal mammals.

The scope for more in depth studies is present and the potential to increase the species list is an exciting motivation for further work.

Bats

Sergio Estrada-Villegas, Lisa Allen, Marycarmen García, Melinda Hoffmann, Megan L. Munroe.

A total of 568 individuals were captured and identified during the 2007 field season in Cusuco, comprising 35 species within 5 families (Table 4). Phyllostomidae was the most abundant and diverse family, followed by Vespertilionidae, Mormoopidae, Molossidae and Natalidae, respectively. The new species for the park are *Mormoops megalophylla*, *Molossus ater*, *Natalus stramineus*, *Phyllostomus hastatus* and *Vampyressa pussila*. This constitutes a remarkable progress of the monitoring program in the CNP, not only for the number of species but also for the high capture success. The methodology that has been standardized corroborates that increasing netting efforts include rare and/or seasonal species (Table 5).

Table 4. Number of bat species and survey efforts in four survey camps in Cusuco National Park, Honduras.

		No. of Species	Unique Species[1]	Survey Time[2]	Nets used[3]	Effort[4]	Capture ratio[5]
Buffer Zone	Buenos Aires	23	8	42.5	892.5	37931.25	0.656
	Santo Tomas	16	4	53.65	915	49089.75	0.507
Core Zone	Base Camp	14	3	51.3	855	43861.5	0.567
	Cortesito	15	4	53	810	42930	0.58
	TOTAL	35		200.45	3472.5	696062.625	0.816

[1] Number of species found only in this survey camp.
[2] In hours.
[3] In square meters.
[4] Squere meters of nets deployed * Survey time.
[5] Total number of individuals captured / Effort

Certain trends can be extracted from the data. Animalivorous species (insectivorous and carnivorous *sensu* Giannini and Kalko 2004) were rare and mostly collected in the core zone. For example, *Trachops cirrhosus* was exclusively captured in the core zone, also in previous surveys in CNP. Other aninalivorous species like *Bauerus dubiaquercus, Myotis albescens, Natalus stramineus* and *Micronycteris schmidtorum*, the latter another new species for the park, were also captured exclusively in the core zone. Within Phyllostomidae, the subfamily Stenodermatinae was the most abundant, expressed in the highest percentage of captures. *Artibeus jamaicensis*, *Artibeus toltecus*, *Sturnira ludovici* and *Sturnira lillium,* all frugivorous, were the most abundant species in this subfamily and responsible for the percentage difference between the subfamilies of Phyllostomidae (Figure 16).

The number of captures and species captured in the buffer zone was higher than in the core zone (Table 2), however, species richness was not statistically different between the two areas (Figure 17a). Data sorted by precipitation showed that richness between dry sites and humid sites were no statistical different (Figure 17b). The percentage of completeness of the survey was high; 81% for the core zone, 87% for the buffer zone and 92% for the pooled data.

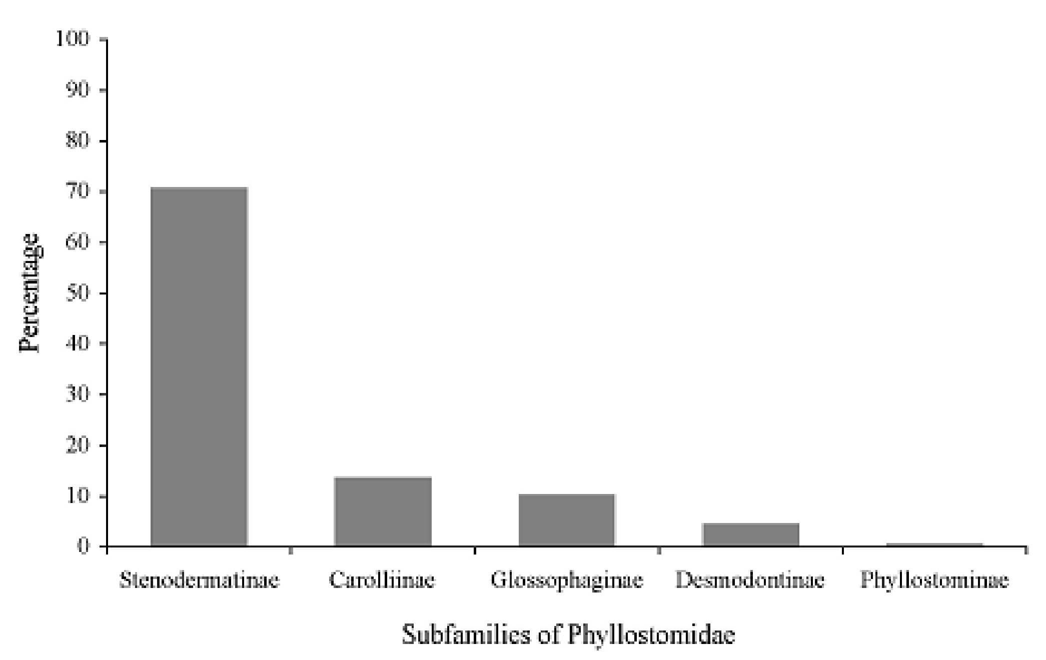

Figure 16. Percentage of total captures among the subfamilies of Phyllostomidae.

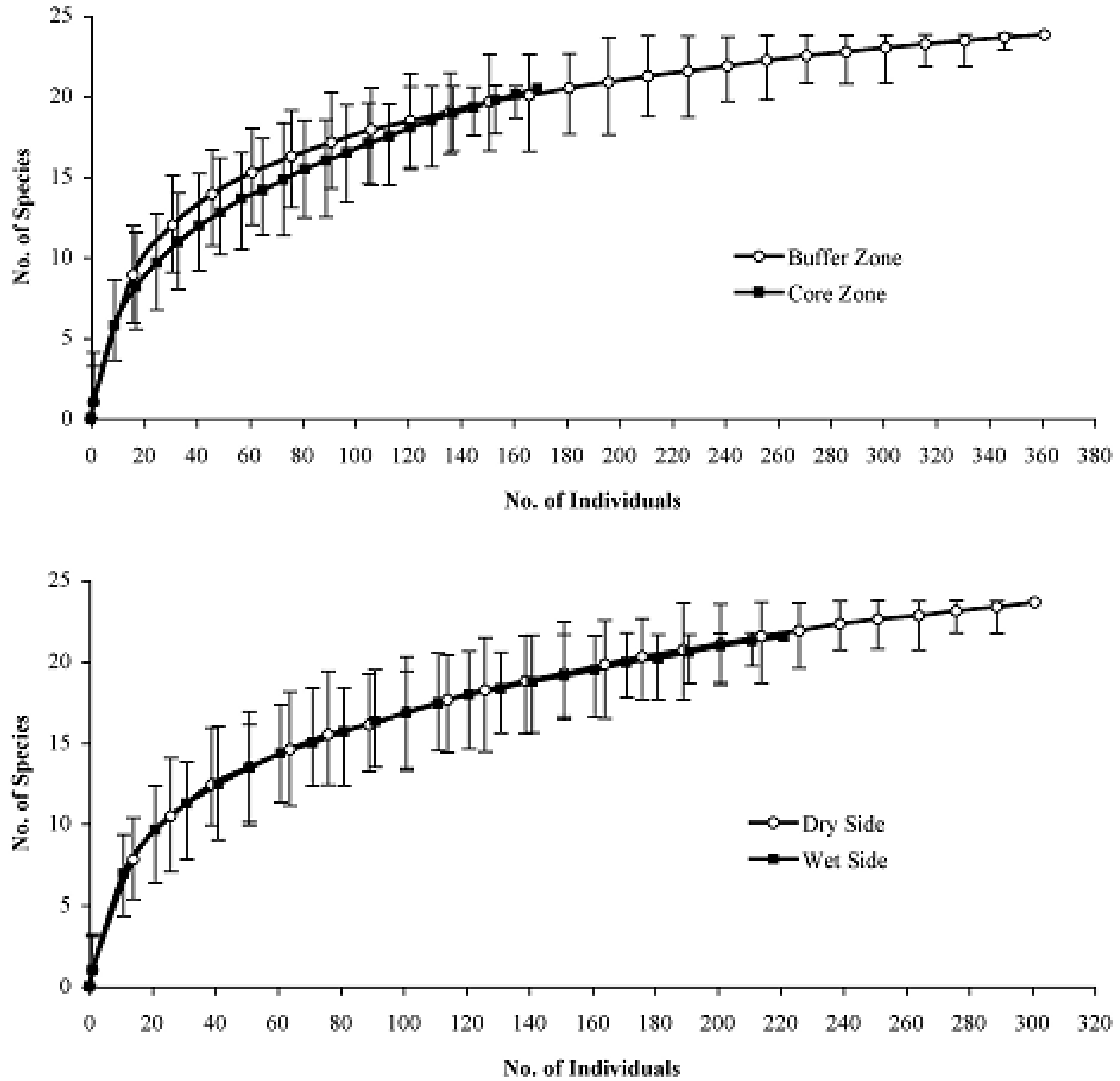

Figure 17. Species rarefaction curves: A) Buffer zone and core zone, B) Dry side (south) and wet side (north) of Cusuco National Park. Bars indicate 95% confidence intervals.

Altitude is a strong confounding factor in Cusuco, therefore it is unfeasible to make a clear cut interpretation when the core zone and the buffer zone want to be compared. Never the less, the steeper curve at an abundance of 160 captures, together with the percentage of completeness, indicates that more species are expected to be found in the core zone in comparison to the buffer zone, regardless of the altitude. This may be due to the habitat heterogeneity of the core zone, an ecotone where pine and oak forest is intertwined with tropical cloud forest. The 2007 survey reflects the mixture of the two ensembles and differs from other studies that have shown lower richness at higher altitudes (Muñoz-Arango 1990 for Colombia; Patterson et al. 1996 for Perú and Sanchez-Coredero 2001for México).

From the conservation stand point; the core zone can serve as source to replenish the bat populations that inhabit forest fragments around the national park, especially for those species that prefer the tropical cloud forest than the pine and oak or the tropical lowland forests. Even though it was not possible to show that the core zone is richer in species than the buffer zone, the complementarity between the two areas suggests that both areas are important for conservations purposes and need to be preserved.

We recommend that future surveys follow the specific guidelines that have been set in Cusuco National Park, standardized long term methodologies in tropical cloud forests are scarce. We are not aware of any study in bat ecology, except maybe for Sanchez-Cordero (2001), that has been done in such an important ecosystem ecotone, where species from tropical Central America share foraging grounds with species from boreal forest. Besides short term projects, no doubt fruitful, is imperative to continue the monitoring program that started in 2004. Finally, it is always desirable to count with researchers acquainted with tropical bat taxonomy due to the complexity of the ensemble present in Cusuco, this will ensure that the data set keeps its good quality.

Table 5. Bat species list with total captures for the buffer zone and core zone of Cusuco National Park, Honduras, 2007 field season.

			Buffer Zone		Core Zone		
Family	Subfamily	Species	Buenos Aires	Santo Tomas	Base Camp	Cortesito	TOTAL
Mormoopidae		*Mormoops megalophylla*			1		1
		Pteronotus parnellii			2	3	5
Phyllostomidae	Carolliinae	*Carollia brevicauda*	14	28	4	9	55
		Carollia castanea		2			2
		Carollia perspicillata	3	9	2		14
	Desmodontinae	*Desmodus rotundus*	17	4		1	22
		Diphylla ecaudata	2				2
	Glossophaginae	*Anoura geoffroyi*		1			1
		Glossophaga commissarisi	1	19		14	34
		Glossophaga soricina	10	2	1	4	17
		Hylonycteris underwoodi				2	2
	Phyllostominae	*Micronycteris schmidtorum*				1	1
		Phyllostomus hastatus	1				1
		Trachops cirrhosus				1	1
	Stenodermatinae	*Artibeus intermedius*	1				1
		Artibeus jamaicensis	32	14	1	29	76
		Artibeus lituraus		3			3
		Artibeus phaeotis	1				1
		Artibeus toltecus	35	2	26	23	86
		Artibeus watsoni		17			17
		Centurio senex	9		14	1	24
		Chiroderma salvini	2			1	3
		Chiroderma villosum	2				2
		Enchisthenes hartii			1		1
		Platyrrhinus helleri	3	1			4
		Sturnira lilium	64	22	3		89
		Sturnira ludovici	19	9	14	7	49
		Uroderma bilobatum	3				3
		Vampyressa pussila	3	3			6
		Vampyrodes caraccioli	2				2
Natalidae		*Natalus stramineus*				1	1
Vespertilionidae		*Bauerus dubiaquercus*	1		1		2
		Myotis albescens			2		2
		Myotis kaeysi	3	3	8	3	17
Molossidae		*Molossus ater*	21				21
		TOTAL	249	139	80	100	568

Howler monkeys
Kathy Slater and Katy Wilson

Data collection at Guanales camp proved extremely difficult and only 1759 scans at 10-minute intervals were collected, during eight observation days. This poor result is likely due to the excessively high numbers of 10
preferences and their effect on behaviour are not possible. Activity budget data is also unreliable as the howler monkeys at Guanales were extremely nervous of human observers and spent nearly all their time being vigilant, watching their human observers. I therefore recommend that attempts to study the howler monkeys at Guanales are terminated and all research efforts are directed to Manacal.

Preliminary data from Manacal is extremely encouraging with a total of 7103 10-minute scans collected on group one, and additional *ad libitum* data of special events such as aggression. Based on the GPS map of the forest fragment inside Rancho Manacal and the number of monkeys observed in the fragment, population density at Rancho Manacal was calculated at 103 monkeys per km^2. This value is extremely high in relation to mantled howler population densities at other field sites and thus it is likely that density has affected dietary preferences and behaviour. Feeding ecology data suggests that the howler monkey at Manacal feed primarily on fruit and young leaves and were never observed to eat mature leaves. Despite the absence of toxin-loaded mature leaves in the diet, diurnal inactivity was maintained in line with reports of A. pigra (Pavelka & Knopff 2004). A total of 37 vocalisation bouts were recorded, producing in excess of 100 individual loud calls. Adult male and females with dependent infant s were more likely to change their behaviour in response to extra-group loud calls, either by responding to the call (males only), being vigilant or by engaging in self-directed behaviour that may be interpreted as a behavioural indication of stress. Due to the success of Manacal as a field site, I strongly recommend that research continues in this location for the 2008 field season and that individual ID's are obtained for one of the larger groups by the water station to use as a comparison with group one. I also recommend the use of playback experiments to gain further understanding of the function of howler monkey loud calls.

Large mammals
No report submitted

Social science
No report submitted

Research and Management Priorities

We now have a better understanding of the biodiversity of Cusuco National Park than ever before. However, our monitoring programmes are only a component in the difficult task of promoting the resourcing and management of the National park so that it can work effectively. It is also imperative to address the needs of the communities living in the buffer zone of the park supporting people develop livelihoods which are compatible with the integrity of the protected area.

Park management recommendations

It is very important to continue monitoring biodiversity on the ground using standard protocols and ensure that this data is used to produce indicators of the state of biodiversity in the park. If the effectiveness of conservation activites is to be measured, it is also necessary to keep monitoring human pressures on the park using a range of method including remote sensing to detect land cover change, ground-based surveys of signs of human disturbance in the park, such as selective cutting of trees for building materials and fuel and for evidence of hunting.

Cusuco is essentially unmanaged at present. Patrolling the park to address over-exploitation of resources and habitat destruction is absolutely essential. Cusuco is potentially a very valuable resource if appropriate infrastructure for responsible ecotourism were to be developed and the biodiversity of the park properly interpreted through an enhanced visitor centre, signage and well-trained guides.

Short-term park management priorities

Outside the Operation Wallacea, Cusuco could easily be used as a site for delivering jungle-training courses to a local and tourist market with almost no additional investment in infrastructure.

Cusuco national park is an important source of clean waters for San Pedro Sula dn many other settlements. This is a very important ecosystem service which could be jeopardised by further forest loss and erosion. It is therefore necessary to begin a programme of monitoring water quality in the major catchments in the park using either chemical means, or better still indicator species which by their presence give a measure of water quality integrated across the whole year.

The park contains several NTFPs that could potentially be harvested sustainably such as Mimbre palm, Capuca palm *Geonoma undata* and orchids and bromeliads which may be possible to micro-propagate in a small enterprise. Studies are needed to understand the effects of harvesting such species.

It is critical to disincentivise the conversion of primary forest to agricultural land, although achieving this may be extremely difficult in practice. All options should be explored including lobbying for legislation change, direct conservation payments, agricultural subsidies for cultivation of marginal land and conservation contracts linked to the provision of alternative livelihoods.

Longer term park management priorities

Marketing Cusuco to tourists visiting Honduras and investing in facilities such as a good restaurant and high quality accommodation which cater to low-volume high-value toursists would be a useful contibution to the local economy, would have a very limited environmental impact on the park and would put Cusuco ‘on the map’.

If it were possible to reintroduce spider monkeys, this would be a major step in restoring the biodiversity of the park and doubtlessly would also be a big draw to tourists. However successfully translocating a group of large primates is an exceptionally difficult and costly undertaking, which requires considerable planning beforehand and monitoring afterwards. It is also essential that all local people support the project and managers can be certain that monkeys will not be hunted.

Research priorities for 2008

The most important single priority is to continue monitoring each taxonomic group using protocols finalised in the 2007 field season to allow consistent data to be collected into the future.

General surveyors will play a more diverse range of roles in 2008. It is necessary to continue to monitor habitat characteristics in a subset of sites surveyed in 2007, both to monitor human impact and to ensure data quality. General surveyors will also assist the botany teams in collecting and preparing specimens and mapping the distribution of key plant species such as figs *Ficus* sp.

The botany team will be back on site in 2008 and will continue to collect specimens in unsurveyed 20m plots to characterise the plant diversity of the park.

The genetics team will focus on two priority groups in 2008:Tree ferns and dung beetles. They will aim to map patterns of genetic diversity in individuals species in each group and compare these results with species distribution models.

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Thomas Ysart

General surveyors

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Acton High School, Canada
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Hanson School, UK
Hillfield Strath Allen School, Canada
Horsforth School, UK
Howard of Effingham School, UK
King Edward VII School, UK
Millfield school, UK
Newport Free Grammar School, UK
Northampton Girls School, UK
Pennington High School, USA
Plymouth College, UK
Queen Margaret School, UK
Rugby School, UK
Sevenoaks school, UK
Shrewsbury School, UK
Thomas Hardye School, UK

Appendix 2 - Visiting academics

Lisa Manne (University of Toronto, Canada) visited from to explore whether it would be possible to make insect abundance-distribution models with respect to climate variables.

Alexis Aguilar (Southwestern University, Maryland), and his student Karla King, visited from to collect ground-truthing data in the Park in order to classify the vegetation communities in the park.

Ed Tanner (University of Cambridge, UK) visited to advise on the establishment of permanent forest plots and the possibility of long-term studies of forest dynamics with respect to disturbance events.

David Lesbarrères (Laurentian University, Canada) visited in order to investigate fungal and viral diseases in frogs in Cusuco.

We were also pleased to welcome Ben Vivian, Martin Suthers and Pippa Suthers, trustees of the Operation Wallacea Trust, to see the Honduras forest projects at the start of the field season.

Appendix 3 – Dissertation projects

Bromeliads
Ana Ceron *Anglia Ruskin University, UK*
The effect of the meta-community on the species richness of invertebrates living in bromeliads.

Invertebrates
Julie MacDonald *University of Cambridge, UK*
Does the diversity and abundance of Lepidoptera differ between shade coffee and secondary forest: fragments?

Victoria Mort *Glamorgan University, UK*
What is the order and timing of colonisation by invertebrates on decaying pig carcasses?

Birds
Sarah Rustage *University of Oxford, UK*
Environmental variables affecting patterns of bird diversity in PNC

Ian James *University of Nottingham, UK*
Environmental variables affecting patterns of bird diversity in PNC

Small mammals
Emily Johnson *University of Oxford, UK*
Habitat selection by two abundant species, *Peromyscus mexicanus* and *Heteromys desmarestianus* in Cusuco National Park, Honduras

Victoria Gretton *University of Oxford, UK*
Environmental factors affecting the abundance of *Peromyscus mexicanus* and *Heteromys desmarestianus*

Rachel Sinclair *University of Aberdeen, UK*
Patterns of small mammal diversity in Cusuco National Park, Honduras

Bats
Megan Munroe
Drivers of bat community diversity

Monkeys
Claudia Bustos, *Warwick University, Canada*
Howler monkey vocalisation

Thomas Read, *University of Nottingham, UK*
A comparison of Howler Monkey (*Alouatta palliata*) diet preference and feeding behaviour within the core zone and on the periphery of Cusuco National Park.

Benjamin Wallis, *University of Nottingham, UK*
Howler monkey behaviour, feeding ecology and habitat use.

Conservation genetics
Colin Hindmarch, *Royal Botanic Gardens Kew* colinhindmarch@talktalk.net
Genetic diversity in the bromeliad *Catopsis hahnii*

Claire Ashler *University of Sussex, UK*
Genetic diversity in relation to habitat structure in two bat species (*Sternura ludovici* and *Artibius tulteca*) in Cusuco National Park, Honduras.

Social science
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Katy Longden
Holly Derry-Evans *University of Nottingham, UK*
Laura Fyre-Levine, *Yale University, USA*
Angel Hertslet

Appendix 4 – Seminar programme

Peter Long - Geographical Information Science

Dario Riviera - Small mammals in Cusuco

Merlijn Jocque - Bromeliads in Cusuco

Peter Long - Protected areas

Peter Long - Monitoring

Ed Tanner - Hurricanes increase tree diversity and growth in Caribbean montane forests: thirty years of change in forests of the Blue Mountains of Jamaica

Lisa Manne - Species distribution models

Richard Field – Biogeography of Krakatoa

Richard Field – Cusuco 2007 results so far

Kimberley Hunter – Conservation genetics

Appendix 5 - Species lists

Plants

Family	Species
A. Tree ferns	
Cyatheaceae	Alsophila erinacea (H. Karst.) D.S. Conant vel aff.
	Alsophila salvinii Hook.
	Cyathea bicrenata Liebm.
	Cyathea divergens Kunze var. tuerckheimii (Maxon) Tryon
	Cyathea valdecrenata Domin
	Sphaeropteris horrida (Liebm.) Tryon
B. Conifers	
Pinaceae	Pinus oocarpa Schiede ex Schtdl. var. oocarpa
	Pinus maximinoi H.E. Moore
Podocarpaceae	Podocarpus oleifolius J.D. Sm.
Araliaceae	
C. Angiosperms (Flowering Plants)	
Actinidiaceae	Saurauia conzattii Busc.
Annonaceae	Guatteria cf. chiriquensis R.E. Fr.
	Guatteria dolichopoda Donn. (?)
Apocynaceae	Tabernaemontana amygdalifolia Jacq.
Aquifoliaceae	Ilex gracilipes I. M. Johnst. ?
	Ilex guianensis (Aubl.) O. Kuntze
	Ilex lamprophylla Standl.
Araliaceae	Dendropanax arboreus (L.) Decne & Planch.
	Oreopanax geminatus Marchal
	Oreopanax nicaraguensis M.J. & J.F.M.Cannon
Arecaceae	Chamaedorea arenbergiana H. Wendl.
	Chamaedorea costaricana Oerst.
	Chamaedorea pinnatifrons (Jacq.) Oerst.
	Cryosophila williamsii Allen vel aff.
	Geonoma undata Klotzsch
	Synechanthus fibrosus (H. Wendl.) H. Wendl.
Asteraceae	Eupatorium hypomalacum var. wetmorei B.L. Robins
Betulaceae	Carpinus tropicalis (Donn. Sm.) Lundell
Bignoniaceae	Amphitecna molinae L.O. Wms
Brunelliaceae	Brunellia mexicana Standley
Caprifoliaceae	Viburnum hartwegii Benth.
Clethraceae	Clethra macrophylla Mart. & Gal.
	Clethra occidentalis (L.) O. Kuntze
Clusiaceae	Calophyllum brasiliense var. rekoi (Standl.) Standl.
	Chrysochlamys sp.
	Clusia salvinii Donn. Sm.
	Garcinia intermedia (Pittier) Hammel
	Vismia baccifera (L.) Triana & Planch.
Cunoniaceae	Weinmannia balbisiana Kunth
Elaeocarpaceae	Sloanea meianthera Donn. Sm.
Ericaceae	Gaultheria acuminata Schlecht. & Cham.
	Orthaea brachysiphon (Sleumer) Luteyn
	Vaccinium poasanum Donn. Sm.
	Vaccinium stenophyllum Steud.
Euphorbiaceae	Acalypha macrostachya Jacq.
	Alchornea latifolia Sw
	Croton draco Cham. & Schtdl.

	Hieronyma oblonga (Tul.) Muell. Arg.
	Tetrorchidium brevifolium Standl. & Steyerm.
Fabaceae	Dussia cuscatlantica (Standl.) Standl. & Steyerm.
	Ormosia isthmensis Standl.
Fagaceae	Quercus cortesii Liebm.
Hamamelidaceae	Liquidambar styraciflua L.
Hippocastanaceae	Billia hippocastanum Peyr
Juglandaceae	Alfaroa costaricensis Standl.
Lauraceae	Cinnamomum triplinerve (Ruiz & Pavon) Klosterm.
	Ocotea helicterifolia (Meissn.) Hemsl.
	Persea vesticula Standl. & Steyerm.
Magnoliaceae	Magnolia guatemalensis subsp. hondurensis (A.R. Molina) A. Vazquez
	Talauma gloriensis Pittier
Malvaceae	Malvaviscus arboreus Cav.
Melastomataceae	Henriettea fascicularis (Sw.) Gomez
	Miconia trinervia (Sw.) D. Don ex Loud.
Meliaceae	Cedrela odorata L.
Mimosaceae	Inga laurina (Sw.) Willd.
	Inga punctata Willd.
	Inga vera Willd.
Monimiaceae	Mollinedia guatemalensis Perk.
	Siparuna grandiflora (H.B.K.) A.DC.
Moraceae	Castilla elastica Sesse in Cerv.
	Cecropia peltata L.
	Ficus sp.
	Perebea xanthochyma H. Karst. vel aff.
	Trophis mexicana (Liebm.) Bureau
Myricaceae	Morella cerifera (L.) Small
Myrsinaceae	Gentlea micranthera (Donn. Sm.) Lundell
	Myrsine coriacea (Sw.) R.Br. ex Roem. & Schult.
	Synardisia nervosa (Masters) Lundell
Myrtaceae	Eugenia sp.
	Myrcia splendens (Sw.) DC.
	Syzygium jambos (L.) Alston
Poaceae	Chusquea heydei Hitchc. ?
Proteaceae	Roupala montana Aubl.
Rosaceae	Prunus brachybotrya Zucc.
Rubiaceae	Elaeagia auriculata Hemsl.
	Faramea occidentalis (L.) A. Rich
	Genipa americana L.
	Psychotria luxurians Rusby
	Randia matudae Lorence & Dwyer?
Rutaceae	Zanthoxylum melanostictum Schtdl. & Cham.
Sapotaceae	Pouteria durlandii (Standl.) Baehni ?
	Pouteria reticulata (Engl.) Eyma
Saxifragaceae	Phyllonoma cacuminis Standl. & Steyerm. vel aff.
Simaroubaceae	Picramnia antidesma ssp. fessonia (DC.) W.W.Thomas
Staphyleaceae	Turpinia occidentalis (Sw.) G. Don
Symplocaceae	Symplocos vernicosa L.O. Wms.
Theaceae	Ternstroemia tepazapote Schtdl. & Cham.
Tiliaceae	Heliocarpus appendiculatus Turcz.
	Mortoniodendron cf. pilosum Meijer ined.
	Trichospermum galeottii (Turcz.) Klosterm. vel aff.
Ulmaceae	Trema micrantha (L.) Blume
Urticaceae	Myriocarpa heterospicata Donn. Sm.
	Myriocarpa longipes Liebm.

Verbenaceae Citharexylum donnell-smithii Greenm.
Cornutia pyramidata L.

Winteraceae Drimys granadensis L.f.

Lepidoptera

Papiliondae
Papilio sp 1
Papilio cresphontes
Papilio iphidamas iphidamas
Papilio polyxenes (asterius?)
Papilio thoas
Papilio astyalus
Eurytides branchus
Eurytides phaon
Parides iphidamas iphidamas

Riodinidae
Calephelis sp
Mesosemia gaudiolum

Pieridae
Ascia monuste
Anteos clorinde
Phoebis argante
Enantia sp. 1
Eurema sp. 2
Eurema albula
Eurema daira
Eurema nise
Eurema proterpia
Leptophobia aripa
Lieinix nemesis

Dismorphinae
Dismorphia amphiona praxinoe

Nymphalidae

Ithomiinae
Dircena sp. 1
Melinaea sp. 1
Hypoleria sp.
Ithomia sp.
Mechanitis sp.
Mechanitis lysimnia doryssus
Mechanitis polymnia isthmia
Napeogenes sp.
Godyris zavaleta sorites
Hypothyris sp.
Pteronymia sp.

Satyrinae
Cissia gigas
Dioriste sp.

Dioriste tauropolis
Cissia gomezi
Cissia hermes
Cissia metaleuca
Cissia hesione
Cissia sp.
Cissia renata
Euptychia westwoodi

Nymphalinae
Diaethria anna
Vanessa virginiensis
Anartia fatima
Siproeta epaphus epaphus
Siproeta sp.
Smyrna blomfida datis
Hamadryas fornax fornacalia
Hamadryas guatemalena
Hypanartia godmani
Hypanartia lethe
Catonephele mexicana
Adelpha leuceria
Marpesia Marcella
Nessaea aglaura
Adelpha sp
Thessalia theona

Heliconiinae
Aeria eurimedea
Dione june
Dione meneta poeyii
Heliconius hecale zuleika
Heliconius erato petiverana
Heliconius cyndo sub sp. Ukn
Heliconius cydno galanthus
Heliconius clysominus
Eueides sp
Eueides isabella
Dryas iulia
Agraulis vanillae
Lycorea cleobaea atergatis
Heliconius charatonius
Tithorea tarricina pinthias

Morphinae
Morpho polyphemus
Morpho peleides limpida
Morpho amathonte

Danaine
Danaus plexippus

Melitaeninae
Chlosyne lacinia
Chlosyne sp.

Chlosyne sp. (2)

Brassolinae
Caligo uranus

Charaxinae
Archeoprepona meander amphimachus
Memphis glycerium
Prepona lygia
Prepona brooksiana

Lycaenidae
Thecla aetolius

Coleoptera

Dung Beetles
Aphodius sp1
Ateuchus near solis sp
Canthidium near ardens sp
Canthidium near ardens (no bumps) sp
Canthidium near moroni sp
Canthidium near vespertinum sp
*Canthon vazquezae**
*Copris laeviceps**
*Copris nubilosus**
Cryptocanthon nov sp
Deltochilum near barbipes/pseudoparile sp
Deltochilum near mexicanum sp
*Dichotomius satanas**
*Eurysternus magnus **
Onthophagus near atrosericeus sp
*Onthophagus breviconus**
*Onthophagus cyanellus**
Onthophagus near gratahelenae sp
Onthophagus near chevlorati group sp
*Onthophagus subcancer**
*Phanaeus endymion**
Uroxys bidentis sp
Uroxys dybasi sp

Jewel Scarab Beetles
Chrysina spectabilis
Chrysina quetzalcoatli
Chrysina pastori
Chrysina karschi
Platycoelia humeralis
Chrysina sp 1

Invertebrates in Bromeliads

Larger taxonomic group	Family	# sp.
Diptera	Culicidae	6
	Syrphidae	7
	Ceratopogonidae	4
	Chironomidae	4
	Tipulidae	4
	Muscidae	2
	Sciomyzidae	2
	Canacidae	1
	Psychodidae	1
	other	8
Coleoptera		13
Hemiptera	Veliidae	1
Turbellaria		1?
Crustacea	Daphniidae	*Ceriodaphnia laticaudatus*
	Chydoridae	*Alona bromelicola*?
	Cyprididae	*Elpidium* sp.
	Cyprididae	1
		58 species

Reptiles and Amphibians
Bromeliahyla sp.
Bufo marinus
Bufo valliceps
Duellmanohyla soralia
Eleutherodactylus chac
Eleutherodactylus charadra
Eleutherodactylus milesi
Eleutherodactylus rostralis
Eleutherodactylus sp.
Hyalinobatrachium fleischmanni
Bromeliahyla bromeliacia
Plectrohyla dasypus
Plectrohyla exquisita
Plectrohyla matudai
Plectrohyla sp.
Ptychohyla hypomykter
Rana maculata
Smilisca baudini
Bolitoglossa conanti
Bolitoglossa diaphora
Bolitoglossa dolfeini
Bolitoglossa dunni
Bolitoglossa rufescens
Cryptotriton nasalis
Nototriton sp.
Oedipina sp.
Oedipina sp.
Ameiva festiva
Basiliscus vittatus
Celestus montanus
Corytophanes cristatus
Corytophanes hernandezii
Laemanctus longipes
Lepidophyma flavimaculatum

Mesaspis morelettii
Norops amplisquamosis
Norops biporcatus
Norops capito
Norops cusuco
Norops johnmeyerii
Norops lemurinus
Norops ocelloscapularis
Norops petersii
Norops sericeus
Norops sp.
Norops tropidonotus
Norops uniformis
Sceloporus malachiticus
Sceloporus variabilis
Sphenomorphus cherriei
Sphenomorphus incertus
Adelphicos quadrivirgatus
Atropoides nummifer
Bothriechis marchi
Bothrops asper
Cerrophidion godmani
Coniophanes sp.
Dendrophidion nuchale
Dryadophis dorsalis
Dryadophis melanolomus
Drymarchon melanurus
Drymobius chloroticus
Drymobius margaritiferus
Geophis sp.
Imantodes cenchoa
Lampropeltis triangulum
Leptophis ahaetulla
Micrurus diastema
Micrurus nigrocinctus
Ninia diademata
Ninia espinali
Ninia pavimentata
Ninia sebae
Omoadiphas aurula
Pseustes poecilonotus
Rhadinaea montecristi
Rhadinaea sp.
Scaphiodontophis annulatus
Sibon nebulatus
Stenorrhina degenhardtii
Sphenomorphus sp
Colubridae sp.
Anura sp.
Unknown

Birds

Family	Common name	Scientific Name
Tinamidae (Tinamou)	Great Tinamou	*Tinamus major*
	Little Tinamou	*Crypturellus soui*
	Slaty-breasted Tinamou	*Crypturellus boucardi*
Cathartidae (New World Vultures)	Black Vulture	*Coragyps atratus*
	Turkey Vulture	*Cathartes aura*
	King Vulture	*Sarcoramphus papa*
Accipitridae (Hawks, Eagles and Kites	Hook-billed Kite	*Chondrohierax uncinatus*
	Swallow-tailed Kite	*Elanoides forficatus*
	White Hawk	*Leucopternis albicollis*
	Common Black-Hawk	*Buteogallus anthracinus*
	Great Black-Hawk	*Buteogallus urubitinga*
	Gray Hawk	*Asturina nitida*
	Short-tailed Hawk	*Buteo brachyurus*
	White-tailed Hawk	*Buteo albicaudatus*
	Red-tailed Hawk	*Buteo jamaicensis*
	* Black Hawk-Eagle	*Spizaetus tyrannus*
Falconidae (Falcons)	Barred Forest-Falcon	*Micrastur ruficollis*
	Collared Forest-Falcon	*Micrastur semitorquatus*
	American Kestrel	*Falco sparverius*
	Bat Falcon	*Falco rufigularis*
	*Orange-breasted Falcon	*Falco deiroleucus*
Cracidae (Guans and Chachalacas)	Plain Chachalaca	*Ortalis vetula*
	Crested Guan	*Penelope purpurascens*
	Highland Guan	*Penelopina nigra*
	Great Curassow	*Crax rubra*
Odontophoridae (New World Quail)	Buffy-crowned Wood-Partridge	*Dendrortyx leucophrys*
	Spotted Wood-Quail	*Odontophorus guttatus*
Columbidae (Pigeons)	*Band-tailed Pigeon	*Patagioenas fasciata*
	Red-billed Pigeon	*Patagioenas flavirostris*
	Short-billed Pigeon	*Patagioenas nigrirostris*
	White-winged Dove	*Zenaida asiatica*
	Maroon-chested Ground-Dove	*Claravis mondetoura*
	White-tipped Dove	*Leptotila verreauxi*
	Gray-chested Dove	*Leptotila cassini*
	White-faced Quail-Dove	*Geotrygon albifacies*
	* Ruddy Quail-Dove	*Geotrygon montana*
Psittacidae (Parrots)	Olive-throated (Aztec) Parakeet	*Aratinga nana*
	Barred Parakeet	*Bolborhynchus lineola*
	White-crowned Parrot	*Pionus senilis*
	White-fronted Parrot	*Amazona albifrons*
Cuculidae (Cuckoos)	Squirrel Cuckoo	*Piaya cayana*
	Groove-billed Ani	*Crotophaga sulcirostris*
	Pheasant Cuckoo	*Dromococcyx phasianellus*
	Lesser Roadrunner	*Geococcyx velox*
Strigidae (Owls)	Mottled Owl	*Ciccaba virgata*
	Crested Owl	*Lophostrix cristata*

	*Mountain Pygmy-Owl	*Glaucidium gnoma*
	Ferruginous Pygmy-Owl	*Glaucidium brasilianum*
Caprimulgidae (Nightjars)	Pauraque	*Nyctidromus albicollis*
Apodidae (Swifts)	Black Swift	*Cypseloides niger*
	White-chinned Swift	*Cypseloides cryptus*
	White-collared Swift	*Streptoprocne zonaris*
	Vaux's Swift	*Chaetura vauxi*
Trochilidae (Hummingbirds)	Long-tailed Hermit	*Phaethornis superciliosus*
	Little Hermit	*Pygmornis longuemareus*
	Violet Sabrewing	*Campylopterus hemileucurus*
	*Brown Violet-ear	*Colibri delphinae*
	Green Violet-ear	*Colibri thalassinus*
	Emerald-chinned Hummingbird	*Abeillia abeillei*
	Black-crested Coquette	*Lophornis helenae*
	Stripe-tailed Hummingbird	*Eupherusa eximia*
	*Crowned Woodnymph	*Thalurania colombica*
	White-eared Hummingbird	*Hylocharis leucotis*
	Rufous-tailed Hummingbird	*Amazilia tzacatl*
	Cinnamon Hummingbird	*Amazilia rutila*
	White-bellied Emerald	*Agyrtria candida*
	Azure-crowned Hummingbird	*Agyrtria cyanocephala*
	Berylline Hummingbird	*Saucerottia beryllina*
	Green-throated Mountain-gem	*Lampornis viridipallens*
	Magnificent Hummingbird	*Eugenes fulgens*
	Sparkling-tailed Hummingbird	*Tilmatura dupontii*
	Wine-throated Hummingbird	*Atthis ellioti*
	Black-headed Trogon	*Trogon melanocephalus*
Trogonidae (Trogons)	Mountain Trogon	*Trogon mexicanus*
	Collared Trogon	*Trogon collaris*
	Resplendent Quetzal	*Pharomachrus mocinno*
Alcedinidae (Kingfishers)	*Green Kingfisher	*Chloroceryle americana*
Momotidae (Motmots)	Tody Motmot	*Hylomanes momotula*
	Blue-crowned Motmot	*Momotus momota*
	Turquoise-browed Motmot	*Eumomota superciliosa*
	*Keel-billed Motmot	*Electron carinatum*
Ramphastidae (Toucans)	Emerald Toucanet	*Aulacorhynchus prasinus*
	Collared Aracari	*Pteroglossus torquatus*
	Keel-billed Toucan	*Ramphastos sulfuratus*
Picidae (Woodpeckers)	Acorn Woodpecker	*Melanerpes formicivorus*
	Golden-fronted Woodpecker	*Melanerpes aurifrons*
	Hairy Woodpecker	*Picoides villosus*
	Smoky-brown Woodpecker	*Veniliornis fumigatus*
	Golden-olive Woodpecker	*Piculus rubiginosus*
	Northern Flicker	*Colaptes auratus*
	Chestnut-colored Woodpecker	*Celeus castaneus*
	Lineated Woodpecker	*Dryocopus lineatus*
	Pale-billed Woodpecker	*Campephilus guatemalensis*
Furnariidae (Oven birds)	Plain Xenops	*Xenops minutus*
	Spectacled Foliage-gleaner	*Anabacerthia variegaticeps*
	Buff-throated Foliage-gleaner	*Automolus ochrolaemus*
	Ruddy Foliage-gleaner	*Automolus rubiginosus*
	Tawny-throated Leaftosser	*Sclerurus mexicanus*
	*Scaly-throated Leaftosser	*Sclerurus guatemalensis*

	Ruddy Woodcreeper	*Dendrocincla homochroa*
	Olivaceous Woodcreeper	*Sittasomus griseicapillus*
	Wedge-billed Woodcreeper	*Glyphorynchus spirurus*
	Strong-billed Woodcreeper	*Xiphocolaptes promeropirhynchus*
	Barred Woodcreeper	*Dendrocolaptes sanctithomae*
	Black-banded Woodcreeper	*Dendrocolaptes picumnus*
	Spotted Woodcreeper	*Xiphorhynchus erythropygius*
	*Streak-headed Woodcreeper	*Lepidocolaptes souleyetii*
	Spot-crowned Woodcreeper	*Lepidocolaptes affinis*
Thamnophilidae (Antbirds)	Barred Antshrike	*Thamnophilus doliatus*
	Plain Antvireo	*Dysithamnus mentalis*
	Slaty Antwren	*Myrmotherula schisticolor*
Pipridae (Manakins)	White-collared Manakin	*Manacus candei*
	Red-capped Manakin	*Pipra mentalis*
Tyrannidae (Tyrant Flycatchers)	Ochre-bellied Flycatcher	*Mionectes oleagineus*
	Yellow-bellied Elaenia	*Elaenia flavogaster*
	*Sepia-capped Flycatcher	*Leptopogon amaurocephalus*
	Eye-ringed Flatbill	*Rhynchocyclus brevirostris*
	Stub-tailed Spadebill	*Platyrinchus cancrominus*
	Tufted Flycatcher	*Mitrephanes phaeocercus*
	Yellowish Flycatcher	*Empidonax flavescens*
	Black Phoebe	*Sayornis nigricans*
	Dusky-capped Flycatcher	*Myiarchus tuberculifer*
	Boat-billed Flycatcher	*Megarhynchus pitangua*
	*Great Kiskadee	*Pitangus sulphuratus*
	Social Flycatcher	*Myiozetetes similis*
	Sulphur-bellied Flycatcher	*Myiodynastes luteiventris*
	Tropical Kingbird	*Tyrannus melancholicus*
	Rose-throated Becard	*Pachyramphus aglaiae*
	Masked Tityra	*Tityra semifasciata*
	*Black-crowned Tityra	*Tityra inquisitor*
Cinclidae (Dippers)	American Dipper	*Cinclus mexicanus*
Troglodytidae (Wrens)	Band-backed Wren	*Campylorhynchus zonatus*
	Spot-breasted Wren	*Thryothorus maculipectus*
	Plain Wren	*Thryothorus modestus*
	Southern House Wren	*Troglodytes aedon*
	*Rufous-browed Wren	*Troglodytes rufociliatus*
	White-breasted Wood-Wren	*Henicorhina leucosticta*
	Gray-breasted Wood-Wren	*Henicorhina leucophrys*
	Nightingale Wren	*Microcerculus philomela*
Turdidae (Thrushes)	Slate-colored Solitaire	*Myadestes unicolor*
	Ruddy-capped Nightingale-Thrush	*Catharus frantzii*
	Black-headed Nightingale-Thrush	*Catharus mexicanus*
	Black Robin	*Turdus infuscatus*
	Clay-colored Robin	*Turdus grayi*
	White-throated Thrush	*Turdus assimilis*
Polioptilidae (Gnatcatchers)	Long-billed Gnatwren	*Ramphocaenus melanurus*
Corvidae (Crows)	Green Jay	*Cyanocorax yncas*
	Brown Jay	*Cyanocorax morio*
	Azure-hooded Jay	*Cyanolyca cucullata*
Vireonidae (Vireos)	Brown-capped Vireo	*Vireo leucophrys*
	*Tawny-crowned Greenlet	*Hylophilus ochraceiceps*
	Lesser Greenlet	*Hylophilus decurtatus*

	*Green Shrike-Vireo	*Vireolanius pulchellus*
Fringillidae (Siskins and Allies)	Scrub Euphonia	*Euphonia affinis*
	Yellow-throated Euphonia	*Euphonia hirundinacea*
	*Blue-hooded Euphonia	*Euphonia elegantissima*
	Olive-backed Euphonia	*Euphonia gouldi*
	Blue-crowned Chlorophonia	*Chlorophonia occipitalis*
	Lesser Goldfinch	*Carduelis psaltria*
Parulidae (New World Warblers)	Tropical Parula	*Parula pitiayumi*
	Grace's Warbler	*Dendroica graciae*
	Black-and-White Warbler	*Mniotilta varia*
	Louisiana Waterthrush	*Seiurus motacilla*
	*Common Yellowthroat	*Geothlypis trichas*
	Painted Redstart	*Myioborus pictus*
	Slate-throated Redstart	*Myioborus miniatus*
	Golden-crowned Warbler	*Basileuterus culicivorus*
	Chestnut-capped Warbler	*Basileuterus rufifrons*
Coerebidae (Bananaquit)	Bananaquit	*Coereba flaveola*
Thraupidae (Tanagers)	Common Bush-Tanager	*Chlorospingus ophthalmicus*
	Red-crowned Ant-Tanager	*Habia rubica*
	Red-throated Ant-Tanager	*Habia fuscicauda*
	Hepatic Tanager	*Piranga flava*
	Flame-colored Tanager	*Piranga bidentata*
	White-winged Tanager	*Piranga leucoptera*
	Crimson-collared Tanager	*Ramphocelus sanguinolentus*
	Scarlet-rumped Tanager	*Ramphocelus passerinii*
	Blue-gray Tanager	*Thraupis episcopus*
	Yellow-winged Tanager	*Thraupis abbas*
	Golden-hooded Tanager	*Tangara larvata*
	Green Honeycreeper	*Chlorophanes spiza*
	Red-legged Honeycreeper	*Cyanerpes cyaneus*
Emberizidae (Buntings and Sparrows)	Blue-black Grassquit	*Volatinia jacarina*
	Variable Seedeater	*Sporophila corvina*
	White-collared Seedeater	*Sporophila torqueola*
	Yellow-faced Grassquit	*Tiaris olivacea*
	Chestnut-capped Brush-Finch	*Buarremon brunneinucha*
	Orange-billed Sparrow	*Arremon aurantiirostris*
	Prevost's Ground-Sparrow	*Melozone biarcuatum*
	Rusty Sparrow	*Aimophila rufescens*
Cardinalidae (Saltators and Allies)	Buff-throated Saltator	*Saltator maximus*
	Black-headed Saltator	*Saltator atriceps*
	Black-faced Grosbeak	*Caryothraustes poliogaster*
	Blue-black Grosbeak	*Cyanocompsa cyanoides*
Icteridae (New World Blackbirds)	Melodious Blackbird	*Dives dives*
	Great-tailed Grackle	*Quiscalus mexicanus*
	Bronzed Cowbird	*Molothrus aeneus*
	Yellow-backed Oriole	*Icterus chrysater*
	*Spot-breasted Oriole	*Icterus pectoralis*
	Black-cowled Oriole	*Icterus prosthemelas*
	Chestnut-headed Oropendola	*Psarocolius wagleri*
	Montezuma Oropendola	*Gymnostinops montezuma*

Mammals

Felidae- Cats	
Panthera onca	Jaguar
Felis yaguarondi	Jaguarundi
Felis concolor	Puma
Felis pardalis	Ocelot
Canidae - Foxes	
Urocyon cinereoargenteus	Grey Fox
Procyonidae - Raccoons	
Procyon lotor	Racoon
Nasua narica	White nosed Coatimundi
Potos flavus	Kinkajou
Bassariscus sumichrasti	Cacomistle
Bassariscus gabbii	Olingo
Mustelidae - Weasels	
Mustela franata	Long-tailed weasel
Eira barbara	Tayra
Lontra longicaudis	Neotropical River Otter
Mephitidae - Skunks	
	Skunk species
Cebidae - Capuchins	
Cebus capucinus	White faced Capuchin
Ateles????	Spider Monkey
Alouatta palliata	Mantled Howler Monkey
Tapiridae - Tapirs	
Tapirus bairdii	Baird's Tapir
Tayassuidae	
Tayassu tajacu	Collared Peccary
Cervidae - deer	
Mazama americana	Red Brocket Deer
Odocoileus viginianus	White-tailed deer
Sciurudae - Squirrels	
Sciurus deppei	Deppe's Squirrel
Sciurus variegatoides	Variegated Squirrel
Heteromyidae - Pocket Mice	
Heteromys desmarestianus	Demarest's Spiny Pocket Mouse
Heteromys nelsoni	Nelson's Spiny Pocket Mouse
Muridae - Rats, Mice, Voles	
Oryzomys alfaroi	Alfaro's Rice Rat
Oryzomys sp.	
Scotinomys teguina	Olston's Brown Mouse
Mus musculus	House Mouse
Rattus rattus	Roof Rat
Peromyscus mexicanus	Mexican Deer Mouse

Peromyscus levipes	Nimble-footed Mouse
Peromyscus sp.	
Nyctomys sumichrasti	Vesper Rat
Reithrodontomys gracilis	Slender Harvest Mouse
Zygodontomys spp.	Cane mouse

Dasyproctidae - Agoutis

Dasyprocta punctata	Central American Agouti

Agoutidae

Agouti paca	Paca

Erethizontidae - Porcupines

	Porcupine sp.

Soricidae

	Shrew sp.

Phyllostomidae - American Leaf-nosed Bats

Anoura geoffroyi	Geoffrey's Tailless Bat
Artibeus intermedius	
Artibeus jamaicensis	Jamaican Fruit-eating Bat
Artibeus lituratus	Great Fruit-eating Bat
Artibeus phaeotis	Pygmy Fruit-eating Bat
Artibeus toltecus	Toltec Fruit-eating Bat
Artibeus watsoni	Thomas' Fruit-eating Bat
Bauerus dubiaquercus	Van Gelder's Bat
Carollia brevicauda	Silky Short-tailed Bat
Carollia castanea	Chestnut Short-tailed Bat
Carollia perspicillata	Seba's Short-tailed Bat
Centurio senex	Wrinkle-faced Bat
Chiroderma salvini	Salvin's Big-eyed Bat
Desmodus rotundus	Common Vampire Bat
Glassophaga commissarisi	Commassaris Long-tongued Bat
Glossophaga leachii	Grey Long-tongued Bat
Glossophaga soricina	Pallas' Long-tongued Bat
Hylonycteris underwoodi	Underwood's Long-tongued Bat
Micronycteris microtis	Little Big-eared Bat
Sturnira lilium	Little Yellow-shouldered Bat
Sturnira ludovici	Highland Yellow-shouldered Bat
Trachops cirrhosus	Fringe-lipped Bat
Uroderma bilobatum	Tent-making Bat
Vampyrodes caraccioli	Great Stripe-faced Bat
Enchisthenes hartii	Velvety Fruit-eating Bat

Vespertilionidae - Vesper Bats

Eptesicus brasiliensis	Brazilian Brown Bat
Eptesicus furinalis	Argentine Brown Bat
Lasiurus blossevillii	Hairy-tailed Bat
Myotis albescens	Silver Tiiped Myotis
Myotis keaysi	Hairy-legged Myotis
Pipistrellus subflavus	Eastern Pipistrelle

Mormoopidae- Leaf chinned Bat

Pteronotus davyi	Davy's Naked Backed Bat
Pteronotus parnellii	Parnell's Moustached Bat
Myrmecophagidae - Anteaters	
Tamandua mexicana	Northern tamandua
Bradypodidae - Three-toed Sloths	
	Sloth sp
Dasypodidae - Armadillos	
	Armadillo sp.
Didelphidae - Opossums	
Marmosa mexicana	Mexican Mouse Opossum
Didelphis sp	
Didelphis virginiana	Common/Virginia opossum
Philander opossum	Brown/Gray 'four-eyed' opossum
Marmosops invictus	Slaty Slender Mouse Opossum

Small mammals

Scientific name	**Common name**
Heteromys desmarestianus	Spiny pocket mouse
Peromyscus mexicanus	Mexican deer mouse
Scotinomys teguina	Alston’s singing mouse
Nyctomys sumichrastu	Vesper rat
Reithrodontomys gracilis	Slender harvest mouse
Tylomys nudicaudus	Northern climbing rat
Oryzomys alfaroi group	Alfaro’s rice rat
Baiomys musculus	
Unknown	
Mustela frenata	Long-tailed weasel
Tamandua mexicana	Northern tamandua (anteater)
Didelphis marsupialis	Common opossum
Marmosa mexicana	Mexican mouse opossum
Marmosa robinsoni	Robinsoni’s mouse opossum

Bats

Family	Subfamily	Species
Mormoopidae		*Mormoops megalophylla*
		Pteronotus parnellii
Phyllostomidae	Carolliinae	*Carollia brevicauda*
		Carollia castanea
		Carollia perspicillata
	Desmodontinae	*Desmodus rotundus*
		Diphylla ecaudata
	Glossophaginae	*Anoura geoffroyi*
		Glossophaga commissarisi
		Glossophaga soricina
		Hylonycteris underwoodi
	Phyllostominae	*Micronycteris schmidtorum*
		Phyllostomus hastatus
		Trachops cirrhosus
	Stenodermatinae	*Artibeus intermedius*
		Artibeus jamaicensis
		Artibeus lituraus
		Artibeus phaeotis
		Artibeus toltecus
		Artibeus watsoni

	Centurio senex
	Chiroderma salvini
	Chiroderma villosum
	Enchisthenes hartii
	Platyrrhinus helleri
	Sturnira lilium
	Sturnira ludovici
	Uroderma bilobatum
	Vampyressa pussila
	Vampyrodes caraccioli
Natalidae	*Natalus stramineus*
Vespertilionidae	*Bauerus dubiaquercus*
	Myotis albescens
	Myotis kaeysi
Molossidae	*Molossus ater*

Appendix 6 - Spatial data holdings and metadata

Spatial data are available to download from:
http://www.bath.ac.uk/bio-sci/biodiversity-lab/honduras/

Landsat images

Path/Row (WRS #)	Date	Sensor	SV	ID	Source
p019r049 (WRS 1)	04-Feb-1979	MSS	Landsat 1	01499092000120010	GLCF
p018r049 (WRS 2)	18-Mar-1987	TM	Landsat 5	01499060300380003	GLCF
p019r049 (WRS 2)	22-Jun-1994	TM	Landsat 5	53679153759	GLCF
P018r049 (WRS-2)	05-Mar-1994	TM	Landsat 5	LT5018049009406410_WO	USGS
p018r049 (WRS 2)	16-Mar-2001	ETM+	Landsat 7	L7CPF20010101_20010331_07	GLCF
p019r049 (WRS 2)	21-Mar-2006	ETM+	Landsat 7	7019049000060909650	USGS
p018r049 (WRS 2)	14-Mar-2006	ETM+	Landsat 7	70180049000607351	USGS

- Georeferenced scanned topographical maps
- Shapefiles
  - Park boundary
  - Core zone
  - Camps
  - Villages
  - Roads
  - Mule trails
  - Camp access trails
  - Main Transects
  - Additional transects (primate work, tourist trails)
  - Sample points
  - Mammal traps
  - Bird mist nets
  - Bat mist nets
  - Streams
  - Drainage basins

Appendix 7 - Agreement on ownership and use of data and intellectual property rights

The Cusuco National Park survey is a large collaborative project with many participating scientists, from around the world, working in the field in relatively isolated camps. This document is designed to address two implications of this. First, the need for careful co-ordination before, during and after the expeditions. Secondly, the analysis and publication of the data will often involve more than one scientist and to avoid future arguments over use and ownership of the data and the intellectual property rights this document has been compiled and needs to be signed by all participants in the survey programme.

The main thrust of the agreement is to ensure that researchers are facilitated in their work as much as possible, and are encouraged to write up their own data and publish papers on their own research and/or that done in collaboration with others. Research findings **generated by field scientists**, students or volunteers in projects in which these researchers had **significant intellectual input**, which were performed in large part by them, **or under their direction** in collaboration with a field scientist, shall be considered the joint property of the collaborating individuals. The data collected by each of the researchers will belong to them with the following provisos that ensure collaborative papers can be prepared from data gathered by various team members:

1. All scientific activity in Cusuco National Park is done under the direction of the Senior Forest Scientist; therefore he is a collaborator, and the normal expectation is for him to be included in the author list. Any applications for funding pre-expedition must be done in liaison with him. All publication plans must be discussed with him and be cleared by him before submission. Copies of all publications must be sent to him. This set of provisos is to ensure collaboration rather than competition (in funding, fieldwork and publication), and so that the diverse findings from the various projects are known by those co-ordinating the work.
2. Any publications that arise from the work should list Operation Wallacea as the scientist's second institution, and where other researchers have made a significant input into the research they **should be included as co-authors**.
3. A copy of the data collected should be made available to Operation Wallacea in an agreed format before each researcher leaves sites. A networked computer system will be available at Base Camp and all data gathered by each researcher will be entered in the required format.
4. Researchers will be able to access and copy all their own data and may request additional data from other researchers to utilise for their work **as long as the main focus of their study is not the same as that of the original researcher**. Thus forest structure data might be utilised as part of a bird habitat selection study or herpetofauna diversity data might be used as part of a study into the use of various taxonomic groups as indicators of overall forest diversity. In these cases the original researchers whose data were utilised would be included in the authorship on any publications or in acknowledgements if being utilised for a dissertation.
5. If the researcher requests data from other researchers in the **same area of study then prior agreements on authorship listing for any papers to be published utilising these data or acknowledgements if being utilised for a dissertation must be reached before release of the data**.
6. Operation Wallacea has appointed a **Data Manager**, José Nuñez-Miño, who receives all requests for access to data and responds to these requests both with the requested data (where appropriate) and also with written agreements over the inclusion of additional researchers on the authorship list of any consequent publications.
7. If the data have not been written up by the researcher within a period of 3 years then Operation Wallacea retains the right to hand those data over to another researcher for them to write it up and ensure publication. This is to get round the problem where a researcher is simply not making progress on getting the data published.

Any individual involved in the project may, at his/her discretion, informally discuss the research data with other researchers and present the data at seminars which are not published in full or only in abstract form.

In addition, all individuals involved with the Operation Wallacea project will follow the spirit and letter of Article 8(j) of the Convention on Biological Diversity: "Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices."

I agree to the above terms on the usage and ownership of data and intellectual property rights

……………………………………………………… (Signature of researcher)

……………………………………………………… (Print name of researcher)

………………………………………………………
Signed on behalf of Operation Wallacea