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Expedition report

Surveying monkeys, macaws and other wildlife of the Peru Amazon.

Expedition dates: 29 May to 8 July 2005

Report published: December 2005

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Abstract

Macaw & parrot survey: Work was conducted at the Las Piedras Biodiversity Station on the Las Piedras river, south eastern Peru into macaw and parrot activity at clay licks and their distribution patterns in the surrounding forest in terms of forest type. This study supports the work of previous studies which show that parrots and parakeets feed mostly in the early morning (before 07:00), while large macaws feed later in the morning (around 09:00). Parrot and macaw feeding can occur at several closely located clay licks simultaneously. Parrot feeding activity is affected by a variety of sources of disturbance, including weather (especially fog), vultures, birds of prey, and boat traffic. Birds arrive at clay licks in smaller groups than are observed departing due to the effect of antipredator activity (or flushing). While waiting to feed, birds engage in a variety of preening and social preening behaviours. Trends in encounter rates during afternoon censuses for dusky-headed parakeet, blue-headed parrot and red-and-green macaw matched trends in feeding activity observed at the clay lick for the period of the study. More encounters with birds were obtained in floodplain forest compared to terra firme and seasonal swamp forest. The floodplain forest also had the highest fruit index, mostly due to the large number of fruiting palms. This study highlights the problems associated with censusing parrots in the afternoon, comparing three commonly used census techniques (long watch, variable circular plots and variable distance line transects). A relative index based on call frequency should not be used to compare relative abundance between species as call volume and frequency strongly biases results towards larger and more vocal species.

Mammal survey: This study is part of a longer term investigation into the impacts of logging and associated subsistence hunting on mammalian populations in forest adjacent to the Las Piedras river, southeast Peru, and reports on data collected during the first three years. Data were collected using standardized line-transect census techniques for 16 species of medium to large bodied mammals and four species of hunted birds. Preliminary results show increases in abundance for many of the bushmeat species suggesting that hunting reduced population abundance, but not to an extent that made recovery impossible.

Caiman survey: Caimans are a genus of crocodilian found throughout the Amazon basin. Numbers of caiman, particularly white caiman (*Caiman crocodilus*), also known as spectacled caiman, and black caiman (*Melanosuchus niger*) have been declining in recent years due to overhunting for their skins and meat by humans. Both species are now listed on CITES (Convention on International Trade in Endangered Species). This project surveyed the local population of caimans along a section of the Las Piedras river, southeast Peru and found white caiman to be the most abundant species, with an abundance of 4.93 individuals per kilometre. The survey also made an attempt to map individual territories.

Estudio sobre guacamayos y loros: El estudio sobre la actividad de loros y guacamayos en colpas y sobre su distribución en diferentes tipos de selva alrededor de la colpa se realizó en Las Piedras Biodiversity Station en el Río Las Piedras, al sudeste del Perú. Este estudio apoya trabajos anteriores que demuestran que loros y pericos comen mayormente temprano en la manaña (antes de las 07:00) mientras que guacamayos grandes comen más tarde (alrededor de las 09:00). Actividad puede ocurrir al mismo tiempo en varias colpas cercanas. La actividad de loros está afectada por varios motivos de alteración, entre ellos el tiempo (especialmente neblina), gallinazos, aves rapaces y botes. Cuando llegan a la colpa los grupos de aves son más pequeños que cuando salen debido a las actividades de protección contra predadores. Mientras esperan antes de bajar a comer, los aves se dedican a arreglarse las plumas con el pico, o solos o mutuamente. Durante el período del estudio la tendencia en los números de encuentro durante el censo de la tarde correspondió a la tendencia en la actividad observada en la colpa para Dusky-headed Parakeets, Blue-headed Parrots y Red-and-green Macaws. Se encontraron más loros y guacamayos en bosque inundable que en tierra firme y pantano estacional. El bosque inundable también tuvo el índicie más alto de frutas, mayormente debido a un gran número de palmeras frutales. Este estudio compara los tres tipos de censo más comúnamente utilizados(observaciones largas, parcelas circulares variables y transectos de distancias variables)y demuestra los problemas asociados con el censo de loros en la tarde. Un índicie relativo basado en la frecuencia de reclamos no debería ser usado para comparar la abundancia relativa entre especies ya que el volumen y la frecuencia de reclamos afectan los resultados porque favorecen las especies grandes y las que más cantan.

Estudio de mamíferos: Este estudio forma parte de una investigación a largo plazo sobre los impactos de deforestación y de la caza de subsistencia sobre poblaciones de mamíferos en el Río Las Piedras, al sudeste del Perú, e informa sobre datos recopilados durante los tres primeros años. Los datos se recopilaron empleando transectos en línea estandarizados para 16 especies de mamíferos de tamaños medianos a grandes y para cuatro especies de aves cazados. Los resultados preliminares demuestran un aumento de la abundancia para muchas de las especies cazadas, lo que indica que la caza redujo la abundancia de la población, sin embargo no hasta un punto que hizo la recuperación imposible.

Estudio de caimanes: Caimanes pertenecen a la familia Crocodylidae y son encontrados en toda la cuenca amazónica. Las poblaciones de caimanes, sobre todo caimanes blancos (*Caiman crocodilus*; también llamados caimanes de anteojos) y caimanes negros (*Melanosuchus niger*) han disminuido en los últimos años porque el hombre les cazó por su piel y carne. Ambas especies están ahora registradas en CITES (Convención sobre el Comercio Internacional de Especies Amenazadas de Fauna y Flora Silvestres). La meta del proyecto fue de estudiar la población local de caimanes a lo largo de una parte del Río Las Piedras, al sudeste del Perú, para saber cuáles de las especies se encuentran y para establecer la densidad de individuos por kilómetro. Otro objetivo era de determinar los territorios de cada individuo.

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1. Expedition Review

M. Hammer (editor) & Clare Fothergill
Biosphere Expeditions

1.1. Background

Biosphere Expeditions runs wildlife conservation research expeditions to all corners of the Earth. Our projects are not tours, photographic safaris or excursions, but genuine research expeditions placing ordinary people with no research experience alongside scientists who are at the forefront of conservation work. Our expeditions are open to all and there are no special skills (biological or otherwise) required to join. Our expedition team members are people from all walks of life, of all ages, looking for an adventure with a conscience and a sense of purpose. More information about Biosphere Expeditions and its research expeditions can be found at www.biosphere-expeditions.org.

This expedition report deals with an expedition to Peru that ran from 29 May to 8 July 2005. The expedition conducted a survey of rain forest wildlife to aid the development of a private protected zone linking the Tambopata and Manu areas, and to assist in the development of an environmentally sensitive and sustainable management strategy. The research area, which has never been studied, is very rich in wildlife but not yet protected. Vital research therefore needs to be carried out and the results presented to conservation groups in an effort to protect this un-researched tract of rain forest.

Increasing economic development is putting a strain on the natural resources of the Peruvian Amazon. Unsustainable forms of farming, logging and tourism are on the rise, especially along the Tambopata River, an area renowned for its biodiversity. The Las Piedras river represents an adjacent river system, connecting Tambopata and Manu, which has never been studied and has far less human presence than Tambopata. Unlike Tambopata and Manu, however, Piedras is not yet protected and for this reason vital research needs to be carried out and the results presented to conservation groups in an effort to conserve this unique tract of rain forest.

Rapid Assessment Programmes (RAPs) are snap-shot studies of an area, investigating the flora and fauna present in order to create species lists and determine relationships and impacts that may exist. The expedition's RAP will include visual encounter surveys, mammal and bird censuses of colpas and behavioural studies.

The study site has several colpas which are frequented by macaws and parrots. It also has mammal colpas inside the forest. Animals and birds visit the colpas to feed on the clay minerals found there. It is thought that these minerals neutralise the harmful effect of toxins contained in the fruits and leaves consumed by the animals. Data collected from the colpas and from the visual encounter surveys will provide important baseline information about the Las Piedras river area, which will be used in comparative studies and to aid local authorities in making informed management decisions.

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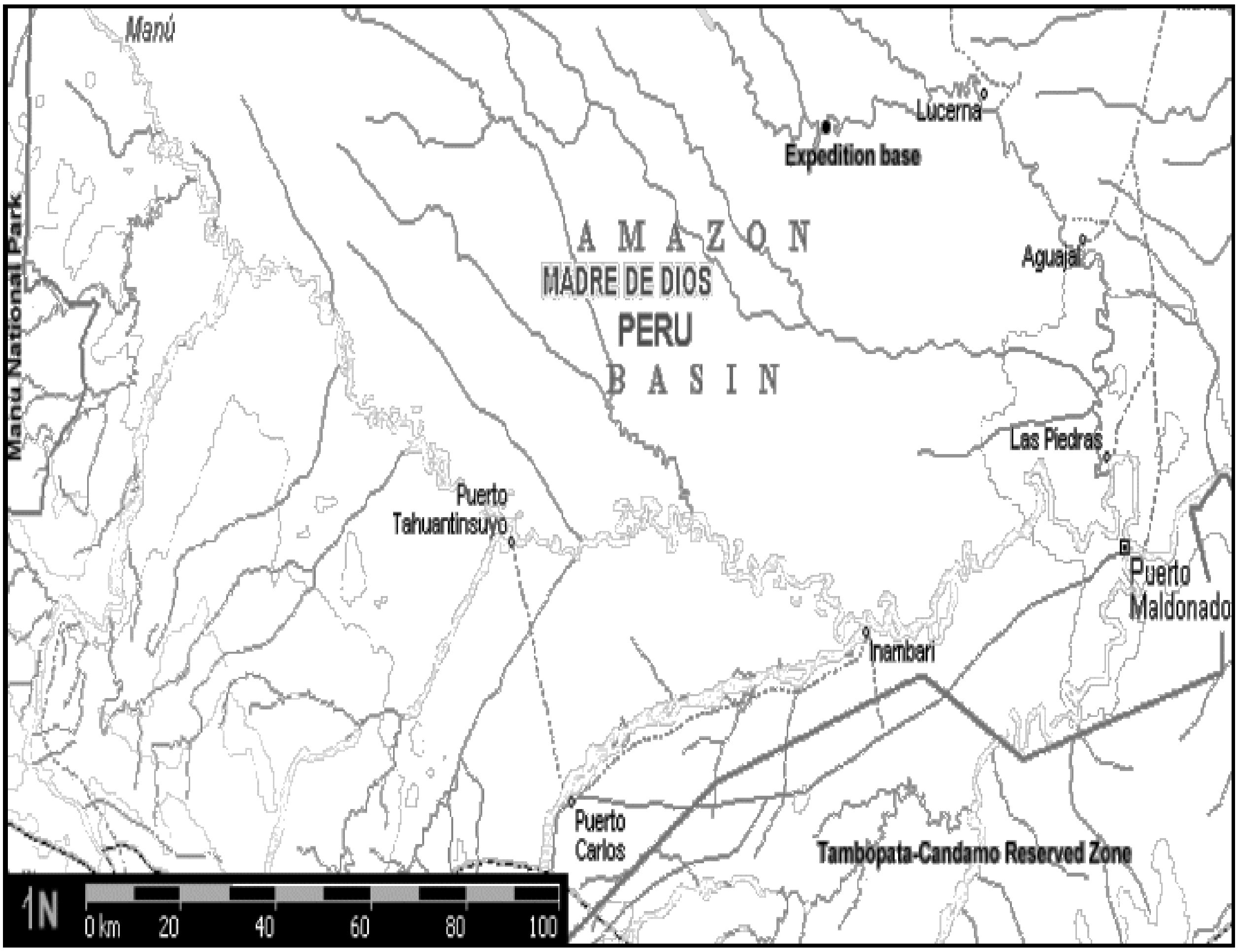
1.2. Research Area

Peru is located on the Pacific coast of South America and is the third largest country on the continent. Two thirds of Peruvian territory is located within the Amazon basin. The expedition base camp is within the department of Madre de Dios, internationally known as "the Biodiversity Capital of the World". The department already contains two large national parks covering over half of its 78,000 km² area – Manu and the vast Bahuaja-Sonene (Tambopata) area. The Las Piedras river is located between the two.

In terms of biological diversity, the research area is amongst the richest in the world. Research conducted over the last 20 years in the Bahuaja-Sonene National Park has shown that it harbours more species of birds (587), butterflies (1,230) and many other animal taxa than any other location of comparable size. Most recently it has also been identified as the largest uninhabited and untouched rain forest wilderness on Earth, covering about 1 million hectares (2.5 million acres) of undisturbed and unhunted habitat (the nearest rival, the island of New Guinea has about 100,000 hectares of uninhabited tropical forest habitat). The area is also home to a number of landmark animals listed in the IUCN's Red Data Book. Amongst them the giant river otter, giant armadillo, giant anteater, ocelot, jaguarundi, jaguar, harpy eagle, crested eagle, spectacled caiman, and black caiman. Over 150 different species of tree can be found within 100 m^2 alone, and the WWF and IUCN have identified the area as a 'Centre of Plant Diversity'.



Map of the area showing Puerto Maldonado (assembly point), Manu (NW corner), Tambopata-Candamo (SE corner) and base camp location (N edge).

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1.3. Dates

The expedition ran over a period of six weeks and was divided into three two-week slots, each composed of a team of international research assistants, guides, support personnel, local scientists and an expedition leader. Slot dates were 29 May - 10 June | 12 June - 24 June | 26 June - 8 July.

1.4. Local Conditions & Support

The area lies within the confines of the Amazon basin in SE Peru with a sub-tropical climate and distinct wet and dry seasons, the wet season being between October and April when it rains nearly every day and the humidity is high, around 90% inside the forest. During the dry season temperatures can rise to 35 °C but the humidity tends to be lower. Between May and July cold weather events known as *friajes* can occur when cold fronts move in from the south and temperatures drop to between 8-15 °C for up to 8 days. Rainfall averages 2,000 mm per year and humidity averages about 75%. The area's ecosystems hold several world records in flora and fauna species numbers and are recognised as one of the planet's hotspots of biodiversity.

Expedition base

The expedition was based in a remote region along the Las Piedras river, approximately seven hours in a motorised boat from Puerto Maldonado. Base camp is a large, comfortable jungle lodge / research station made from local materials. It has twin rooms, showers and toilets. Team members paired up to share rooms, although sometimes it was possible to cater for team members wishing to stay in single accommodation. All meals were prepared for the team and vegetarians could be catered for.

Field communications

There is no mobile phone coverage at base camp or within the study area. There is one radio used for emergency communication with Puerto Maldonado. The expedition carried a radio/satellite phone for emergency calls and to transmit an expedition diary every few days.

Transport & vehicles

Team members made their own way to the Puerto Maldonado assembly point. From there transport to the base camp involved a boat ride of approximately six to seven hours to the base camp, and once at base studies were conducted on foot, from boats or from hides. All transport, boats and vehicles were provided from the expedition team assembly point onwards and back.

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Medical

The expedition leader was a trained first aider, and the expedition carried a comprehensive medical kit. Further medical support was available through a medical post in the Colpayo community, about two hours by boat. The nearest hospital was in Puerto Maldonado, about six hours by boat. Prior to departure all team members purchased adequate travel insurance covering emergency medical evacuation and repatriation.

There were no major medical incidences during the expeditions. Minor incidences included a couple of stomach upsets, one case of sunburn, and a suspected broken finger. The expedition leader contracted a non-virulent strain of subcutaneous leishmaniasis, which at the time of writing is treated with medication and expected to run its course within six to ten months.

1.5. Local Biologists

The expedition's local biologist was Emma Hume. Born and raised in England, she first came to Peru in 1994 and hasn't been able to leave since! After spending a year working on conservation projects in Australia, she studied Natural Environmental Science at Sheffield University and shortly after went to Peru to work as a Resident Naturalist for Explorers Inn – one of the big lodges in Tambopata. She has also been an operations manager of another lodge and has worked as a naturalist guide in Tambopata and Manu. She set up Tambopata Expeditions and its associated research centre, the Las Piedras Biodiversity Station (= expedition base), along with her partner Juan Julio, a local guide. She has travelled extensively including an expedition to the Tien Shan Mountains, Kyrgyzstan.

The expedition's guest biologist was Alan Lee, currently doing an MPhil at the Manchester Metropolitan University. Like Emma, after arriving in Peru in 2002, he has been locally involved ever since, after deciding that life as a web developer was not offering enough in London. The life in London was preceded by a degree in Zoology and Botany in South Africa and a year as a game ranger. In Peru Alan has worked as a Resident Naturalist for Explorer's Inn, doing a small project on the impact of tourism on wildlife. This led to a bigger opportunity with Project Fauna Forever with the Tambopata Reserve Society after working on the Tambopata Macaw Project. Combining experiences from both of these, he is currently looking at the landscape level effects of clay licks on parrot and macaw distribution across the Tambopata region.

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1.6. Expedition Leader

This expedition was led by Clare Fothergill. Clare graduated from the University of Wales, Aberystwyth, with an MSc in Environmental Impact Assessment. She has led groups into the field to places such as Lesotho, South Africa and Zimbabwe, working for organisations such as Outward Bound. Clare's experience in co-ordinating logistics in remote locations is drawn from her involvement in organising a major international adventure challenge in the South Pacific. Her interest in the natural environment means she is happiest when being active in the outdoors, be it mountaineering, mountain biking or climbing. She has travelled extensively in Europe, Africa, India and the South Pacific.

1.7. Expedition Team

The expedition team was recruited by Biosphere Expeditions and consisted of a mixture of all ages, nationalities and backgrounds. They were:

29 May – 10 June 2005

Stefan Brandl (Germany), Robyn Ede (Australia), Ralph Gaertner (Germany), Eveline Haeusler (Switzerland), Rebecca Hall (UK), Gemma Johnson (UK), Connie Varnhagen (Canada), Stanley Varnhagen (Canada).

12 June – 24 June 2005

Steven Carlson (USA), Melissa Craddock (USA), Eveline Haeusler (Switzerland), Rob Ritchie (UK), Sarah Stannard (UK), Wendy Wood (USA).

26 June – 8 July 2005

Judith & Peter Bird (Canada), Jany Dredge (Czech Republic), Lynn Fecteau (USA), Mark Keegan (USA), Claire-Louise & Charlie McLaughlan (UK), Deanna, Bill & Harrison Steele (USA).

Staff (throughout the above period):

Anja Kirchdorfer (scientific assistant), Juan Julio Durand (local guide), Antonio Corale (local guide), Garza-Edgar Arimuya (local guide), Jose Durand (boat driver), Pico Durand (boat driver), Gladys Huyaban (cook), Gisela Torres (cook's assistant).

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1.8. Expedition Budget

Each team member paid towards expedition costs a contribution of £1100 per person per two week slot. The contribution covered accommodation and meals, supervision and induction, a permit to access and work in the area, all maps and special non-personal equipment, all transport from and to the team assembly point. It did not cover excess luggage charges, travel insurance, personal expenses like telephone bills, souvenirs etc., as well as visa and other travel expenses to and from the assembly point (e.g. international flights). Details on how this contribution was spent are given below.

Income	£
Expedition contributions	29,672
Expenditure	
Base camp and food includes all meals, base camp equipment, gas, wood	1,574
Transport includes fuel, boat hire & maintenance	1,234
Equipment and hardware includes research materials & gear etc purchased in UK & Peru	1,380
Biosphere Expeditions staff includes salaries, travel and expenses to Peru	4,756
Local staff includes salaries, travel and expenses, gifts	1,430
Administration includes permits, registration fees, sundries etc	367
Scientific services, logistics & accommodation Payment to Tambopata Expeditions	5,040
Team recruitment Peru as estimated % of PR costs for Biosphere Expeditions	4,700
Income – Expenditure	9,191
Total percentage spent directly on project	69%

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1.9. Acknowledgements

This study was conducted by Biosphere Expeditions which runs wildlife conservation expeditions all over the globe. Without our expedition team members (listed above) who provided an expedition contribution and gave up their spare time to work as research assistants, none of this research would have been possible. The support team and staff (also mentioned above) were central to making it all work on the ground. Thank you to all of you, and the ones we have not managed to mention by name (you know who you are) for making it all come true. Biosphere Expeditions would also like to thank Land Rover, Cotswold Outdoor, Globetrotter Ausrüstung and Gerald Arnhold for their sponsorship and/or in-kind support.

1.10. Further Information & Enquiries

More background information on Biosphere Expeditions in general and on this expedition in particular including pictures, diary excerpts and a copy of this report can be found on the Biosphere Expedition website www.biosphere-expeditions.org.

Copies of this and other expedition reports can be accessed via at www.biosphere-expeditions.org/reports.

Enquires should be addressed to Biosphere Expeditions at the address given below.

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2. Monitoring changes in mammal populations after selective logging and associated subsistence hunting

Emma Tatum-Hume
Las Piedras Biodversity Station

2.1. Introduction

Much of the Amazon forest is now inhabited by humans, so there are few areas left with extensive untouched forest. Paramount to the protection of the remaining forests and its inhabitants is an understanding of the impacts that humans have on the ecosystem and the introduction of management policies that help both coexist. Selective logging is a major industry in tropical rainforests; its impacts on the forest system are poorly understood. By studying the effects of logging and associated subsistence hunting on medium to large mammal and bird populations the information collected can be used to help manage and protect wildlife in and around logging concessions and areas of human habitation.

Background to Las Piedras river and logging activities

The Las Piedras river lies between Tambopata and Manu, two areas in southeast Peru renowned for their high biodiversity and protected by the Peruvian government as a Reserve Zone and a National Park respectively. In its headwaters is the recently created Alto Purus National Park, the largest national park in Peru covering some 2.7 million hectares. The Las Piedras river contains some of the last commercially viable stands of big-leafed mahogany (*Swietenia macrophylla*) in Peru. Mahogany is one of the finest species of tropical timber and is highly sought after on the international markets. Its high price ($2.90 per board foot in September 2005) makes it an obvious target for both legal and illegal woodcutting operations in the area.

Subsistence hunting goes hand in hand with logging. Generally, loggers take with them bare essentials such as rice, pasta and oil and hunt for the rest of the food they consume, thus decreasing operational costs by using game meat. The impact of their hunting activities depends on factors such as the length of time they are present in the forest, the number of people working at the camp and the mammal populations in the surrounding forest.

The current study aimed to produce baseline data of mammal populations in terra firme forest of the Las Piedras river area and monitor the recovery of mammal populations after a logging event.

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2.2. Background to the Survey Site

Location

The expedition base was the Las Piedras Biodiversity Station on the banks of the Las Piedras river, approximately 60 km northwest (approximate bearing 325º) along the Las Piedras river (GPS position S 12º05.663' W 69º52.852'). The site can be reached by river taking approximately seven hours in a boat with outboard motor.

The area consists of lowland tropical rainforest that receives an average annual rainfall of approx. 2,500 mm. The wet season is from October to April and the mean temperature 27°C.

The study has so far collected data during the dry seasons (between April and September) in 2003, 2004 and 2005. Much of the data were collected by expedition members as part of a research expedition conducted by Biosphere Expeditions and the Las Piedras Biodiversity Station.

History of the site

The survey site was part of a large logging concession between 1994 and 1999, during which time wood was selectively extracted using chainsaws, circular saws and tractors. For three months between 1993 and 2000 a Brazil nut collector also worked in the study area. He reported that he had hunted ten white-lipped peccary (*Tayassu pecari)*, six collared peccary (*Tayassu tajacu)* and three deer (*Mazama* spp.) per month. Several other species were hunted at very low frequency, e.g. one Tapir (*Tapirus terrestris)* in eight years. He stated that when the woodcutters left the area "no animals could be found".

A study carried out in the Las Piedras river area found that each logging camp had an average of 8.76 workers each of whom consumed 313.2 g of bushmeat per day (Schulte-Herbruggen et al. 2003). Based on these calculations about 1 t (998.68 kg) of bushmeat was consumed annually at the study site by loggers, or a total of 6 t (5992 kg) over the extraction period! If this mass is converted to actual animals, it would be the equivalent of 799 spider monkeys (*Ateles belzebuth)* or 198 white-lipped peccary (*Tayassu pecari*), two of the preferred bushmeat species.

Since 2002 the study site has been protected from logging and hunting activities as it is now part of an ecotourism concession.

Importance of mammals

Mammals play a varied and important role in many aspects of rainforest ecology from predation to frugivory and folivory and most importantly, seed dispersal for rainforest regeneration (Raez-Luna 1995, Terborgh 1983). Highly mobile primates such as spider monkeys are thought to be the most important group of seed dispersers (Bourlière 1985). Primates also are good indicators of low level disturbance and hunting (Perez 1999). Mammals also play an important role in the livelihood of native peoples as a source of protein in their diets.

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Of the 16 species of mammal monitored during this study, ten are considered to be primary bushmeat species due to their size and hunters' taste preferences (Schulte-Herbruggen 2003). These include brown agouti (*Dasyprocta variegata*), brown capuchin monkey (*Cebus apella*), collared peccary (*Tayassu tajacu*), grey brocket deer (*Mazama gouazoubira*), monk saki monkey (*Pithecia monachus*), red brocket deer (*Mazama americana*), red howler monkey (*Alouatta seniculus*), spider monkey (*Ateles belzebut*), white-fronted capuchin (*Cebus albifrons*), white-lipped peccary (*Tayassu pecari*).

The four species of hunted bird included in the study were blue-throated piping guan (*Pipile cumanensis*), pale-winged trumpeter (*Psophia leucoptera*), razor-billed curassow (*Mitu tuberosa*) and spix guan (*Penelope jacquacu*).

2.3. Methods

Mammal populations were monitored using standardized line-transect methodology as described by Peres (1999). The transect used measured 4.25 km and was cut in 2002 through terra firme high forest. The transect was cut in the direction of a fixed bearing but avoiding natural obstacles such as "aguajales" (swamp areas) and was marked with tape every 50 m to aid distance measurements. It took a week to prepare and was then cleared of debris before each subsequent monitoring event in order to reduce the chance of mammals detecting the observer before data were collected.

Transect surveys have proven to be the most reliable method of producing relative abundance data in rainforest environments. Previous studies (Perez 1999, Emmons 1984) recorded primates, caviomorph rodents, sciurids, ungulates, cracids, trumpeters, tinamous, wood quails and a number of species of avian canopy frugivores. In this study the only bird species included were those that are commonly hunted. All mammal species encountered on the transects were recorded. The transects were walked daily between 06:00 – 10:30 to avoid the hottest part of the day when animals tend to be less active (Peres 1999). If it rained whilst on the transect for more than ten minutes, the transect was abandoned as rain decreases the observer's ability to detect species.

The transect was walked at an average speed of 1.21 km/h and took between three and four hours to complete. The transect was walked by a minimum of two and maximum of three observers. One observer was always a local guide was primarily responsible for detecting all mammals and birds, the other observers were Biosphere Expeditions team members trained to take accurate data on the species observed. For each detection event the observers recorded the time, distance along the transect, species, number of individuals, the perpendicular distance from the trail, group width, cue (how first detected), demography, visibility and weather conditions (see figure 2.3a). Where possible the perpendicular distance was measured using a Leica rangefinder.

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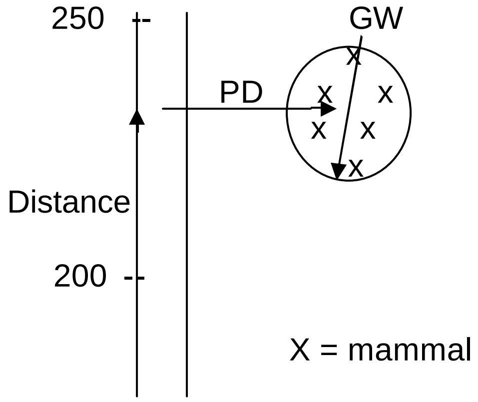

Figure 2.3a. Schematic diagram of data recorded, where GW is group width, PD is perpendicular distance.

Data from all the transects were combined to produce figure 2.3b, which shows at what distance from the centre of the transects the highest frequency of mammals were encountered. One of the basic underlying assumptions for accurate estimation of sighting probability is that all mammals are encountered on the transect. As can be seen from the graph, this assumption was upheld as the majority of sightings were encountered on or close to the transect.

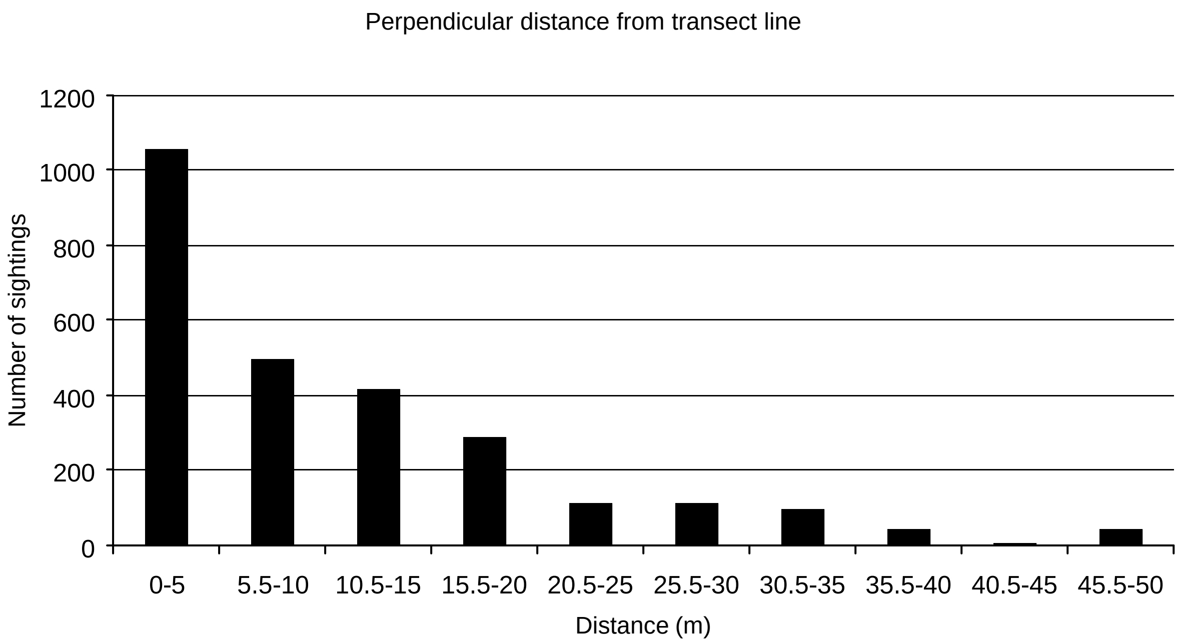

Figure 2.3b. Frequency distribution of perpendicular distance, combined from three years.

Mammal densities can be calculated from line transect methodology (Bodmer et al. 1997), but require a large number of observations for meaningful analysis. Twenty observations per species is the minimum recommended for density analysis, the ideal is 40. In this study the minimum number of observations per year over the three year period was only achieved for two species, the saddle-back tamarin and the southern Amazon red squirrel. Relative estimates of animal abundance were therefore used to compare the different populations over the three years (groups per 10 km, animals per 10 km). Data were analysed using the Kruscal-Wallis test, which is a simple nonparametric test that compares the medians of the species counts over the three years. Percentage changes in population abundance were also calculated.

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2.4. Results

Over the three year period a total of 359.8 km of transects were surveyed.

Table 2.4a. Sampling effort.

	2003	2004	2005	**Total**
Total km	157	96.4	106	**359.8**
Average speed (km/h)	1.16	1.18	1.28	**1.21**
Months surveyed	June-September	April-August	April-beginning July	

Data were collected for 16 mammal species and four species of bird during each of the survey periods over the three years and is summarized below.

Table 2.4b. Summary of results over three years, 2003-2005.

Species	Total individuals			Individuals per 10 km			Total groups			Groups per 10km		
	2003	2004	2005	2003	2004	2005	2003	2004	2005	2003	2004	2005
BA	15	15	11	0.76	1.55	1.04	12	14	10	0.94	1.45	0.94
BCM	125	47	116	7.95	4.87	10.92	21	12	33	1.65	1.24	3.11
BTPG	16	10	2	1.02	1.04	0.19	10	8	2	0.78	0.83	0.19
CP	14	20	8	0.89	2.07	0.75	4	8	3	0.31	0.83	0.28
CSQM	120	62	107	7.63	6.42	10.07	3	7	6	0.24	0.73	0.56
DTT	17	8	6	1.08	0.83	0.56	5	4	3	0.39	0.41	0.28
GBD	3	2	4	0.19	0.21	0.38	3	2	4	0.24	0.21	0.38
GSQ	12	11	4	0.76	1.14	0.38	7	9	4	0.55	0.93	0.38
MSM	36	10	22	2.29	1.04	2.07	9	3	8	0.71	0.31	0.75
PWT	42	23	8	2.67	2.38	0.75	8	9	2	0.63	0.93	0.19
RBC	2	2	4	0.13	0.21	0.38	2	1	3	0.16	0.10	0.28
RBD	12	13	4	0.76	1.35	0.38	11	12	4	0.86	1.24	0.38
RHM	44	43	14	2.8	4.46	1.32	13	10	6	1.02	1.04	0.56
SARSQ	55	48	56	3.5	4.97	5.27	37	44	41	2.9	4.56	3.86
SBT	207	225	215	13.2	23.32	20.24	33	40	36	2.59	4.15	3.39
SG	62	72	56	3.94	7.46	5.27	35	41	31	2.75	4.25	2.92
SM	27	59	51	1.72	6.11	4.80	6	16	13	0.47	1.66	1.22
WFC	39	33	47	2.48	3.42	4.42	6	4	8	0.47	0.41	0.75
WLP	136	172	148	8.65	17.82	13.93	8	9	4	0.63	0.93	0.38

Key: BA brown agouti (*Dasyprocta variegata*), BCM brown capuchin monkey (*Cebus apella*), BTPG blue-throated piping guan (*Pipile cumanensis*), CP collared peccary (*Tayassu tajacu*), CSQM common squirrel monkey (*Saimiri sciureus boliviensis*), DTT dusky ti-ti (*Callicebus moloch brunneus*), GBD grey brocket deer (*Mazama gouazoubira*), GSQ grey squirrel (*Sciurus spp*.), MSM monk saki monkey (*Pithecia monachus*), PWT pale-winged trumpeter (*Psophia leucoptera*), RBC razor-billed curassow (*Mitu tuberosa*), RBD red brocket deer (*Mazama americana*), RHM red Howler monkey (*Alouatta seniculus*), SARSQ southern Amazon red squirrel (*Sciurus spadiceus*), SBT saddleback tamarin (*Saguinus fuscicollis*), SG spix Guan (*Penelope jacquacu*), SM spider monkey (*Ateles belzebuth chamek*), WFC white-fronted capuchin (*Cebus albifrons*), WLP white-lipped peccary (*Tayassu pecari*).

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Abundance data were plotted into bar graphs, which more readily show the changes in populations over time (figures 2.4a - s).

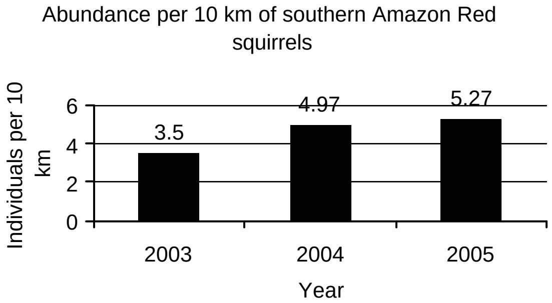


Figure 2.4a

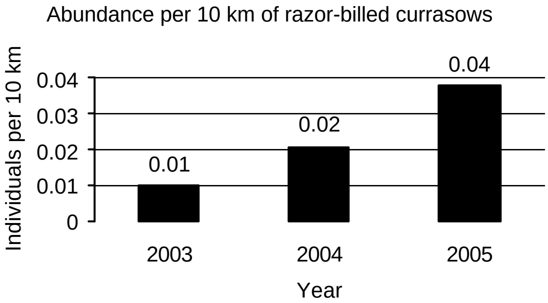


Figure 2.4b

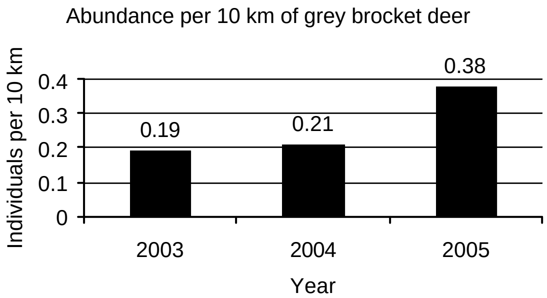


Figure 2.4c

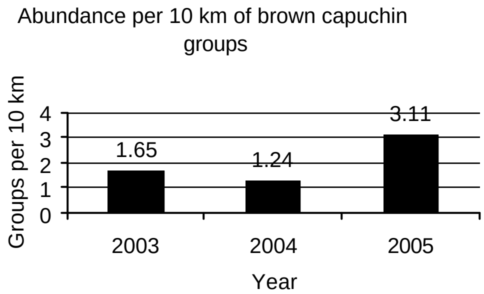
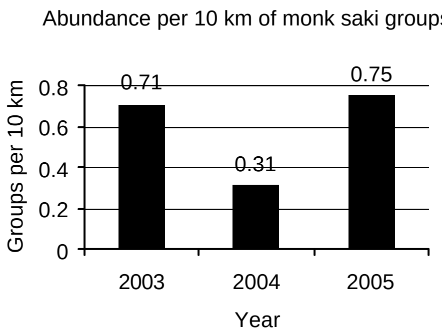


Figure 2.4d



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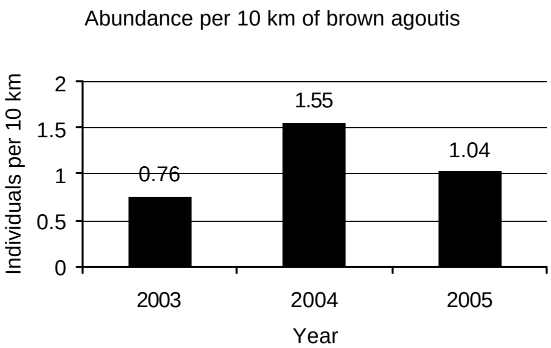

Figure 2.4f

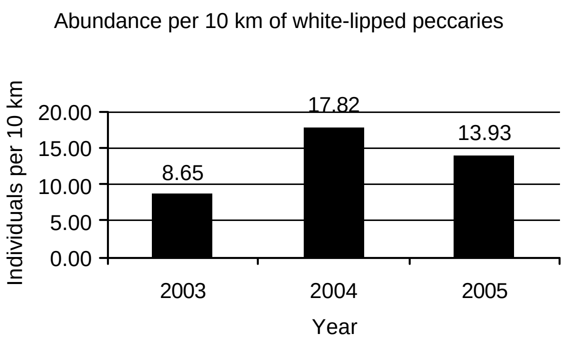

Figure 2.4g

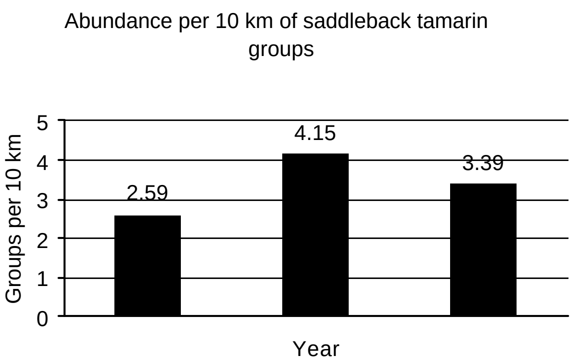

Figure 2.4h

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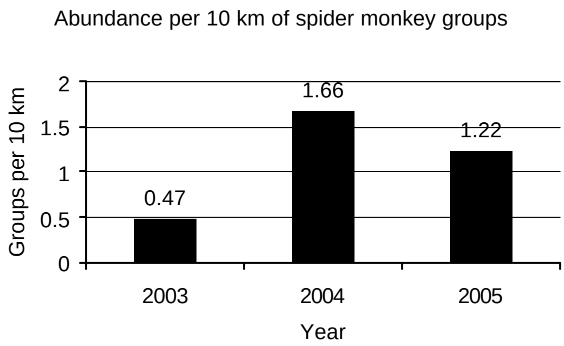

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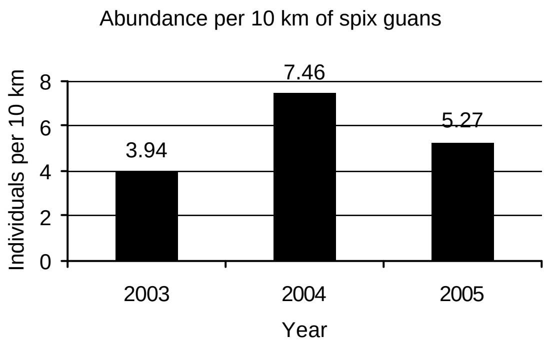

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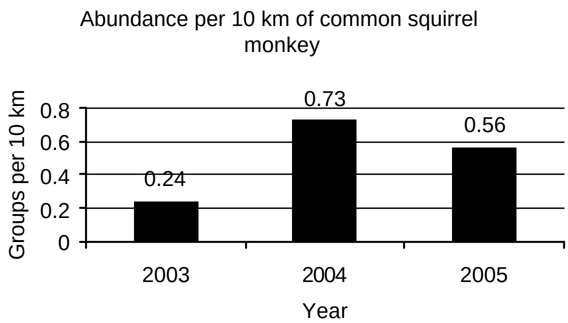

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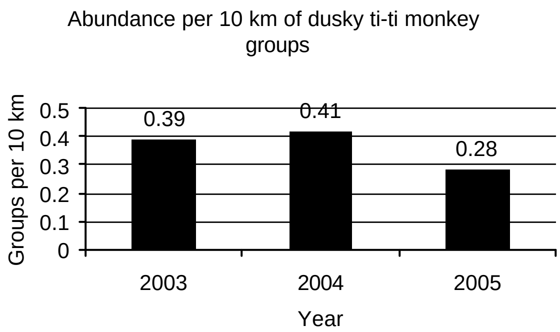

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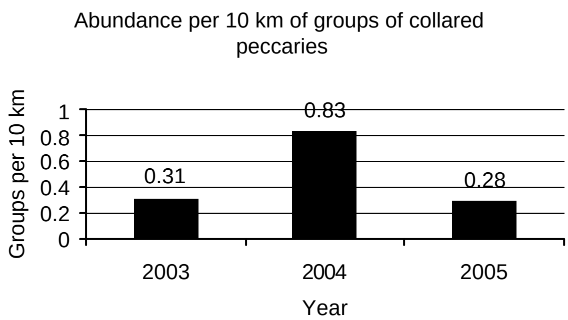

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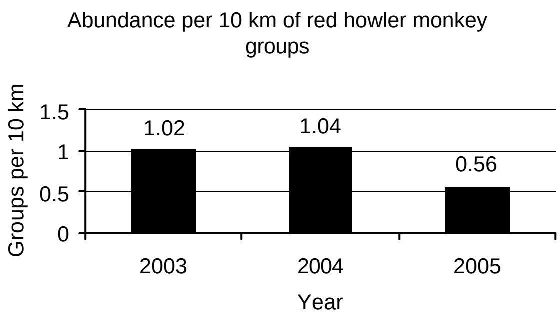
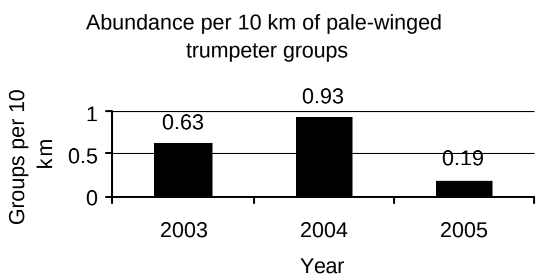


Figure 2.4n



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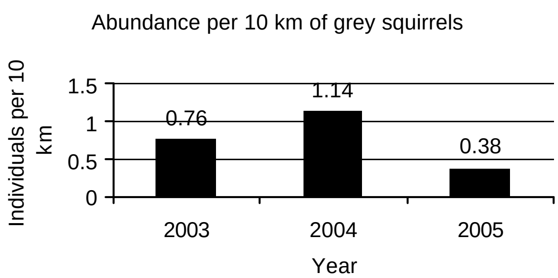

Figure 2.4p

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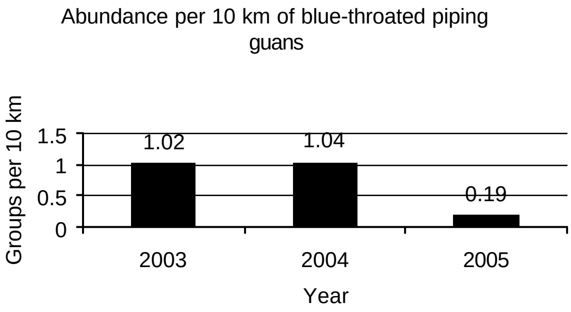

Figure 2.4q

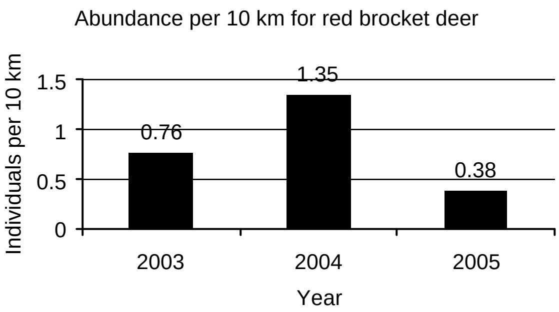

Figure 2.4r

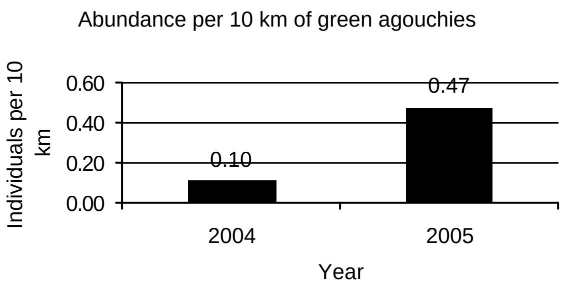

Figure 2.4s

The changes in abundance can be divided into four groups. Firstly those that show increases in abundance in each of the three years. Species in this group include southern Amazonian red squirrels, razor billed curassows and grey brocket deer. Those that show an overall increase in abundance over the three years, but with a decrease between years 1 and 2. Species in this group include brown capuchin monkeys, white-fronted capuchin monkeys and monk saki monkeys. Those that show an overall increase in abundance, but with a decrease between years 2 and 3. Species in this group include brown agoutis, saddle-back tamarins, spider monkeys, common squirrel monkeys, white-lipped peccaries and spix guans. Those that show an increase in abundance the second year and a decrease in the third. Species in this group include collared peccaries, red howler monkeys, dusky ti-ti monkeys, blue-throated piping guans, pale-winged trumpeters, red brocket deer and grey squirrel species. From the baseline data collected in 2003 no species showed a decrease in abundance in both 2004 and 2005. Green agouchies were only recorded from 2004 and have shown an increase in abundance to 2005.

When the data for each species were compared over the years for significant differences using a statistical test known as the Kruscal Wallis test, only two species showed differences. They were the saddleback tamarin and the spider monkey.

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Table 2.4c. Kruscal Wallis results, where species with a test result of less than 0.05 (highlighted in red) are statistically significant.

Species	Test results
Brown agouti	0.40
Brown capuchin monkey	0.08
Blue throated piping guan	0.08
Collared peccary	0.16
Common squirrel monkey	0.62
Dusky ti-ti monkey	0.83
Green agouchy	0.28
Grey brocket deer	0.59
Grey squirrel	0.42
Monk saki monkey	0.34
Pale winged trumpeter	0.17
Razor billed currasow	0.52
Red brocket deer	0.24
Red howler monkey	0.48
Southern amazon red squirrel	0.19
Saddle back tamarin	0.03
Spix guan	0.27
Spider monkey	0.01
White-fronted capuchin	0.86
White-lipped peccary	0.74

The percentage change in abundance was calculated based on the difference in abundance between 2003 and 2005 and the results are shown in table 2.4d. Of the bushmeat species, eight species have experienced a population increase since the cessation of hunting and five species appear to have experienced a decrease.

Table 2.4d. Percentage change in species abundance between 2003 and 2005. Highlighted in red are the preferred bushmeat species.

Species	Percentage Change
Brown agouti	36.84
Brown capuchin monkey	88.48
Blue throated piping guan	-81.30
Collared peccary	-9.67
Common squirrel monkey	133.33
Dusky ti-ti monkey	-28.20
Green agouchy	N/A
Grey brocket deer	100.00
Grey squirrel	-50.00
Monk saki monkey	5.63
Pale winged trumpeter	-69.84
Razor billed currasow	192.31
Red brocket deer	-50.00
Red howler monkey	-45.10
Southern amazon red squirrel	50.57
Saddle back tamarin	30.89
Spix guan	33.76
Spider monkey	159.57
White-fronted capuchin	59.57
White-lipped peccary	61.04

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Changes in relative abundance

Spider monkeys are a preferred bushmeat species. Since 2003 there has been a 160% increase in the relative abundance of this species at the study site. This suggests that spider monkeys were heavily affected by hunting activities and since the cessation of logging populations are beginning to recover. Since abundance is still increasing it would appear that numbers of spider monkeys have not reached saturation point.

Red howler monkeys, another bushmeat species, have shown a 45% decline in abundance since 2003. Abundance levels were very similar in 2003 and 2004, but showed a marked reduction in 2005.

Monk saki monkeys have shown a small increase in abundance over the study period. Their size makes them a possible bushmeat species, but their shy nature makes them difficult to find and so they may not have been affected by hunting activities.

Brown capuchins are a bushmeat species. Their abundance has increased by 88% over the study period.

White fronted capuchins are another bushmeat species and the abundance of this species has increased by 60%.

Dusky ti-ti monkeys are not usually a bushmeat species, especially in areas where other game is abundant, as they are small in size. Their abundance was similar in 2003 and 2004 but declined by 28%, in 2005.

Common squirrel monkeys are too small to be considered a bushmeat species. Abundance of this species has increased by 133%.

Saddleback tamarins are also too small to be bushmeat species. The abundance of this primate has also increased, by 31%.

White-lipped peccaries are a preferred bushmeat species. Abundance has increased by 61% over the study period. The abundance of white-lipped peccaries is however hard to calculate accurately as they tend to travel in large herds through dense undergrowth in the forest making counts difficult. Data were always collected based on actual numbers counted rather than estimations of herd size and so actual abundance is likely to be higher than reported here.

Collared peccaries, a preferred bushmeat species, showed an increase in abundance in 2004 and then a decrease in 2005. Overall abundance declined by 10%.

Grey brocket deer have shown a 100% increase in abundance since 2003. Along with red brocket deer they are a preferred bushmeat species. Red brocket deer abundance, however, has seen a 50% decline over the period of the study.

Brown agoutis are a bushmeat species and their abundance has increased by 37%.

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The largest species of game bird, the razor-billed curassow has shown the largest increase in abundance of all bushmeat species. Its abundance has increased by 198% over the study period. Despite this increase its relative abundance is still quite low at only 0.04 individuals per 10 km.

There maybe various explanations for the decline in abundance seen in some bushmeat species. The most likely reasons are due to failure in experimental design and the collection of data rather than an actual decline in abundance. It is highly unlikely that there has really been a decline in abundance since no gun shots have been heard from inside the protected area or cartridges found on the trails since 2002. In 2005 data were only collected until the beginning of July. In 2003 and 2004 data were collected until the end of September. August and September are the driest months in the forest when many trees loose their leaves due to water stress, making often immobile monkeys such as howlers easier to spot. In 2005 the average speed that the transect was walked was much higher than in previous years (1.28 km/h). It is possible, therefore, that animals were missed as a result. Further years of data collection will reveal a clearer trend for these species.

2.5. Discussion

Previous studies carried out in conjunction with Biosphere Expeditions have shown that hunting has not depleted species richness in the area, but may have affected abundance (Hammer and Tatum-Hume 2003, Tatum-Hume et al. 2003). From the data collected the majority of bushmeat and remaining mammal species show a clear increase in abundance since the cessation of logging activities, suggesting that although hunting at the site had a large impact on mammal populations, recovery was still possible.

Many studies have demonstrated that hunting has a negative impact on mammal populations and in some case can cause extinction (Bodmer et al. 1997). This was not the case at the study site for a number of possible reasons. Primarily, during the time of logging and until today the site is surrounded by relatively undisturbed forest, which may have acted as a source for the dispersal of mammals into the study site. Such source-sink dispersal has been widely accredited for rebuilding mammal populations in areas of hunting (Novaro et al. 2000). Secondly, the nature of the hunting activity at the study site was not of such a level as to cause local extinctions, as hunting only occurred over a relatively short period of time.

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Future of logging and wildlife in Las Piedras

Changes in Peruvian law have brought about the introduction of woodcutting concessions to the middle reaches of the Las Piedras river. Around 30 concessions of between 5,000 and 8,000 hectares were auctioned off to woodcutting companies in the year 2000. At the time of writing extraction has not yet begun in many concessions, as the most valuable species of wood have already been removed and loggers are taking advantage of relaxed enforcement of laws to cut mahogany illegally from further upriver inside the Alto Purus National Park (see Fig. 2.5a). However, in the next few years as accessible mahogany stands become few and far between, woodcutters will begin working inside their concessions. The impacts that this change from short-term selective logging to long-term clear-cut logging will have on the flora and fauna of the region are manifold. If wildlife management strategies are not implemented, mammal populations will be severely impacted as the forest becomes fragmented by logging activities and potential source areas for dispersal of mammals will be over-hunted causing local extinctions.

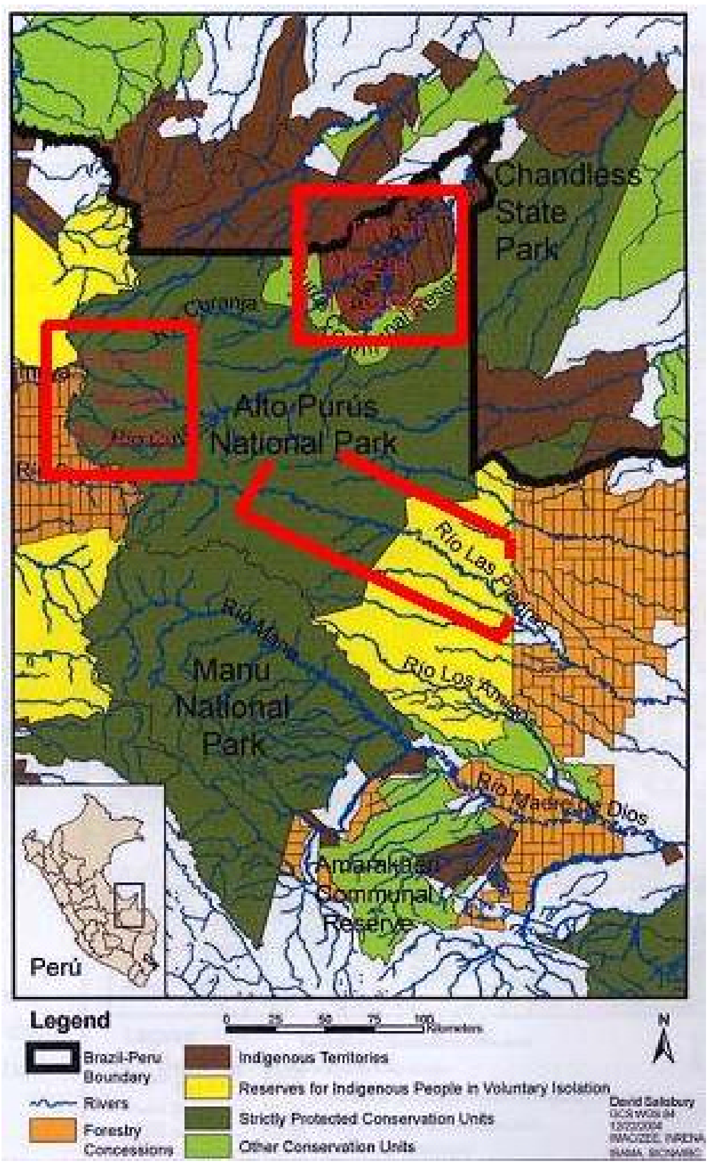

Fig. 2.5a. Areas of illegal logging (red boxes) in and around the study site.

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Wildlife management could bring benefits not only to the conservation of species, but also to concessionaries as it would enable annual harvests of bushmeat rather than a situation of overexploitation and extinction. Also, if concessionaries were able to demonstrate that the wood they are selling is derived from a sustainable source, it would open up additional sections of the international market and increase the value of wood extracted.

This study suggests that subsistence hunting can be sustainable if impacts are low and the area hunted is surrounded by a source of undisturbed forest. In this case purely by luck, rather than as a result of a wildlife management plan that this occurred. The only way to assure viable populations of mammals for conservation of species and bushmeat consumption is through continued monitoring programmes at control sites such as in this study and with the cooperation of wood cutters inside concessions. Only by working with wood cutters can any positive outcome be achieved. Results from surveys such as the present one can then be used to implement realistic hunting quotas that assure the long term future of game species.

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3. Dry season observations on parrots and macaws from clay licks on the Las Piedras river, southeastern Peru

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3.1. Introduction

The family Psittacidae is the most endangered large avian family in the world due to habitat loss, hunting and the pet trade, making its study a conservation priority (Bennett and Owens 1997, Collar 1997). New World parrot diversity is highest in the western Amazon basin where communities commonly include more than 15 species (Roth 1984, Killeen and Schulenberg 1998, Montambault 2002). This diversity peaks in southeastern Peru with various sites reporting 18 to 20 species (Terborgh et al. 1984, Valdez 1995, Walker 2003), including the near threatened *Nannopsittaca dachilleae* Amazonian parrotlet and the endangered *Primolius couloni* blue-headed macaw (Birdlife International 2005a, b).

Geophagy, the intentional consumption of soil, is widespread and well documented for mammals, but avian geophagy has only recently become the subject of serious scientific investigation (Brightsmith 2004a, Diamond et al 1999, Gilardi et al 1999, Hammer 2001). Published studies from Peru on parrot behaviour and ecology at clay licks are based on only three geophagy sites, two along the Tambopata river (Brightsmith 2004b, Brightsmith and Aramburu 2004) and one from the Manu river (Gilardi 1999, Munn 1994, Burger and Gochfeld 2003). The soils from these "clay licks" provide an important source of sodium (Brightsmith and Aramburu 2004) and protection against dietary toxins (Gilardi et al. 1999). These soils may permit geophagous species to exploit a wider range of plant resources and allow the high diversity and density of parrots found in the western Amazon basin (Diamond et al. 1999). No studies have been done on the importance of clay licks for the surrounding parrot populations or whether clay licks affect parrot distribution or densities, although it has been shown that salt licks in southern Africa play an important role in wildlife distribution and behaviour (Knight et al. 1988).

Brightsmith (2004a) has shown that the number of parrots feeding on one clay lick in southeastern Peru varies dramatically depending on the time of year, with a general peak in activity occurring from August to January and a low period from February to July. Anecdotal evidence suggests that this pattern repeats itself at other clay licks in southeastern Peru (Lee, peronal observation) These changes do not coincide well with wet and dry seasons and cannot be well explained by species feeding predominantly on unripe fruit, but parallel the abundance of birds in the forest recorded during afternoon censuses, so low lick use season may be due to parrots "migrating" away from the area (Brightsmith 2004b). The reason they leave is unknown, but may be due to low food availability as recorded in nearby Manu National Park (Terborgh 1983). Seasonal variation in macaw numbers suggesting seasonal movements has also been recorded along the Manu river (Renton 2002).

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Bjork (2004) recorded radio collared mealy parrots *Amazona farinosa* from the Tikal area in Guatemala travelling large distances from areas occupied during the breeding season. He concludes that the migration is to a large extent driven by fluctuations in fruit availability. In montane forest habitats, birds migrate altitudinally as they track seasonal fruit availability along an elevational gradient, for example the resplendent quetzal *Pharomachrus mocinno* (Powell and Bjork 1995) and great green macaw *Ara ambigua* (Powell et al. 1999). The fact that parrots will travel to find food sources highlights the importance of gaining an idea of food resources in a study area.

It is now generally recognised that conservation of biodiversity in tropical montane ecosystems requires the protection of a suite of habitats along the elevational gradient (Bjork 2004). The lack of data and understanding of ecological processes in neotropical lowlands has limited conservation planners' ability to delineate habitat heterogeneity and functional ecological linkages for long-term protection of biodiversity (Bjork 2004). What role clay licks play in determining a part of this heterogeneity is not known.

With little data on parrot movements at a local or large scale in Peru, it is not possible to say whether parrot migrations result in the observed annual patterns in the number of individuals at the clay lick, or whether the clay licks are having a drawing affect on local populations of parrots and macaws with seasonally greater requirements for the benefits resulting from geophagy as recent crop sampling of red-and-green macaws *Ara chloroptera* and scarlet macaws *Ara macao* has shown that young chicks are being fed large amounts of clay (Brightsmith, unpublished data). A more likely scenario is that birds leave the area during the dry season, associated with low fruit availability, and return at the start of the wet season to make use of increasing fruit resources and to start defending nesting sites (Brightsmith 2003).

Many parrot species congregate in large numbers around clay licks (Brightsmith 2004a), where they are vulnerable to hunters and other human disturbance (Burger and Gochfeld 2003). Clay licks are an important tourism resource that when managed correctly can help generate income for local people and help increase the value of wildlife conservation to local people (Munn 1992, Munn 1998). If birds stop visiting clay licks, this will have severe consequences for this industry and highlights the need for proper conservation practices and for studies into sources of disturbance to clay lick activity.

As most clay licks regularly visited by tourists are along river edges they are subject to various sources of disturbance including tourist, mining, farming activity and passing boat traffic. The impacts of boat traffic for shoreline birds are well documented (Vermeer 1973, Galicia and Baldassarre 1997, Burger 1998, Bright et al. 2004). In general, mobile birds move away from areas of high boat activity, whereas nesting birds show behavioural, growth, or reproductive effects (Rodgers and Smith 1995), with varying degrees of habituation (Burger 1998). The impacts of boat traffic on the feeding activity of macaws and parrots has been recorded to be severely disturbed by the canoes of native Indian people passing in the vicinity of a clay lick in Manu (Burger and Gochfeld 2003). A study by Clegg (2004) into the impact of tourism on the number of birds in the vicinity of a clay lick in the Tambopata recorded a decreased number of larger Psittacidae with increased motorised boat traffic, although dusky-headed parakeets *Aratinga weddellii* were not significantly affected by boat traffic. Previous studies by Biosphere Expedition along the Las Piedras river have shown that birds regularly flush

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in response to approaching boats (Hammer and Tatum-Hume 2003, Tatum-Hume et al. 2003). Tatum-Hume (in preparation) has shown that large macaw feeding activity decreases with increasing boat traffic over periods when visitation rates for macaws is higher (from July to February).

Understanding the impact of boat traffic on clay lick activity along the rivers of southeastern Peru is vital to implementing management plans to avoid repercussions on feeding activity and to ensure that the spectacle of hundreds of macaws, parrots and parakeets that tourists come to see remains viable into the future.

3.2. Methods

The research was carried out as part of a Biosphere Expeditions study at the Las Piedras Biodiversity Station (S 12°05.663' W 69°52.852'), in the Tambopata Region of the Madre de Dios Department, Peru from 31 May to 7 July 2005. The lodge is associated with a conservation concession of 5000 ha, between the Manu National Park, the Alto Purus Reserve and the Tambopata National Reserve. The river is sparsely populated by native Indians, more recent settlers and seasonal families of Brazil nut collectors, all of whom engage in subsistence hunting (Tatum-Hume et al. 2003). Extraction of *Swietenia macrophylla* mahogany has been taking place for over five years, with increasing intensity over the last few years as mahogany sources from other parts of the Amazon dry up (Schulte-Herbruggen 2004). Despite increasing human activity on the river, the study site has more species of primates and much higher abundances of other neotropical mammals compared to comparable sites on the Tambopata River (Hammer and Tatum-Hume 2003). However, the impact of the increasing boat traffic to parrot and macaw activity at clay licks is of increasing concern, and regular dry season monitoring of the clay lick has been conducted over the past two years (Tatum-Hume et al. 2003).

3.2.1. Clay lick monitoring

In previous years the aim of the macaw clay lick studies was to determine patterns of use and to identify sources of disturbance to feeding. As the purpose of this Biosphere Expedition project was to gain an idea of parrot and macaw numbers and match colpa activity with census activities carried out in the surrounding forests, all known macaw clay licks in the concession were monitored. Three were identified, two from previous years of observation and one new area where no large macaw activity has been recorded before (Tatum-Hume, personal communication). The clay licks monitored during this study are described below:

Clay lick 1 is the principal clay lick that has been monitored in previous studies. The riverbank where feeding takes place is approximately 10 m high and 25 m wide on the left hand side of the river as one proceeds upstream. The GPS coordinates for this lick are S12° 02'19.7" W069° 32'00.0". The lick is 2 km from the research station, and 1.6 km in a straight line from clay lick 2. The observation blind was positioned 138 m away in a *Gynerium* reed bed at the location used in previous studies. Monitoring was conducted at this clay lick whenever a boat was available to carry observers. Observers would be dropped off a 10 minute walk downstream from the clay lick to try and minimise disturbance to clay lick activity, although the drop off point would have been visible to birds perched in trees above the clay lick.

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Clay lick 2 is a new clay lick close to the port of embarkation to the lodge, where no macaws were observed in previous studies or by casual observation in previous years, although anecdotal evidence exists that early morning parrot feeding may have occurred here. The riverbank where feeding takes place is approximately 15 m high and 20 m wide on the left hand side of the river as one proceeds upstream. The GPS coordinates for this lick are S12°03'04.4" W069°31'45.4". The lick is 0.5 km from the research station. The observation blind was positioned 108 m away on the opposite river bank, but at least 20 m from the river's edge beyond the reed bank. Based on reports of macaws feeding at this new location, an initial three days of monitoring were carried out as to the feasibility of placing a permanent monitoring station. During these initial days of observation, no feeding activity was seen, although some parrots were observed in the vicinity and macaws were often seen in the trees above the clay lick. It was felt that boat activity taking observers to clay lick 1 was disturbing any potential activity. As a result, it was decided that no permanent monitoring would be done. Macaw feeding was subsequently seen by the boat drivers and monitoring was initiated, lasting from 14 June to 7 July.

Clay lick 3 is a small clay lick that has been observed, but not monitored in previous studies. Macaws have been seen feeding at this clay lick in previous years by boat drivers, but no large macaws perched in the area of the clay lick or showed any interest in it during this observation period. The riverbank where feeding takes place is approximately 10 m high and 4 m wide on the left hand side of the river as one proceeds upstream, close to a waterfall. The GPS coordinates for this lick are S12°04'06.1" W069°31'04.6". The lick is 2 km from the research station, and 2.4 km from clay lick 2. Initially the observation blind was positioned on a beach with what was thought to be a clear view of the area of activity. By 8 July after several feeding sessions had passed, it was noted that many birds seemed to be disappearing behind overhanging vegetation. An effort to clear this vegetation led to the realisation that the area where birds were feeding could be viewed from further down river without interfering with vegetation, and the position of the blind was moved there. The final position of the observation point from the clay lick was 132 m. As a result it is possible that the number of parrot-minutes presented for this clay lick is an underestimation of the feeding activity, which can potentially take place here. The initial two weeks of observations carried out here recorded feeding on several occasions, but on 17 June a roadside hawk was observed building a nest 30 m downstream from the clay lick. Subsequent to the increased hawk activity close to the clay lick, feeding by the principal species using this lick, dusky-headed parakeets and blue-headed parrots, ceased. Subsequently for the last two weeks of the study observations were carried out on alternate days only.

3.2.2. Parrot and macaw feeding at the clay lick

Observers arrived at observation points on the opposite side of the river from the clay licks at daybreak, before birds started to arrive to the surrounding area. Between one and three observers were allocated at each of the clay licks under observation in a dark mosquito net. At clay licks 1 and 2, where large macaws were known to feed, observations ended between 11:00 and 14:00. Although a small amount of macaw feeding occurs after this time, it was not considered necessary to continue monitoring into the late afternoon as observers were needed to conduct census work in the afternoon. An early morning shift monitored the clay licks from 05:30 till 08:30, and a

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second shift of observers then took over to record activity for the rest of the day. At clay lick 3 where no macaws were observed, observations ended at 08:00 or when bird feeding activity at the clay lick ceased after this time. The date, start and end times of observations and the observers involved were recorded in all cases. The following specific information was collected:

1. The first psittacine to be seen or heard in the vicinity of the clay lick was recorded, together with the time. The time that any psittacine was first seen or heard in the vicinity of the clay lick was also recorded, even if it was thought that the species in question would not be feeding on the clay lick.

2. The species and time that birds were observed descending towards the clay lick was recorded as a "fly by". A "fly by" is defined as the activity of birds as they begin to show an increased interest in the clay lick and begin to fly across the clay lick. In many cases birds slowly drifted down through the vegetation over the clay lick, and if no distinctive "fly by" was observed the time a species crossed down below half the height of the vegetation above the clay lick was recorded.

3. The first species to land on the clay lick was recorded, as well as the number of individuals to first land on the clay.

4. Total number of birds for each species on the clay lick was recorded at five minute intervals from when the first bird was recorded on the clay lick.

5. Weather was recorded at five minute intervals from when observers first arrived at the clay lick as "misty" or "foggy" if low lying cloud was observed; as "clear" if there was good visibility and no cloud; as "cloudy" if the weather was overcast or when no sun could be observed falling in the vicinity of the clay lick; and as "rain" if precipitation was recorded in the area of the clay lick.

6. If birds flew from the trees or the clay lick together in a large group, this was recorded as a flush. The percentage of birds leaving the clay lick or the trees was recorded as well as if an alarm call was heard before the flush. Any reason for the flush was noted if known (birds of prey, boats, vultures, mammal or people activity).

7. All boats passing the front of the clay lick were recorded. The following information was recorded for boat traffic: the time the boat passed in front of the clay lick; whether the boat was travelling upstream or downstream; whether the boat was carrying brazil nuts; how many rows of wood were being carried if the boat was pushing a raft of wood; if the boat was driven by a peke-peke motor or an outboard motor; how birds on the clay lick or in the trees above the clay lick reacted to the boat (no reaction or flushed).

3.2.3. Parrot and macaw behaviour activity in the vicinity of the clay lick

Bird behaviour was recorded at five minute intervals for mealy parrots at clay lick 3 before 08:00, and for red-and-green macaws at clay licks 1 and 2 after 20:00. Recording started once birds were in clear view and activity could be clearly noted. Attempts were made initially to follow individual birds, but this proved unfeasible in this study where observers were recording different data unrelated to bird behaviour and

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were thus not able continually to follow individual birds, especially due to the large amount of activity and movement associated with the early morning clay lick activity. As a result the activity recorded here are for random birds in the vicinity of the clay lick, within the field of view of the observers.

Activity was classified into the following categories:

1. Nothing or no observable behaviour (0). The bird was perched and not engaged in any of the activities listed below. Birds recorded in this category may have been engaged in activity not easily classified from a distance, e.g. sleeping without head under the wing, soft calling, watching for predators, or activities of a social nature not easily classified e.g. begging or submission.

2. Preening (PR). A bird was recorded as preening if it was using its beak to clean its own feathers.

3. Scratching (SC). Although this is recognised as a form of preening, scratching was differentiated from preening for activity where the bird used its claw to scratch its feathers, normally in the head or neck area.

4. Allopreening (ALLO). If a bird was preening another bird, it was recorded as allopreening if the bird it was preening was engaged in some other activity and not allopreening in return.

5. Being Allopreened (BA). Birds being preened by another bird or sometimes more than one other bird, but not involved in any other activity themselves, were recorded as being allopreened.

6. Mutual Allopreening (ALLOBA). If a bird was preening another bird and being allopreened itself by the bird it was preening, then these birds were classified as mutually allopreening.

7. Moving (MV). A bird was recorded as moving if it was travelling along a branch without the aid of its wings.

8. Flying (FLY). If a bird under observation took off from its perch, either to move to another branch or depart from the area of observation, it was recorded as flying.

9. Aggression (AG). If a bird approached another bird with head stretched and beak open, it was recorded as being aggressive.

10. Fighting (FT). If two birds were involved in an aggressive interaction where neither bird would give way, and the aggressive interaction escalated to a point where there was loud screaming and flapping of wings and potentially biting, then this was recorded as a fight.

11. Hanging upside down (HA). Especially in the case of the macaws, birds were often observed suspended from a branch as opposed to perched on it. The birds may have been involved in playful type activity, but to avoid anthropomorphising activity playing was not recorded.

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12. Branch biting (BB). Birds seen chewing on branches around them or biting the branch they were perched on were recorded as branch biting.

13. Calling (CALL). In the case of mealy parrots, certain loud calls were accompanied by a distinctive slight opening of the wings. Other distinctive calls were notable from an opening of the beak and movement of the tail. In the case of red-and-green macaw, if an observer could hear calling and observe a moving beak, tail and chest movements, then that bird was recorded as calling. Soft contact calls are not included in this category as it would not have been possible positively to determine if the bird was engaged in such activity from a distance.

14. Sleeping (S). In the case of red-and-green macaws who spent long periods of time in the vicinity of the clay lick, birds were recorded as sleeping if they had their heads tucked under their wings for a prolonged period of time and the observer was sure the bird was not preening.

Future studies should consider including other activities that better characterise friendly social interactions. Other activities that were seen but not recorded were stretching of the wings and defecation.

3.2.4. Arrivals and departures of parrots and macaws around the area of the clay lick

To gain an idea of the average group size and activity times for selected parrots and macaws using the clay licks, the following protocol was implemented:

At clay lick 3, the time of groups of mealy parrots and blue-headed parrots was recorded for groups that could clearly be seen approaching or departing a predefined “zone of activity”. The zone of activity was defined as the area most used by birds that would potentially use the clay lick, and was delineated by a leafless tree 100m downstream of the clay lick, and up to and including a large emergent upstream of the clay lick, beyond which groups could clearly be seen to arrive or depart. Birds flying within the zone of activity were ignored, even though this meant that all birds approaching the zone of activity from the forest behind the clay lick were ignored but observers were not able to tell the difference between these birds and birds already present in the zone of activity. Only groups of birds clearly seen flying over the river, or above the trees from the left or right of the zone of activity were recorded. It was not the priority of this exercise to record the same number of birds arriving and departing.

Group size for arriving and departing birds was recorded. A group was defined as a cluster of birds flying in the same direction, with individual birds within 10 m of another bird of the same species. In the case of blue-headed parrots this meant that group width could be over 100 m wide. Average group width was not recorded.

At clay licks 1 and 2 group sizes of red-and-green macaw were recorded along with time of arrival or departure within five minute periods of observation. The zone of activity at clay licks 1 or 2 was defined as the area visible from the blinds, which were situated in the vegetation and thus had a restricted field of view.

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3.2.5. Mealy parrot speed of flight

To gain an idea of how fast mealy parrots are able to fly, observations were carried out at clay lick 3. The distance from the observation point to two trees where birds were known to perch were recorded with a Bushnell rangefinder. The time birds took to fly from directly overhead the observation post to when the birds perched in these trees was then recorded using a stopwatch.

3.2.6. Parrot and macaw census

An aim of this study was to trial methodologies for the advantages and disadvantages of census techniques for afternoon counts of parrots and macaws in the rainforest environment. To do this, two commonly used methodologies were implemented - variable distance line transects (VDLTs) and variable circular plots (VCPs). VCPs were undertaken during certain VDLTs or in separate walks. Birds encountered during a VCP were not subsequently rerecorded during the VDLT and vice versa. In addition, monitoring was conducted from a tower and platform.

Variable Distance Line Transects (VDLT)

Transects were set up along paths cut for previous research projects for the purpose of monitoring mammalian wildlife. Four sections of previously established transect were chosen so that monitoring would fall within only one vegetation type. These were identified beforehand from a satellite image and from previous inspection of the area.

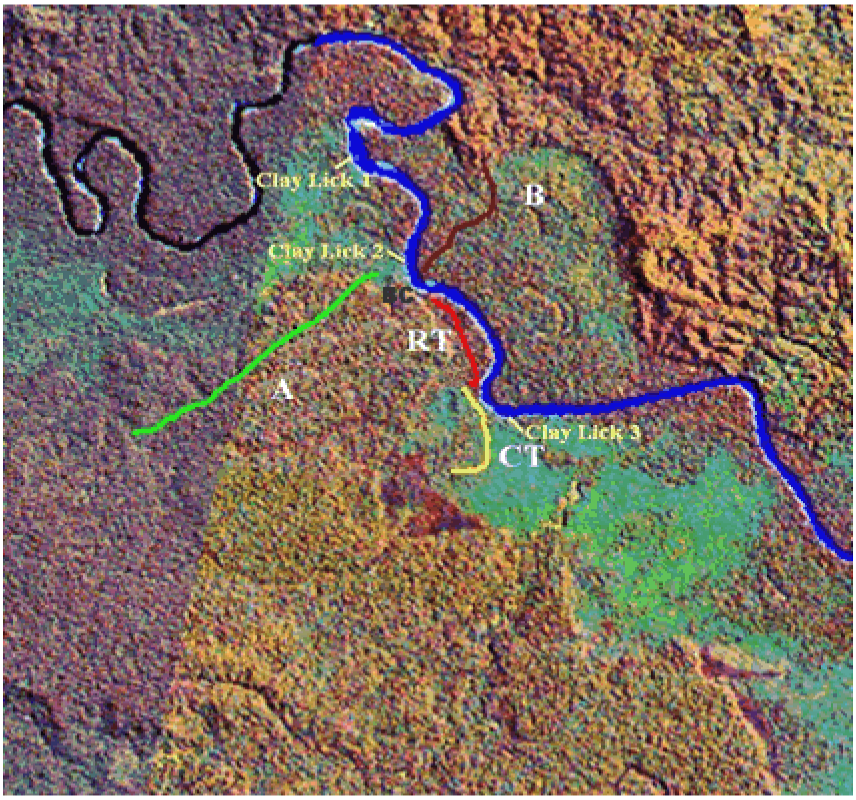

Figure 3.2a. A satellite image of the study area showing the location of the four transects (A, B, CT and RT) and the associated forest types. BC = Base Camp. The locations of the three clay licks are also indicated.

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The forest types and transects (as seen in the image above) were:

1. Terra firme high forest, characterised by sandy soils and forest with a low palm density. One transect of 4300 m (A) was placed in this forest type. However, initial walks showed that the total length of the terra firme transect could not be walked completely in the time available in the afternoon and it was subsequently divided into two transects of 2150 m each, A1 and A2.

2. Mature floodplain forest, characterised by soils of high clay content and forest with a high palm density. Two transects (B and RT, 1700 m and 1400 m respectively) were situated in this forest type, on either side of the river.

3. Seasonal swamp, characterised by soils with poor drainage and vegetation covered with abundant lianas. One transect of 2000 m (CT) was placed in this vegetation type.

Walks were conducted between 15:00 and 17:30 at a speed of around 1 km/h. This time period was chosen so that bird activity would not be affected by clay lick activity and also because observers were occupied with clay lick monitoring in the early morning. Previous studies (e.g. Gilardi and Munn 1998) have shown a rise in parrot activity at this time, although it does not compare with early morning activity. Since the aim of VDLT is to gain a snapshot of a period of time along a transect where distances are recorded to perched birds, it was speculated that this could be a good time for censuses to be carried out as birds are less likely to be flying (Marsden, personal communication), as flying birds cannot be used for calculating abundance (Buckland et al. 1993)

During a walk, the following information was recorded during an encounter:

1. Time and position along the transect.

2. Species.

3. Whether birds were heard only, seen only, heard then seen or seen then heard. Whether birds were flying or perched, or perched then flying or flying then perched.If birds were perched, the perpendicular distance from the transect to the centre of the group of birds was recorded. If birds could be heard to be perched, but could not be seen, then the perpendicular distance was still taken to the tree in which the birds were perched. If birds were thought to be perched, but at undeterminable distance away or at a distance greater than 50 m, then no distance was recorded.

4. Activity of perched birds if known.

5. Group size for birds seen.

6. Flight bearing for flying birds.

7. Surrounding understorey vegetation density was recorded as dense (visibility 0-10 m), medium (11-25 m) or light (25+ m).

8. Weather at the time of encounter was recorded as sunny or cloudy.
Variable Circular Plots (VCP)

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Survey points were placed at 500 m intervals along the existing transects. This distance was chosen to try and keep counts independent as mealy parrots and certain macaw species can be heard for distances greater than 250 m and with bends in the path in some cases a 500 m interval along a transect could mean only 400 m in a straight line. VCPs were conducted during the same time period as for VDLTs during the late afternoon. VCPs were undertaken for a period of 10 minutes.

During a count the following information was recorded:

1. Percentage cloud cover and strength of wind at the start of the count.

2. Time birds were detected.

3. Species.

4. Whether birds were heard only, seen only, heard then seen or seen then heard. Whether birds were flying or perched, or perched then flying or flying then perched. If birds were perched, the perpendicular distance from the centre of the survey point to the centre of the group of birds was recorded. If birds could be heard to be perched, but could not be seen, then the perpendicular distance was still taken to the tree in which the birds were perched. If birds were thought to be perched, but at undeterminable distance away or at a distance greater than 50 m, then no distance was recorded.

5. Activity of perched birds if known.

6. Group size for birds seen.

7. Flight bearing for flying birds.

3.2.7. Tower monitoring

Afternoon monitoring of psittacids was conducted from two locations: a wooden tower of 15 m height on the edge of a terra firme forest terrace overlooking mature floodplain forest; and a wooden platform built in a fig tree overlooking mature floodplain forest. Observations were carried out from the tower on most afternoons, while the platform was only used occasionally, initially due to safety concerns and later simply due to the amount of time needed to set up the climbing equipment to safely ascend the platform. In addition, the presence of large numbers of sweat bees around the platform meant that observations had to be carried out from mosquito netting that restricted observer effectiveness.

Data was collected for visual encounters only (birds that could be heard only were not recorded), as some of the observers undertaking observations did not have extensive bird identification experience.

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During observations, the following information was collected:

1. Time that a group of parrots or macaws were initially detected.

2. Species and group size.

3. If the birds were initially detected by call or if they were detected visually before any calling.

4. If the birds vocalized at any time during the observation.

5. Flight direction, using a compass for the general flight path.

6. Height of average flight above the canopy (0-10 m, 11-25 m or >25 m).

7. Distance at which birds were first detected.

8. If birds perched within view, then distance to the perched birds was recorded together with a description of what the birds were doing. Time of departure for departing birds was recorded.

9. A description of the weather was recorded for each encounter (sunny or cloudy).

3.2.8. Vegetation and fruit availability survey for different forest types

500 m of transect was sampled along the A, B, C and river transects. No trained neotropical biologists accompanied this survey, but the importance of fruiting trees and habitat types to frugivorous species is well documented throughout the literature. Therefore a novel technique to determine forest architecture and to create an index of fruit availability was developed for this study.

Due to previous experience with the difficulties of implementing quadrats within seasonal swamp, variable distance line transect methodology was used to calculate average number of selected species per area as this also allowed observers to work rapidly through an area. This is an important point for tropical forest phenological studies as fruiting tree composition can change over the course of a few weeks. In this study many parrots were recorded feeding during the first two weeks of the survey on the fruit of the Wasai palm *Euterpe* spp, many of which were observed fruiting. However, by the time vegetation monitoring began on 16 July almost no individuals of this palm species were recorded with fruit.

The following target trees and classes of trees were chosen:

1. All palm species over 5 m. Most genera of palm are easily distinguished, and were known to the observers undertaking this survey. The 5 m cut-off point was chosen as few of the target palms bear fruit under this height, with the exception of *Attelea* sp.

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2. All woody trees with a diameter at breast height (DBH) of over 50 cm. A note as to whether the trees had buttress roots over the DBH or not was recorded as this factor influences DBH (Chave 2002). The rationale for the selection of large trees only was to limit the time that would need to be taken to record all trees, and trees with a DBH over 50 cm are more important as a source of nesting sites (Brightsmith 2003) and birds such as mealy parrots tend to nest in trees with DBH greater than 65 cm (Bjork 2004). Large trees, regarded as trees with stems over 70 cm are keystone organisms in tropical jungles (Chave 2002).

3. All obvious fruiting trees. This includes all trees where fruit were easily visible to the observer from the path, regardless of DBH. During observations two observers would walk along the transect path, one to take notes and another to record measurements. All target trees for which the crown and part of the trunk could be seen were recorded. The following information was recorded:

1. Position along the transect from which the perpendicular distance from the transect to the target tree was recorded off a tape measure laid along the trail.

3. Tree type (buttress, non buttress, palm, fruiting).

4. Tree name if known.

5. Perpendicular distance from the transect (measured with a Bushnell rangefinder 450).

6. Tree height. In the case of palms this was recorded with the Bushnell rangefinder to the point where leaves emerged from the trunk, and in the case of large trees a reading was taken to the highest visible leaves, taking into account the height of the observer. DBH for non-palms.

7. Branching architecture for non-palms (branching above the total tree height, branching under half the total tree height, branching over the total tree height with scarring on the lower trunk).

8. Presence or absence of lianas.

9. Presence of fruit, flowers or both.

10. Fruiting capacity if applicable (the amount of potential fruit on the tree estimated to one of the following three categories: 0-33%, 34-66%, 67-100%).

11. Fruit ripeness if applicable (green, nearly ripe, ripe).

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3.2.9. Fallen potential food resources

For 500 m of each transect, 50 random 1x1 m quadrats were examined for the presence or absence of fruit or other potential sources of food for parrots and macaws, including leguminosae seed pods and the flowers of lianas where feeding had been observed. A count of all potential food items was also made. A final potential food index was created for each section of trail by multiplying different types of food by the number of items of that food type counted.

3.2.10. Canopy density

To obtain an idea of canopy density, a canopy-scope was used as described by Hale (2004). The canopy scope assesses the relative size of the largest canopy gap within the field of view, which has been found to correlate well with either canopy openness or canopy transmittance measured using hemispherical photography in a range of forest types (Brown et al. 2000). The canopy scope is a square made from perspex with 25 dots marked at 3 cm intervals in a 5x5 cm grid. For the purposes of this study a canopy scope was created from a clear plastic sheet. Eight to ten measurements are recommended for a 0.25 ha plot to represent the average canopy openness, and five recordings were taken for each 50 m stretch of transect in this study, for a total of 50 recording per trail. Canopy transmittance is calculated using the following equation:

Transmittance = 1.2 x (average no. of unobstructed dots) + 8.6

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3.3. Results

3.3.1. Clay lick monitoring

Sample Effort

Table 3.3.1a. Sample effort for hours of observations at the three different clay licks monitored with a summary of parrot and macaw feeding activity.

Clay lick	Hours of observation	Days of observation	Days feeding occurred	Feeding days when only macaws fed	Total Parrot Minutes
1	146.1	25	21	6	9290
2	111.6	24	13	7	3595
3	50.7	23	9	0	235
Total	**308.4**	**72**	**43**		

With three clay licks being monitored, the total hours of observation (308.4) is greater than for the last Biosphere Expeditions study, even though the clay licks were not monitored until as late in the day. Most activity was recorded at clay lick 1 when feeding was observed on more days and more parrot minutes were accumulated. Clay lick 3 experienced the lowest activity levels. This is a function of macaw activity, which was observed at clay licks 1 and 2, but not at clay lick 3. Parrots preferred to feed on clay lick 1 compared to clay lick 2, and a higher rate of feeding might have been experienced at clay lick 3 since visits to this clay lick were regular up until the date the roadside hawks were observed building their nest next to the clay lick. However, as the other clay licks are in easy flying distance, the sum of the parrot minutes observed here for all three clay licks should be comparable to major clay licks for a similar time of year.

3.3.2. First arrivals

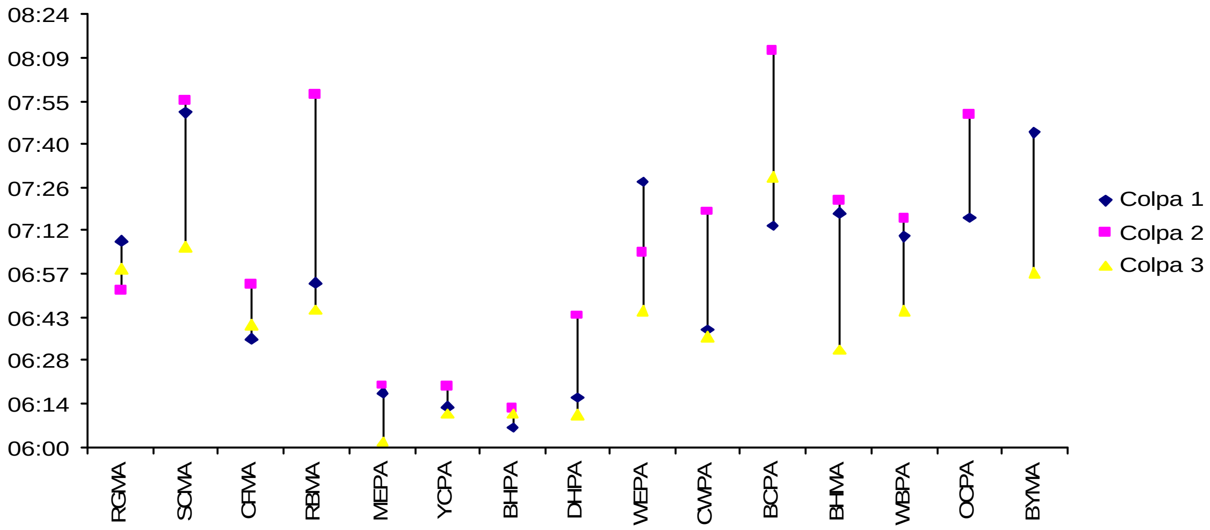

Figure 3.3.2a. Average time species were first recorded (seen or heard) in the vicinity of the three clay licks (colpas) under observation. Key: RGMA *Ara chloroptera*, SCMA *A. macao*, CFMA *A. severa*, RBMA *A. manilata*, MEPA *Amazona farinosa*, YCPA *A. ochrocephela*, BHPA *Pionus menstruus*, DHPA *Aratinga weddellii*, WEPA *A. leucopthalmus*, CWPA *Brotogeris cyanoptera*, BCPA *Pyrrhura rupicola*, BHMA *Propyrrhura couloni*, WBPA *Pionites leucogaster*, OCPA *Pionopsitta barrabandi*, BYMA *Ara ararauna*.

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With the exception of scarlet macaws, species that were not recorded feeding on the clay licks show a greater spread for their average arrival times between the clay licks, while species that fed most often (red-and-green macaws, mealy parrots, blue-headed parrots and yellow-crowned parrots) show a narrower spread for their average arrival times (see figure above). All the parrot and parakeet species that fed in the early morning arrived earlier than species that did not. Dusky-headed parakeets were recorded as arriving fairly late at colpa 2, a clay lick where they were only observed feeding once. Red-and-green macaws, which fed later in the morning, were first recorded around the clay licks on average at 07:00, compared to "early morning" feeders which were first recorded at 6:10 on average.

3.3.3. Feeding activity at clay licks

Table 3.3.3a. Summary of feeding activity by species seen feeding at the three clay licks in terms of parrot minutes and number of days feeding was observed.

Clay Lick	Total parrot minutes	Red-and-green macaw	Scarlet macaw	Chestnut-fronted macaw	Mealy parrot	Yellow-crown parrot	Blue-headed parrot	Orange-cheek parrot	Dusky-headed parakeet
1	9290	4280	65	10	115	690	3540	15	575
2	3595	2955	35	0	35	10	550	0	10
3	235	0	0	0	15	20	50	0	150
Total parrot minutes per species:		**7235**	**100**	**10**	**165**	**720**	**4140**	**15**	**735**
Number of days feeding was recorded:									
1		16	2	1	3	10	10	1	5
2		10	2	0	1	2	5	0	1
3		0	0	0	2	2	4	0	5
Total feeding days per species:		**26**	**4**	**1**	**6**	**14**	**19**	**1**	**11**

Of the 16 psittacid species observed in the vicinity of the clay licks for which arrival times were recorded, only eight species were observed feeding on the clay licks. Early morning activity was dominated by dusky-headed parakeets, blue-headed parrots, mealy parrots and yellow-crowned parrots, with chestnut-fronted macaws and orange-cheeked parakeets appearing on a few days only. Late morning activity was dominated by red-and-green macaw. For them most feeding was observed out of all the species. The Biosphere Expeditions study of 2003, whose observations were carried out from 17 June to 24 July, also recorded white-eyed parakeets and cobalt-winged parakeets feeding (Tatum-Hume et al. 2003). 17725 red-and-green macaw parrot minutes were recorded in that study – 76 parrot minutes per hour, compared to 7235 in this study – 28

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parrot minutes per hour (see below). These figures are affected by the amount of “dead” observation time i.e. when parrot activity does not occur e.g. late afternoons, but also highlight that to make comparisons between years, studies ideally should be done over the same month interval due to the ten fold increase in feeding activity from low season to high season.

Table 3.3.3b. Comparison of the boat traffic intensity and red-and-green macaw feeding activity for the different Biosphere Expeditions studies.

Year	Period of observation	Boats per Hour	Parrot minutes per hour for red-and-green macaw
2002	20 May – 16 June	1.50	24
2003	17 June – 24 July	0.44	76
2005	31 May – 7 June	0.77	28 (clay licks 1 and 2)

3.3.4. Daily feeding patterns

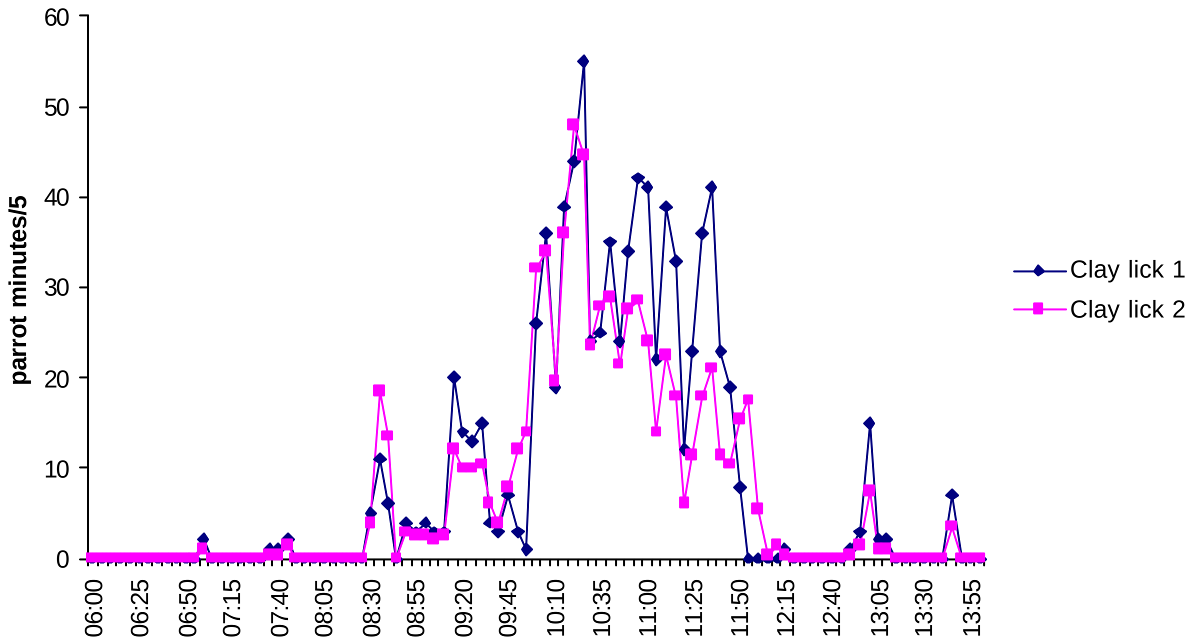

Figure 3.3.4a. Daily feeding patterns of red-and-green macaw at clay licks 1 and 2 showing cumulative parrot minute intervals of 5 minutes against time of day.

The daily feeding patterns of the parrots and macaws at the clay licks observed is similar to that seen in previous years, with most parrots feeding before 08:00 and macaws feeding after 09:00. There is no difference in the trend in feeding activity between clay licks 1 and 2. Although feeding recorded appears to stop at 12:00 in figure 3.3.4a above for red-and-green macaw, this is a function of the observation times which generally finished at 11:00 (unless feeding was taking place, in which case it was recorded for longer). Feeding undoubtedly takes place until the mid-afternoon as observed in previous years.

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The overall trend for parrot feeding was best seen at clay lick 1 as seen in figure 3.3.4b below. Insufficient parrot feeding took place at clay licks 2 and 3, although the general pattern of most species feeding early in the morning was reflected at both clay licks. Blue-headed parrots were most commonly seen, in line with expectations for this time of the year from observations by Brightsmith (2004a) which show June and July to be the start of the peak in feeding activity for this species.

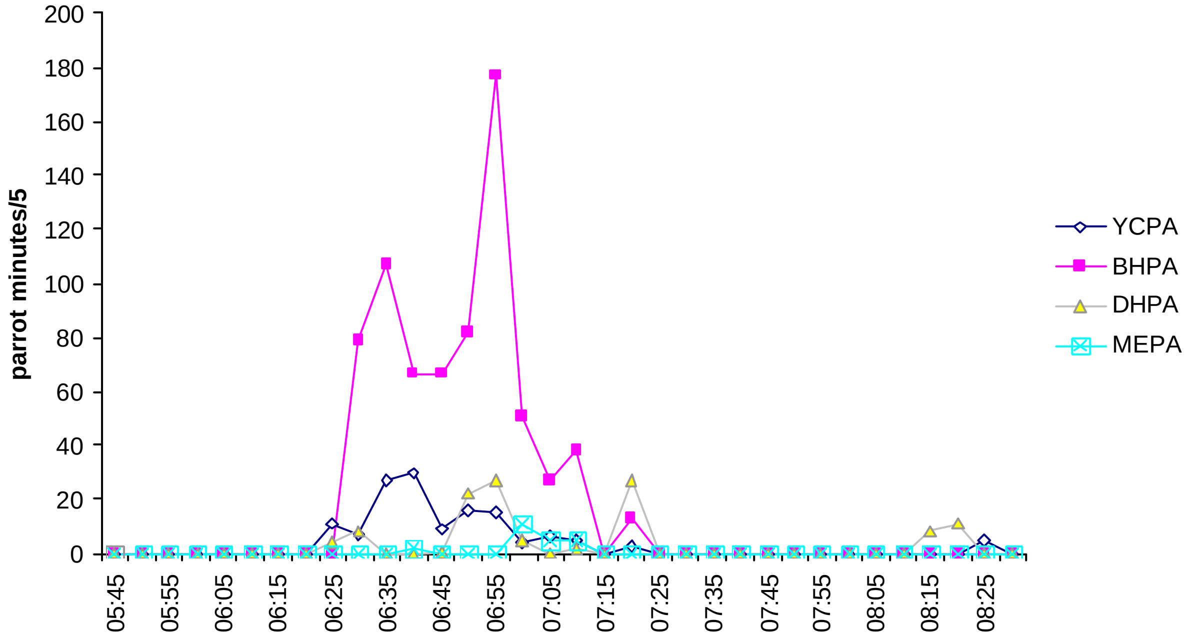

Figure 3.3.4b. Daily feeding patterns of the four main parrot species (MEPA *Amazona farinosa*, YCPA *A. ochrocephela*, BHPA *Pionus menstruus*, DHPA *Aratinga weddellii)* observed feeding in the early morning showing cumulative parrot minute intervals of 5 minutes against time of day at clay lick 1.

3.3.5. Flushes

Table 3.3.5a. Parrot and macaw flush information for the three riverside parrot clay licks along the Las Piedras river. The "Other" category for clay licks 2 and 3 includes: pied lapwings flying past; a large falling leaf; a mealy parrot flushing dusky-headed parakeets off the clay lick; a falling branch; macaws flying past; wood storks flying past; and crashing noises from the jungle.

	Flushes (large groups of birds taking flight at the same time)					Alarm call given before flush		Reasons for flush							
Clay Lick	Total	Flushes from clay lick		Flushes from trees		All flushes	For boats	Boat		Unknown		Vultures and raptors		Other	
1	159	46	29%	150	94%	48%	57%	28	18%	109	69%	6	4%	0	0%
2	169	16	9%	161	95%	34%	40%	45	27%	109	64%	6	4%	4	2%
3	78	11	14%	67	86%	53%	50%	16	21%	52	67%	7	9%	3	4%
Total:	**406**	**73**	**18%**	**378**	**93%**	**45%**	**49%**	**89**	**22%**	**270**	**67%**	**19**	**5%**	**7**	**2%**

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Most of the flushes (93%) involved groups of birds flying from the trees above the clay licks, while 7% were recorded from the face of the clay lick itself only. Most flushes from the clay licks were recorded at clay lick 1, where most of the parrot and macaw feeding took place. Alarm calls before the birds took off in flight were recorded for 45% of the flushes, while approaching boats only elicited a slightly greater number of alarm calls (49%). Boats flushed more birds at clay lick 2, where boat traffic per hour was highest. In the majority of cases (67%), observers were not able to identify a reason for a flush. Birds of prey and vultures combined only caused 5% of all observed flushes on average, but were the cause of more flushes at clay lick 3 (9%). No flushes were recorded to have been caused by rain, rockfalls, people or other mammal activity, although on one day of monitoring at clay lick 1, white-lipped peccaries *Tayassu pecari* could be heard feeding in the vicinity of the clay lick. No feeding was observed and few birds were seen in the area.

3.3.6. Boat activity

Table 3.3.6a. Boat traffic passing the three riverside clay licks during periods of clay lick monitoring. The downstream direction of travel is south towards Puerto Maldonado. A peke-peke is a 16 hp engine that is loud and cheap to run, compared with the outboard motors, which are at least 25 hp, but can be up to 75 hp. "Carrying wood" indicates the number of boats seen which were pushing rafts of timber, all of which were going downstream.

Clay lick	Total boats	Boat type		Direction of travel		Carrying Wood
		Peke-peke	Outboard	Upstream	Downstream	
1	113	105	8	42	71	23
2	119	88	31	44	75	16
3	33	30	3	7	26	8

More boats were recorded going downstream than upstream. This may be due to the fact that boats, which leave Puerto Maldonado in the early morning would only pass the clay licks in the late afternoon or evening when no monitoring of the clay licks was taking place, whereas boats coming from upstream had no major staging post that would result in more boat traffic passing in the afternoon. At clay lick 2 substantially more boats with outboard type motors were recorded as a boat with an outboard motor was used to carry observers upriver to the clay lick 1 observation post for the first two weeks of the clay lick 2 observation period. For the last two weeks a peke-peke boat was used to carry observers to clay lick 1. These boats would have been recorded passing the clay lick both going up and returning downstream. Fewest boats were recorded passing clay lick 3 as this clay lick was monitored in the early morning only.

Table 3.3.6b. The effects of boat traffic on parrots and macaws at the three riverside parrot clay licks along the Las Piedras river associated with the Las Piedras Biodiversity Research Station.

Clay lick	No birds when boat passed	Birds present	No flush from birds present		Birds flushed from trees or clay lick attributed to boat approaching or passing the clay lick	
1	48	49	20	41%	29	59%
2	53	65	18	28%	47	72%
3	11	21	8	38%	13	62%

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Almost 50% of boat traffic had no obvious influence on clay lick activity as there were no birds present (see table above). However, over 60% of boats that passed when birds were present caused birds to leave the vicinity of the clay lick. Birds that remained were often in the trees far back from the river's edge. Although not quantified in this study, we believe that there is a correlation between size and the probability of a flush, where smaller parakeets and parrots are less likely to flush compared to larger parrots and macaws. In a few instances feeding activity has continued with dusky-headed parakeets and blue-headed parrots in the presence of boats, while this was never recorded for red-and-green macaws. This is reflected in that at colpa 2, where most of the feeding recorded was by red-and-green macaw, more flushes occurred compared to clay lick 3, where only parrots fed. Tatum-Hume et al. (2003) recorded very similar figures for bird reaction from clay lick 1.

It is clear from the above tables that boats play a significant role in flushing birds from the clay licks and from the trees around them. If all incidents of flushing are caused by natural causes that were beyond the ability of the observers to identify, then passing boat traffic is causing birds to expend up to 25% more energy on an average visit to one of the clay licks under observation due to the extra flushing initiated by boats. There is a non-significant trend towards lower clay lick use with increasing rate of hourly boat traffic for both clay licks 1 and 2 (figures 4 and 5). The increased rate of boats passing clay lick 2 corresponds with a greater overall decrease in feeding activity compared to clay lick 1 with a slightly lower rate of boat traffic per hour.

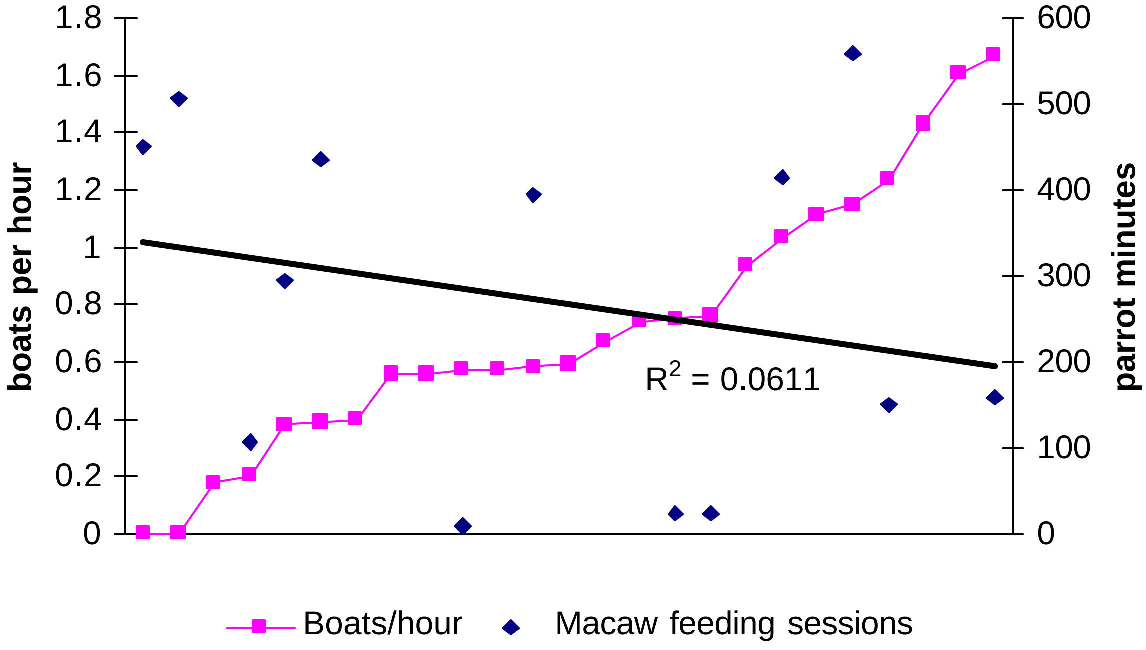

Figure 3.3.6a. Chart showing the trend in total daily parrot minutes for red-and-green macaws in relation to increased boat traffic at clay lick 1. The relationship is not significant (p=0.877, Pearson Product correlation). There is also no significant relationship between total feeding intervals and boat traffic (p=0.939).

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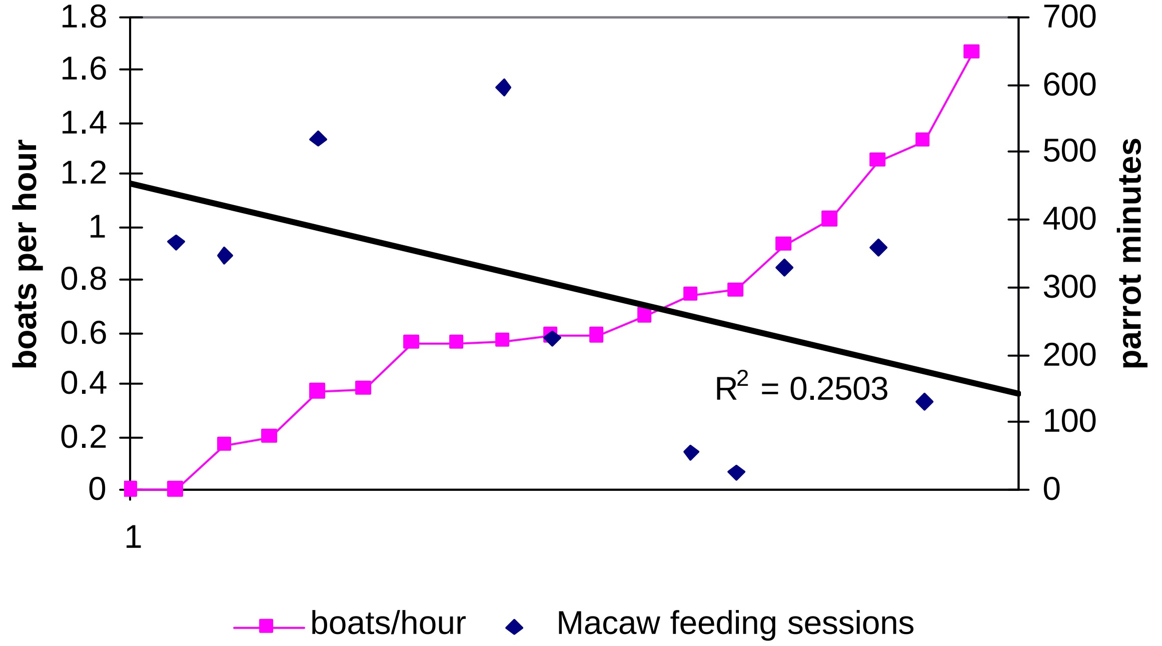

Figure 3.3.6b. Chart showing the trend in total daily parrot minutes for red-and-green macaws in relation to increased boat traffic at clay lick 2. The relationship is not significant with all data included (p=0.294). The correlation between boats per hour and the length of feeding interval is nearly significant (p=0.058)

3.3.7. Weather

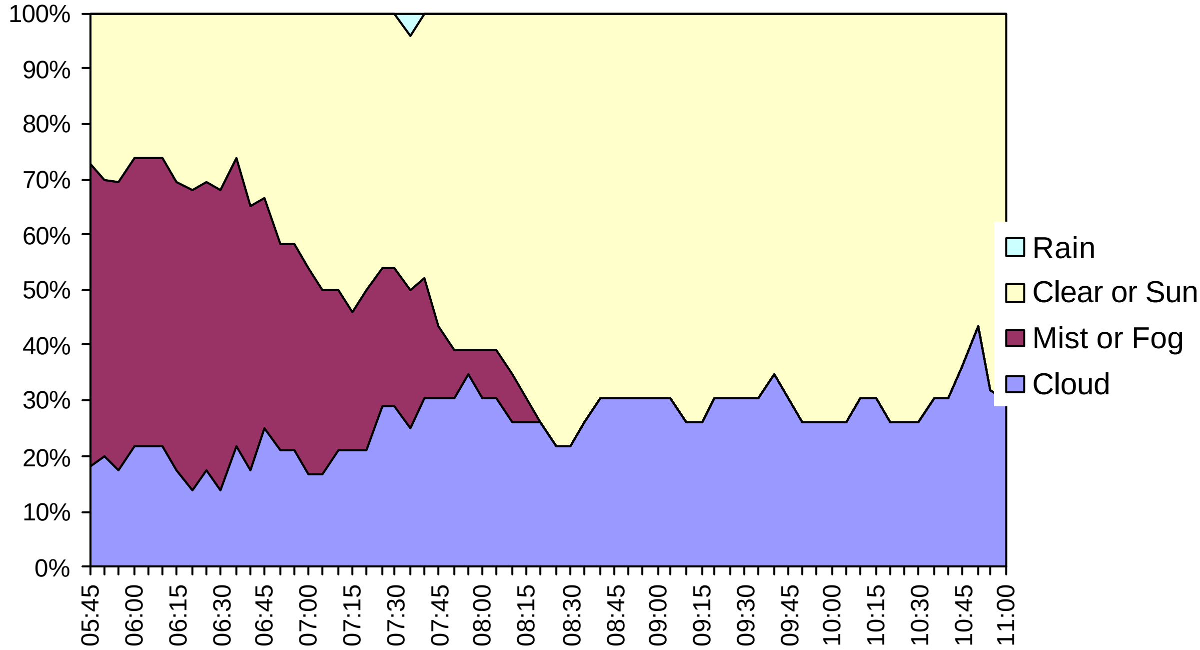

Figure 3.3.7a. Average morning weather conditions depicted as percentage cloud mist and clear mornings from 31 May to 7 July, from 5 minute interval weather recordings at clay lick 1 from 05:45 to 11:00.

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Most mornings (almost 50%) started misty at all the clay licks, but cleared up by 08:00 (see figure above). Brightsmith (2004a) recorded that when fog or rain occurred between 05:00 and 07:30, it almost completely prevented the early morning species from using the lick.

Weather was mostly clear and sunny after 08:00 at clay licks 1 and 2. Observations were not conducted on rainy mornings (two mornings), although a few periods of precipitation were recorded at clay lick 3. On one of these mornings, 20 minutes of rain was recorded up till 06:05 and feeding by dusky-headed parakeets and blue-headed parrots was seen subsequently, contrary to expectations that rain prior to morning clay lick activity prevents early morning species from feeding (Brightsmith 2004a).

3.3.8. Variation in group sizes for arriving and departing macaws and parrots.

Table 3.3.8a. Variation in group size for red-and-green macaw, mealy parrots and blue-headed parrots arriving and departing the area around the clay licks.

Group size	Average	Median	Standard Deviation
Arrivals – red-and-green macaws, Colpa 1	2.8	2	2.05
Departures – red-and-green macaws, Colpa 1	5.98	2	9.07
Arrivals – red-and-green macaws, Colpa 2	3.02	2	2.57
Departures – red-and-green macaws, Colpa 2	5	2	7.89
Arrivals – mealy parrots, Colpa 3	2.56	2	1.68
Departures – mealy parrots, Colpa 3	4.82	2	7.21
Arrivals – blue-headed parrots, Colpa 3	14.41	8.5	15.38
Departures – blue-headed parrots, Colpa 3	12.29	4	17.12

Mealy parrots

Mealy parrots most often arrived in pairs with single birds or parties of three occasionally. As the morning advanced, average arriving group size increased (see figure below), but this is thought to be a function of birds which had flushed earlier in a large group, some of which would then return in groups of over five. It is not thought that larger groups of birds arrived in the area of the clay lick later in the morning, although this may be the case for birds which aggregate into larger groups which are travelling from far away. The rate of birds arriving peaks around 06:30, after which the rate of arrivals falls until 08:00. The rate of groups departing peaks around 07:00, with a lag of half an hour behind the rate of arrivals.

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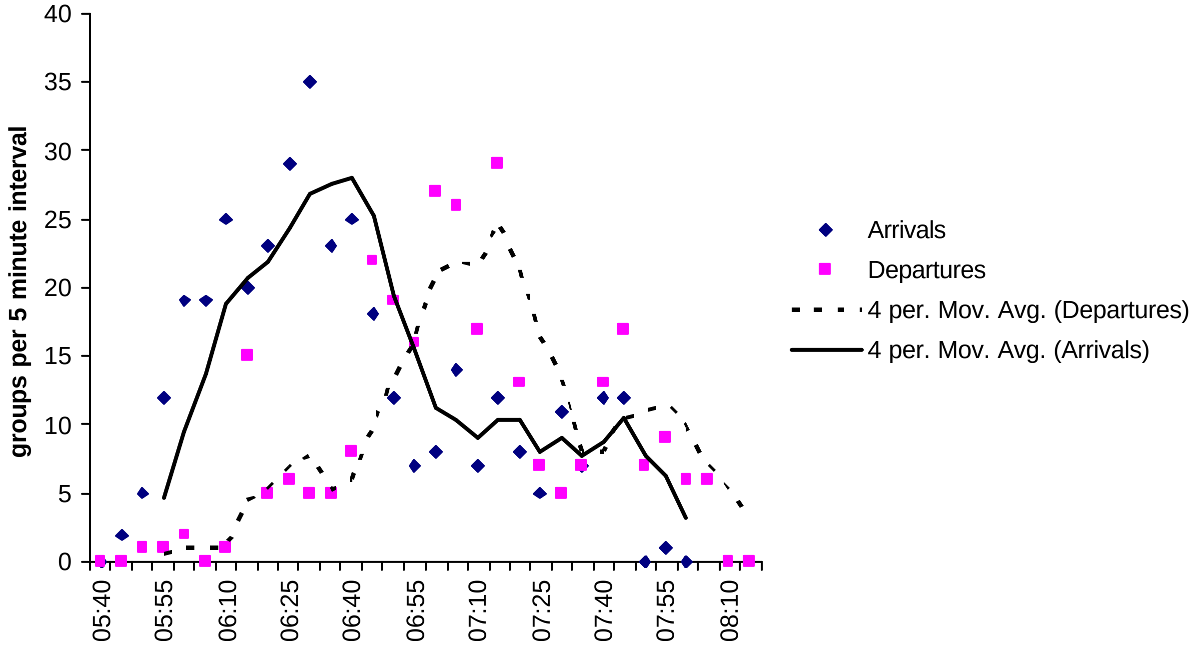

Figure 3.3.8a. Rate of arriving and departing groups of mealy parrots at clay lick 3, shown as number of groups recorded or leaving per 5 minute interval. The trend lines are 4 period moving averages.

With birds often departing the area of the clay lick due to flushes from the trees or the clay lick, unsurprisingly, average group size for departing birds was far greater than that for arriving birds ($t = -3.566$, $p = 0.002$). The variation in group sizes for departing birds is large (see table above). Although it is possible that these aggregations of birds remain together for the remainder of the day, observers should be wary of using group sizes of mealy parrots departing the vicinity of a clay lick as an indicator of average group size.

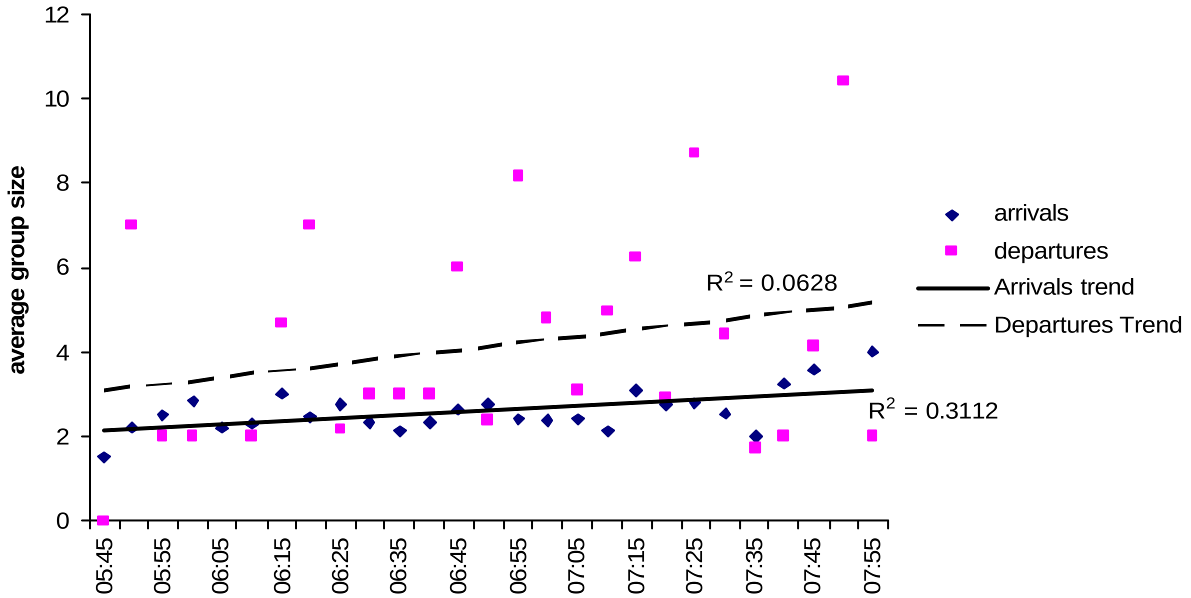

Figure 3.3.8b. Trends in group size for arriving and departing groups of mealy parrots at clay lick 3 during early morning activity.

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A casual inspection of the direction from which birds arrived and departed shows that birds arrived from all directions around the clay lick, but there seems to be a bias in departures upstream from the clay lick in the direction of clay licks 1 and 2. Early morning observations from the tower between clay licks 1 and 2 showed that groups of up to 40 individuals were flying on a bearing between these clay licks. Clearly disturbance at one clay lick would cause the parrots to fly to the other clay licks in the area.

The reason why large numbers of mealy parrots arrived in the vicinity of the clay lick every day cannot be explained by the need for clay, as feeding was observed on only two mornings out of the 23 days when observations occurred. How the presence of the roadside hawk nest close to the clay lick affected feeding is not clear, as one of the feeding events was observed after the presence of the nest was established by observers. Whether the birds continued to visit the area out of habit from previous years, or whether the congregations were merely part of a staging process before feeding analogous to staging of migrating birds, or whether the area served as a congregational ground for birds for social reasons other than feeding, remains unclear.

3.3.9. Mealy parrot flight speed

Although the methodology outlined above to calculate flight speed is fairly simple, practically it was hard to implement as the incoming flight path of the mealy parrots to the target trees was concealed from the observation point. Thus not only would birds have to be flying on a trajectory over the observer's position, but birds could only be recorded if they called in advance and the observer was able to prepare and start the stopwatch in time.

Table 3.3.9a. Flight speeds for mealy parrots based on time recordings to cross from the observation point to perches of known distance. (n=4)

Time to tree 1 (145m) (seconds)	Time to tree 2 (136 m) (seconds)	Flight Speed to tree 1 (km/h)	Flight Speed to tree 2 (km/h)	Average Speed
14.00	13.10	37.29	37.37	
11.27	11.60	46.32	42.21	
12.64	12.35	41.81	39.79	40.80

The average flight speed recorded was 40.8 km/h. Factors that may have influenced flight speed are the velocity over different substrates (speed over water in this case) and that birds were approaching a perch (indicating that speed of flight is likely to be slower than a potential maximum).

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3.3.10. Blue-headed parrots

The large numbers of this species at this clay lick was astonishing considering feeding was only observed on five of the 23 days that observations were undertaken. Large flocks would arrive from the direction of clay licks 1 and 2. These large flocks account for the higher average group size and median for blue-headed parrots described above. Occasionally flocks would fly on a bearing of 150 degrees. The next known clay lick on the Las Piedras river is on a bearing of 160 degrees, almost 8 km away but whether this was the birds' ultimate destination is not known. The activity of the pair of roadside hawks at the clay lick may have affected feeding as no feeding occurred after the date the nest building activities of the hawks was observed, halfway through the observation period.

The average group size for arriving blue-headed parrots (14.41) was much larger than for the larger sized mealy parrots. There was no great difference between the average group size of arriving and departing birds ($t = -0.530$, $p = 0.602$), but the high standard deviation is not a surprise, since flocks of up to 100 birds would occasionally arrive or leave the area.

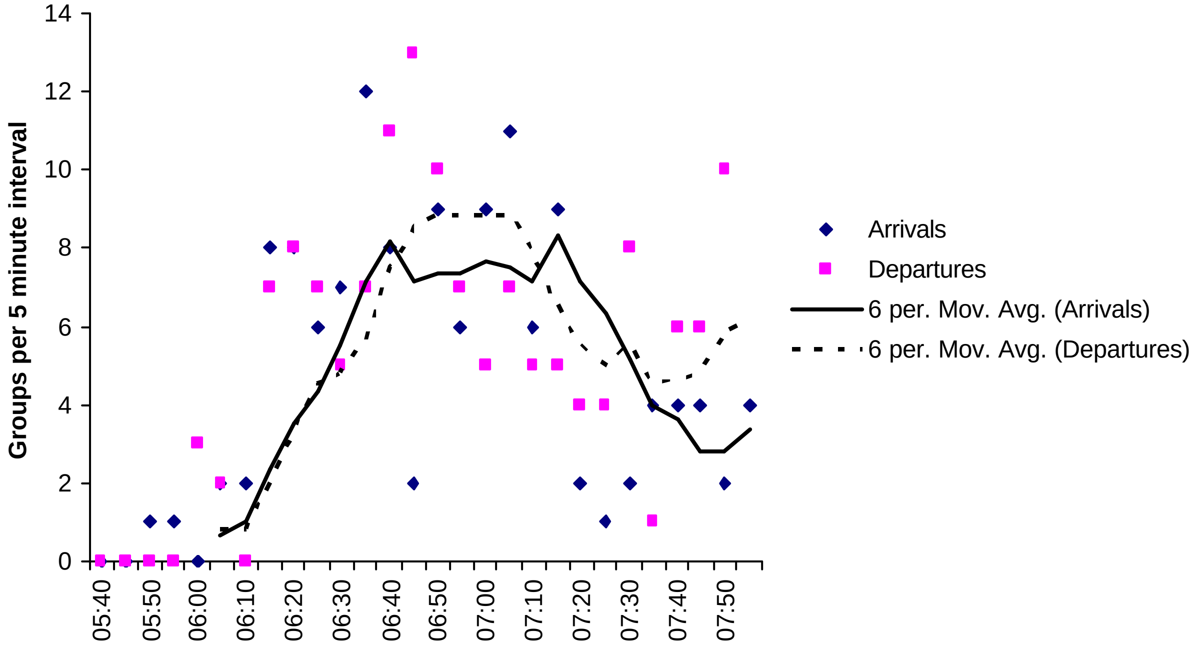

Figure 3.3.10a. Rate of arriving and departing groups of blue-headed parrots at clay lick 3, shown as number of groups recorded or leaving per 5 minute interval. The trend line is a 6 period moving average.

The difference between the rate of arrivals and departures is not as clearly marked for blue-headed parrots as for mealy parrots. With flock sizes varying considerably and a lot of movement between clay licks, a far greater sample size would be needed in order to gain a clearer idea of this species early morning's movements in relation to the clay licks. Activity continued beyond 08:00, the time at which observations from clay lick 3 generally ceased when no feeding on the clay lick was recorded. Towards 08:00 arrival rate fell below departure rate as the probability that feeding on the clay lick decreases.

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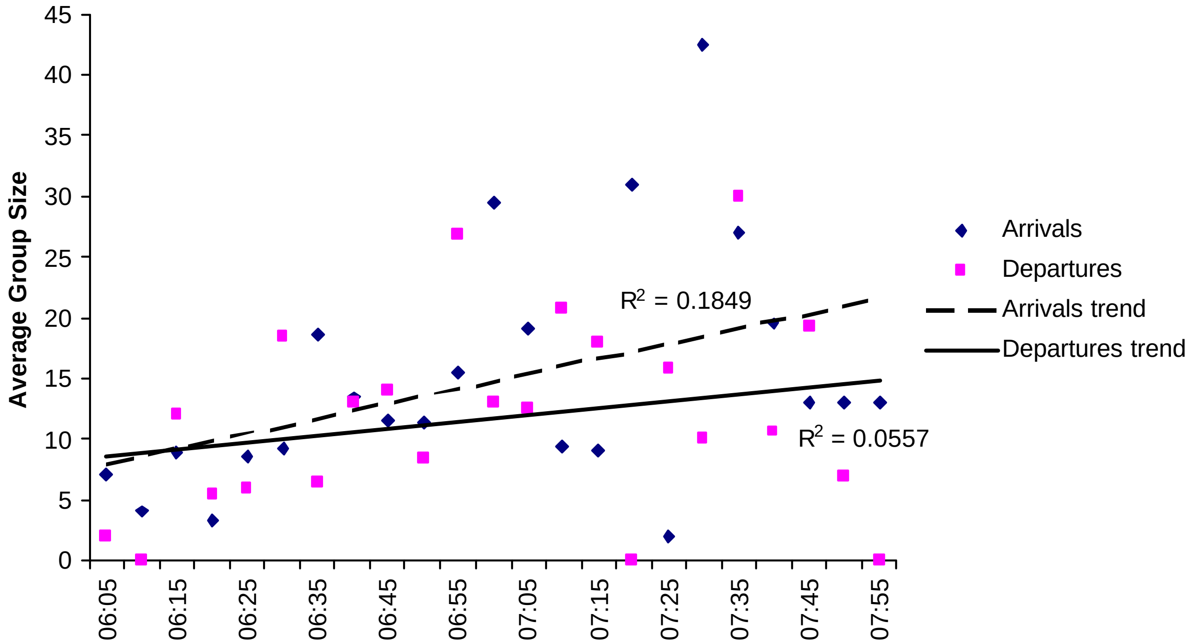

Figure 3.3.10b. Trends in average group size for arriving and departing groups of blue-headed parrots at clay lick 3.

The average group size of both arriving and departing groups increased as the morning progressed, undoubtedly due to the aggregation of groups of birds arriving in the area. Unlike mealy parrots, the trends in group size for arriving birds was larger than for departing birds. This was due to the large flocks of birds, which would fly into the area from other clay lick sites. Sometimes parts of these groups would remain in the vicinity of the clay lick, while the rest of the group would continue on.

3.3.11. Red-and-green macaws

At both clay licks 1 and 2 average size of departing groups of red-and-green macaws was greater than the average size of arriving groups ($t = 3.938$, $p < 0.001$). As with mealy parrots, the effects of flushing increases the size of groups leaving the vicinity of the clay licks (see figures below). Average group size for arriving birds remains constant over time at both clay licks, but average group size for departing birds increases as the morning progresses, as more birds arrive through the morning and subsequently leave in larger groups.

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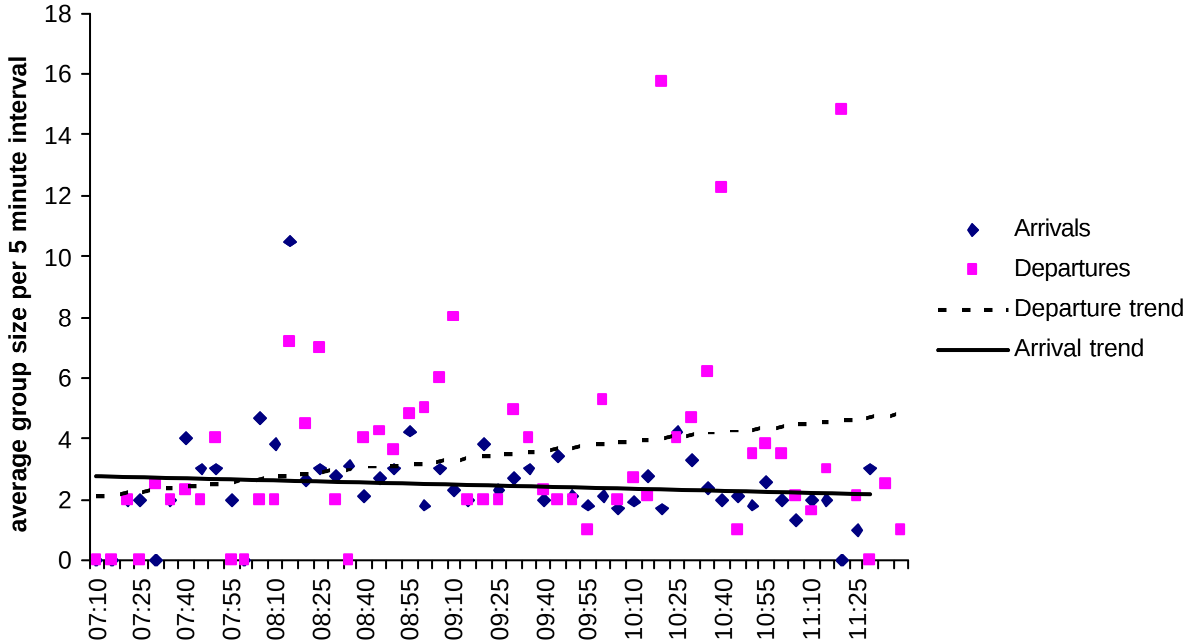

Figure 3.3.11a. Average group size per 5 minute intervals for red-and-green macaws arriving and departing from clay lick 2.

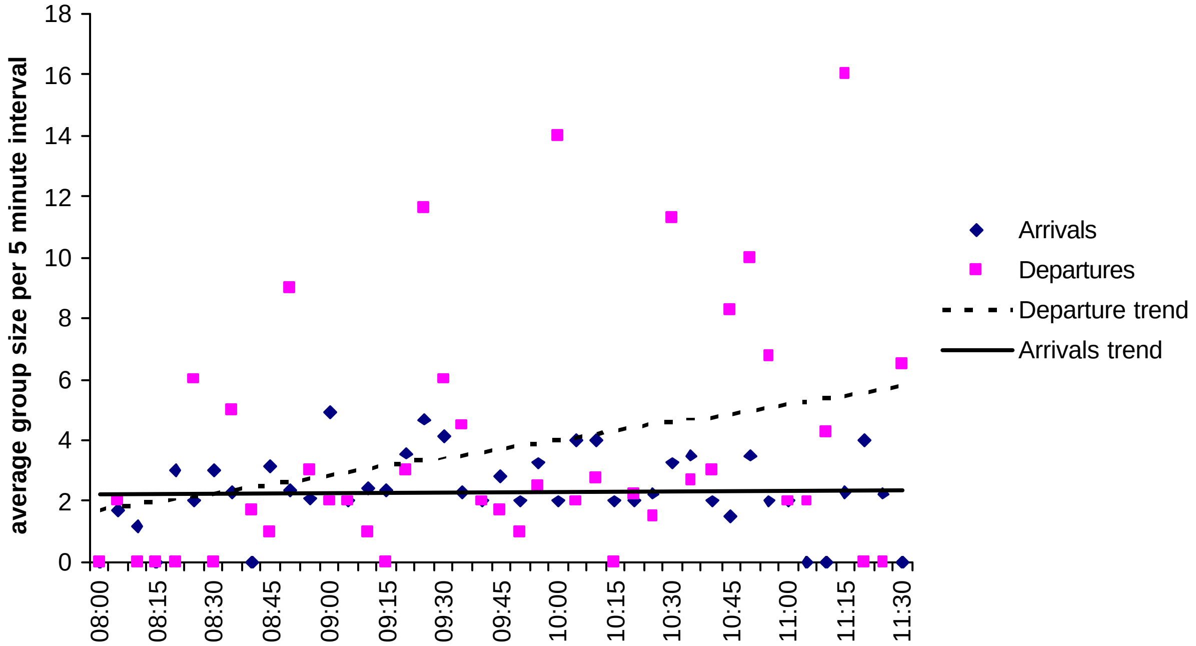

Figure 3.3.11b. Average group size of arriving and departing birds per 5 minute intervals for red-and-green macaws from clay lick 1.

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The rate of arrivals of groups of red-and-green macaws peaked at 09:20, an hour before the recorded peak in feeding at 10:20. There is no clear peak in the rate of departures as birds simply move between clay licks and do not depart en mass to head to feeding grounds, as observed for the mealy and blue-headed parrots. This highlights the importance of the clay licks as an area of congregation for the macaws, possibly serving some social function in the macaw community.

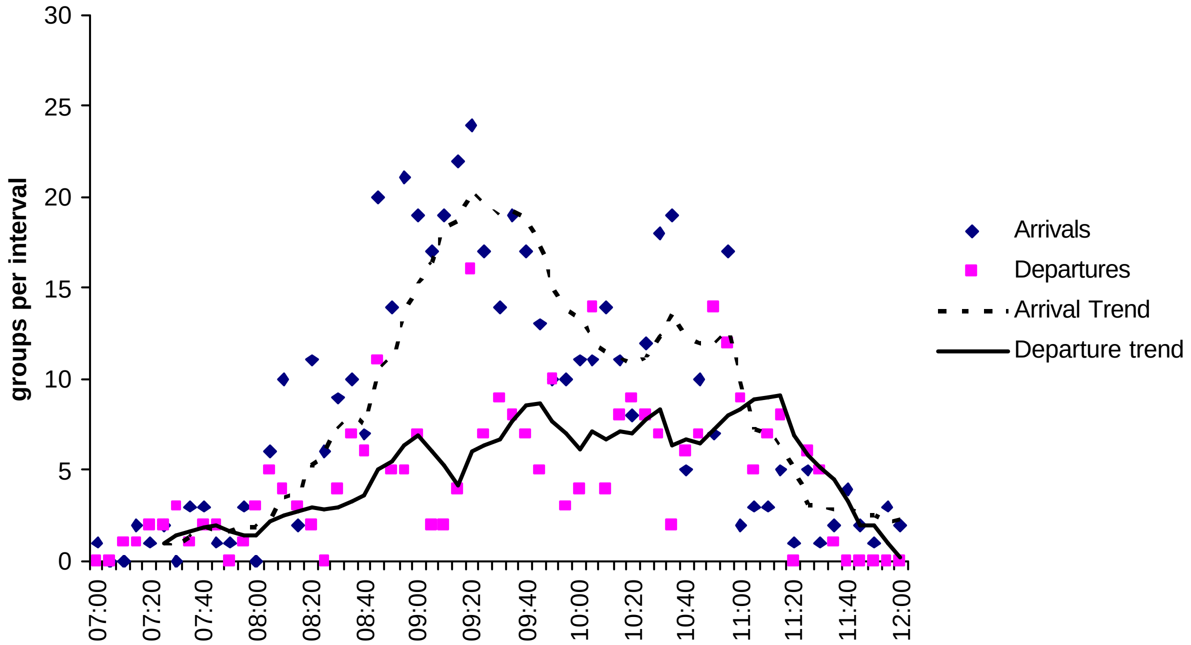

Figure 3.3.11c. Rate of arriving and departing groups of red-and-green macaws at clay licks 1 and 2, shown as number of groups recorded or leaving per 5 minute interval. The trend line is a 6 period moving average.

The average larger group size for departing birds compared to arriving birds means that fewer groups are recorded departing than arriving, as shown in the above figure, if one assumes that the same numbers of arriving and departing birds are observed. More groups are seen to arrive than depart as departures occur in larger sized groups. There is no clear peak in the rate of birds departing, as activity continues throughout the morning into the early afternoon. The sudden decline in arrivals and departures after 11:00 is a function of the number of observations that occur after this time period rather than a reflection of bird activity, which declines slowly until 14:00 (Tatum-Hume et al. 2003).

There is a speculative correlation between the departure at one clay lick and arrival of birds at the other clay lick. The distance separating the clay licks (2 km) cannot be considered a big obstacle to the birds. Observers would often report birds arriving from the direction of a clay lick flushed by an approaching boat.

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Figure 3.3.11d. Chart showing the total number of birds per 5 minute interval for the period of the study departing from clay lick 1 plotted against the total number of birds per 5 minute interval arriving at clay lick 2.

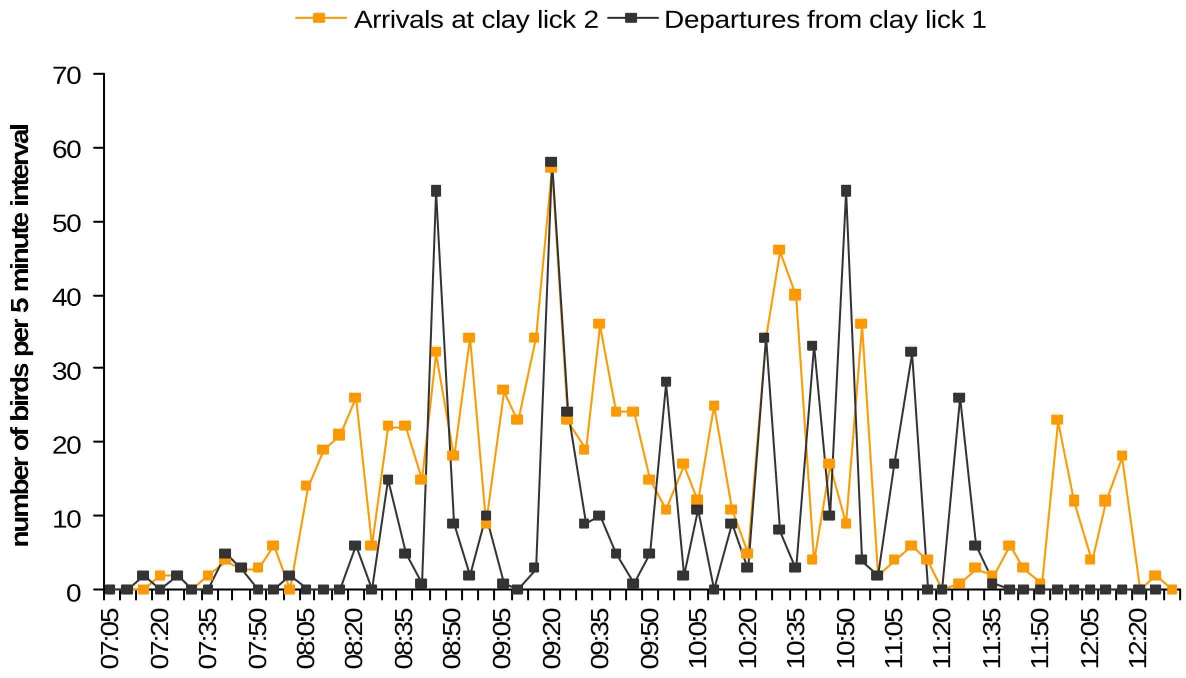
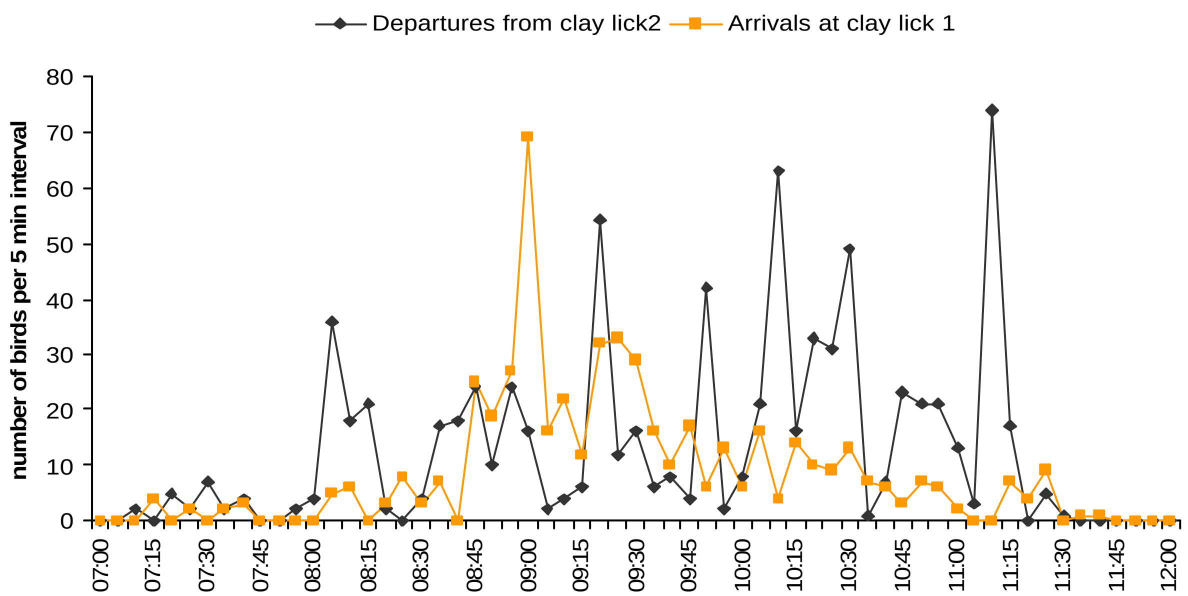


Figure 3.3.11e. Chart showing the total number of birds per 5 minute interval for the period of the study departing from clay lick 2 plotted against the total number of birds per 5 minute interval arriving at clay lick 1.



For both the above charts, there is a peak in departures from one clay lick, which corresponds to a peak in arrivals at the other clay lick between 09:00 and 10:00, the period of highest clay lick activity. In the case of departures from clay lick 1, there is a corresponding peak in arrivals at clay lick 2 at 09:20. If a large group of birds departed at the start of the 5 minute period interval, it is feasible that they could have arrived at clay lick 2 towards the end of a 5 minute period since birds would have to fly at 19.2 km/h, far less than the average speed calculated above for mealy parrots.

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As the zone in which arrivals and departures were recorded from was limited at both clay licks 1 and 2 and it was known that a large tree favoured by the macaws for perching was outside the field of view, a clearer picture may have been possible had observations been carried out with a wider field of view.

For days when feeding was recorded while both clay licks were being monitored, feeding occurred simultaneously 27% of the time. From the table below it is clear that feeding only occurred concurrently at clay licks 1 and 2 in large numbers on two occasions, most notably on 7 July, the last day of monitoring, when 44 macaws were recorded in total at clay licks 1 and 2 feeding around the same time. This was the maximum recorded for a feeding session.

Table 3.3.11a. Feeding overlap for red-and-green macaw between clay licks 1 and 2.

Dates on which feeding occurred and where monitoring was done at both clay licks	Feeding occurred?		Time at which an overlap in feeding occurred	Counts of birds on clay lick at comparable 5 minute intervals	
	Clay lick 1	Clay lick 2		Clay lick 1	Clay Lick 2
01-Jun-05	Yes	No			
02-Jun-05	Yes	No			
15-Jun-05	Yes	No			
17-Jun-05	Yes	No			
18-Jun-05	Yes	No			
20-Jun-05	Yes	Yes	09:55-10:05	1, 26, 32	7, 2, 1
23-Jun-05	Yes	Yes	No overlap		
28-Jun-05	Yes	No			
29-Jun-05	Yes	Yes	No overlap		
30-Jun-05	Yes	Yes	08:50-08:55	2, 2	2, 2
01-Jul-05	No	Yes			
02-Jul-05	Yes	No			
04-Jul-05	Yes	Yes	10:05-10:40	1, 14, 26, 14, 10, 7, 8, 6	1, 1, 5, 17, 12, 8, 8, 8
05-Jul-05	Yes	Yes	No overlap		
07-Jul-05	Yes	Yes	10:15-10:35	2, 21, 27, 4, 9	15, 23, 12, 6, 8
Total: 15	**14**	**8**		**4**	

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Figure 3.3.11f shows a trend in increasing feeding over the course of the study period, following the seasonal patterns which would be predicted from year round monitoring of clay licks conducted by Brightsmith (2004a). However, we have shown a correlation between the amount of feeding which occurs and boat traffic. During the course of this survey, boat traffic decreased (figure 3.3.11g), probably due to falling levels of water in the river. When the river is low wood cutters are unable safely to drive their rafts of wood downstream. Thus the reason why red-and-green macaw feeding increased over this study period cannot be clearly attributed to either seasonal patterns or boat traffic.

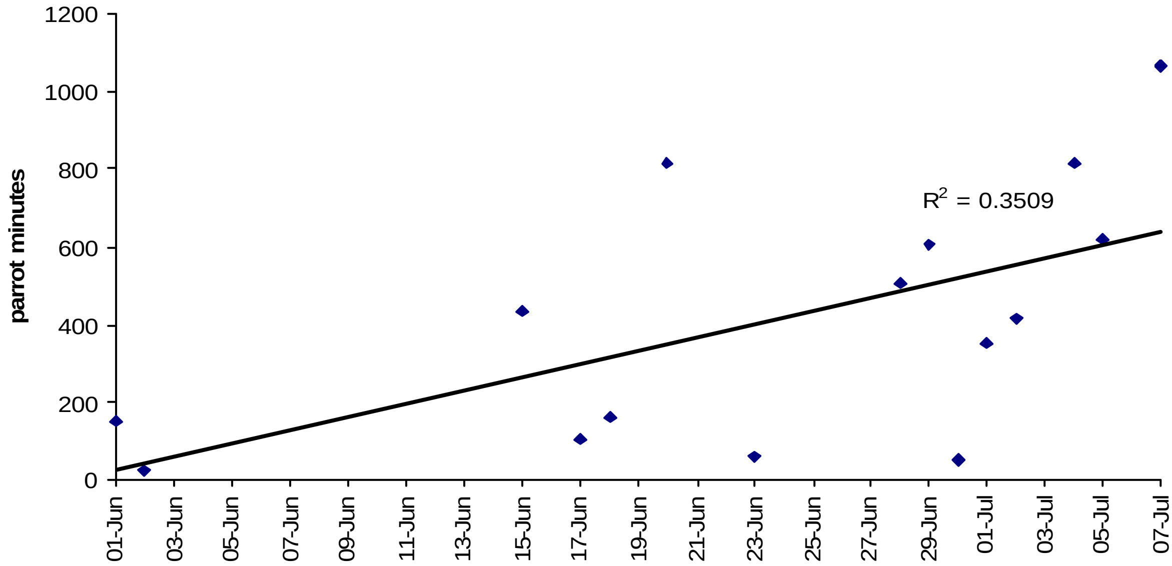

Figure 3.3.11f. The trend in total parrot minutes for red-and-green macaws, summed for clay licks 1 and 2, for the duration of the survey period.

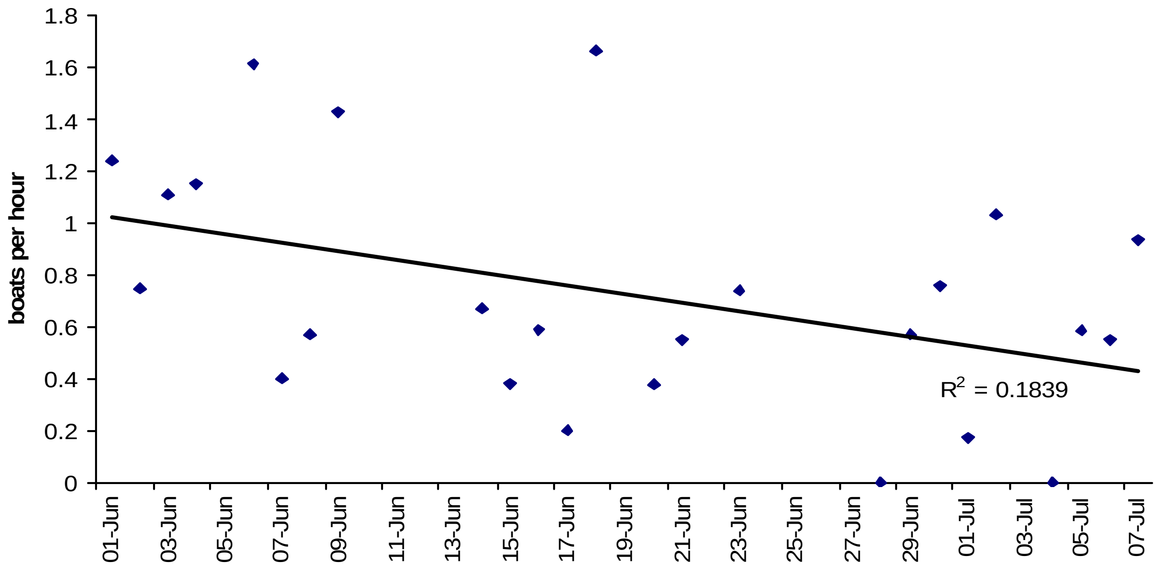

Figure 3.3.11g. The trend in boat traffic (boats per hour) passing clay lick 1 for the duration of the survey period.

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3.3.12. Bird behaviour

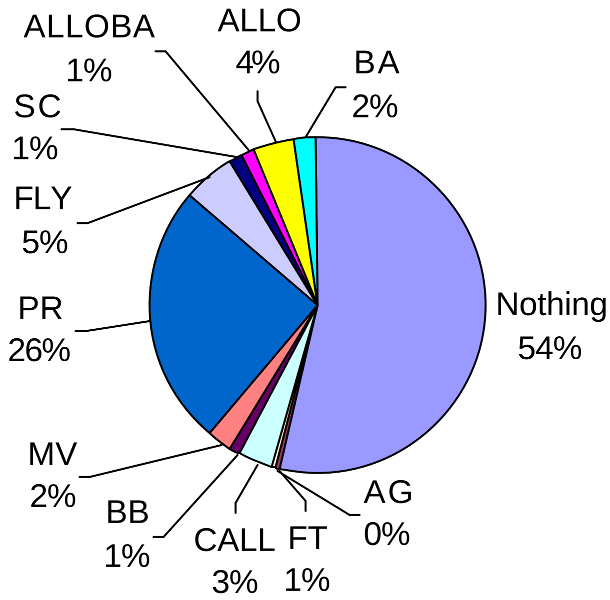

Figure 3.3.12a. Bird activity for mealy parrots at clay lick 3. Key: Nothing – no activity; FT – fighting; AG – aggression; CALL – calling; BB – branch biting; MV – moving; PR – preening; FLY – flying; SC – scratching; ALLOBA – mutual allopreening; ALL0 – allopreening other; BA – being preened by another bird; FD – feeding; SLEEP – sleeping; HA – hanging upside down.

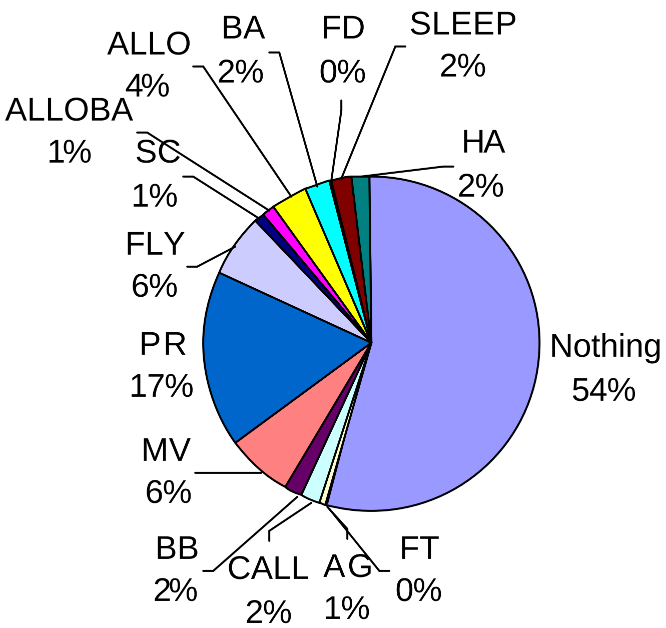

Figure 3.3.12b. Bird activity for red-and-green macaws at clay lick 1. Key: Nothing – no activity; FT – fighting; AG – aggression; CALL – calling; BB – branch biting; MV – moving; PR – preening; FLY – flying; SC – scratching; ALLOBA – mutual allopreening; ALL0 – allopreening other; BA – being preened by another bird; FD – feeding; SLEEP – sleeping; HA – hanging upside down.

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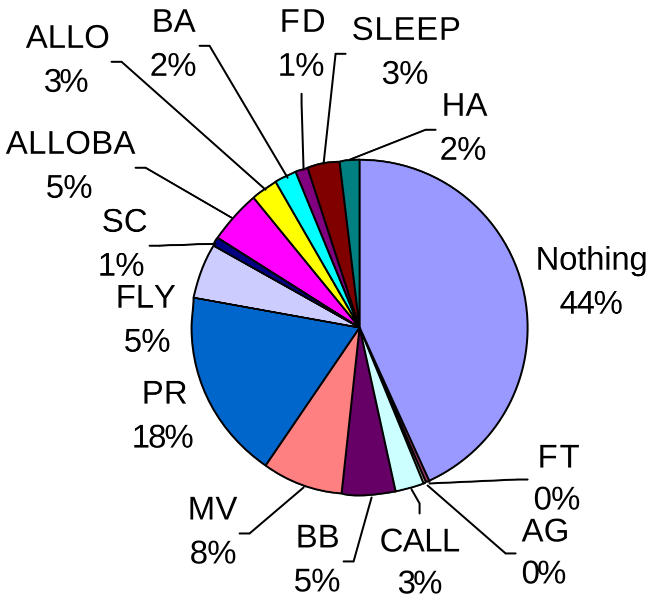

Figure 3.3.12c. Bird activity for red-and-green macaws at clay lick 2. Key: Nothing – no activity; FT – fighting; AG – aggression; CALL – calling; BB – branch biting; MV – moving; PR – preening; FLY – flying; SC – scratching; ALLOBA – mutual allopreening; ALL0 – allopreening other; BA – being preened by another bird; FD – feeding; SLEEP – sleeping; HA – hanging upside down.

For nearly half the recordings, individual birds were not doing anything that could be recorded by the observers. The second most common activity for both mealy parrots and red-and-green macaws was self-preening. Mealy parrots were recorded preening more often than macaws. This is not to say that macaws preen less generally, as of course activity was recorded for macaws later in the day when preening activities were possibly not as important, or had been completed at roost sites before arriving at the clay licks. However, social preening (allopreening activities) were also recorded very regularly for both species, being recorded at clay lick 1 for 10% of all activity checks. This highlights the social nature of these birds. A comparative study of preening and allopreening away from the clay licks would allow us better to place the importance of the clay licks in the light of social activities. In contrast, fighting and aggressive behaviour was hardly recorded for either species. Red-and-green macaws were more mobile along branches than mealy parrots, and were also recorded biting branches more. Mealy parrots were never recorded sleeping, while red-and-green macaws were recorded sleeping in the trees around the clay licks. Despite the lengthy periods of time that red-and-green macaws were in the vicinity of the clay lick, feeding on fruits etc was hardly ever observed – only on one occasion at clay lick 1.

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3.3.13. Variable Distance Line Transects (VDLT) and Variable Circular Plots (VCP). Sample effort and comparison of methods

Table 3.3.13a. Summary of transect effort showing average encounters with psittacidae groups per hour.

Transect	Total number of walks	Total of all encounters, heard and seen, for all species	Total distance sampled (km)	Cumulative hours of observation	Average encounters with psittacidae groups per hour
A1	6	86	10.95	11:04	7.80
A2	3	32	5.35	05:11	6.15
B	8	125	12.53	13:39	9.16
CT	6	49	9.80	08:33	5.73
RT	6	59	8.30	07:31	7.87
TOTAL	**29**	**351**	**46.93**	**45:27**	

Nearly 47 km of transects were walked during the survey period, over roughly the same number of hours (see table above). Results are presented as encounters per hour rather than per kilometre to make them comparable to results from VCPs. The highest encounter rate was for the B trail (floodplain forest), the lowest was for CT (seasonal swamp).

Table 3.3.13b. Summary of VCP effort showing average encounters with Psittacidae groups per hour.

	Total number of counts made	Total of all encounters, heard and seen, for all species	Cumulative hours of observation	Encounters per hour
A1	62	53	5.67	9.35
A2	31	24	2.83	8.47
B	38	27	4.33	6.23
CT	34	28	3.50	8.00
RT	33	30	2.83	10.59
TOTAL	**198**	**162**	**19.17**	

Encounter rates are represented in the above tables as group encounters per hour for all birds heard or seen, flying or perched. Note that this is a relative index, applicable only to this study site for this time period due to the variables, which can affect call rate per site and time period. This index is useful for the purposes of this study to compare results between the trails and habitats surveyed. Not enough visual encounters with perched birds were recorded to give an accurate snapshot of the psittacidae activity and distribution using DISTANCE (Laake et al. 1994).

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This is partly due to the methodology used, with surveys conducted during what is recognised as being a quiet period for bird activity, and due to the low accumulation of transect distance, despite a transect walked or point counts conducted on almost every afternoon of the survey period.

Although VCPs and VDLTs were conducted on the same number of afternoons, the cumulative time for VDLTs (45 hours) and the associated total number of encounters is far greater than for VCPs (19 hours). Although the encounter rate per hour is on average greater for VCPs than for VDLTs, the added information was of little value for calculating abundance as the additional birds recorded were generally of birds flying far off, for which distances could not be obtained or used for abundance calculations. As table 3.3.13c below shows, the number of encounters per hour for different species for which distance measurements could be obtained was greater for VDLTs than for VCPs on average. This is because distances were not recorded for birds where observers were unsure of the distance thought to be greater than 50 m. Also, during a transect the position for birds which were heard were more likely to be located due to the flexibility of the observers in being able to move along the path to a point from which the position of birds could be identified.

VCPs are thus concluded to be less efficient for collecting information for density estimation purposes at this site in the late afternoon. All subsequent comparison between variables examined will be made with results from VDLTs. For the VDLTs, there is a strong correlation between group encounters per hour and group encounters per kilometre, as transects were waked at an average working speed of 1 km/h. Results are presented as group encounters per kilometre to keep them comparable with VCP and tower monitoring results.

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Table 3.3.13.c. A comparison of the rate of encounters with perched and flying birds to which distances were obtained for VCPs and VDLTs. Perched includes all birds which were perched, or flew off during observation, or were flying and then perched near the observers. Flying represents all birds recorded by the observers that did not perch at any stage of the encounter. * indicates where rate of encounters is higher for a species during VCPs compared to VDLTs.

Species (in alphabetical order)	Flying				Perched			
	Point Counts (VCP)		Transects (VDLT)		Point Counts (VCP)		Transects (VDLT)	
	Total	Encounters per hour	**Total**	Encounters per hour	**Total**	Encounters per hour	**Total**	Encounters per hour
Black-capped parakeet	**4**	0.24 *	**8**	0.18	**3**	0.18	**12**	0.26
Blue-headed macaw	**1**	0.06	**3**	0.07		0.00		0.00
Blue-headed parrot		0.00	**24**	0.53	**1**	0.06	**7**	0.15
Blue-and-yellow macaw	**1**	0.06 *	**2**	0.04		0.00		0.00
Chestnut-fronted macaw	**1**	0.06	**3**	0.07		0.00		0.00
Cobalt-winged parakeet	**11**	0.67	**68**	1.49	**6**	0.37	**23**	0.51
Dusky-headed parakeet		0.00	**19**	0.42	**2**	0.12	**9**	0.20
Mealy parrot		0.00	**21**	0.46	**2**	0.12	**19**	0.42
Orange-cheeked parrot		0.00	**7**	0.15		0.00		0.00
Red-and-green macaw	**4**	0.24	**18**	0.40		0.00	**8**	0.18
Scarlet macaw		0.00	**4**	0.09	**1**	0.06	**6**	0.13
White-bellied parrot	**1**	0.06	**8**	0.18	**4**	0.24	**18**	0.40
White-eyed parakeet		0.00	**7**	0.15		0.00	**1**	0.02
Yellow-crowned Parrot		0.00	**6**	0.13		0.00	**3**	0.07

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3.3.14. Species results

17 species of psittacidae were recorded during surveys. Amazonian parrotlet was recorded once during a VCP, but never during transects. Scarlet-shouldered parrotlet was recorded from call once during a transect. Although one observer claimed to be able to distinguish between tui parakeet and cobalt-winged parakeet calls, this was not confirmed in the field and there were no visual identifications of this species. As it is recognised that this species is nearly impossible to tell apart in the field, results presented here for cobalt-winged parakeet may include tui parakeet. However, if the latter species is present in the study area, it is at very low densities.

Table 3.3.14a. Species density data as calculated from DISTANCE (Laake et al. 1994) for species with more than ten encounters with perched birds.

	Individuals per kilometer	95% Confidence intervals		%CV	Groups per kilometer	95% Confidence intervals		%CV
Cobalt-winged parakeet	40.02	16.51	97.05	46.48	7.3	3.17	16.83	43.29
White-bellied parrot	17.8	8.62	36.73	37.2	3.84	1.91	7.75	35.77
Black-capped parakeet	16.68	7.07	39.36	44.43	4.63	2.02	10.63	42.62
Mealy parrot	4.15	1.49	11.60	54.61	1.96	0.76	5.10	49.88

The most common species of psittacidae at the site were the cobalt-winged parakeet, white-bellied parrot, black-capped parakeet and mealy parrot, of which the cobalt-winged parakeet was most abundant. This was most commonly encountered in mature floodplain forest, especially on RT (see figure below). Although encounter rates with mealy parrot appear higher than for white-bellied parrots (also below), they were half as abundant (see table above). This highlights how an index based on call encounter rate can be misleading for judging a species relative abundance when comparing between birds of different sizes and different vocal capacities. The harsh call of the mealy parrot can be heard from far greater distances compared to the quieter, melodious whistles of the white-bellied parrot.

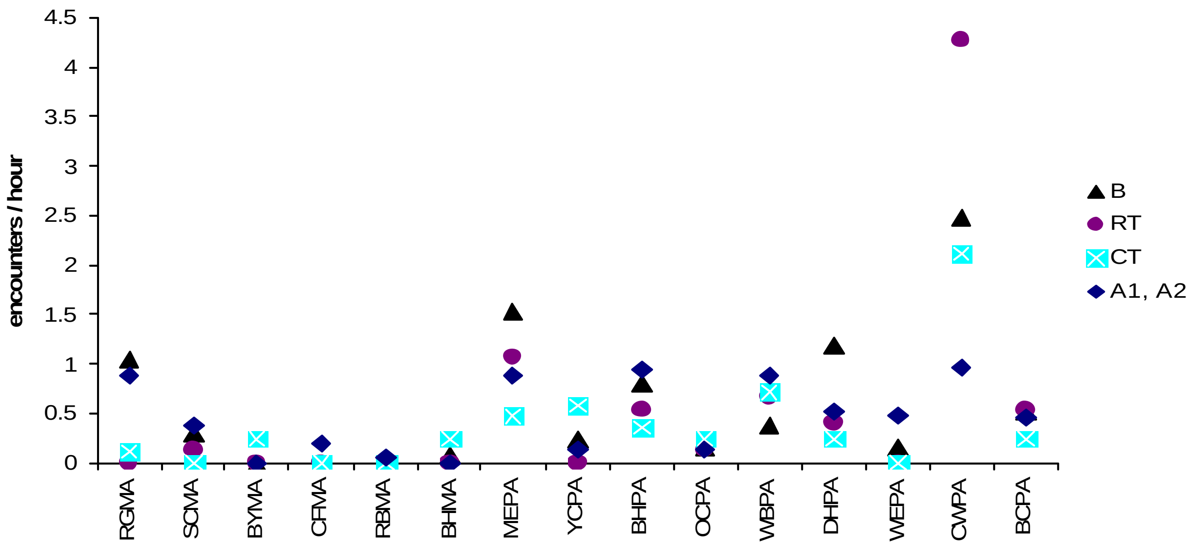

Figure 3.3.14a. Species encounter rate (groups heard or seen per hour, both flying and perched) for VDLTs for different transects.

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3.3.15. Species and forest types

Floodplain forest was favoured by cobalt-winged parakeets, dusky-headed parakeets, blue-headed parrot, red-and-green macaw and mealy parrot.

Terra firme forest was favoured by red-and-green macaw, scarlet macaw, chestnut-fronted macaw, blue-headed parrot, white-bellied parrot and white-eyed parakeet. It was the least popular habitat for cobalt-winged parakeet.

Seasonal swamp was favoured by blue-and-yellow macaw and yellow-crowned parrot, but was least favoured by red-and-green macaw, scarlet macaw, black-capped parakeet, mealy parrot, blue-headed parrot and white-eyed parakeet.

3.3.16. Trends in abundance over time and comparisons with clay lick activity

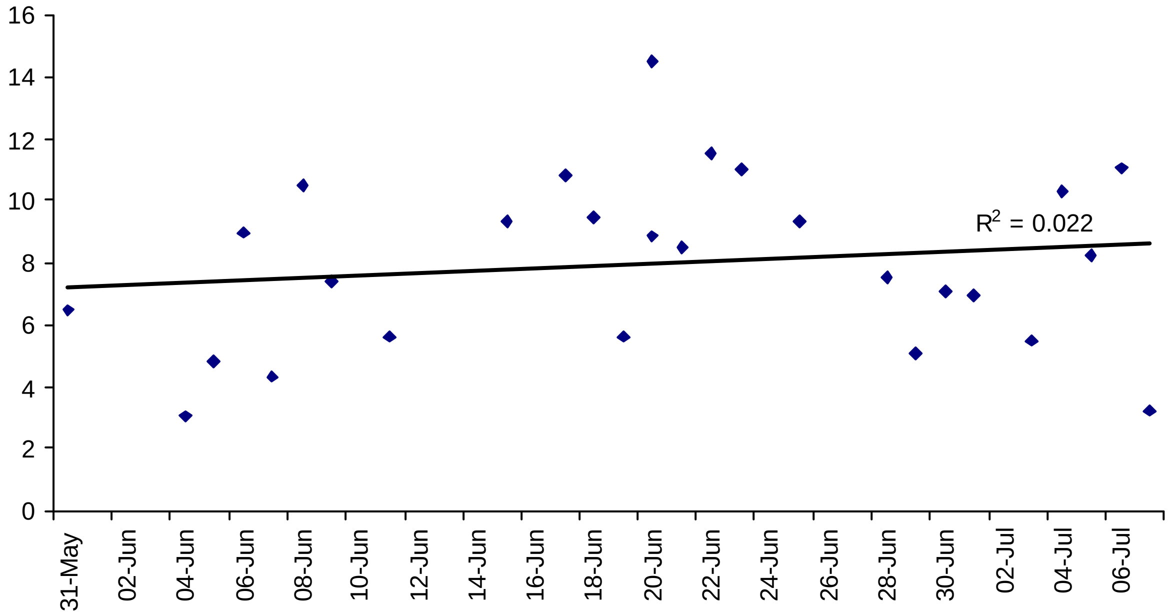

Figure 3.3.16a. Encounter rate for all species per hour for all transects over the period of the study.

There is no trend to show that any increase in activity in the clay licks is associated with increased encounter rate during transects for all species combined (see figure above). However, there are trends at a species level (see figures below). Red-and-green macaws show an increasing trend of encounters per hour during the duration of the study, as do blue-headed parrots. Both species also recorded increased feeding activity on the clay licks during the course of the study. White-bellied parrots showed no change in encounter rates for the duration of the study, although cobalt-winged parakeets, a species not recorded on the clay licks at Las Piedras during this study, also showed an increase in encounter rate per hour for the duration of the study. However, the trend of an increase in number of encounters with cobalt-winged parakeets during the study is a weak one (R^2 = 0.1). As most of the encounters with this species are from RT, a trail in close proximity to the river, the possibility that an increase in the number of balsa trees, an important food source for these parakeets, associated with the river's edge could explain this trend.

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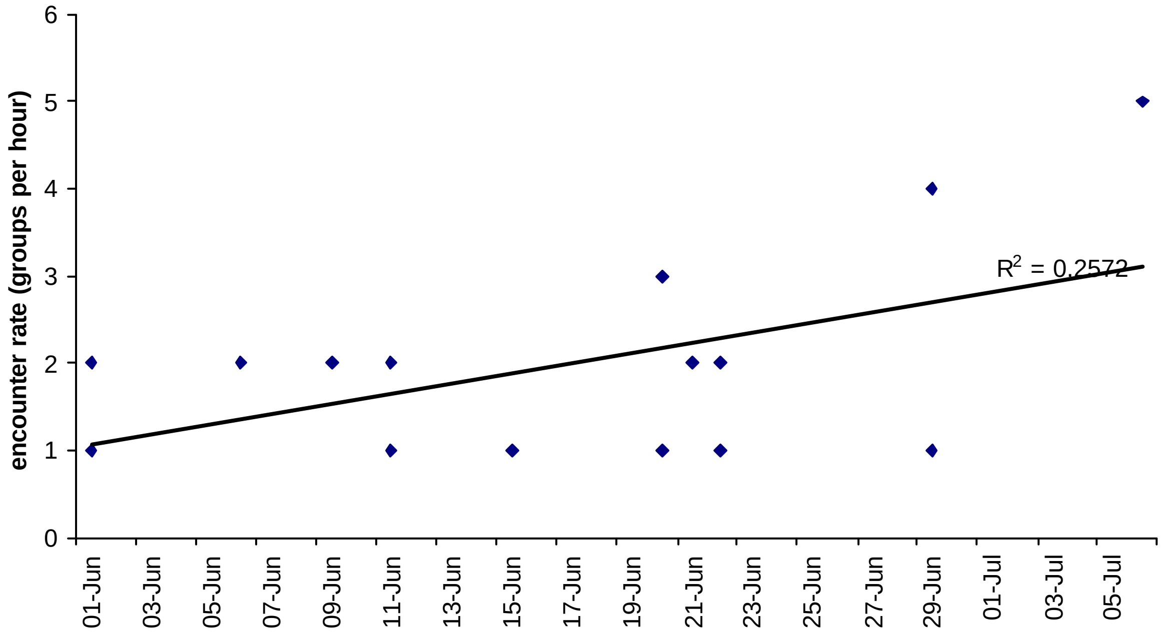

Figure 3.3.16b. Red-and-green macaw encounter rate during VDLTs for the duration of the study.

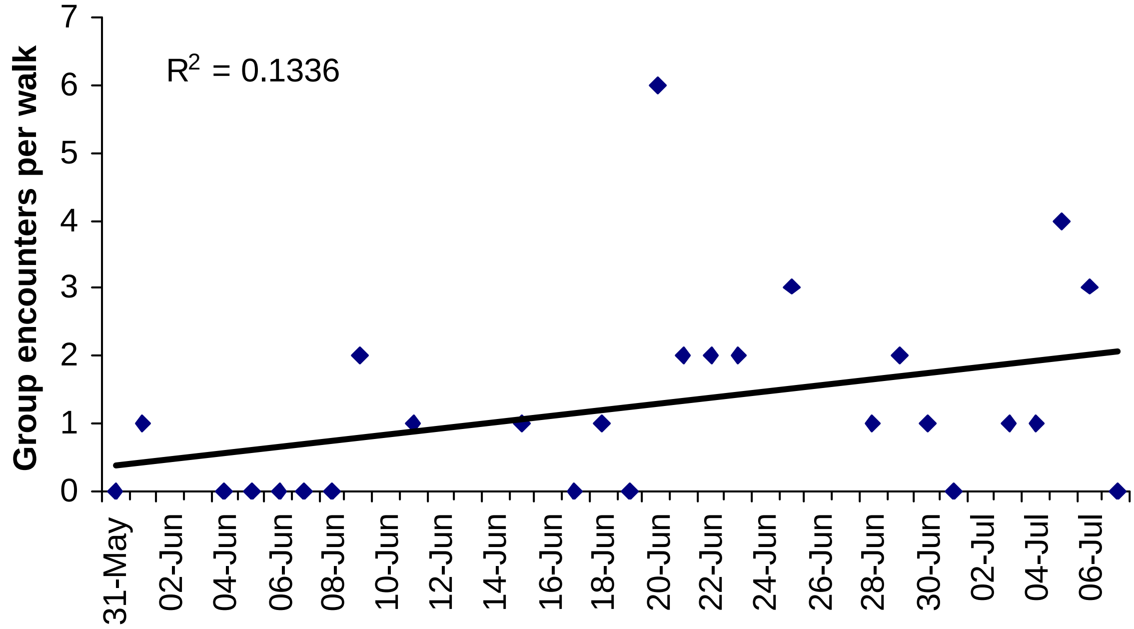

Figure 3.3.16c. Blue-headed parrot encounter rate for VDLTs over the period of the study.

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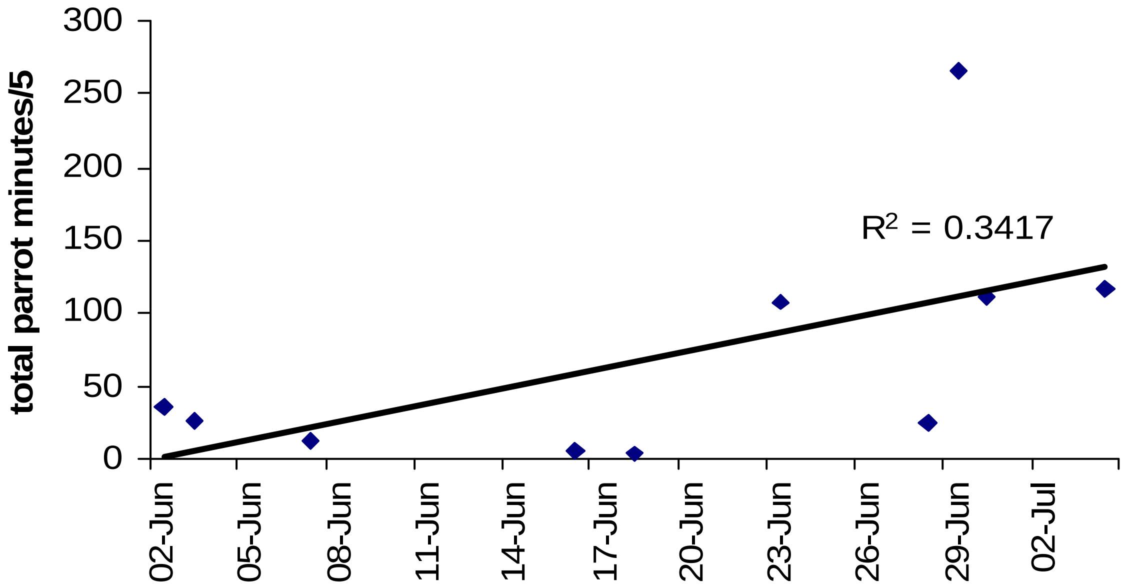

Figure 3.3.16d. Blue-headed parrot clay lick activity as shown in total number of parrot minutes divided by 5 from clay lick 1 over the period of the study

Two species showed a decline in the trend of encounters per hour: dusky-headed parakeets and black-capped parakeets. Black-capped parakeets were not recorded feeding on the clay licks, but were often recorded during the first two weeks of the study feeding on Wasai fruit. When the local crop of this fruit disappeared, the species was no longer recorded frequently on transects, although it was still recorded consistently in smaller numbers.

Dusky-headed Parakeets provided a surprise result for this study. While it is predicted that numbers of this species feeding on clay licks should be increasing over the period of the study (Brightsmith 2004a), this was not observed. This species almost totally disappeared from the clay licks after the first ten days of monitoring. The disappearance of feeding activity is correlated with a decrease in encounters with this species recorded during VDLTs (see figures below).

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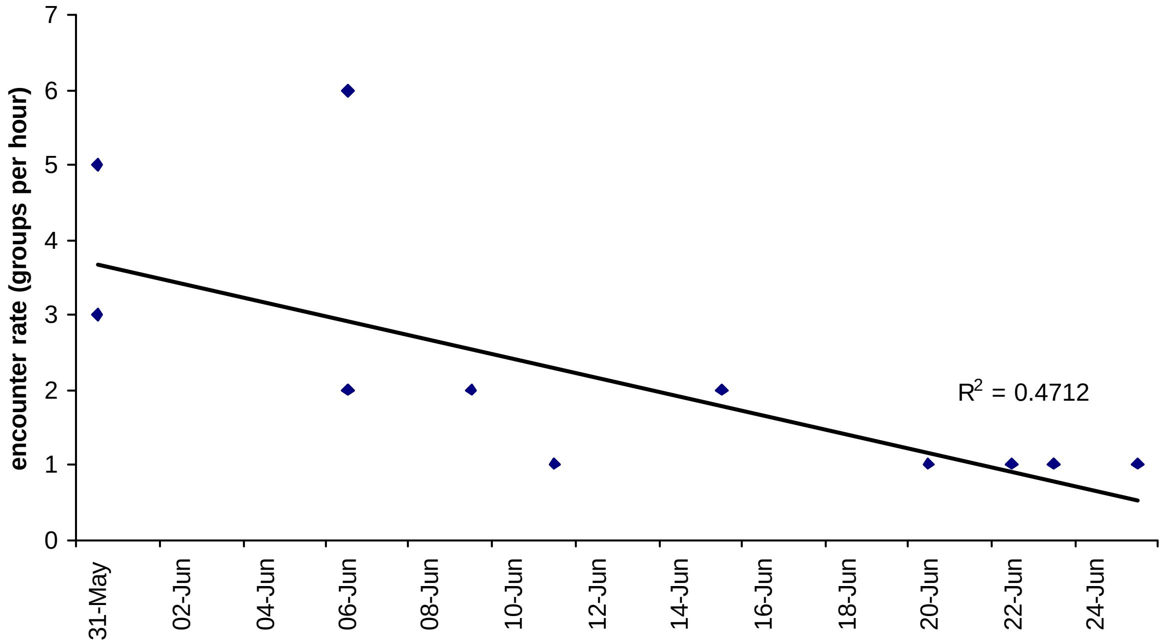

Figure 3.3.16e. Encounter rate for dusky-headed parakeets during VDLTs for the duration of the study.

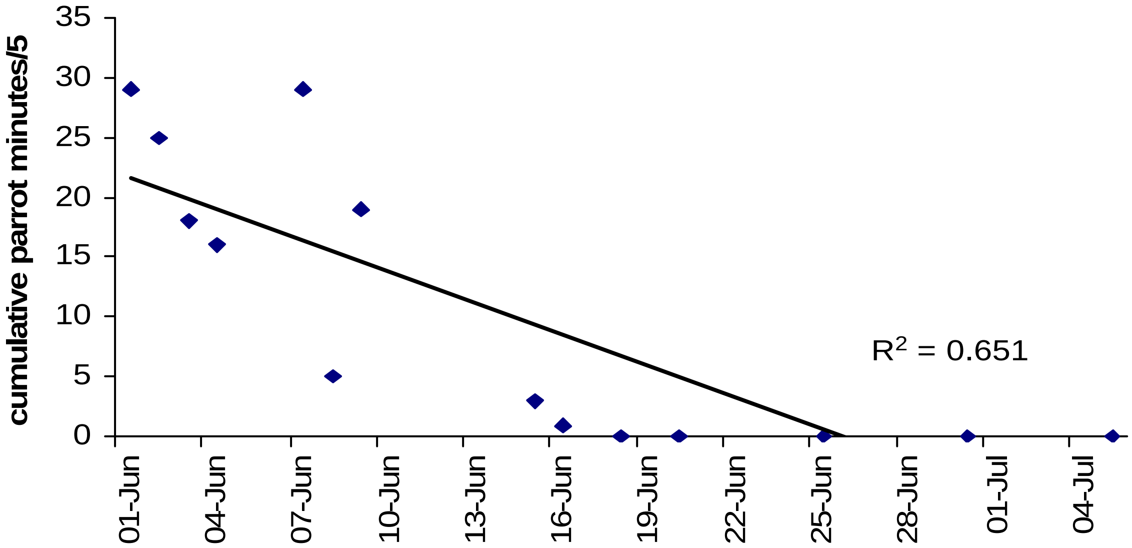

Figure 3.3.16f. Clay lick activity for dusky-headed parakeets measured in parrot minute intervals of 5 minutes for the duration of the study. Figures are based on summed parrot minutes from clay licks 1 and 3, where feeding activity for this species was recorded.

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3.3.17. Tower monitoring

Sample effort

Table 3.3.17a. Sample effort for tower and platform monitoring conducted during afternoons from 1 June to 7 July showing encounters and encounter rates for visually identified psittacid species.

	Monitoring periods (total afternoons)	Total hours of observation conducted	Total encounters	Encounters/hour
Tower	30	58.2	320	5.50
Platform	5	6.50	38	5.85
Total	**35**	**64.7**	**358**	**Average: 5.67**

Monitoring was conducted on 35 afternoons, during which time 64.7 hours of observation were logged. 358 encounters with 16 different species of psittacid were recorded. Observations were carried out from the tower on 30 afternoons, and from the platform on 5 afternoons. The cue for most encounters was a call (79%) and birds were heard to vocalise for 93% of all recorded encounters. This shows the psittacidae to be a highly vocal group, and also provides confidence in the encounter index from afternoon transects, where the principle cue for encounters is birds calling.

Species observations

The most commonly observed bird was the cobalt-winged parakeet (134 observations), followed by mealy parrots (44) and blue-headed parrots (43). Red-bellied macaw was only observed once, while orange-cheeked parrots and chestnut-fronted macaws were only observed on two occasions each. Notably, the endangered blue-headed macaw was observed on seven occasions, on four separate days. Although uncommon, the visibility of this species is an exciting development as its occurrence at the study site was not recorded prior to this study.

Visual encounters from the tower generally follow the pattern of the index created mostly from birds heard along transects and point counts conducted during the same time period during the same time of day, with the notable exception of white-bellied parrots, which were the fourth most commonly observed species. White-bellied parrots appeared to be still be more numerous than mealy parrots, as indicated in table 3.3.14a, as average group size was greater. On the whole, blue-headed parrots are a very mobile and vocal species, as although they were regularly recorded, they were hardly ever recorded perched (once in 43 observations), whereas white-bellied parrots were seen perched in the vicinity of the tower on 15 occasions. This situation again highlights the problems of trying to compare the relative abundance of species without some form of distance-based sampling.

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Since both blue-headed parrots and mealy parrots were common on the clay licks during the study period, it is possible that these species were more commonly seen from the tower due to the tower's location between clay licks 2 and 3. Studies from other times of the year will be needed in order to ascertain whether counts from a tower in the vicinity of a clay lick can be considered independent of clay lick activity, even though counts are conducted in the afternoon. This has been a principal assumption of some major studies involving studies of parrot populations from lookout points e.g. Gilardi and Munn (1998) and Bjork (2004) and would be worth evaluating in the future.

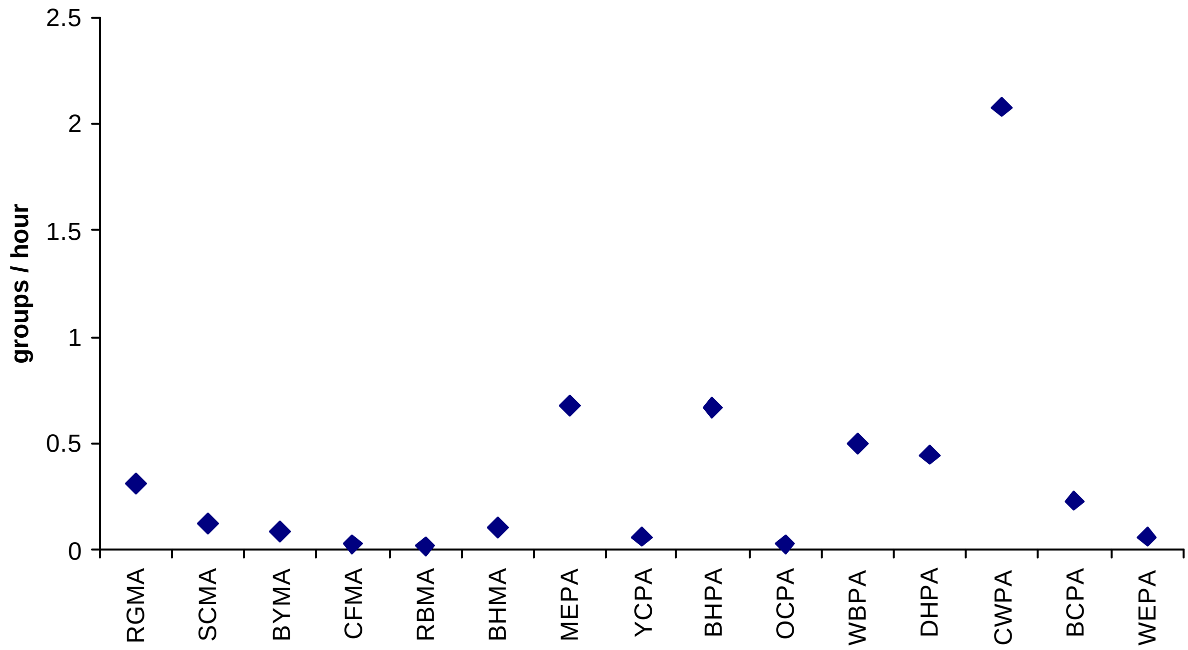

Figure 3.3.17a. Visual encounters of groups of various species of psittacidae during afternoon surveys from the tower and platform. Key: RGMA *Ara chloroptera*, SCMA *A. macao*, CFMA *A. severa*, RBMA *A. manilata*, MEPA *Amazona farinosa*, YCPA *A. ochrocephela*, BHPA *Pionus menstruus*, DHPA *Aratinga weddellii*, WEPA *A. leucopthalmus*, CWPA *Brotogeris cyanoptera*, BCPA *Pyrrhura rupicola*, BHMA *Propyrrhura couloni*, WBPA *Pionites leucogaster*, OCPA *Pionopsitta barrabandi*, BYMA *Ara ararauna.*

For species that were observed on more than ten occasions, average distance to where birds were first detected shows the expected negative correlation with size (Bjork 2004), with red-and-green macaw, mealy parrots and blue-headed parrots detected first further away compared to dusky-headed parakeets, cobalt-winged parakeets and black-capped parakeets as shown in the figure below.

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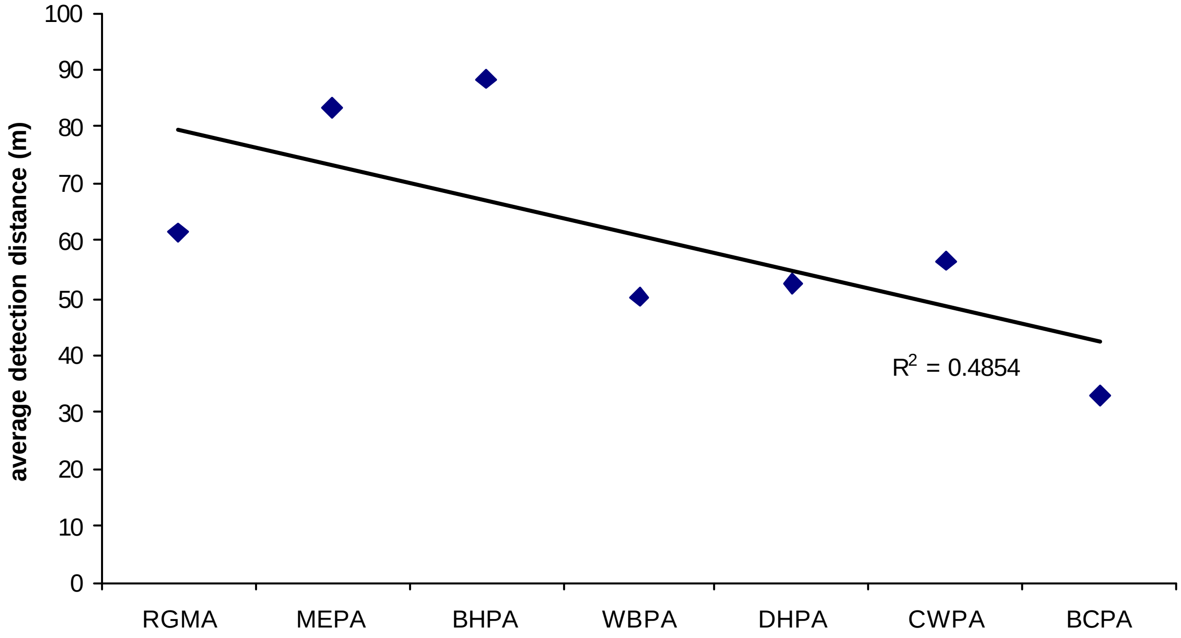

Figure 3.3.17b. The correlation between average detection distance and bird size for seven species that were observed on more than ten occasions during afternoon monitoring sessions from the platform and tower. Key: RGMA *Ara chloroptera*, MEPA *Amazona farinosa*, BHPA *Pionus menstruus*, DHPA *Aratinga weddellii*, CWPA *Brotogeris cyanoptera*, BCPA *Pyrrhura rupicola*, WBPA *Pionites leucogaster.*

Most flying birds were recorded flying on a bearing between 136 and 225 degrees. This trend was most evident for cobalt-winged parakeets and red-and-green macaw, species whose flight path may be influenced by the location of clay licks as they are known to feed in the afternoons. This trend was also observed clearly in mealy parrots, whose flight path in the afternoon should be independent of clay licks as this is a species that feeds only in the mornings (see figures in Appendix). A possible explanation is that mealy parrots were flying towards clay lick 3 where large numbers of this species were observed congregating every morning, or to a nearby roost site. Red-and-green macaws could potentially have been observed flying towards or leaving clay licks 1 and 2 where this species was recorded feeding, as the flight path corresponded with this trajectory. White-bellied parrots, a species not recorded on clay licks in the vicinity were not observed to favour this trajectory. This species has only been recorded feeding in the morning at other clay licks that have been studied, and although common in the area, were never seen feeding on the clay licks monitored in this study. White-bellied parrots were never recorded flying east (from terra firme forest to floodplain forests), but were recorded flying towards terra firme forest.

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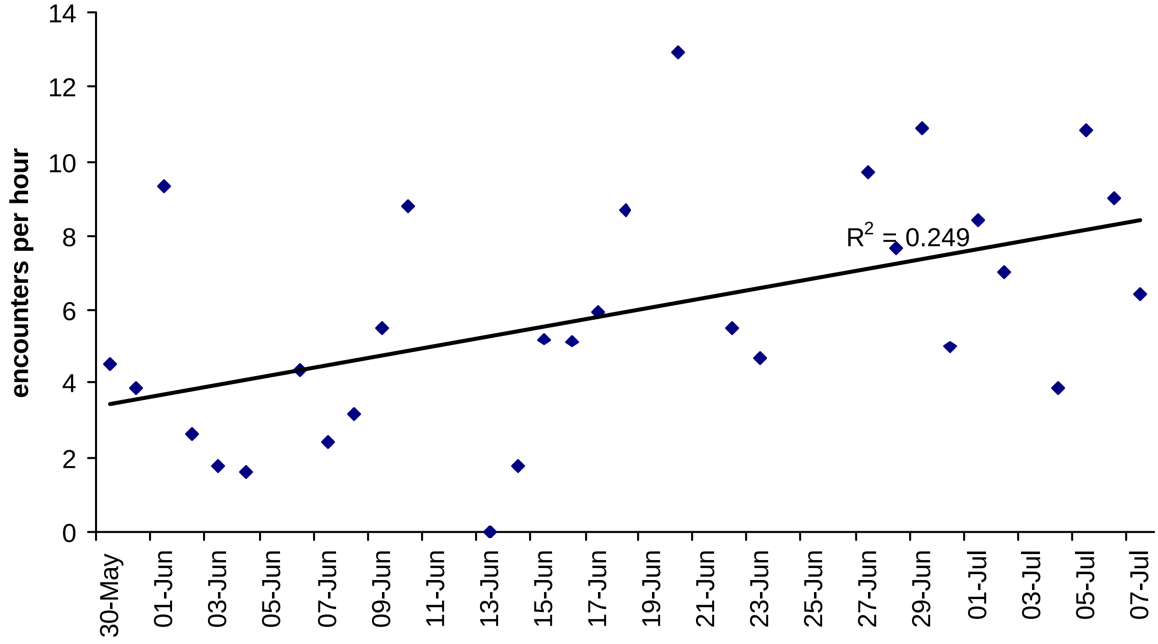

Figure 3.3.17c. Encounter rate per hour for all visually identified psittacid species for the duration of the study showing an increased encounter rate over time. Results are presented for observations from the tower only.

The general encounter rate of birds seen from the tower during the study increased over the six week monitoring period. This cannot be attributed to more birds arriving in the area to visit clay licks, as observations were biased by increased sightings of cobalt-winged parakeets, white-bellied parrots and black-capped parakeets visiting flowering lianas *Combretum* sp. close to the tower to feed. Feeding was first recorded from these flowers on 18 June, and continued to be recorded for the rest of the study. The flowers attracted a wide variety of birds, as well as brown capuchin monkeys *Cebus apella*.

3.3.18. Vegetation survey

Non-palm trees with DBH (diameter at breast height) greater than 50 cm

Table 3.3.18a. Fruiting trees with a DBH of greater than 50 cm. 206 large trees were counted in all, of which seven were recorded as being dead, and 32 of which the fruit or flower status was unknown.

	Total		Fruiting Capacity			Fruit Ripeness		
Transect	n	Fruiting trees	0-33	34-66	67-100	Green	Nearly ripe	Ripe
A	74	2	1		1		1	1
B	44	5		3	1	4		
CT	15	1		1				1
RT	34	7	1	2	4	2	2	3
Totals	**167**	**15**	**2**	**6**	**6**	**6**	**3**	**5**

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Fewer than 10% of the large trees observed had fruit (see table above). An additional three fruiting trees were counted with DBH lower than 50 cm, two from the RT and one from CT. Eight of the fruiting trees were not identified. Of the remaining, three were identified as *Ficus* sp.

Five trees were recorded as being in flower, one from A, two from B and two from RT. No trees were recorded as being both fruiting and flowering. The total number of fruiting trees per transect was not sufficient to run an analysis of abundance using DISTANCE software (Laake et al. 1994). There is no significant correlation between the number of fruiting trees counted per transect and average encounter rate per hour (Pearson correlation, p=0.242).

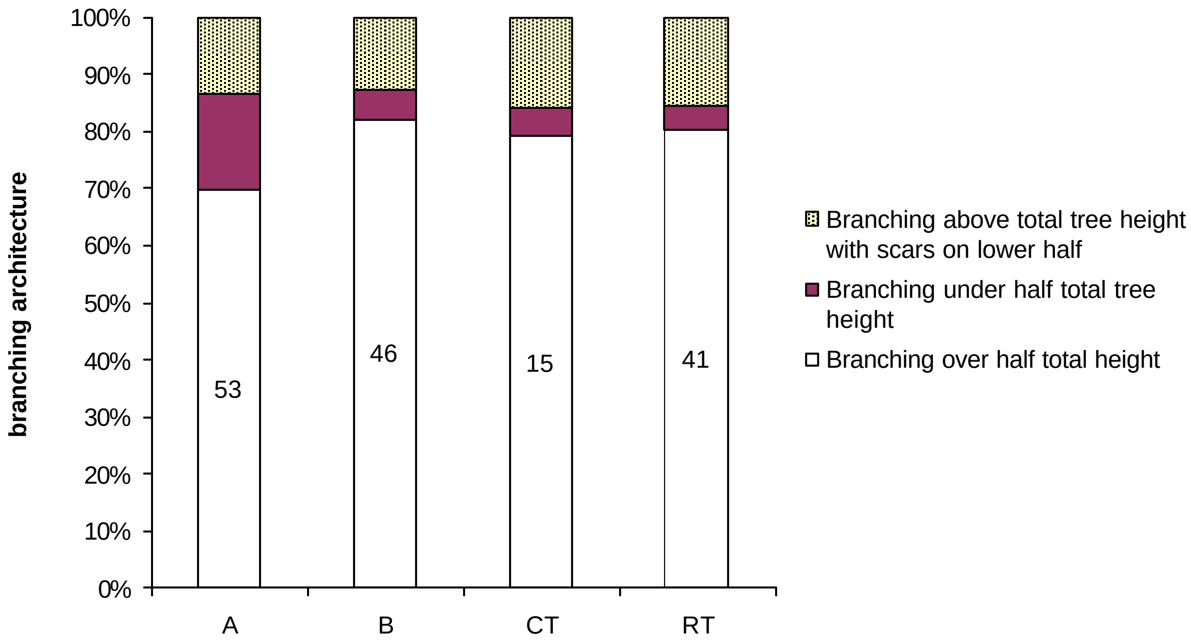

Figure 3.3.18a. Branching architecture of trees surveyed with DBH greater than 50 cm by transect. Values within the bars represent total number of trees from which percentage bars are calculated.

Transect A is the only transect that stands out as having a greater proportion of trees with branching under half the total tree height (see figure above). For all transects most tall trees branch above half the total tree height. This shows that in general the forest is undisturbed, as branching occurs under half the tree height (or scarring is evident) more often when trees grew in open canopy conditions associated with tree falls.

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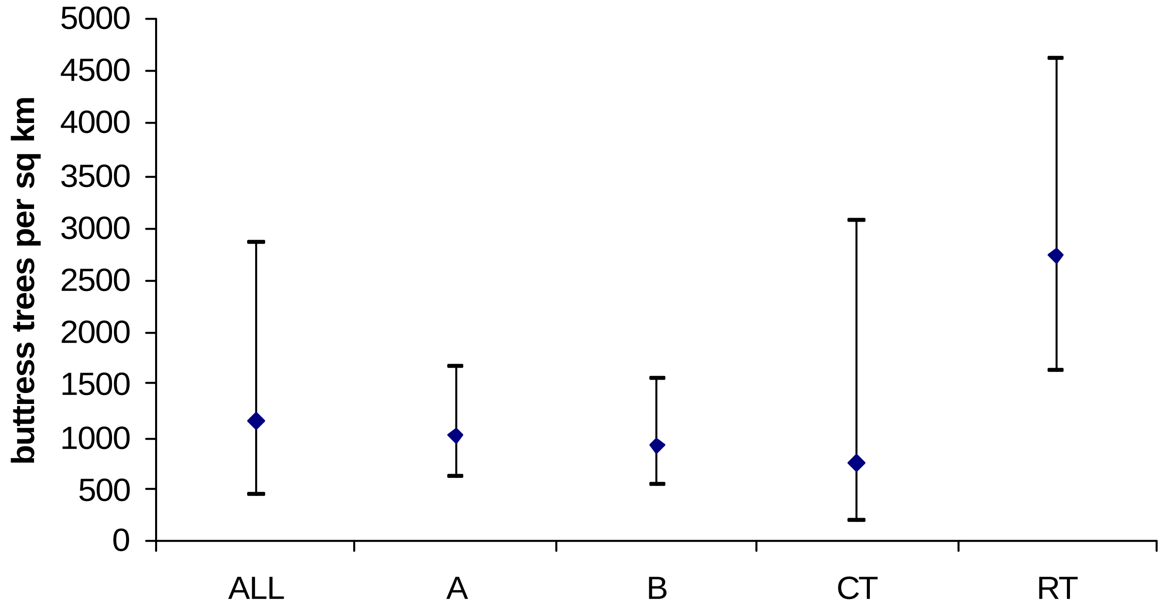

Figure 3.3.18b. Average relative abundance of trees per square kilometre with a DBH over 50 cm for which buttress roots extended above 1.7 m as calculated by DISTANCE software (Laake et al. 1994). Bars represent 95% C.I. ALL shows the results for all transects (A, B, CT, RT) combined.

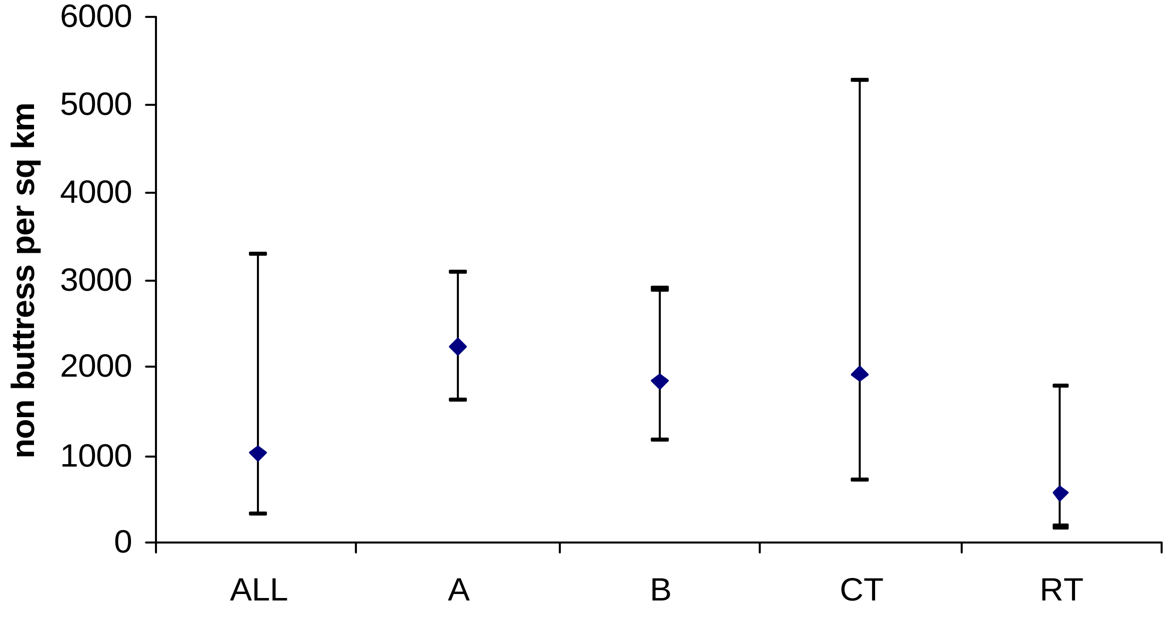

Figure 3.3.18c. Average relative abundance of trees per square kilometre with a DBH over 50 cm for which no buttress roots extended above 1.7 m or where no buttress roots were observed, as calculated by DISTANCE software (Laake et al. 1994). Bars represent 95% C.I. ALL shows the results for all transects (A, B, CT, RT) combined.

The above two figures show the different growth forms, which can predominate in different forest types. The river trail had a much higher proportion of tree with buttress roots and a lower proportion of trees where no buttress roots were recorded. The confidence intervals for both groups of trees for CT are high due to the low number of large trees recorded along this transect.

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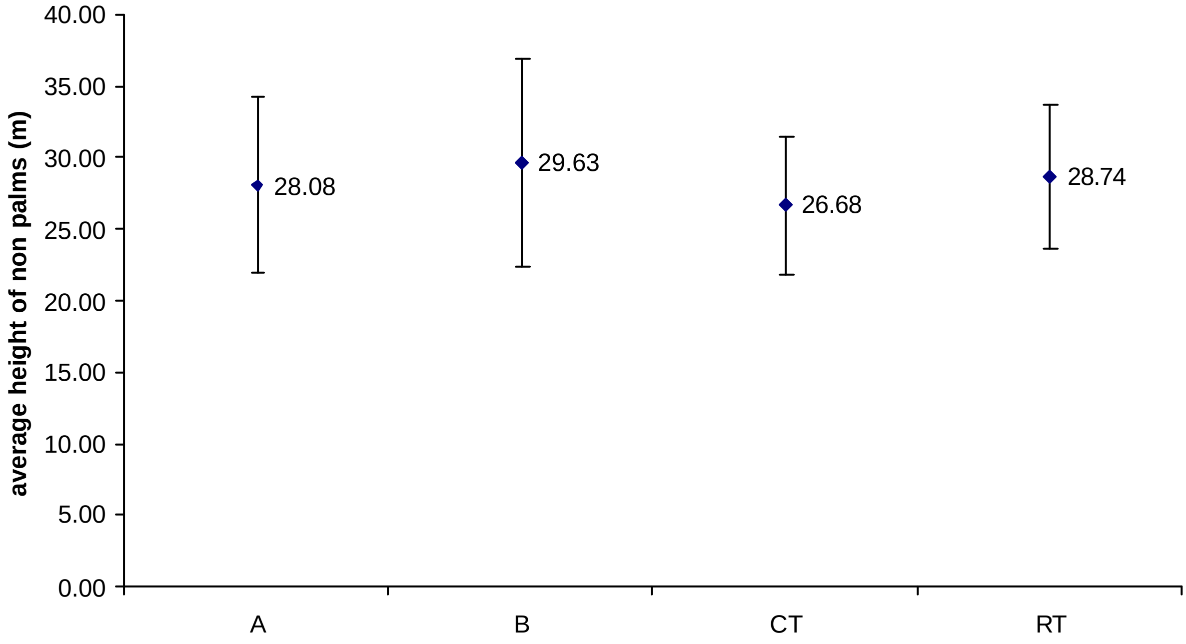

Figure 3.3.18d. Average height of trees with DBH greater than 50 cm for each transect. Bars represent standard deviation, with the average value per transect displayed.

The average canopy height for large trees recorded along the trails is not significantly different. However, it is lowest for CT, associated with seasonal swamp.

Table 3.3.18b. Percentage of large trees and palms recorded with lianas for each transect.

		A	B	CT	RT	**Total**
Large trees	Lianas present	58%	64%	84%	71%	**65%**
	Lianas absent	43%	36%	16%	29%	**35%**
Palms	Lianas present	8%	8%	40%	4%	**10%**
	Lianas absent	92%	92%	60%	96%	**90%**

CT had the highest number of large trees with lianas, and substantially more palms were recorded with lianas than without (see table above). Generally, this forest type is associated with higher liana density, explaining the local name for the habitat type "sogal", meaning ropey. *Attalea*, the dominant palm genus in this forest type, may be more prone to infestation with lianas due to its lower overall growth form with many protruding leaf scars, and rough trunk. The number of palms with Lianas on A, B and RT were low. These trails were characterised by higher numbers of smooth trunk, tall palms like *Iriartea* and *Euterpe*, which would allow less purchase for lianas.

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Palms

Table 3.3.18c. The fruiting and flowering status of all palms over 5 m in height, surveyed using VDLTs for 500 m transects. 907 palms were recorded in total, of which 12 were recorded as being dead, and for which 129 the fruit or flower status was unknown.

		Total			Fruiting Capacity			Fruit Ripeness		
Trans-ect	N	Flower-ing	Fruit + flower	Fruiting	0-33	34-66	67-100	Green	Nearly ripe	Ripe
A	106	9	1	4	1	1	3	0	2	3
B	306	12	2	14	7	2	7	0	3	13
CT	78	0	0	2	0	0	2	2	0	0
RT	276	16	5	19	8	7	9	1	4	18
Totals	**766**	**37**	**8**	**39**	**16**	**10**	**21**	**3**	**9**	**34**

About 7% of all the palms recorded were recorded with fruit. RT and B, both floodplain forest, recorded the most number of fruiting palms (see table above). Fruit was mostly recorded as ripe. *Iriartea* palms were the most abundant fruiting palm and were found in the largest numbers on these trails (see table below), being almost absent from CT (seasonal Swamp or "sogal"). DISTANCE software (Laake et al. 1994) density values for the next three most common genera are shown in the Appendix (figures A5, A6 and A7). CT was the only trail to record *Bactris* but recorded neither *Oenocarpus* species. RT had more *Euterpe* than the other trails (figure A7). There is no significant correlation between the number of fruiting palms counted per transect and average encounter rate per hour (Pearson correlation, p=0.202).

Table 3.3.18d. Table of total number of genera of palms over 5 m identified for 500 m transects surveyed using variable distance line transects, including palms classified as dead and palms for which fruiting status was unknown.

Palm genus	Common name	A	B	CT	RT	**Species total**
Iriartea	Pona	14	228	1	212	**455**
Attalea	Shapaja	32	58	54	35	**179**
Astrocaryium	Huicungo	24	24	18	37	**103**
Euterpe	Wasai	25	13	7	41	**86**
Oenocarpus bataua	Ungurahui	10	15		12	**37**
Oenocarpus mapora	Sinamilla	17	8		5	**30**
Bactris	Pijuayo			7		**7**
Socratea	Cashapona		6		1	**7**
Trail Total		**124**	**352**	**87**	**344**	**907**

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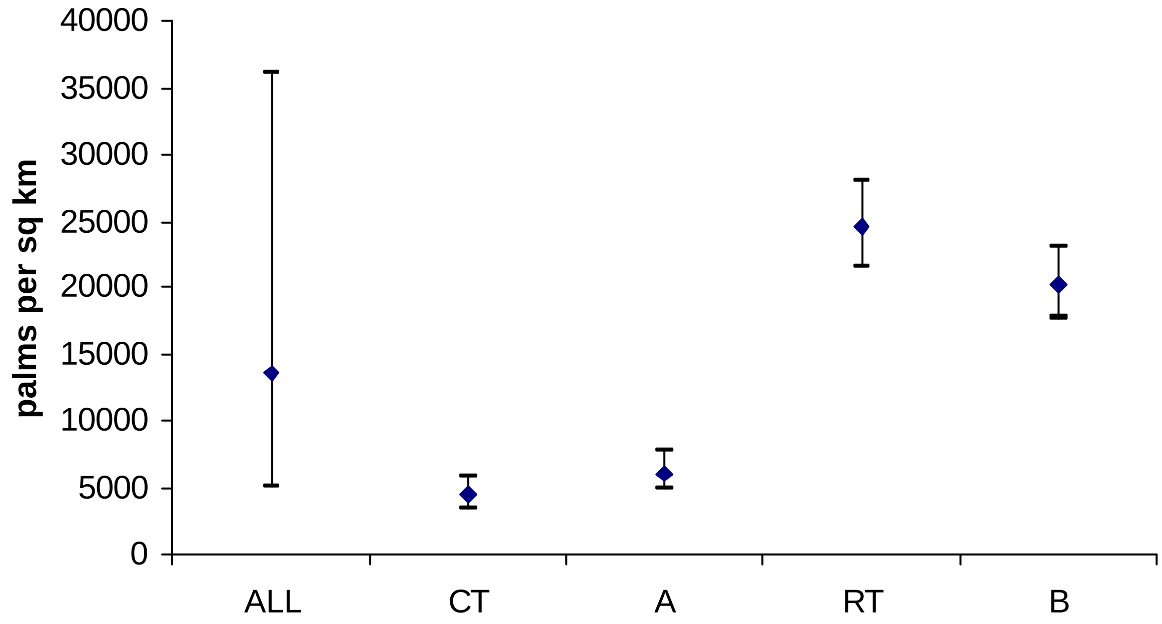

Figure 3.3.18e. Palm density (palms per kilometre squared) for all palm species surveyed for four transects. Bars indicate 95% C.I. Values calculated from DISTANCE software (Laake et al. 1994). ALL shows the results for all transects (A, B, CT, RT) combined.

Floodplain forest, represented by RT and B, has a significantly higher palm density compared to High Forest (A) and Seasonal Swamp (CT) (see figure above). Palm composition also varies according to habitat type (see table above).

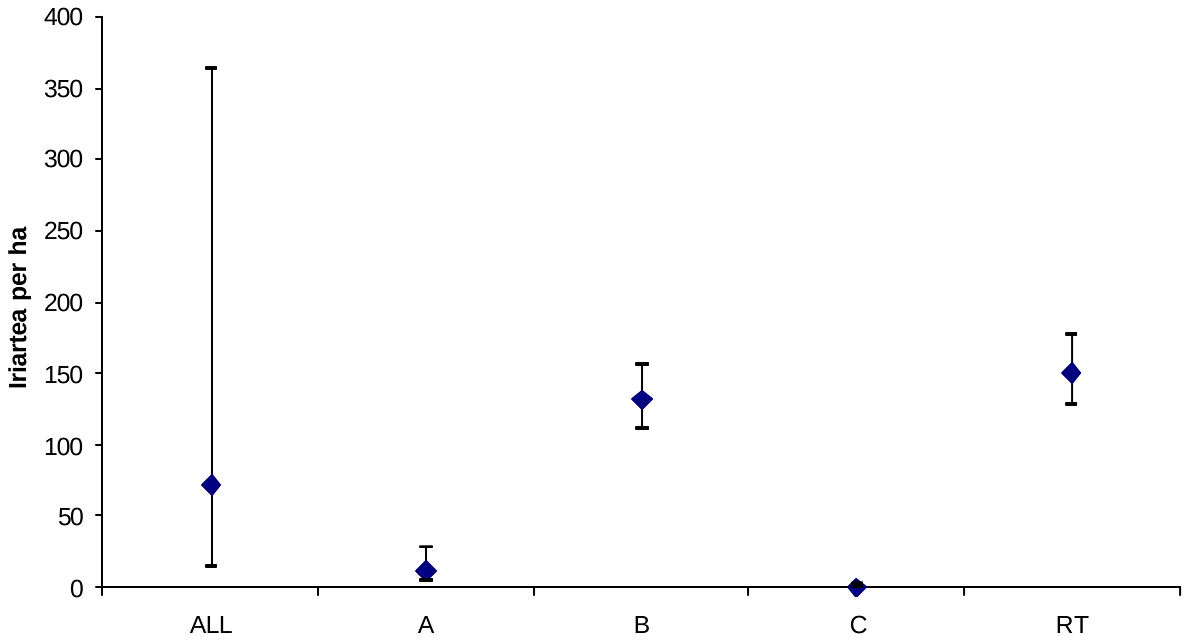

Figure 3.3.18f. *Iriartea* palm density (palms per hectare) for transects surveyed. Bars indicate 95% C.I. Values calculated from DISTANCE software (Laake et al. 1994). ALL shows the results for all transects (A, B, CT, RT) combined.

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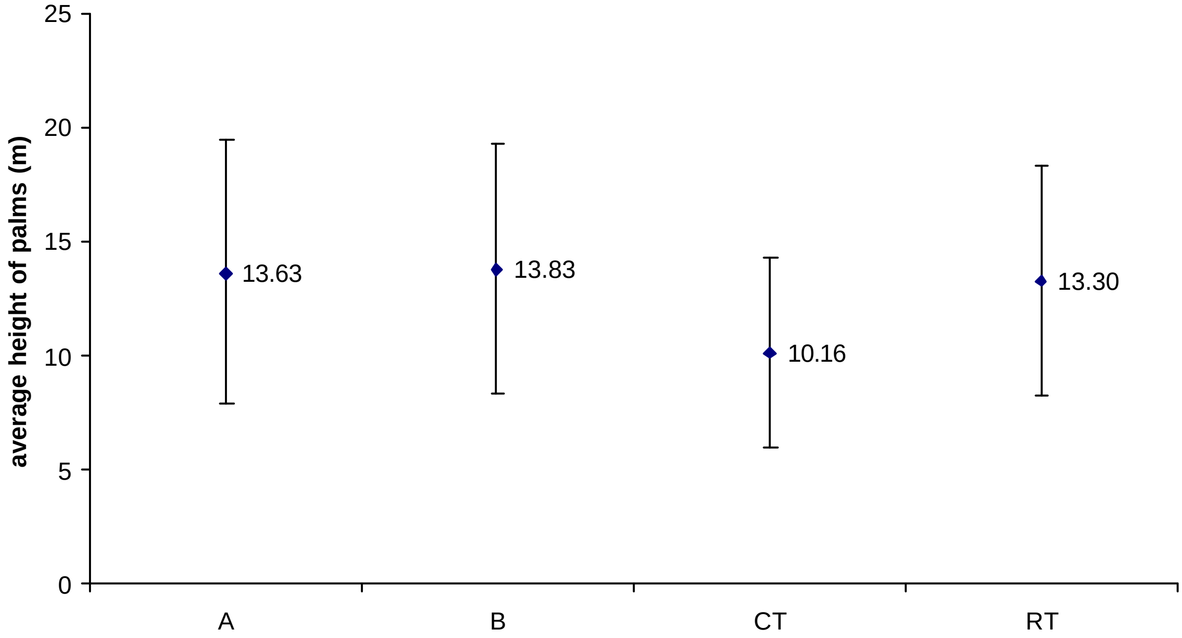

Figure 3.3.18g. Average height of all palms over 5 m for each transect (values displayed for each transect), bars represent standard deviation.

Figure 3.3.18g above shows that CT has a lower average height for all palms. This is due to the lack of *Iriartea*, a species abundant on RT and B, which was often recorded at heights over 15 m. However, there is no significant difference between values overall. The low average palm height and palm density combined with the lower average large tree height would lead one to expect the overall canopy for seasonal swamp to be lower than for the floodplain forest and high forest.

Canopy Density – Light Transmittance

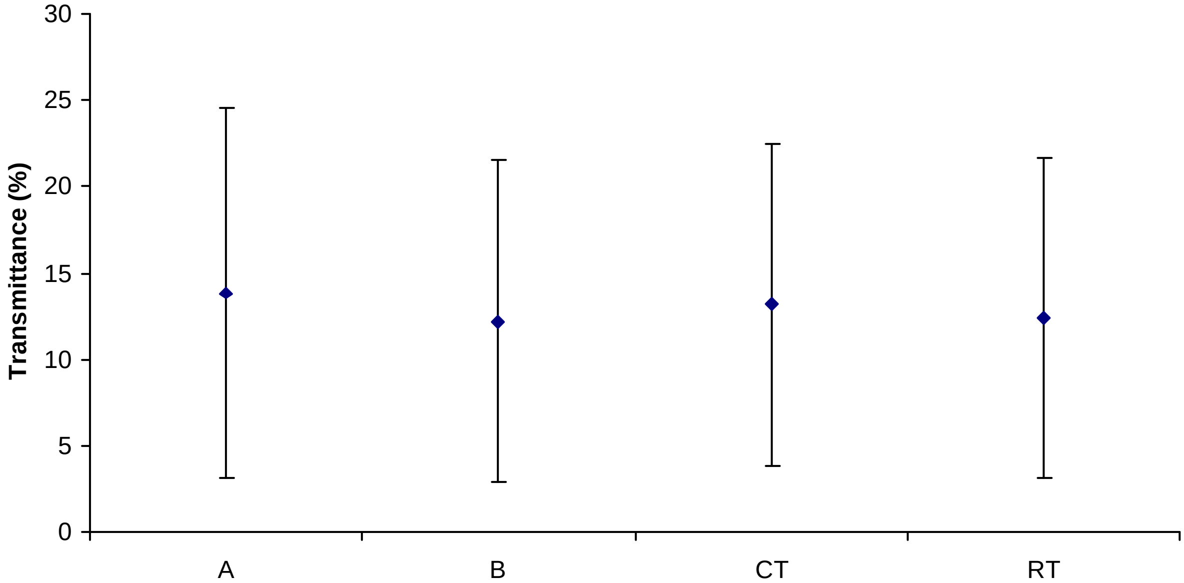

Figure 3.3.18h. Light transmittance values from the canopy-scope study, represented as percentage light transmittance to the forest floor.

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Although it may have been expected that CT would have a higher light transmittance due to lower average canopy height, this was not observed (see figure above). The average transmittance for all trails was very similar. The amount of canopy cover and the size and distribution of canopy gaps determine the amount of light transmitted through the canopy (Hale 2004). Thus the results presented here are influenced by tree falls gaps as well as by general foliage density. Either way, the canopy density is not a key variable in explaining variation in parrot and macaw density in this study.

Fallen food availability index

Table 3.3.18d. Potential food resource availability per transect as calculated from 1x1m quadrats. *Parrot encounters per hour (from VDLTs) for A transect based on the average of A1 and A2.

		A	B	CT	RT	**All transects**
Food index (types of food x number of items)	Average	1.97	5.42	0.82	3.36	**2.98**
	StdDev.	5.27	13.46	2.07	11.19	**9.58**
Types of potential food per 1m^2 quadrat	Average	0.23	0.46	0.32	0.47	**0.38**
	StdDev.	0.49	0.73	0.59	0.63	**0.63**
Parrot encounters per hour		6.98*	9.16	5.73	7.87	

Table 3.3.18d above shows the highest food index for B, followed by RT, A and CT. The chance of finding a potential food source was highest in B and RT. Although it is commonly recognised that fruit availability on the ground is not representative of fruit availability in the canopy as a lag occurs between trees fuiting and fruit falling, the floodplain forest types show the highest food index. It is recognised that many of the potential food sources as determined by the observers in this study may not be considered so by frugivores in general. It is recognised that a far superior methodology would be to identify and quantify food sources from known food sources only, but this information was not available to the observers in this study. Despite this, there is a significant positive correlation between encounters per hour recorded during transects and the fallen food index (Pearson correlation, $p<0.01$).

Termitaria

Arboreal termitaria (nesting sites for termite species) are known to be nesting sites for various species of bats and birds, including the cobalt-winged parakeet. Results for the VDLT of termitaria were analysed using DISTANCE (Laake et al. 1994). Although this small survey of termitaria was undertaken to show that cobalt-winged parakeet encounter rate was not related to potential nesting sites as figure 3.3.18i shows, this possibility cannot be ruled out. The estimated density of termitaria was highest on RT, where the rate of encounters per hour of cobalt-winged parakeets was the highest both during point counts and transects. Although A had the lowest encounter rate with cobalt-winged parakeets and a slightly higher termitaria density compared to B and CT, this may be a function of termitaria size, as A had the highest percentage of small termitaria (see figure 3.3.18j). Although the results are not significant, a larger sample effort may well show this in the future.

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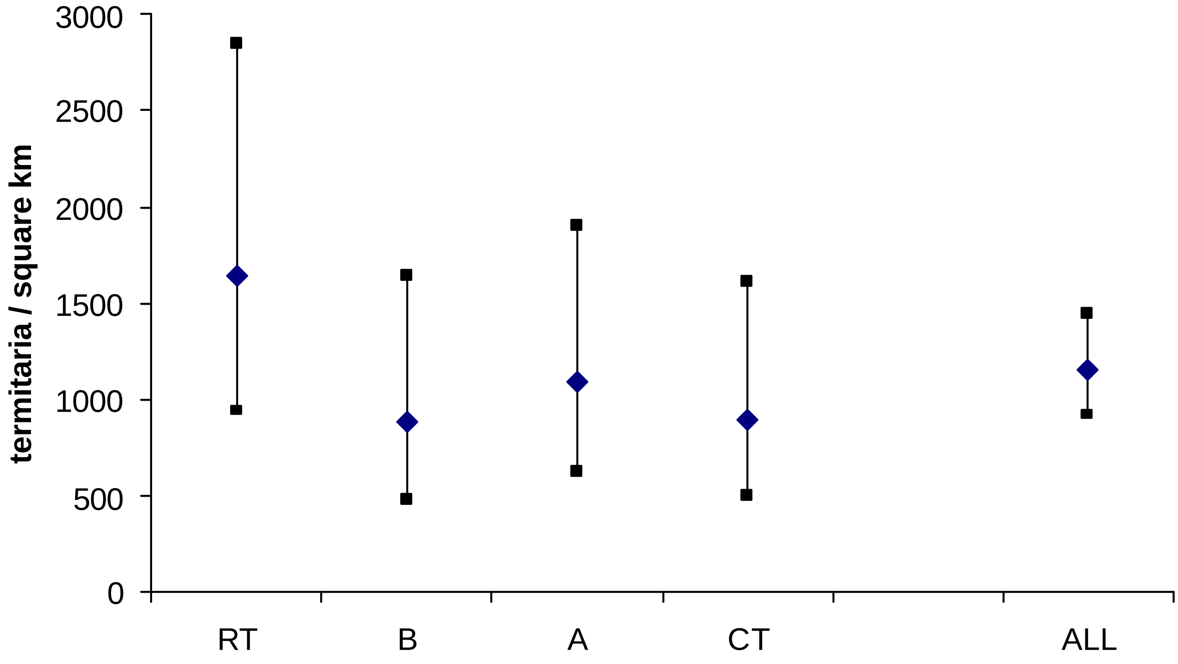

Figure 3.3.18i. Arboreal termitarium density (termitaria/km^2) for four trails along which transects and point counts were conducted. Bars represent 95% confidence intervals around the estimated density as calculated by DISTANCE (Laake et al. 1994).

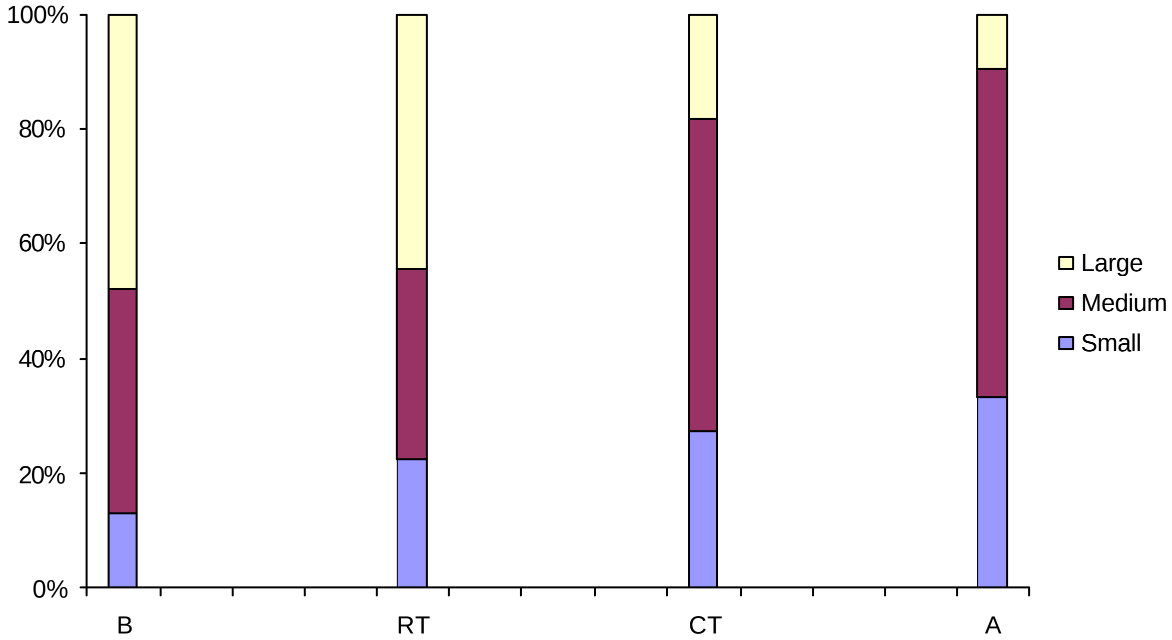

Figure 3.3.18j. Termitaria size classes per trail.

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3.4. Discussion

General patterns of clay lick use

The patterns of activity for the various species seen feeding on the clay licks is similar to those observed in previous years. This study also showed the dynamic use of closely situated clay licks, where birds travel between clay licks in the morning should they perceive potential dangers in the vicinity of another. This highlights the dangers of predicting clay lick use patterns from a single clay lick where multiple clay licks are available. In addition, birds are evidently able quickly to learn the location of new geophagy sites as seen by the large numbers of macaws visiting a site where they have never been recorded to feed before. How these sites become attractive or are identified by birds initially, however, remains unknown. Presumably clay colour and texture of banks of exposed soil are clues, which will lead these birds (that can be very experimental) to finding new clay licks.

The effects of weather

In line with previous studies, days with inclemental weather recorded fewer parrots and macaws feeding. However, contrary to expectation, on one morning following early morning rain, feeding was observed. Thus, although weather is a factor in influencing overall patterns, it appears that birds will still feed when they feel inclined to do so. Feeding was not recorded on cold and windy mornings associated with the first day of the cold fronts or "friajes" that move over the region during the dry season. Feeding was observed, however, on subsequent cold and cloudy days. Mist had a far greater influence on the number of birds which eventually fed, if feeding occurred at all. With low visibility of birds that do congregate around clay licks, it would be advisable to tour operators to find alternative activities for tourists to partake in on misty mornings.

The effects of birds of prey

The presence of certain birds of prey affects the activity of certain size psittacidae, even though the birds of prey in question are not known to feed on birds. Roadside hawk, the most abundant raptor observed, negatively impacted on feeding of dusky-headed parakeets. Blue-headed parrots seemed wary, while mealy parrots appear to be affected only by sudden movements of these birds of prey as opposed to their presence. Roadside hawk and laughing falcon presence during the mid-morning did not affect red-and-green macaw feeding, but the appearance of an ornate hawk eagle on one day put all the birds to flight.

The hunting activity of an orange-breasted falcon on one morning where the raptor was actively seen pursuing a blue-headed parrot, resulted in flight of all parrots and parakeets from the vicinity.

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The effects of boat traffic

Boat traffic is clearly seen to reduce the amount of feeding activity observed in large macaws. This trend is most evident at clay lick 2. The fact that this is a new clay lick that birds have only recently begun to visit and are thus more cautious at, may also be a connected factor. Combined with other factors such as accoustic effects, these causes remain a matter of speculation. If feeding continues here, however, it will be interesting to see if the impact of boat traffic over the coming period decreases.

The effect of boat traffic on feeding rate is of concern due to the potentially negative impacts on macaw survival rates. The effects of clay deprivation on these birds is not known, but since these birds are willing to risk many potential hazards to congregate on exposed clay surfaces, one must presume the long-term benefits outweigh any costs endured by short-term exposure to predators. As the Las Piedras river is narrow, passing boat traffic has an immediate impact on feeding activities. The increased energy expended in antipredator responses by the macaws and potential costs of clay deprivation are a cause for concern, especially with boat traffic looking to increase in the forthcoming years due to continued colonisation and utilisation of the resources of the Las Piedras river. Although there is evidence to suggest that birds can get used to boat activity, whether this will happen at this study site where hunting occasionally occurs, is not known and appears unlikely.

Bird activity around clay licks

No known behavioural study has been conducted into the social activity of birds in the vicinity of clay licks. The location of clay licks as social sites, similar to leks, has to be seriously considered. In this study, very large numbers of mealy parrots consistently arrived in the vicinity of clay lick 3, yet feeding activity for this species was recorded on only three occasions for very brief periods of time. For both mealy parrots and red-and-green macaw, preening and interactive social activities feature significantly in our observations. However, as our study was primarily focused on clay lick activity, we were not able to follow specific individuals for behaviour patterns, a study which would produce very interesting results as to intra-species social order and into the importance of these areas for pairing prior to the mating season. Part of our aim in counting arriving and departing groups of parrots and macaws was to see if any pairing could be observed happening i.e. were birds arriving more often alone or in groups of threes, but leaving more regularly in pairs. This was not observed due to the complications of anti-predator responses.

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Psittacine census - a comparison of methodologies

Counts of birds arriving at clay licks were complicated by the restricted field of view, flushes and activity of birds within the field of view. However, useful information was collected regarding groups sizes and how they relate to clay lick activity. Counting birds arriving at clay licks could provide useful information as to the minimum population of a species, especially during peak seasons of clay lick activity, bearing in mind that proportions of populations of certain species that visit clay licks may differ from area to area. That is to say that if we know blue-headed macaws are known to visit clay licks in certain parts of the river, it would not be safe to say that at a clay lick where none of these birds are observed, that none of this species occurs. The "catchment area" of a clay lick, i.e. the distance from which parrots will travel from, is not known for any of the psittacine species, and in the Las Piedras river, where clay licks are evenly interspersed it would not be safe to relate a population count to the surrounding area if birds are capable of travelling to other clay licks, or even of flying into the area from catchment areas of other clay licks.

Long watch studies have been used in many avian studies (Gilardi and Munn 1998, Cougill and Marsden 2004, Bjork 2004, Vaughan *et al.* 2005). These studies are coming into favour in forest environments for obtaining visual encounters with target species. Increasingly these studies have moved from creating indices to providing more useful information on population status. However, the specialised equipment and difficulty associated with implementing survey points puts this methodology in its useful forms beyond the reach of most practical field studies. Our study highlighted the problems associated with "look-down" methodologies from the point of view of safety, comfort, logistics, time and bias at points due to changes in local conditions. Despite this, the information obtained from the long watches in this study presented results comparable to those from the other census methods employed. Observations done from canopy tops are definitely more visually rewarding than transects and point counts where a far greater effort has to be made merely to catch glimpses of birds.

Although indices are useful on a local scale, the need for distance based sampling is being emphasized in current literature (Rosenstock et al. 2002, Bibby et al. 1998). Variable distance line transects (VDLTs) and variable circular plots (VCPs) are used to this end. We employed these methodologies in the afternoon in an attempt to keep observations from being biased by activity in the early mornings associated with clay licks and to trial the effectiveness of these methodologies. Unfortunately with VCPs, there were no added benefits of spending longer periods of time at one spot with regards an increase in the number of perched birds seen, records of which are vital for analysis using the program DISTANCE (Laake et al. 1994). In general, more perched birds were seen during transects not only because more time was invested in searching for them, but also because more time could be spent searching for perched birds heard further away. Afternoon VDLTs therefore provided more useable data, but unfortunately not enough of them for good analysis for all species. The small window of opportunity that one has to sample birds during their active period in the afternoon and the associated small effective transect distances may have accounted for this. Our sample effort, 45 km, did not produce adequate sightings for good analysis of species density, and a distance of at least double this would be required. However, employing this methodology in the morning could provide better results for a similar sample effort. In addition, it would be better to get distances to all perched birds, even if these are

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estimations. Our data were limited by only taking precise data to birds where the location of the perch was known exactly, and this was normally within 50 m of the transect. Estimating distances to distance bands will be useful.

Of the habitat variables that were measured in this study (number of palms, large woody trees, light transmittance, termitaria, fruiting trees and fallen fruit), the best overall explanation for the index of number of encounters per hour was with the potential food sources observed on the ground. A more complete phenological survey may have found a correlation with the number of potential food sources, but such a study was beyond the resources of this study. Food resources have been sited on many occasions as being important in determining the distribution of birds. In addition, the termitaria count, initially done to remove these as a potential complicating variable, may account for higher numbers of cobalt-winged parakeets along the river trail, highlighting the importance of potential nesting sites for parrot density studies.

3.5. Acknowledgements

This project would not have been able to take place without the help of the many people involved. Firstly, Dr Matthias Hammer for the foresight and resources to set up and organise Biosphere Expeditions. Biosphere Expeditions has drawn together the skills of many diverse people to make a research project under difficult circumstances possible. Emma Tatum-Hume deserves huge recognition for organising activities in Puerto Maldonado, the lodge, with baby Joe and staff. Without Emma the research station would not exist and we would not be able to appreciate this amazing part of the world. Clare Fothergill was a skilled and able expedition leader who took care of everyone magnificently. Everyone appreciated her sense of humour and energy. Antonio helped greatly in the collection of a host of data and his perky energy and charisma made him a pleasure to work with. Similarly JJ Durand. Anja Kirchdoerfer volunteered her time and did a great job taking care of the laborious data entry process. Gladys, with the help of Gisella, prepared us fantastic meals in great quantities. Jose and Rolando Durand and Melo helped immensely with hoisting people up the platform as well as driving us safely up the very low Las Piedras river. Edgar also helped on long clay lick watches. But without the extra eye, ears, hands and minds of the expedition members who contributed two weeks of their time (or more) to collecting data in rain or shine, this report would not be in the format we see it today. Thank you to all of you.

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3.7. Appendices

Transect information

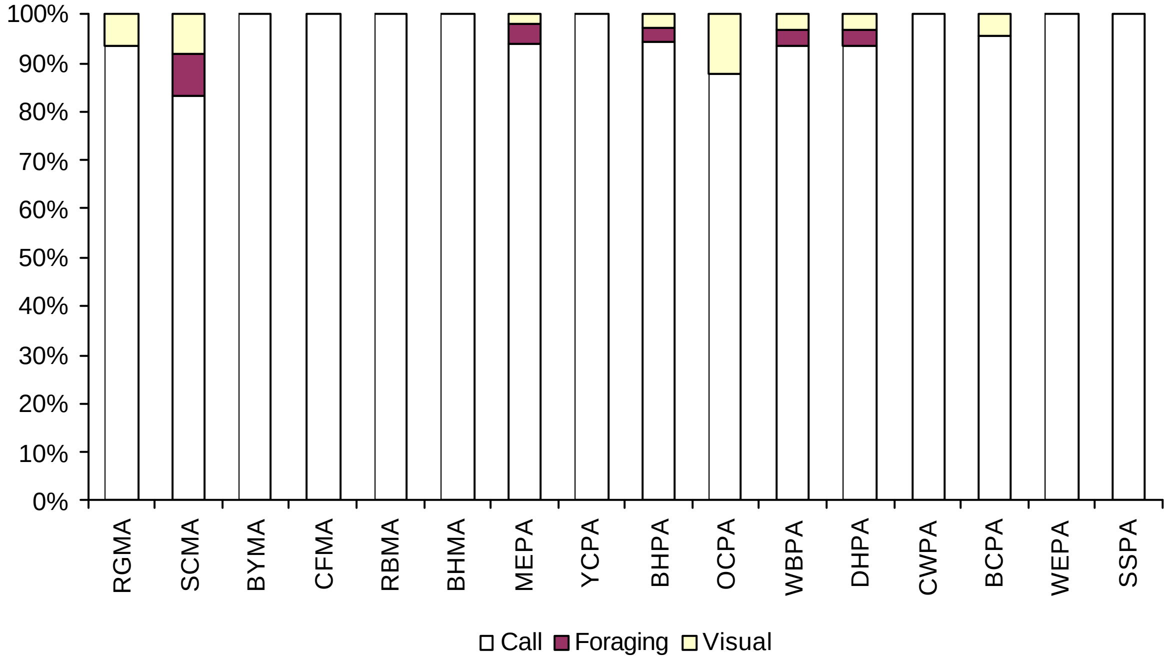

Figure A1. Principal detection for 16 psittacidae species encountered during afternoon transects.

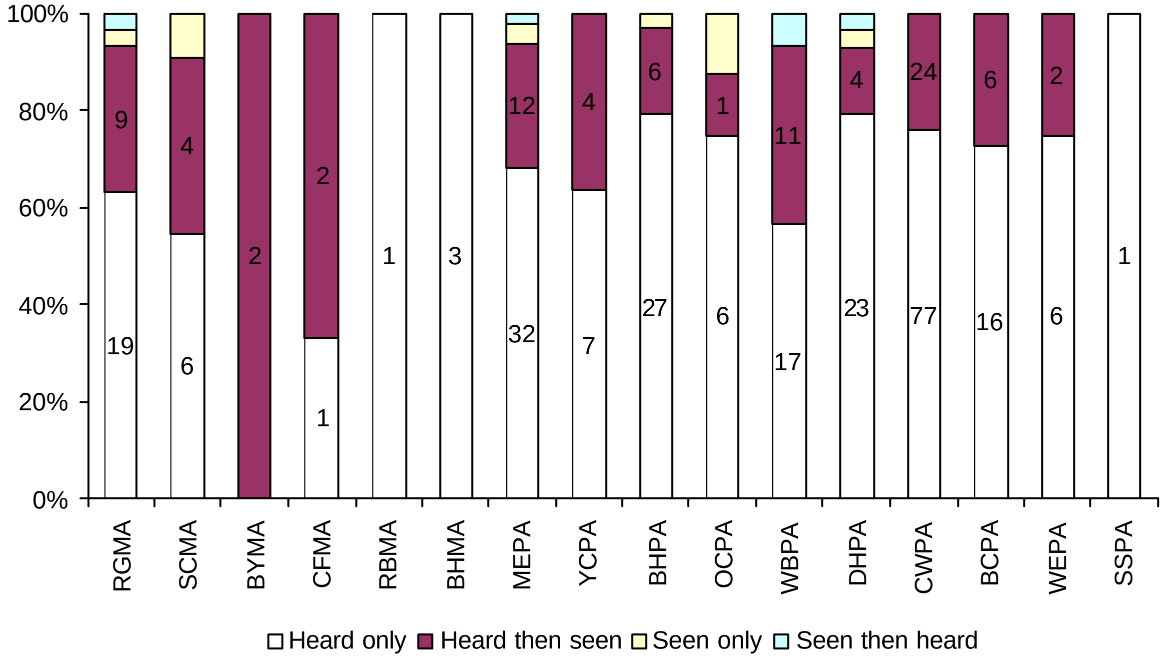

Figure A2. A percentage bar chart for visual and audible encounter types with 16 psittacidae species encountered during afternoon transects. Data combined for all transects. Figures indicate encounter size for each class of encounter.

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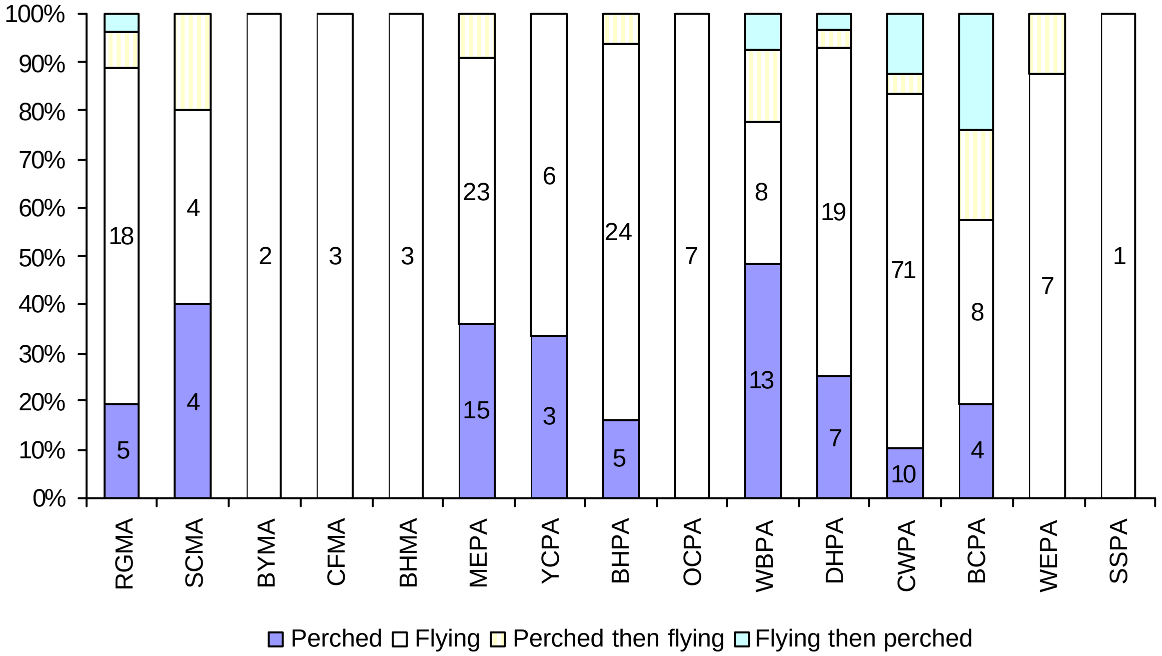

Figure A3. A percentage bar chart for activity (perched or flying) for 16 Psittacidae species encountered during afternoon transects. Data combined for all transects. Figures indicate number of encounters for each class of activity type.

Tower monitoring – flight trajectories

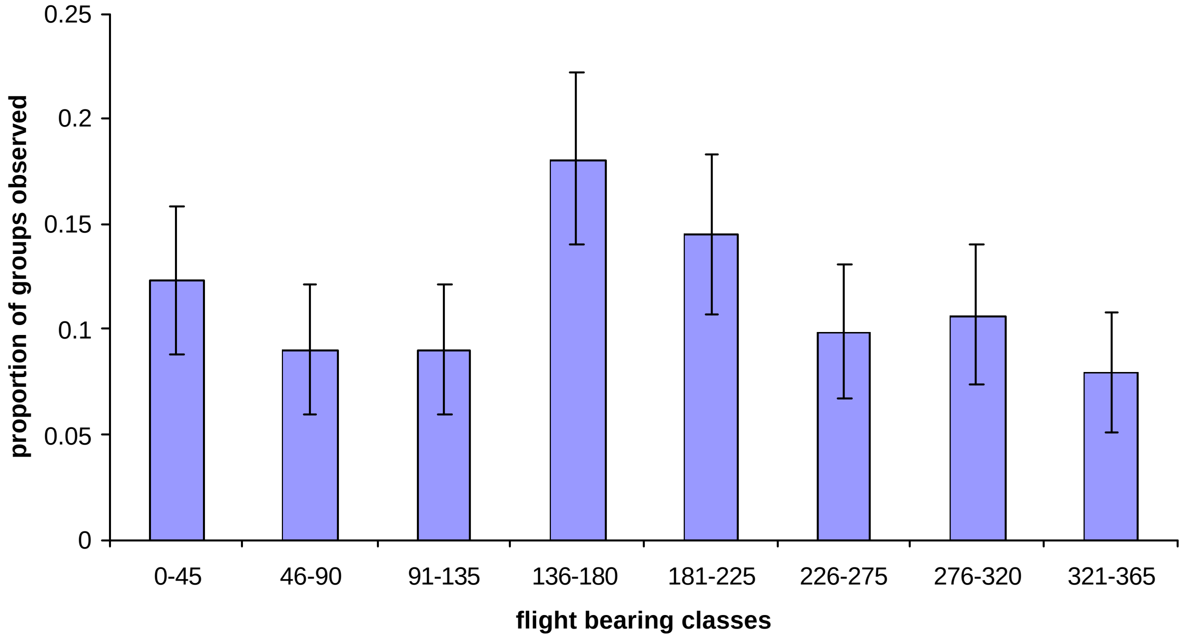

Figure A4. Proportions of flight paths for eight groups of compass bearing for groups of all psittacidae species observed flying past the tower. 95% confidence interval bars are shown.

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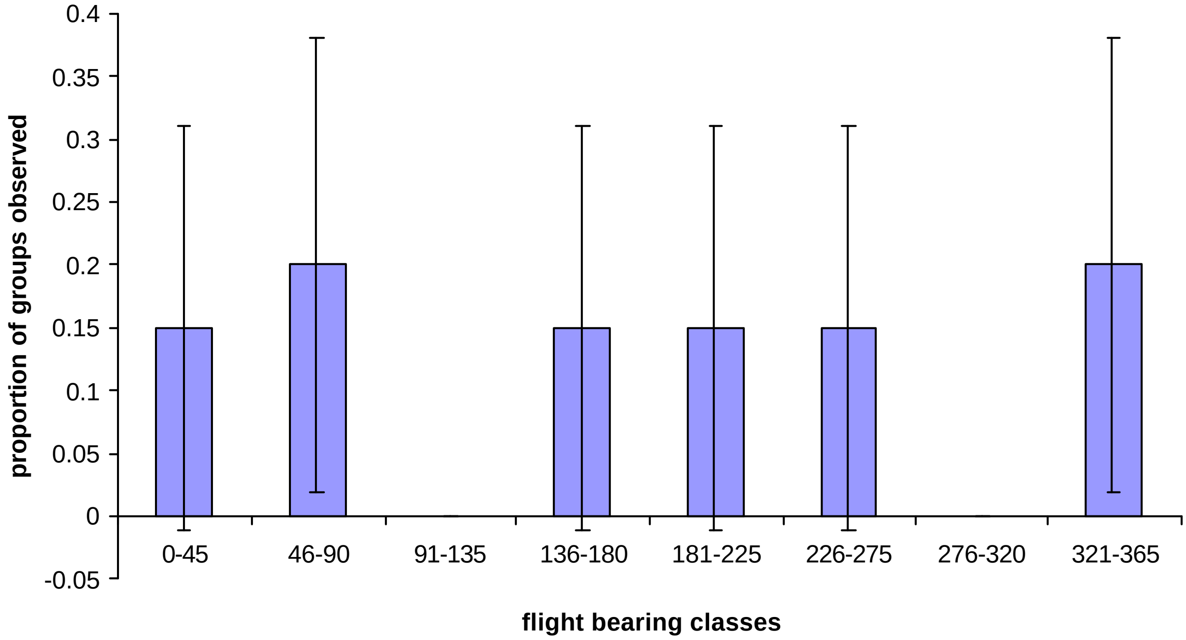

Figure A5. Proportions of flight paths for eight groups of compass bearing for all groups of red-and-green macaw observed flying past the tower. 95% confidence interval bars are shown.

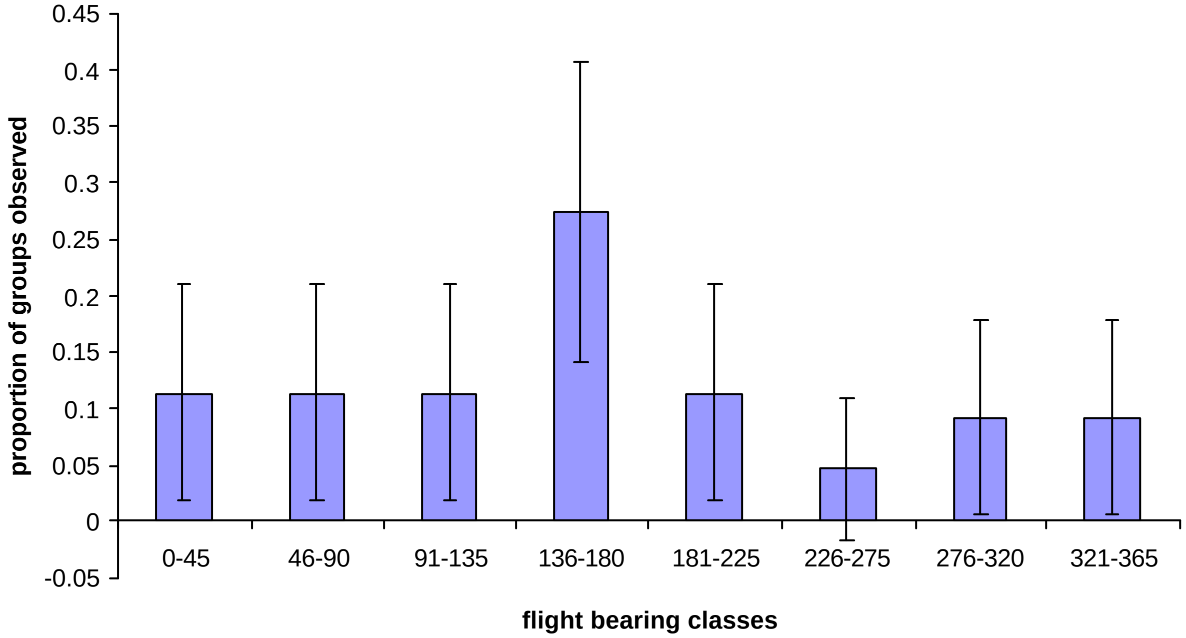

Figure A6. Proportions of flight paths for eight groups of compass bearing for all groups of mealy parrots observed flying past the tower. 95% confidence interval bars are shown.

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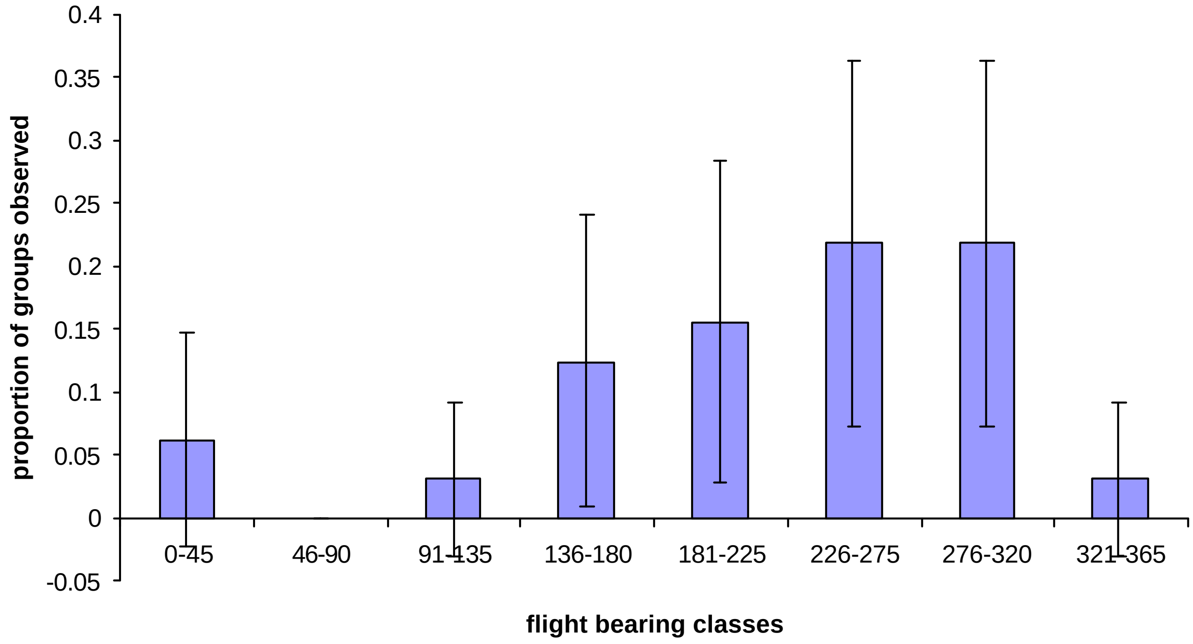

Figure A7. Proportions of flight paths for eight groups of compass bearing for all groups of white-bellied parrot observed flying past the tower. 95% confidence interval bars are shown.

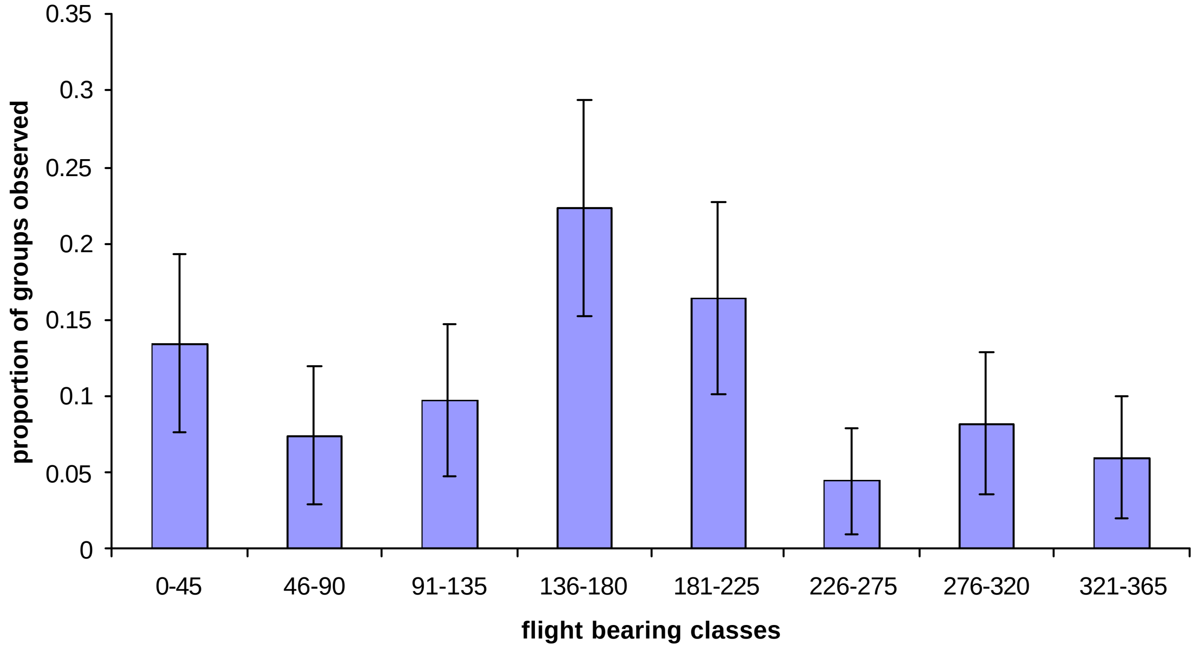

Figure A8. Proportions of flight paths for eight groups of compass bearing for all groups of cobalt-winged parakeet observed flying past the tower. 95% confidence interval bars are shown.

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Vegetation – Relative palm density for selected species between transects.

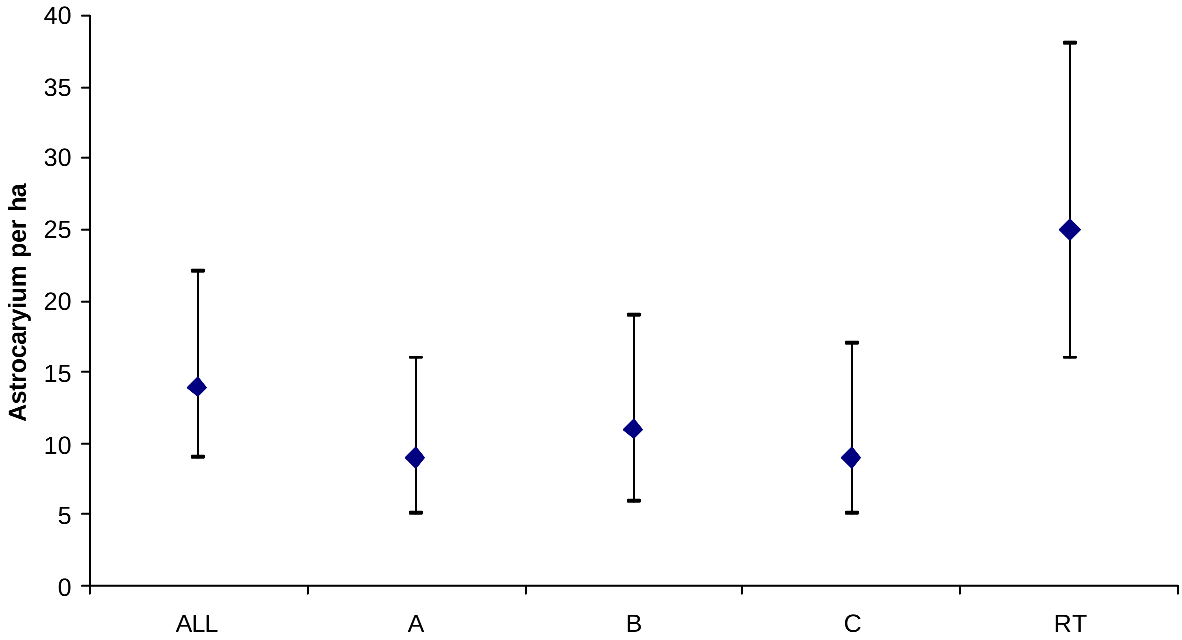

Figure A9. *Astrocaryium* palm density (palms per hectare) for transects surveyed. Bars indicate 95% C.I. Values calculated from DISTANCE (Laake et al. 1994).

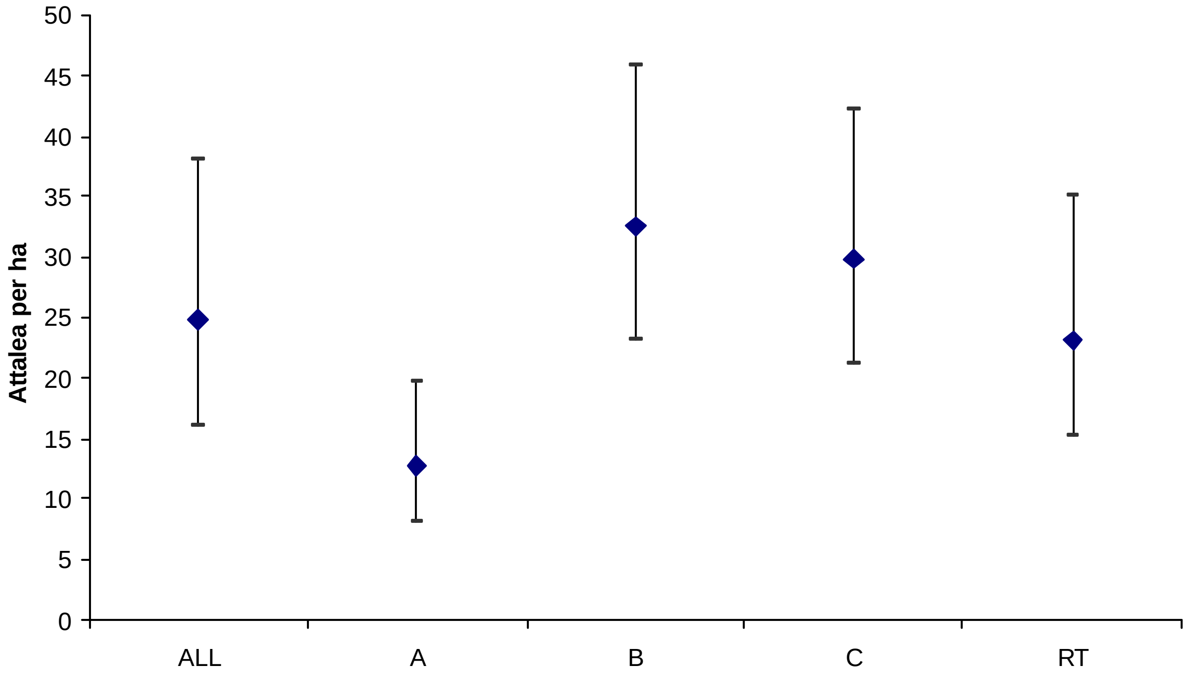

Figure A10. *Attalea* palm density (palms per hectare) for transects surveyed. Bars indicate 95% C.I. Values calculated from DISTANCE (Laake et al. 1994).

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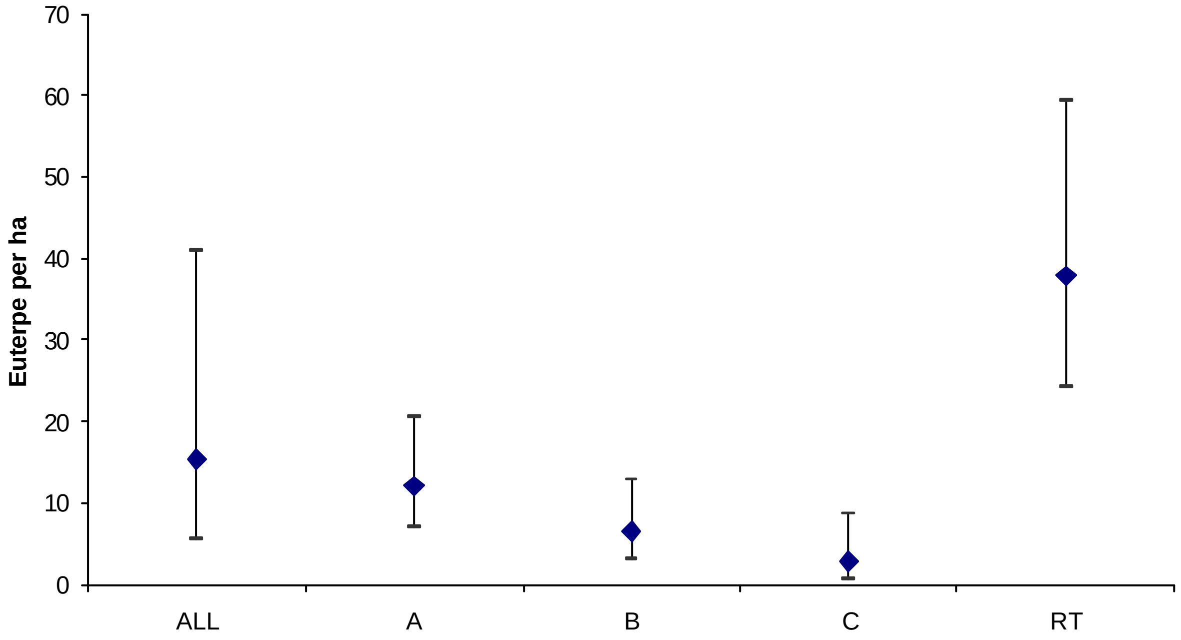

Figure A11. *Euterpe* palm density (palms per hectare) for transects surveyed. Bars indicate 95% C.I. Values calculated from DISTANCE (Laake et al. 1994).

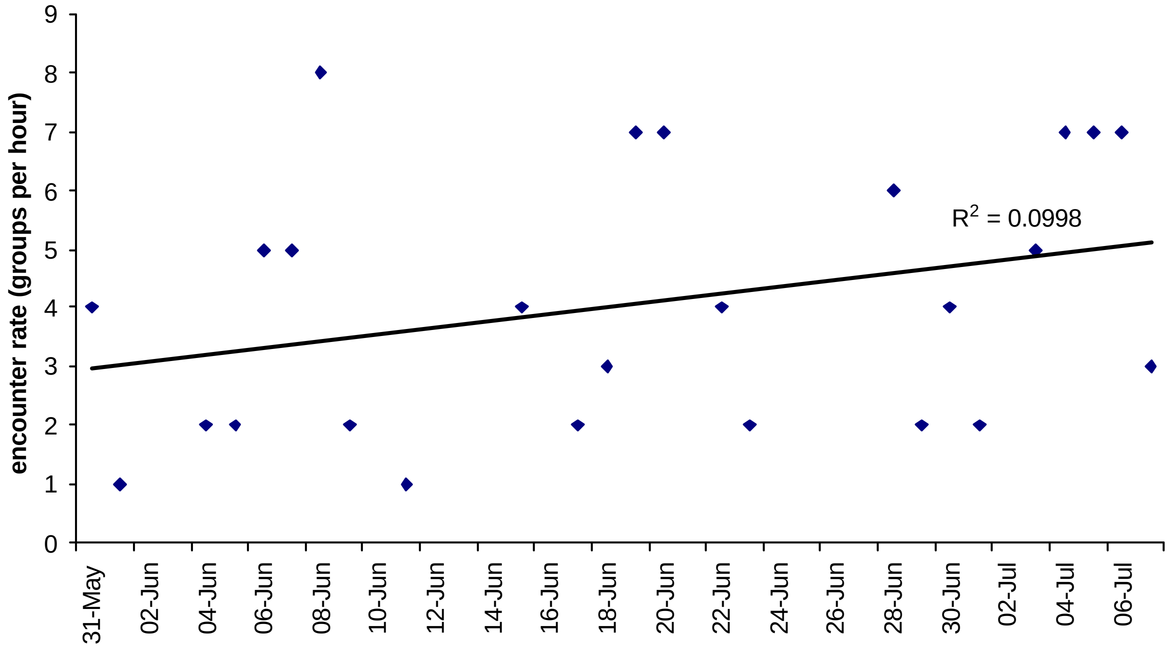

Figure A12. Encounter rates with cobalt-winged parakeets during VDLTs over the duration of the study.

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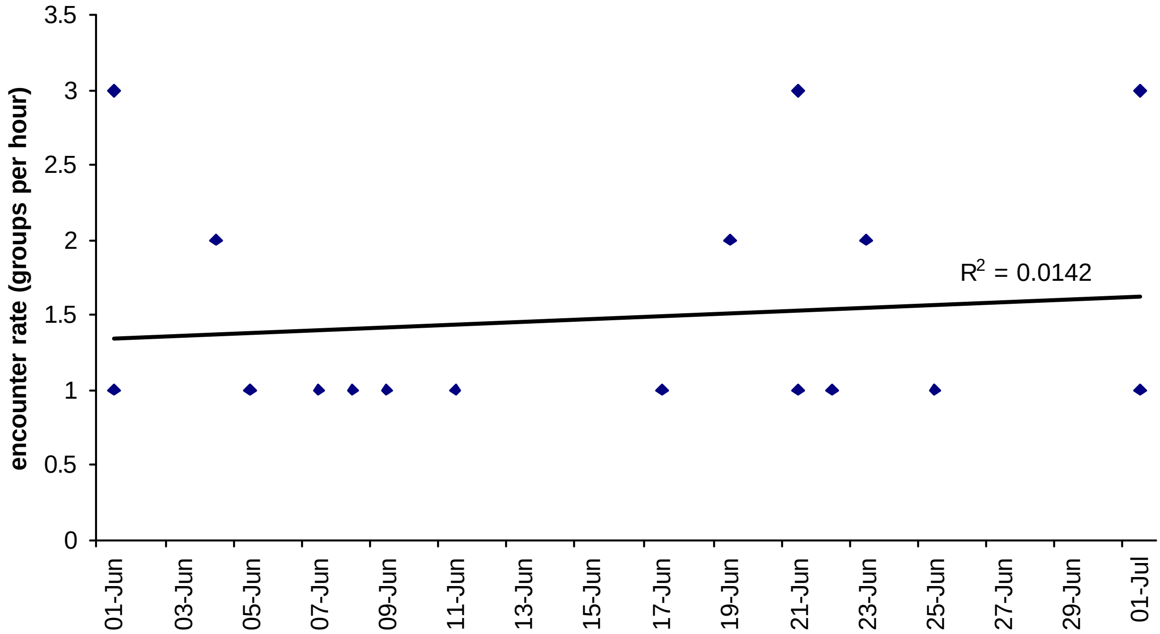

Figure A13. Encounter rates with white-bellied parrots during VDLTs over the duration of the study.

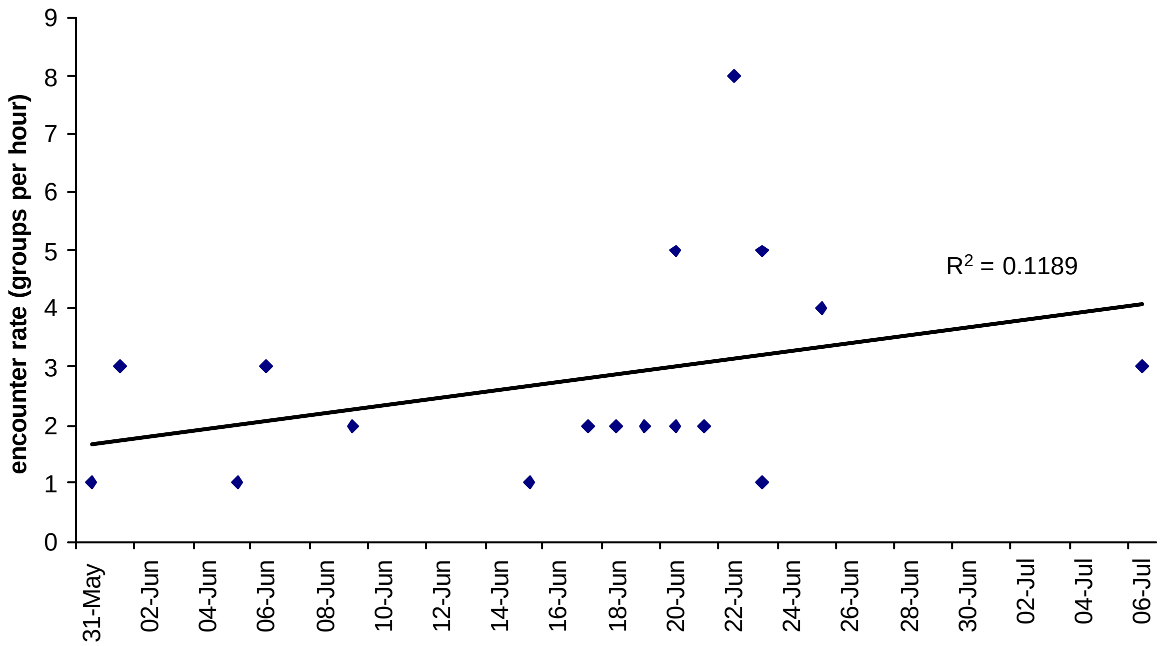

Figure A14. Encounter rates with mealy parrots during VDLTs over the duration of the study.

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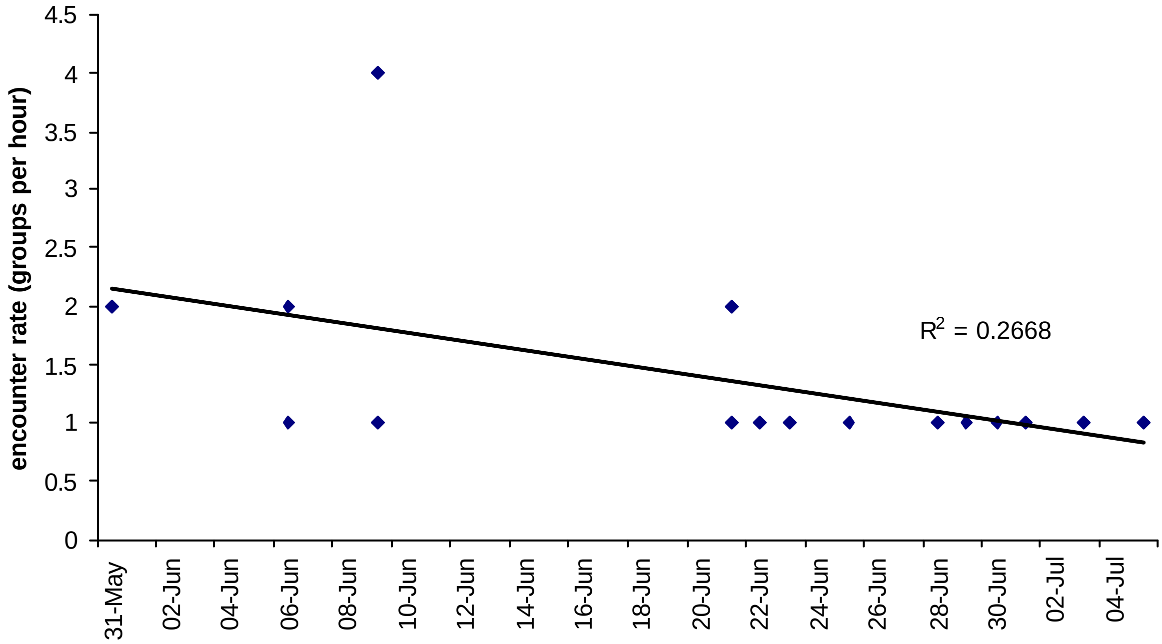

Figure A15. Encounter rates with black-capped parakeets during VDLTs over the duration of the study.

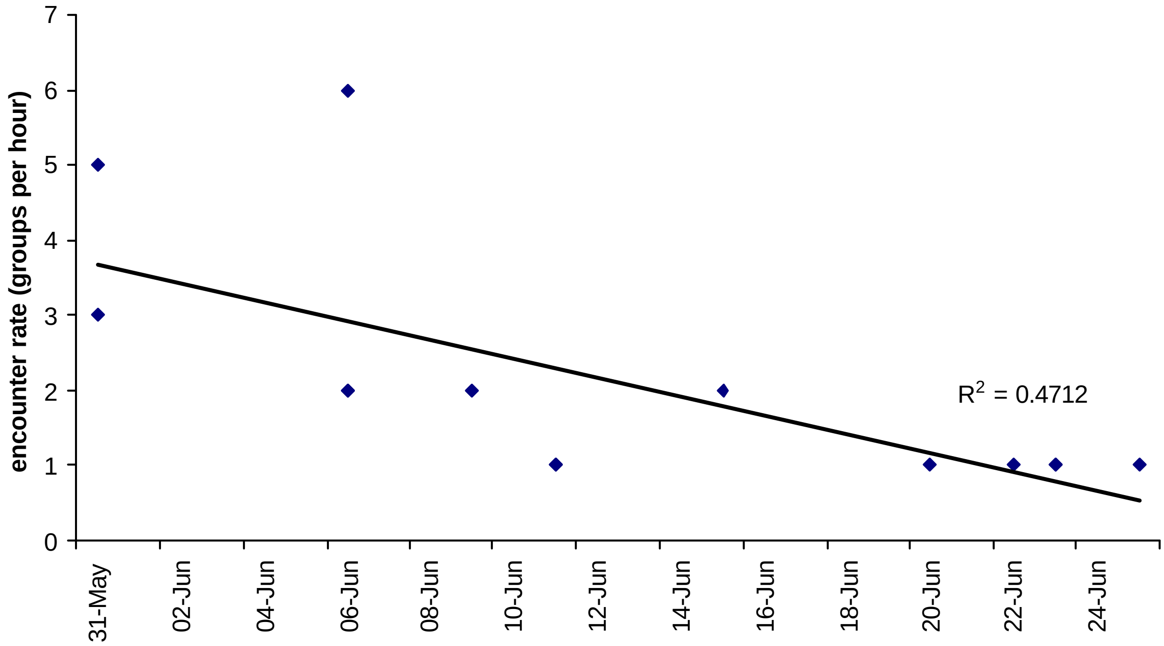

Figure A16. Encounter rates with dusky-headed parakeets during VDLTs over the duration of the study.

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4. Preliminary survey of caiman populations at Las Piedras river, southeastern Peru

Emma Tatum-Hume
Las Piedras Biodversity Station

4.1. Introduction

Caimans are a genus of crocodilian found throughout the Amazon basin. Numbers of caiman, particularly white caiman (*Caiman crocodilus*), also known as spectacled caiman, and black caiman (*Melanosuchus niger*) have been declining in recent years due to over hunting for their skins and meat by humans. Both species are now listed on CITES (Convention on International Trade in Endangered Species).

The project aimed to survey the local population of caimans along a section of the Las Piedras river, southeast Peru to see which species can be found, ad to establish the density of individuals per kilometer. A further objective was to try and map the territories of each individual.

4.2. Methods

The most effective way of surveying caimans is at night using a spotlight to pick up their eye shine. A total of ten surveys of the caiman population were made over a six week period as part of an expedition run by Biosphere Expeditions to Las Piedras Biodiversity Station. The surveys were carried out between 3 June and 7 July over a 2.7 km stretch of the Las Piedras river, southeast Peru (see maps in the Appendix).

Surveys were carried out from a dug out canoe moving downstream with four observers on board. One person paddled whilst a second spotted the caimans using a battery operated handheld spot light. A third person was responsible for logging the positions of the caimans using a Silva GPS and the fourth person wrote down the data. Data were collected at each encounter; each individual was given an identification code and logged on the GPS, its approximate length was recorded and whether it was seen on the left hand or right hand side of the river, what species it was and if it was in or out of the water. The coordinates were then plotted onto a map using the program Arc View GIS.

In order to map territories, the survey that encountered the most individuals was used as a base and caimans of the same size and species found near to each other during this survey were considered to be the same individual. Territories were therefore measured on the basis of the range of each individual over the survey period.

Abundance of each species was calculated. A statistical test called Spearmans rank correlation analysis was used to verify if relationships existed between different variables. Firstly between the number of caiman encountered on each survey and the maximum and minimum temperatures of that day. Secondly between temperature and the number of caiman encountered in and out of the water to see if temperature affected the numbers of individuals recorded.

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4.3. Results

Three species were recorded and a total of 140 individuals encountered (see map Appendix A1). White caiman (*Caiman crocodilus)* was the most common species found, with a total of 133 individuals counted. Black caiman (*Melanosuchus niger*) was recorded three times and a dwarf caiman (*Paleosuchus* spp.) once (four caimans were unidentified). White caiman in this stretch of the Las Piedras river have an abundance of 4.93 individuals per km, Black caimans 0.07 individuals per km and Dwarf caiman 0.04 individuals per km.

The highest number of caimans recorded was on 6 June when 21 individuals were spotted, the lowest on 4 July when only nine were counted. The locations of the individuals from the survey on 6 June were therefore used as a basis for mapping the territories – see the maps in Appendix A2 for the upper section of river surveyed and Appendix A3 for the lower section of river surveyed. On both maps each of the letters A to I belongs to a different survey night and each mapped point is an individual caiman. Only nine of ten surveys were mapped due to missing co-ordinates for one of the surveys.

The largest territory appears in Appendix A2 as number 5, it was 304 m long and belonged to a white caiman measuring between 1.1 m and 1.2 m. The smallest territory belonged to a white caiman measuring 30 cm.

Table 4.3a. Territory sizes and associated caiman sizes.

Territory number	Species	Size of territory (m)	Size of Caiman (cm)
1	White caiman	21	30
2	White caiman	47	60
3	White caiman	47	50 - 70
4	White caiman	58	50 - 70
5	White caiman	304	110 - 120
6	White caiman	72	100 - 110

The Spearmans rank correlation coefficient was 0.203 for minimum temperature and number of caimans encountered, 0.401 for minimum temperature and number of caimans out of the water and 0.602 for maximum temperature and the number of caimans out of the water. The nearer the result is to 1 the more positive (or the stronger) the correlation.

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4.4. Discussion

The survey found white caiman to be by far the most abundant species along this section of the Las Piedras river. This ties in with the ecology of the species. Since its maximum length is around 3.5 m it cannot compete with the larger black caiman that tend to inhabit oxbow lakes and so is more commonly found along rivers. Surveys in other rivers in the Amazon have found the abundance of white caiman to be highly variable. In Jaú National Park in Brazil 1.1 caimans per km were encountered (Rebelo 2001) whilst a study in creeks in Argentina found 46.2 caimans per km (Walker 2002). The abundance in Las Piedras is likely to be lower than in other areas of the Amazon due to hunting activities and because of disturbance by boat traffic.

The study revealed the presence of two black caiman, which indicates that although the species is still present in the area, numbers are probably low as a result of hunting activities along the river.

The dwarf caiman seen on one survey may have been temporarily visiting the main river to hunt, as this species is more often found on small, fast flowing streams inside the forest.

It proved difficult accurately to map caiman territories without capturing and tagging each individual. Individuals were mapped and territories defined based on size estimations only. As such we cannot be certain that the territories mapped actually belong to the same individual or if they were different caimans of the same size. For this reason only the six most probable territories were mapped, where a large number of caimans were spotted of the same size in the same area on different nights. From the results it appears that larger caiman defend larger territories and that within their territories there can be territories of smaller individuals which presumably do not compete with the larger caimans for the same food source.

The Spearman rank correlation result shows a fairly strong correlation between temperature and the number of caimans encountered during a survey, and temperature and the number of caimans found in the water. Surveys carried out on cooler nights encountered fewer caiman and of those, more were found in the water than out of the water. This may be because caiman are cold blooded and so on cooler nights, such as occur during a friaje, tend to be in the water where the temperature is higher. The strength of the correlations found was not as strong as might have been expected, as only one survey was carried out during a friaje when the temperature was recorded at 13.3 degrees, 7.3 degrees lower than the average night temperatures recorded on all nights during the survey.

The survey successfully completed its objectives and produced baseline data of caiman abundance for a section of the Las Piedras river, which can be used as a basis for further work on caiman populations.

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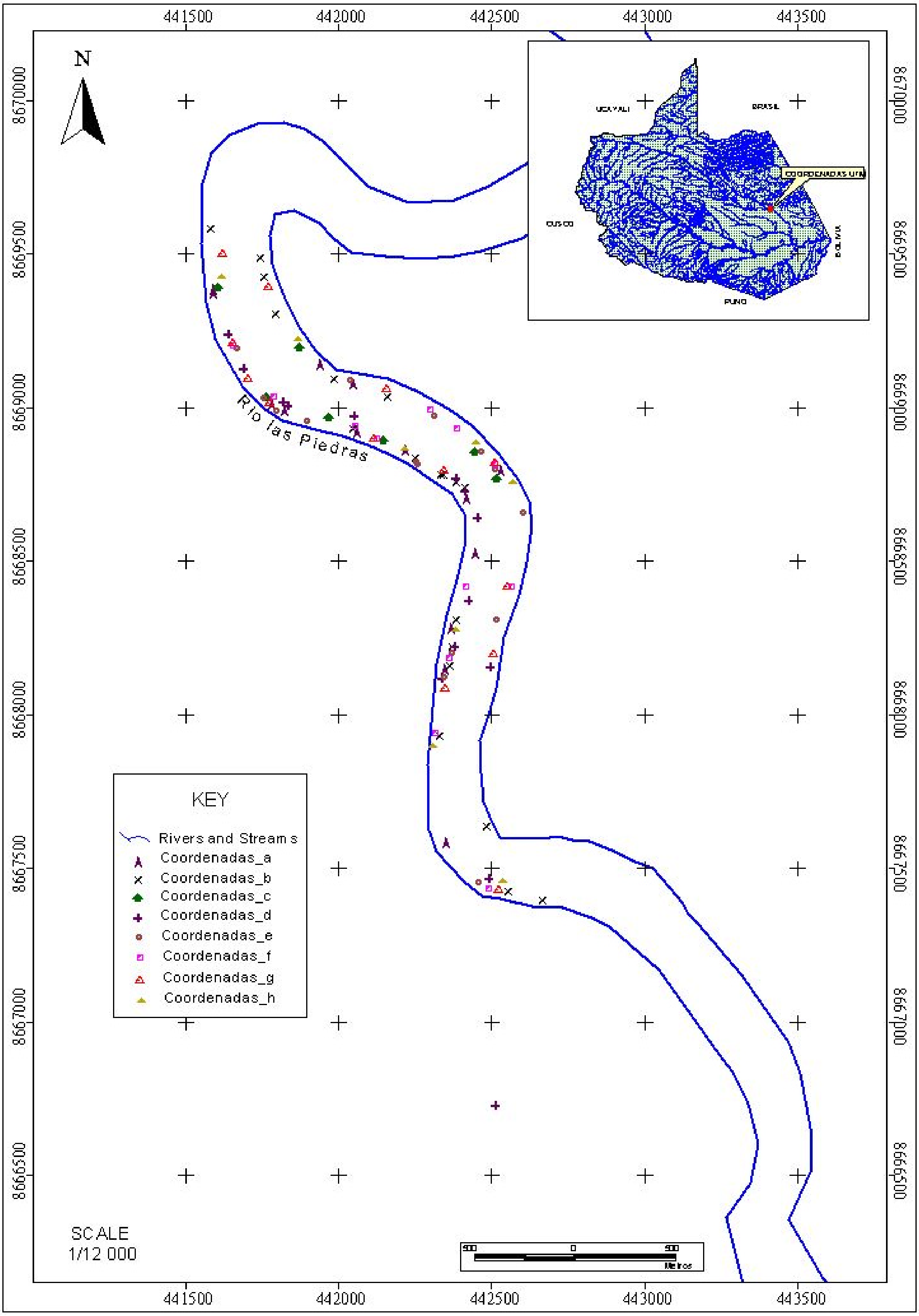
4.6. Appendices

Appendix A1



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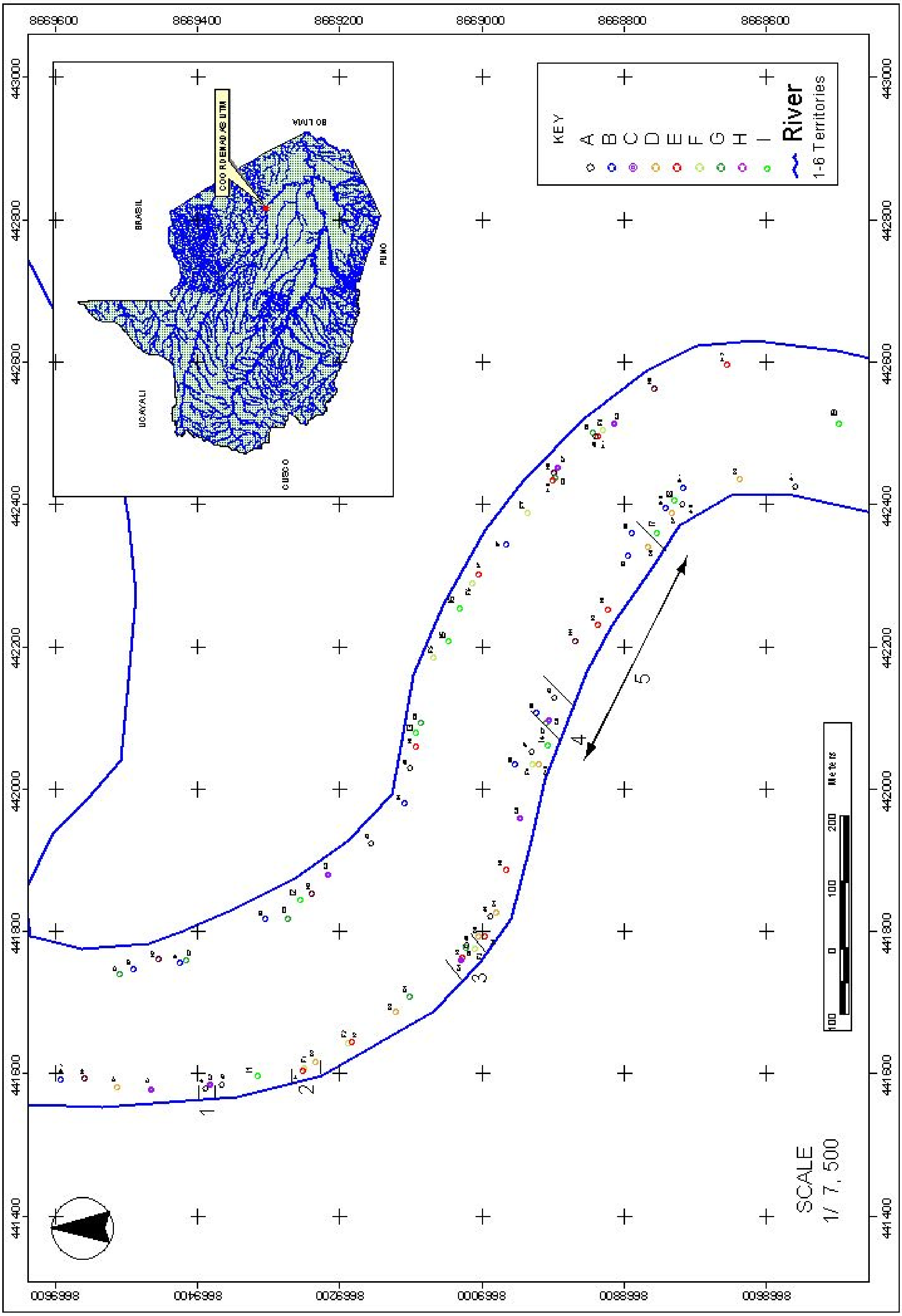
Appendix A2



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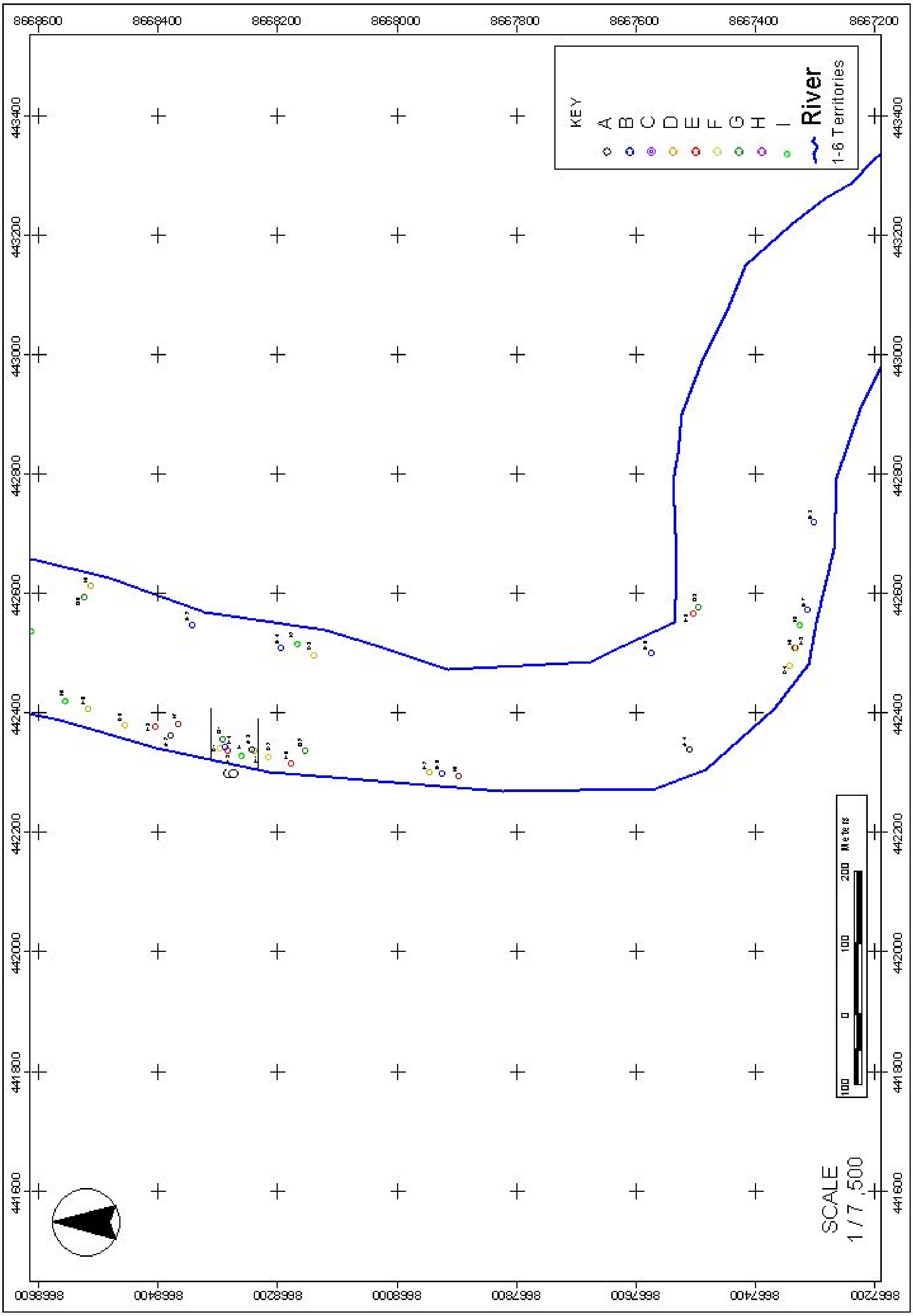
Appendix A3



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5. Expedition leaders' diary: Peru 2005 (kept by Clare Fothergill)

21 May

Hello all!

The final preparations for the Peru 2005 Biosphere Expedition have now been completed at the Biosphere HQ. Matthias and I have been busy packing all the equipment, which we will be using for our research in the rainforest including video cameras, digital cameras, global positioning systems, solar panels and the essential battery re-chargers.

In Tambopata the research station staff are eagerly awaiting the arrival of the first team members. The temperature is currently at 32°C with humidity up to 70%. As usual the forest is a hive of wildlife activity.

I am looking forward to meeting the first group in Puerto Maldonado on the 29th of May. Safe travels.

26 May

Our arrival at base camp was greeted by a majestic golden moon rising above the forest. This was followed by an orchestra of nocturnal creatures settling in for a concert of chirruping, shrills, squawking, squealing and yelps which lulled us to sleep after the long boat trip here. Quite an incredible welcome!

Although it is not a full blown friaje, the weather is relatively cool and it has been raining. Having said that temperatures were still in the mid 30s yesterday and the mosquitoes have been biting! Already spotted in and around the camp have been a rainbow boa, a cheeky tayra and hundreds of birds including blue headed macaws, trumpeter birds and mealy parrots.

Everyone is excited about the imminent arrival of the first group of team members so that the project can get into full swing.

31 May

The boat journey to base camp for the first Biosphere Expeditions team in Peru this year was blessed with glorious weather. Although a little hot for some people the sightings of capybara, several caiman, howler monkeys, yellow spotted side necked turtles, wood storks and scarlet macaws more than made up for the heat.

Settling in to camp life team members have been out and about in the forest for both day and night walks to familiarise themselves with the different species that are to be studied and identified. Robyn, Gemma, Rebecca and Eveline returned to camp last night in jubilant mood having been lucky enough to spot their first ocelot!! Other team members were pretty happy also, having seen a mixture of spider monkeys and tamarins earlier on in the day.

We are just experiencing a refreshing downpour of forest rain. Fingers are crossed, however, as we hope this isn't the start of a friaje. Three groups are currently out at the macaw colpas, but the boat has gone back to collect them as the birds are unlikely to feed in such weather.

Another entry will be sent in a few days when I hope to report warmer and drier weather.

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2 June

The start of June has brought with it many successful sightings. The pilot surveys at the colpas have been completed and it has been decided that we will continue surveying two sites. Yesterday Ralph, Stefan and Emma were extremely satisfied with 15 red-and-green macaws feeding at colpa 1. Some good filming from Ralph meant that everyone was able to see the amazingly colourful feast and flush that followed. Monkeys have been spotted all over the place with very close encounters with spider monkeys and tamarins. Eveline even disregarded her fear of spiders to get close to one monkey in particular who seemed to be posing for photos!

Last night's caiman trip again was incredibly lucky with a very rare encounter with a tapir. The female seemed totally undisturbed by our presence and casually carried on feeding whilst we watched from the river. What an amazing feeling to watch a CITES appendix II listed endangered species at such close range.

5 June

Today everyone has had a well deserved break from data collection. A few games of volleyball and a trip to the waterfall in brilliant sunshine has made the day off extremely relaxing. The past two days of activity has seen a number of exciting mammal transects. Transect A is a long but rewarding hike through terra firme forest. Seven species of monkey have been seen on the transect including saddleback tamarins, spider monkeys, dusky titi monkeys, squirrel monkeys, brown capuchins, white-fronted capuchins and monk saki monkeys. In addition peccaries have been frequently smelt (an unbearable stench!) and two separate sightings have been made before the herds scattered away snorting and snuffling through the undergrowth. The whole experience leaves quite an impression on the senses.

Ralph and Stefan who have always been eager to try anything other than the ordinary have been helping to cut trails with their new found machete skills. They reported jaguar tracks on the far side of the river as well as on the Brazil nut trail.

The macaws have also been busy with feeding at both colpas 1 and 3 throughout the mornings. Colpa 1 appears to be dominated at the moment by red-and-green macaws despite the calls of chestnut fronted, red bellied and blue-and-yellow macaws being heard in the hours just after dawn. Whilst on colpa 3 blue headed parakeets and dusky headed parrots seem to have found their favourite feeding site.

Robyn, Gemma, Eveline and Antonio are all sleeping out at the mammal colpa tonight hoping to see some animal action. Maybe the jaguar will be sociable tonight - who knows!

7 June

The days seem to be flying by for the first BE Peru team members. We have been incredibly lucky to have Stanley and Connie on this first slot who have been so diligently inputting all of out data into the computer.

Aside from the numerous oropendulas Gemma has sighted on mammal transect B, she seems to have a strange affinity with ticks. Whilst few have been found on anyone else, Gemma has had no fewer than 16 ticks taken off her!! Ralph has tried to comfort her by demonstrating the Germans' natural talent for dancing with his skills in "Disco Fox".

Feeding on the macaw colpas is continuing daily although not quite as consistently as we hoped. Species seen however have increased to include cobalt winged parakeets, yellow crowned parrots and blue headed parrots as well as those seen previously.

So far the mammal colpa itself has not been particularly active and our attempts at catching the jaguar on the camera trap have not been successful.

Only two days left of data collection for the current Biosphere team.

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Enthusiasm, however, has not declined for any of the activities in spite of a good collection of insect bites and some aching limbs.

10 June

The last two days in the jungle were again rewarding for the team members. A record number of parrots, parakeets and macaws were seen from the viewing tower close to camp. Seven orange cheeked parrots perched in the surrounding trees allowing us an amazing view of their incredible plumage. In addition a pair of golden collared toucanettes have also been seen regulary at the tower. Feeding at both colpas 1 and 2 has been continuing with everyone having had a chance to see feeding. An amazing amount of monkeys have been spotted on all activities, many of whom seem to be intrigued by our presence.

Connie had her second encounter with peccaries on the mammal transect and I believe has overcome her initial fear of them! Eveline and Rebecca had a close encounter with a tarantula. Nothing, however, (even her arachnophobia) seems to sway Eveline from her mission to photograph everything she can! No jaguars spotted this time though.

A truly fantastic 12 days has passed with the first Biosphere team this season. A big thank you to all of the team who have been incredibly enthusiastic throughout. A large amount of data have been collected and we hope to continue in this vein for the next two slots. Many thanks to all.

We are now looking forward to the arrival of the next team members. Let's hope we are as lucky in our species spotting in the next two weeks.

13 June

The second group of Biosphere team members all arrived safely despite some delays in flights. Our journey up to base camp was again blessed with some superb sightings of birds including an ornate hawk eagle, the third largest bird in the rainforest, white and dwarf caiman and a number of capybara. We also experienced a full-on downpour of torrential rain, and our ponchos were well used by the time we reached camp. The cooler weather certainly made it a little easier to unload the boat although humidity was still up in the 90s!!

After their first night in camp the team members are currently out on an introductory walk into the forest. With over 20 different bird species sighted on the boat journey yesterday alone, let's hope today brings more successful sightings.

More in a couple of days or so (laptop & satellite uplink permitting).

15 June

All three macaw and parrot colpas have been extremely busy over the last two days. Colpa 2 has once again become active and Sarah and myself saw over 40 red-and-green macaws in the trees directly above the colpa today. For two hours the birds preened, played and fought amongst themselves whilst gradually coming closer to the colpa. A number of flushes enabled us to see the magnificent colours of their plumage, bright reds and blue against the white sky. Unfortunately the presence of a laughing falcon and eventually a downpour of rain stopped them from actually feeding. On colpa, 1 however, Wendy and Emma had great success with over 40 minutes of feeding from another 13 red-and-green macaws. The longest we have seen consistent feeding for since Biosphere arrived this year. Colpa 3 was also visited by dusky headed parakeets and blue headed parrots.

A tamandua was seen yesterday on the way back from the colpas, and came within metres of the team members before ascending a nearby tree and proceeded to fall asleep totally unaware of the excitement it was creating!

Rob and Antonio were lucky enough to spot some of the herd of peccaries that were so blatantly in the vicinity (due to their smell) before they disappeared off into the forest in a flurry of snorts and grunts.

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Everyone has experienced the spontaneity of the rainforest today when a torrential downpour drenched the entire team at various different locations this morning. The sun is out once more with temperatures back up to a mild 28 degrees Centigrade and 95% humidity!

18 June

Peccaries, peccaries everywhere! Whilst we had to search hard on the last slot to have a glimpse of peccaries, it now seems that they are tripping over themselves to be on route almost every day. A large herd with over eight young, have been sighted on the mammal colpa trail twice and others on and around the route known as transect A.

An initial attempt at netting some of the local bats was unsuccessful last night; probably due to the bright moonlight. Melissa, who works with bats in her day to day job is eager to identify some new species. We have decided to try again later on in the week in a darker area!

Melissa and I were lucky enough to have a close encounter with a pair of red howler monkeys who were as intrigued by us as we were with them. In the evening sunlight we had an amazing view of their red fur and they were totally undisturbed by our presence. In fact it was the first time I have walked away from an animal before it has moved on. On our return back to camp JJ enticed a red brocket deer within metres of us by a series of gentle whistles before it strolled off into the jungle. Truly a magical moment.

This morning was a success at colpa 1 with approximately 13 red-and-green macaws feeding. It was Rob's first time to see them feeding and he was particularly thrilled to tell us that on the way back to camp he had been urinated on by a dusky titi monkey!!

We were all excited (particularly Emma) by the arrival of an Amazonian milk frog a couple of nights ago, who according to the species guide is not local to these parts. It jumped onto one of the walk ways and proceeded to devour a huge moth.

The jungle always seems to be bringing new species that even the guides who have been working here for years have not seen before. It really starts to give you a taste of how biodiverse the forest is.

22 June

The summer solstice brought with it the first real friaje that Biosphere has experienced this season. Temperatures have fallen to 18 degrees but with humidity still around 80% it feels a lot cooler and sleeping bags and fleeces have been brought out in force. It definitely feels strange being in the rainforest trying to keep warm!

Saturday was a great success at the macaw colpas. Over 68 red-and-green macaws were flying around colpa 1 and perching in the adjacent trees with more than 32 feeding at any one time. At colpa 2 a further 25 were seen with feeding for over an hour and a half. There is a definite increase in numbers generally at the colpas.

Sunday was a day off for the team members and volleyball was again a close and competitive match. The Peruvians seem to have a natural talent for the game, even Gladys and Gisela our wonderful cooks, are total experts. Not much chance of spotting any wildlife whilst we are playing, however, due to the loud cheers and laughing from both teams!!

The onset of rain and the friaje on Monday meant that our activities were more focused on vegetation surveys and trail marking. Animal and bird activity is usually greatly reduced when the weather is wet and cold. However, whilst the rain was pouring down we managed to see so many smaller but intensely colourful birds from the station. Paradise and turquoise tanagers, blue crowned and black tailed trogans, black faced dacnis and russet backed oropendolas were all seen just outside of the dining area. We were even visited by saddle backed tamarins and dusky titi monkeys, presumably trying to find somewhere a bit drier to sit.

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Whilst clearing a new trail with our expert machete skills, Eveline came across a huge beetle larvae which she hoped was the edible type JJ had told her about! White in colour, approx 6 cm long, and squirming about in her hand she was getting ready to indulge herself when JJ told her it was the wrong type - this one wasn't tasty enough!!!

Only two days of data collection left to go for the second slot of Biosphere team members. Hopefully the weather will warm up although Rob and Pere seem a lot happier now that they are back to "normal temperature"!

25 June

The second Biosphere team returned to the hub hub of Puerto Maldonado on Friday. The boat trip down the Rio Piedras was a little chilly to say the least. However, the mini friaje does seem to be moving on and we are hoping for some warmer weather for the next team.

Despite the cold weather, data collection was still possible in the last few days of the expedition. Steve, ever optimistic predicted he would see yellow-and-blue macaws on his last shift at the colpa! Unfortunately for him this did not happen but Anya and Melissa did manage to see over 85 blue headed parrots feeding, which was a real treat.

We have managed to cover quite a large distance with the vegetation surveys, which are designed to identify the distribution of palms and buttressed trees which parrots and macaws feed on. Steve developed a skill for identifying the different plant species amazingly quickly and Sarah really seemed to enjoy bashing about in the undergrowth with her machete.

The last night walk did not reveal the ever illusive ocelot that everyone was hoping for much to Wendy’s delight, who due to her enthusiasm for long transect walks had to sit it out to rest her sprained ankle. Rob, Pere and JJ only managed to see a few arboreal rats on the new Actimel trail which everyone has worked so hard on to clear.

Hopefully when our scent has worn off the trail we will see a few more animals. We may even find Pere´s glasses which he dropped when fighting off a swarm of wasps. He then temporarily lost his wellies in the swamp and fell up to his thigh in mud!

A big thank you for the huge amount of energy and effort that was made by everyone involved on this slot both in work and play. I don’t think that the coconut bar knew what hit it when Rob Ritchie, the world’s biggest trogan fan, strutted his stuff on the dance floor!! Thanks to everyone for all the data that have been collected.

28 June

The final group of Biosphere team members for this year are already well into the research programme. The journey up river was blessed with great weather and a record number of capybara sightings. We stopped on four occasions and saw over seven in one location. Lynn with her keen eyes spotted a coati even before Antonio did! Hoatzins were also out in force and a number of wood storks and jabiru storks were also prancing about on the sand banks.

Although the initial night walks did not bring out the mammals in force, the local ocelot was spotted firstly by Deanna and then by Antonio on two consecutive evenings.

The first morning shifts at the colpas were quiet for feeding on 2 and 3 although large numbers of birds were seen in the surrounding trees. Colpa 1, however, provided a fantastic introduction to Charlie and Claire, to red-and-green macaw feeding. For over an hour the birds were there with a maximum of 18 on the clay at a time. A couple of big flushes revealed that over 40 birds were in the surrounding trees. An additional treat was that three scarlet macaws came down to the clay lick, two of which fed. This is the first time we have recorded scarlet macaws feeding this year.

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The team members are now getting to grips with filling in the data sheets and will be going to test out their skills on a mammal walk this afternoon.

Let’s hope their initial luck at spotting animals will continue!

29 June

It is not often that getting up at 4.50am feels like a privilege. Today, however, was one of those occasions. A beautiful clear starlit morning was a good omen for both colpas 1 and 2. The first shift brought with it blue headed parrots, mealy parrots and yellow crowned parrots in force. At one point over 100 birds were feeding at colpa 1 including two red-and-green macaws mixed in with the parrots. It was an amazing sight to see so many birds feeding at one time all vying for position on a small piece of clay cliff. It was a frenzy of chirrups and shrieks when they finally flushed and the sky was filled with the blues, greens, reds and yellows of thousands of feathers. Jany and I were totally elated by the sight and had big smiles on our faces. Lyn and Antonio also had an equally impressive shift at colpa 2 but were also stampeded by capybara whilst sitting in the hide! Colt and Deanna followed with yet another fantastic shift with over 70 red-and-green macaws in the trees and 30 feeding for over half an hour.

The two transects again were exciting with peccaries, spider monkeys, red howler monkeys and tamarins being recorded. Three separate groups of spider monkeys and tamarins were seen on transect B, the most recorded yet on the other side of the river.

Antonio and Bill truly early birds (up at 4.40am) reaped the benefit when they spotted an ocelot sitting behind the dinning area. Presuming that it is the same one we have seen around camp on many occasions now, we feel we are really getting to know him!!

1 July

Yesterday was quite special for a couple of reasons. Firstly Judy and Peter came back from transect B having seen the first brown throated three toed sloth this season. I think they were more excited when they realized just how rare a sighting it was. However, it didn't top their evening floating downstream in the canoe looking for caiman under a moonlit sky.

Charlie and Bill had a close encounter with red howler monkeys where some good facial expressions were exchanged. "Like two grumpy old men" said Charlie - I am sure he meant the monkeys!

I think that Alan, Mark and Lyn took first prize yesterday though when they virtually stepped on a 3 metre long red tailed boa constrictor that was as thick as Mark's thigh!! Eveline, this one would have kept you going for years!! Caught both on a stills camera and video camera meant that everyone could look and exclaim "Oh my word" (or similar such phrases). Alan with his expertise in snake handling picked up the beast and told us he could hardly hold it because it was so heavy! I was amazed to see that it was so colourful with big splashes of red and black on its scaly skin. It certainly beat my 8 cm flat headed snake which I found yesterday!!

What will tomorrow bring?!

4 July

Claire, Judy and Antonio had an usual sighting of an ornate hawk eagle attacking a group of dusky titi monkeys on Friday. Apparently the noise was intense and understandably the monkeys were pretty freaked out! The monkeys managed to protect themselves, however, and the bird left empty clawed.

According to "A Neotropical Companion" by John Kricher the reputation that white lipped peccaries have for aggression is "considerably exaggerated". I think that Peter, Charlie and Garza might have something to say about this: On Saturday they came face to face with at least 80 beasts who in smaller groups proceeded to surround the trio and then began to charge! Luckily Garza had his machete handy and

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fended off the attackers who were obviously extremely protective over a number of piglets. Luckily both men and animals came away unscathed if not a little more wary of each other!

A relaxing day and a well deserved break from data collection followed on Sunday for most of us. Lynn managed to catch a sting ray whilst fishing which gave her a little fright as "a huge thing with two massive eyes" came flapping ashore! As usual volleyball was competitive and the players could be heard from as far away as the tower!!

Only four days left of data collection but fortunately everyone is eager to get as much completed as possible before the end of this year's Biosphere expedition. The colpas are still active with over 60 macaws split between 1 and 2 this morning. Vegetation surveys are now well under way and the dream team of Emma, Deanna and Jany are aiming to get all of transect A completed by Friday. I really can't believe how quickly time has passed whilst here in the forest. I think I had better order some bananas in for when I get home so that I can practice for my new book "100 and 1 ways to cook a banana"!

9 July

Yesterday marked the end of this year's Biosphere expedition in Peru. The last few days of activity were still packed full with exciting tales of bizarre and wonderful sightings in the forest.

The mammal colpa finally rewarded our patience when Deanna watched a red brocket deer stroll around the hide whilst she was on watch in the middle of the night. Antonio and Bill also managed to see the elusive armadillo that we have been hoping to see for weeks. On their return journey back to camp Colt who had not managed to stay awake all night (very sensible) spotted both spider monkeys and peccaries. The latter were a little more friendly than those encountered earlier on in the expedition.

On her final shift at colpa 1 Judy finally saw the magnificent feeding of red-and-green macaws. Up to 27 were on the colpa and the birds for over 50 minutes. Three scarlet macaws even arrived to top the experience off. She said it was well worth waiting for, especially when over 40 birds flushed into the sky scared by the presence of a king vulture overhead. For some reason vultures seem to be following her around this last week rather too closely on one occasion. One yellow headed vulture swooped down into the forest missing Emma's head by a claw and landed in a tree close to Judy who was a little surprised to say the least.

Although these last couple of days in the forest have been sunny, the arrival of another friaje has meant that nights have been really chilly. A motley combination of clothing has been worn by everyone trying to keep warm - there is something particularly fetching about socks and flip flops!!

The journey back to town was slow due to the low water levels in the river and we had to push the boat on several occasions to avoid being marooned on the sand banks. The last morning sunrise however, was incredibly beautiful with the mist rising slowly above the river as the sun's rays started to break through the trees. A fantastic farewell gift from the jungle.

So, as everyone prepares to leave Puerto Maldonado I would like to say a massive thank you to all the team members who have participated in the expedition this year. It has been such a pleasure to work with people who seem to have an unending supply of enthusiasm for working in the forest be it at 4.30 am or in the pouring rain. We have collected massive amounts of data, which without your dedication would not have been possible. The expedition report should be available within six months so that you can see exactly what your hard work has contributed towards.

I hope that everyone has some fantastic memories of what has been a great expedition (I certainly have) and I look forward to seeing the photos!

Take care

Clare Fothergill
Expedition leader

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