Expedition report

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

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Authors: Emma-Tatum Hume
Las Piedras Biodiversity Station

Alan Lee
Manchester Metropolitan University

David Moore
Biosphere Expeditions

Matthias Hammer (editor)
Biosphere Expeditions

Abstract

Mammal survey: This study aims to monitor the long term changes that occur in mammal populations after the cessation of hunting activity. 2006 was the fourth consecutive year of data collection along line transects. Populations recorded this year were compared to levels in 2003. The spider monkey (Ateles belzebuth chamek) was the only species to have shown a statistically significant increase in population abundance. This species has been the most severely affected by hunting activities in adjacent river systems (the lower part of River Tambopata) where over hunting has caused the species to become locally extinct. For other hunted species, it may be that it is too soon in the study to see significant increases and that future studies will reveal a clearer trends. Recommendations for wildlife protection in the River Las Piedras are made.

Macaw & parrot survey: Results are presented here on the impacts of boat traffic on red and green macaws at two study sites in south eastern Peru, for two time periods. More activity was seen at the more remote site compared to the site located closer to the region's principal town. Both clay licks showed peaks in use and numbers of birds in the vicinity of the clay licks for the months of January and February (wet season), compared to June, July, August (the middle of the dry season). Red and green macaws showed less inclination to flush at the site where boat traffic is not associated with danger even though boat traffic was higher, while at the study site where hunting has been recorded from passing boats, even though on a low scale, birds show stronger anti-predatory responses. At the remote study site day to day feeding was not impacted due to the low overall boat traffic for either season, while at the less remote study site intense boat traffic associated with the tourist season and possible tourist activity in the vicinity of the clay lick resulted in a marked reduction in overall feeding. Macaw populations were monitored at both sites using variable distance line transects. Macaw populations were slightly higher at the more remote study site. During peak levels of activity at the clay lick, counts of the numbers of macaws in the vicinity of the clay lick reflect the abundance calculated for a surrounding area of 25 km2. This has important implications for how clay licks can be used to monitor red and green macaw population levels without the need for intensive transect surveys.

Fish survey: Work began on identifying and photographing fish species caught in the rivers, streams and lakes around the Piedras Biodiversity Station. To date 29 species have been caught, 16 of which have been identified and 13 are awaiting identification. Future work will concentrate around lakes and streams were fish were more readily caught.

Estudio de mamíferos: La meta de este estudio es monitorear a largo plazo los cambios que ocurren en poblaciones de mamíferos en una zona que ha sido casado y deforestado selectivamente. El año 2006 fue el cuarto año consecutivo del estudio que utiliza transectos en línea para recopilar los datos de las abundancias de mamíferos. Poblaciones del 2006 fueron comparado con poblaciones del 2003. La maquisapa (Ateles belzebuth chamek) es la única especie hasta ahora que ha mostrado un incremento significante de población. Esta especie es lo que esta mas afectada por cazadores y en otras zonas (como el parte bajo del Rió Tambopata) ha sido exterminado por sobre casamiento. Para las otras especies puede ser que es muy temprano para ver grandes incrementos de población o puede ser que hay un error en la metologia para recoger los datos. Vamos a renovar la metologia para el año. Recomendaciones para la protección de la fauna silvestre están presentado.

Estudio sobre guacamayos y loros: Aquí presentamos los resultados del impacto de movimiento de botes sobre Ara chloroptera alrededor de 2 colpas en el sur este de Perú para dos tiempos. Había mas actividad en la colpa mas lejano de la cuidad principal de la región comparando con la colpa mas cerca. Los dos colpas mostraron cumbres en actividad para los mese Enero y Febrero (época de lluvia) comparando con Junio, Julio y Agosto (época seca). Las Aras mostraron menos tendencia de huir de los botes en la colpa donde trafico de botes no esta asociado con peligro, aunque pasa mas botes. En la colpa donde a veces casan guacamayos, (aunque muy infrecuente) los aves mostraron más tendencia de volar cuando pasó un bote. Día tras día en la colpa lejana la actividad de comer no era afectada por los botes, tal vez porque el total de botes era poco por las dos épocas del estudio. Mientras en la colpa mas cerca de la cuidad el incremento de botes asociado con la época alta de turismo y la actividad de turismo cerca de la colpa resulto en un marcado disminución en la actividad de comer. En la zona mas lejana de la cuidad poblaciones de Ara chloroptera eran un poco mas alto. Durante el tiempo con niveles de población mas elevados de guacamayos los números de guacamayos contado en la vecindad de la colpa reflexionó la abundancia calculado por los 25km2 alrededor. Eso tiene implicaciones muy importante porque colpas podrían ser utilizado para monitorear poblaciones de Ara chloroptera sin tener que hacer transectos intensivos.

Etudio de peses: Trabajo comenzó para identificar y sacar fotos de los especies de pescado encontrado en el Rio Las Piedras y las quebradas y lagunas cerca de la estación. Hasta ahora 29 especies han sido encontrados de lo cual 16 han sido identificado y 13 esperen ser identificado. Futuro trabajo debe concentrar en las lagunas y quebradas donde es mas fácil encontrar peses.

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1. Expedition Review

M. Hammer (editor) & David Moore
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 28 May to 23 June 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.

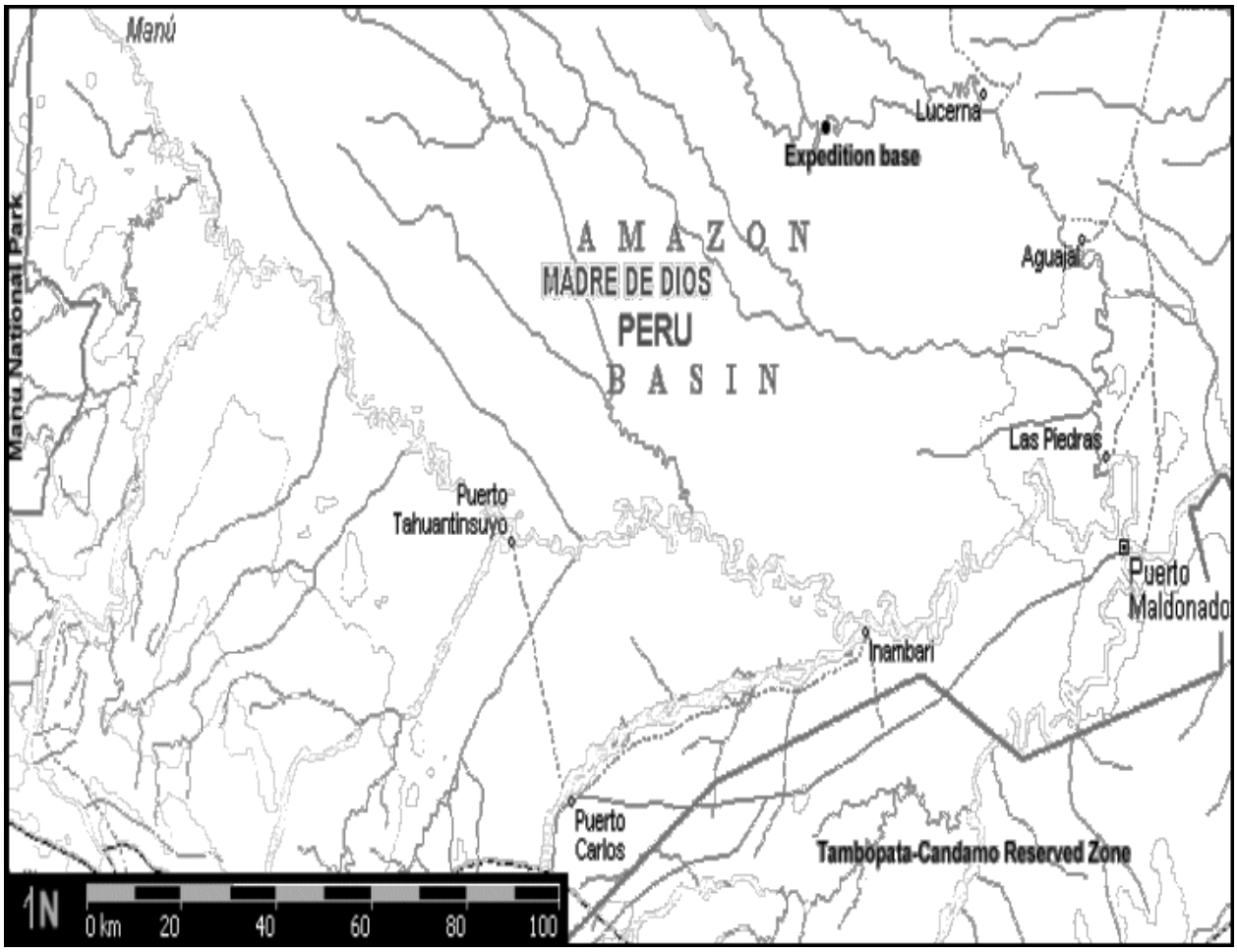
Rapid Assessment Programmes (RAPs) are snap-shot studies of an area, investigating the flora and fauna present in order to create species lists and determine relationships and impacts that may exist. The expedition's RAP will include visual encounter surveys, mammal and bird censuses of colpas and behavioural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

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).

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 28 May - 9 June | 11 June - 23 June.

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.

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 expedition. Minor incidences included a couple of stomach upsets and one case of sunburn,

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.

1.6. Expedition Leader

This expedition was led by David Moore. David Moore was born and educated in England and now lives in the UK and France. He graduated in French and German and studied Japanese while working for two years in Tokyo. His expedition/group leading experience began with Japanese educational trips in Australia and he has since worked in the Caribbean and throughout Europe for companies such as P&O, Explorica and Alyson Adventures. David joined Biosphere Expeditions in 2003 and has led expeditions to the Azores, Peru, Brazil and Namibia.

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:

28 May – 9 June 2006

Daryl Armstrong (Canada), Phil Bannister (UK), Ralf Darius (Germany), Valerie Morris (UK), Jane Orton (UK), Frank Schleicher (Germany), Sibille Schleicher (Germany).

11 June – 23 June 2006

Bjørn Aslaksen (Norway), Ralf Darius (Germany), Klaus Engelhardt (Germany), Laura Johnson (USA), Nicole Mullen (USA).

Staff (throughout the above period):

Juan Julio Durand (local guide), Antonio Coral (local guide), Jose Durand (boat driver), Gloria Perdomo (cook), Garza-Edgar Arimuya (cook's assistant).

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	13,581
Expenditure	
Base camp and food includes all meals, base camp equipment, gas, wood	780
Transport includes fuel, boat hire & maintenance	480
Equipment and hardware includes research materials & gear etc purchased in UK & Peru	140
Biosphere Expeditions staff includes salaries, travel and expenses to Peru	1,900
Local staff includes salaries, travel and expenses, gifts	555
Administration includes permits, registration fees, sundries etc	248
Scientific services, logistics & accommodation Payment to Tambopata Expeditions	3,400
Team recruitment Peru as estimated % of PR costs for Biosphere Expeditions	2,800
Income – Expenditure	3,278
Total percentage spent directly on project	76%

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 Buff 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.

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

Emma Tatum-Hume
Las Piedras Biodiversity Station

Please note: Each expedition report is written as a stand-alone document that can be read without having to refer back to previous reports. As such, much of this section, which remains valid and relevant, is a repetition from previous reports, copied here to provide the reader with an uninterrupted flow of argument and rationale.

2.1. Introduction

Outside of protected areas, even the remoter parts of the Amazon rainforest are accessible to human exploitation. These regions are subject to growing pressures on their resources from such diverse activities as farming, selective logging, tourism and Brazil nut extraction. Of these, selective logging has the greatest impact on the forest ecosystem. In order for selective logging to become a long-term sustainable use of the forest rather than a short-term exercise in exploitation, it is crucial to have an understanding of the wide-ranging impact it can have on the ecosystem and to introduce realistic management policies that help both coexist. This is of vital importance since recent studies suggest that protected areas are currently inadequate to conserve the biological diversity found within tropical forests, because of their limited size, number, distribution, composition, and protection status (Fimbel et al. 2001). The future of the neotropical rainforest therefore depends on humans correctly managing the productive forests so as to compliment the protected areas.

This study aims to monitor the recovery rates of hunted mammal and bird species in an area of productive forest that was selectively logged. The results and conclusions drawn can be used to help manage and protect wildlife in and around selective logging concessions and areas of human habitation.

2.2. Survey site and its surroundings

The river Las Piedras and logging activities

The river Las Piedras 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. Las Piedras 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 2006) makes it an obvious target for both legal and illegal woodcutting operations in the area.

Logging has both direct and indirect effects on wildlife. Direct effects include loss of food sources, especially fruiting trees, and the creation of large canopy openings which combined with the removal of vines make it difficult for non-flying mammals to move around. The largest indirect effect of selective logging is bush meat hunting, which occurs around all logging camps (Schulte-Herbruggen and Rossiter 2003).

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. Bush meat is an important source of protein since logging camps are often far from town and other means of obtaining fresh meat (such as from domestic animals) are scarce. Bush meat is also much cheaper and considered tastier than tinned foods or dried meats. The impact of these hunting activities on mammal populations depends on many factors such as the length of time woodcutters are present in the forest, the number of people working at the camp, the density of the mammal populations in the surrounding forest, the forest type and the use of the forest outside of the area being selectively logged.

Location

The expedition base was the Piedras Biodiversity Station on the banks of the river Las Piedras, approximately 60 km northwest (approximate bearing 325º) along the river Las Piedras (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 appro3. 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, 2005 and 2006. Much of the data were collected with the help of team members from Biosphere Expeditions who conduct yearly expeditions to the site.

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 a year 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".

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

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 bush meat per day (Schulte-Herbruggen et al. 2003). Based on these calculations about 1 t (998.68 kg) of bush meat 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 bush meat species.

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

Ideally, to study the effects of logging on mammal populations an area which has been selectively logged would be compared to a pristine area. However, an untouched area is extremely difficult to find within the Las Piedras watershed as woodcutters have extracted mahogany and other species from far inside National Park boundaries, up to 24 days travel from the nearest town of Puerto Maldonado. Alternatively, comparisons could be made with density estimates from Manu National Park, but it would be unclear whether differences encountered there are due to the effects of selective logging or inherent differences between the two sites. Given that the Manu area has been protected since logging ceased, it is assumed that the results reflect the natural recovery of mammal populations and can be used to quantify the effects of similar logging activities in areas of permanent production forest in this river basin.

Importance of wildlife

Wildlife plays 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. Up to 90% of the plant species in tropical rain forests are dependent on animals for their pollination or dispersal—including many important timber species (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). Furthermore primates 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.

Of the 15 species of mammal monitored during this study, ten are considered to be preferred bush meat 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 belzebuth*), white-fronted capuchin (*Cebus albifrons*), white-lipped peccary (*Tayassu pecari*).

The four species of bird included in the study were blue-throated piping guan (*Pipile cumanensis*), razor-billed curassow (*Mitu tuberosa*), spix guan (*Penelope jacquacu*) pale-winged trumpeter (*Psophia leucoptera*). The first three species are bushmeat species and the fourth is considered an indicator of undisturbed forest.

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 firma 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 05:30 – 10:30 to avoid the hottest part of the day when animals tend to be less active (Peres 1999). The start time varied by up to 30 minutes depending on the time of year and the time of sunrise. If it rained whilst on the transect for more than five minutes, the transect was abandoned as rain decreases the observer’s ability to detect species.

Transects were walked at an average speed of 1.17 km/h and took between three and four hours to complete. Each 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 to the individual or centre of the group, 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 to achieve the greatest accuracy.

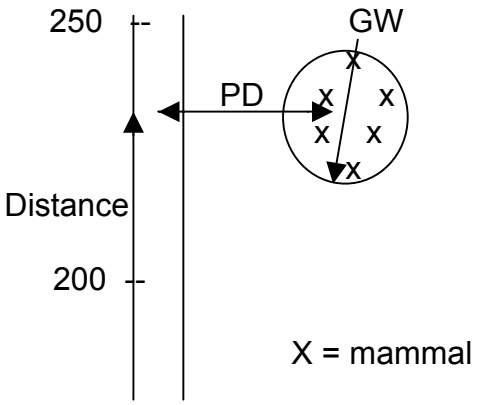


Figure 2.3a. Schematic diagram of data recorded, where GW is group width, PD is perpendicular distance.

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. Results are therefore presented as relative abundance but density estimates can be found in Appendix 1.

The mean number of encounters was used to compare the change in population abundance between 2003 and 2006 and any significant changes were demonstrated using the Mann-Whitney U analysis, a simple nonparametric test that compares the medians of two samples.

2.4. Results

Over the four year period a total of 486 km of transects were surveyed.

Table 2.4a. Sampling effort.

	2003	2004	2005	2006	**Total**
Total km	157	96	106	127	**486**
Average speed (km/h)	1.16	1.18	1.28	1.06	**1.17**
Months surveyed	June-September	April-August	April-early July	April-August	

Data from the four years of transects were combined to produce the figure below, which shows at what perpendicular distance from the centre of the transect the highest frequency of mammals were encountered. Accurate estimation of sighting probability assumes that all mammals are encountered on the transect and that the probability of detection decreases with distance from the transect as seen in the graph below.

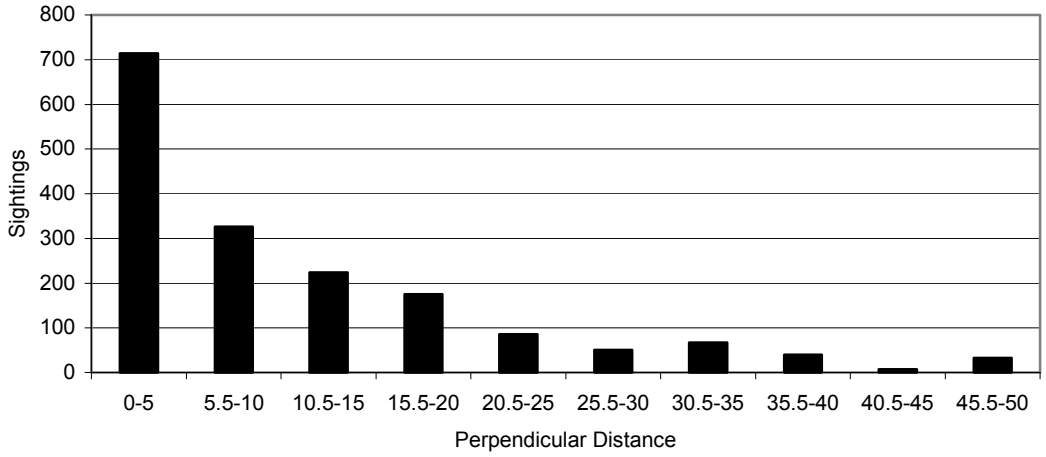


Figure 2.4a. Frequency distribution of perpendicular distance from transect line, combined 2003-2006.

Data were collected for 15 mammal species and four species of bird during each of the survey periods over the four years and is summarized below.

Table 2.4b. Summary of results over four years 2003-2006.

Species	Total individuals				Individuals per 10 km				Total groups				Groups per 10 km			
	2003	2004	2005	2006	2003	2004	2005	2006	2003	2004	2005	2006	2003	2004	2005	2006
BA	15	15	11	9	0.76	1.55	1.04	0.71	12	14	10	9	0.94	1.45	0.94	0.71
BCM	125	47	116	105	7.95	4.87	10.92	8.29	21	12	33	24	1.65	1.24	3.11	1.90
BTPG	16	10	2	8	1.02	1.04	0.19	0.63	10	8	2	7	0.78	0.83	0.19	0.55
CP	14	20	8	12	0.89	2.07	0.75	0.10	4	8	3	7	0.31	0.83	0.28	0.55
CSQM	120	62	107	185	7.63	6.42	10.07	14.61	3	7	6	12	0.24	0.73	0.56	0.95
DTT	17	8	6	7	1.08	0.83	0.56	0.55	5	4	3	4	0.39	0.41	0.28	0.32
GBD	3	2	4	6	0.19	0.21	0.38	0.47	3	2	4	5	0.24	0.21	0.38	0.40
GSQ	12	11	4	8	0.76	1.14	0.38	0.63	7	9	4	8	0.55	0.93	0.38	0.63
MSM	36	10	22	15	2.29	1.04	2.07	1.18	9	3	8	7	0.71	0.31	0.75	0.55
PWT	42	23	8	35	2.67	2.38	0.75	2.77	8	9	2	8	0.63	0.93	0.19	0.63
RBC	2	2	4	3	0.13	0.21	0.38	0.24	2	1	3	2	0.16	0.10	0.28	0.09
RBD	12	13	4	88	0.76	1.35	0.38	0.63	11	12	4	8	0.86	1.24	0.38	0.63
RHM	44	43	14	48	2.80	4.46	1.32	3.79	13	10	6	14	1.02	1.04	0.56	1.11
SARSQ	55	48	56	31	3.50	4.97	5.27	2.45	37	44	41	27	2.9	4.56	3.86	2.13
SBT	207	225	215	256	13.2	23.32	20.24	20.22	33	40	36	44	2.59	4.15	3.39	3.48
SG	62	72	56	46	3.94	7.46	5.27	3.63	35	41	31	26	2.75	4.25	2.92	2.05
SM	27	59	51	96	1.72	6.11	4.80	7.58	6	16	13	30	0.47	1.66	1.22	2.37
WFC	39	33	47	45	2.48	3.42	4.42	3.55	6	4	8	8	0.47	0.41	0.75	0.63
WLP	136	172	148	331	8.65	17.82	13.93	26.15	8	9	4	9	0.63	0.93	0.38	0.71

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*).

Changes in abundance of each species can be seen in the graphs below, which show the mean number of encounters of each species in 2003 and 2006, the error bars show standard deviation at the 95% confidence interval.

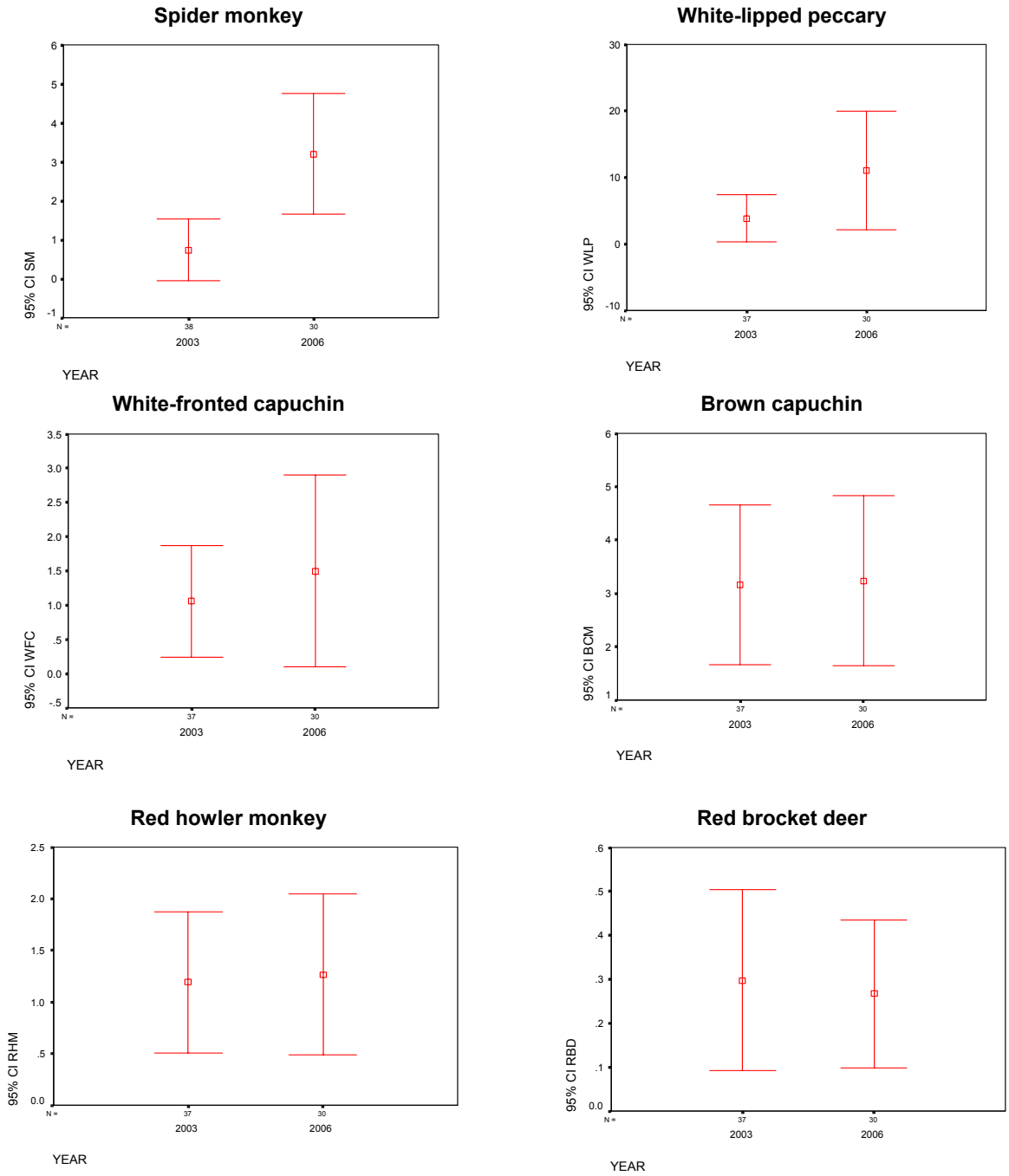


Figure 2.4b. Changes in species abundance from 2003 to 2006.

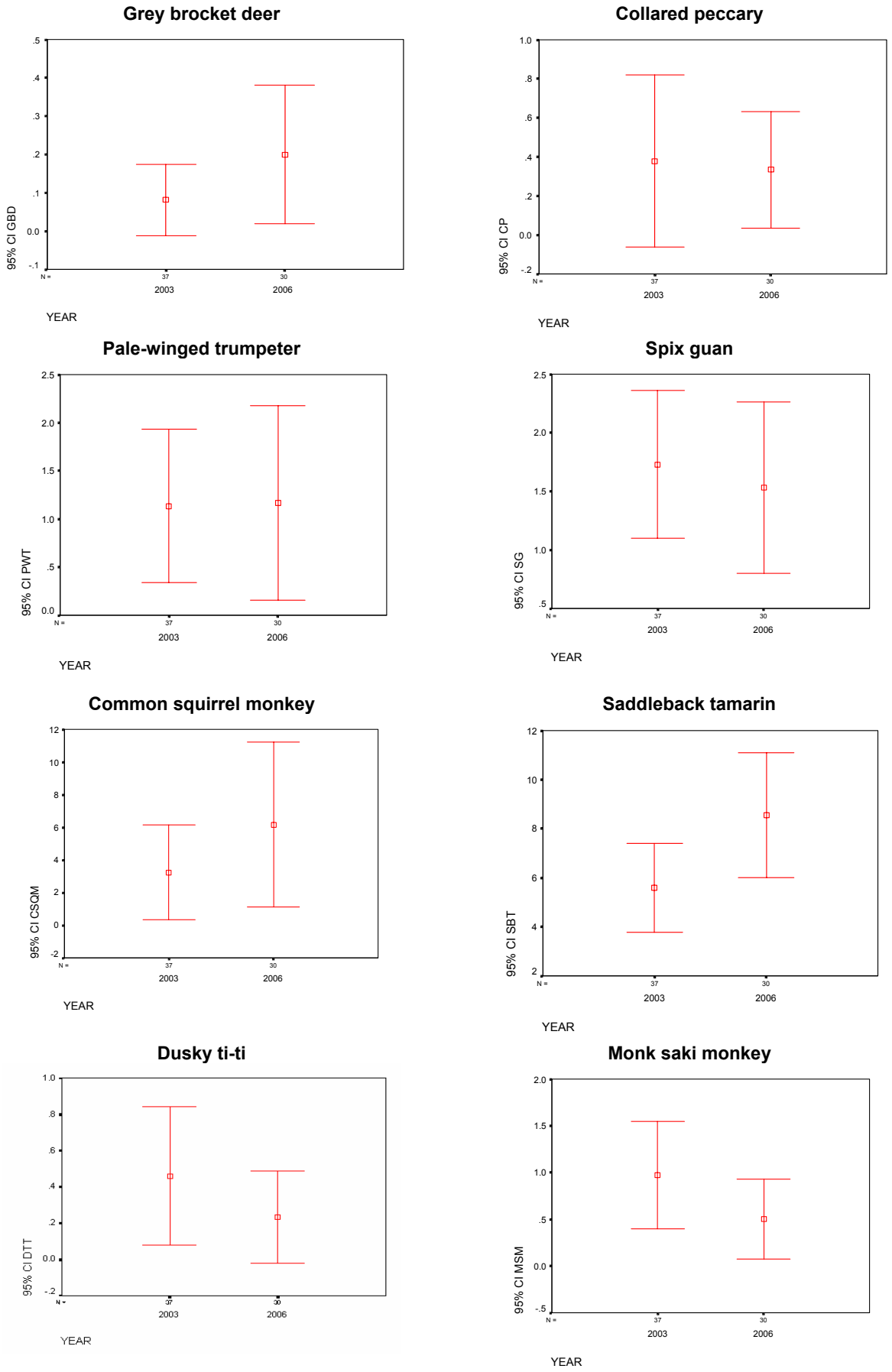


Figure 2.4b (continued). Changes in species abundance from 2003 to 2006.

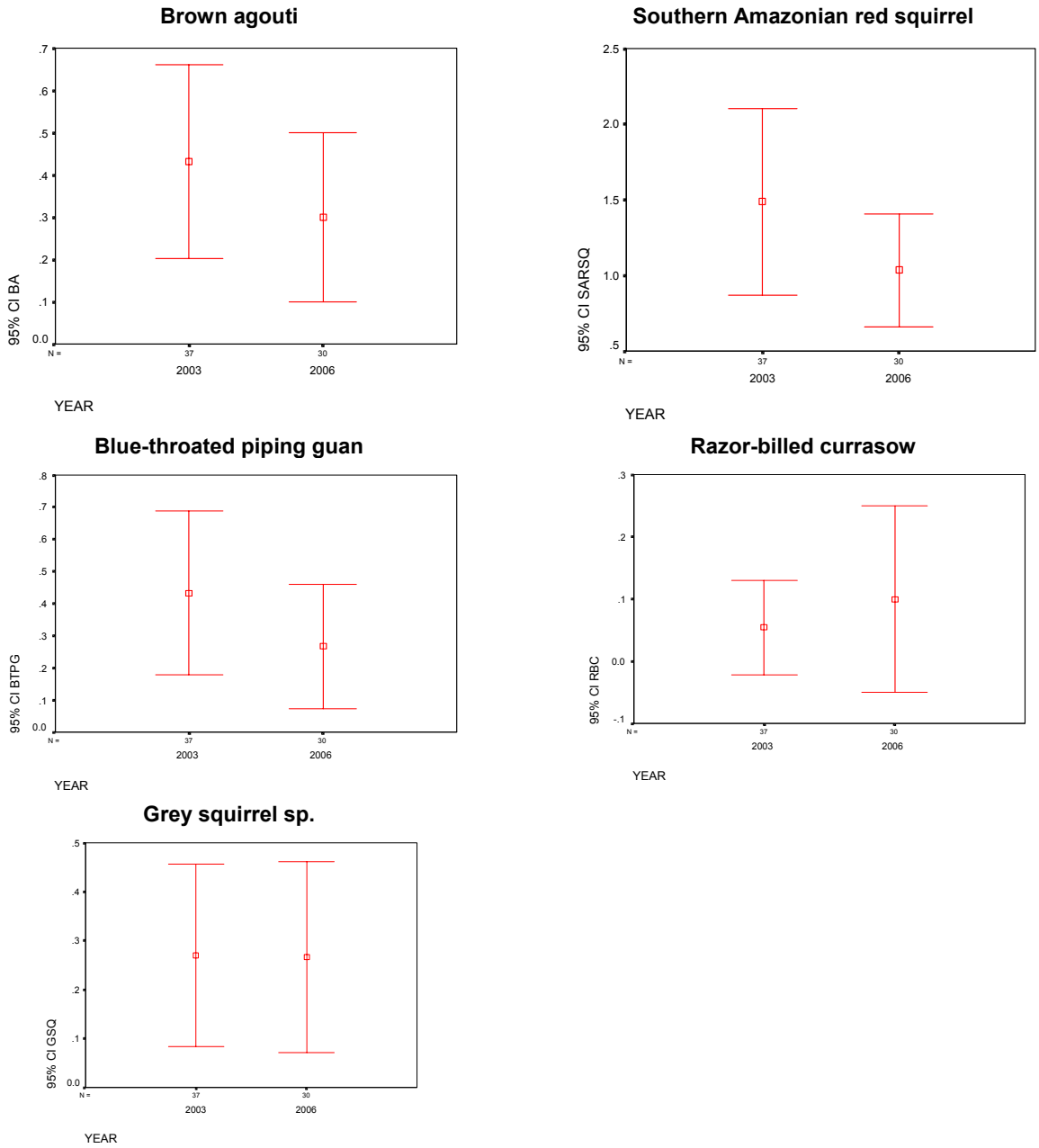


Figure 2.4b (continued). Changes in species abundance from 2003 to 2006.

The Mann-Whitney U test was used to see if any of the changes seen in the above graphs were statistically significant. The results are presented in the table below where species with a test result highlighted in red are highly significant ($p < 0.001$). The spider monkey is the only species that shows a change at the 99% (and 95%) level. All other species showed changes that were not statistically significant (at both the 95% and 99% level).

Table 2.4c. The Mann-Whitney results.

Species	Test results
Brown agouti	506
Brown capuchin monkey	541
Blue throated piping guan	510
Collared peccary	505
Common squirrel monkey	426
Dusky ti-ti monkey	532
Grey brocket deer	506
Grey squirrel	548
Monk saki monkey	502
Pale winged trumpeter	550
Razor billed currasow	547
Red brocket deer	546
Red howler monkey	546
Southern amazon red squirrel	493
Saddle back tamarin	407
Spix guan	506
Spider monkey	297
White-fronted capuchin	554
White-lipped peccary	510

Changes in relative abundance

Of the ten species of mammal considered to be preferred bush meat species, six species have shown increases in their populations and four have shown decreases. However only one of the population increases was large enough to be statistically significant.

Bush meat species

Since 2003 there has been a highly significant increase in spider monkeys at the study site from 1.72 to 7.58 individuals per kilometer. This suggests that spider monkeys were heavily affected by hunting activities and that since the cessation of logging the population is beginning to recover. Since abundance has shown an increase in three of the four years of the study, it would appear that numbers of spider monkeys have still not reached carrying capacity.

Red howler monkeys, brown capuchins and white-fronted capuchins have all shown a small but not statistically significant increase in abundance since 2003.

Monk saki monkeys have shown a small, non-significant decrease in abundance over the study period.

The population of white-lipped peccaries appears to have increased over the study period, but their abundance is 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. As they travel over large distances they probably move outside of the protected area around the research station and so may still be being hunted in small numbers.

Brocket deer, collared peccaries and brown agoutis are all species of terrestrial mammal that make little noise and are easily disturbed. Only the grey brocket deer has shown a small, non-significant increase in numbers since 2003.

Non-bush meat species;

Common squirrel monkeys and saddleback tamarins are small species of primate, both have shown a large but non-significant increase in population since 2003. The medium sized dusky ti-ti monkey, however, shows a decline in abundance, albeit not statistically significant.

The population of the largest species of game bird, the razor-billed curassow has increased whilst the two smaller hunted species the spix guan and blue-throated piping guan have decreased. The population of pale-winged trumpeters has shown a small increase. None of these changes were statistically significant, however.

Since no gun shots have been heard from inside the protected area or cartridges found on the trails, any decreases seen in populations are thought to be attributed to natural fluctuations and experimental error. Also, there are two potential problems in the experimental design, which may have resulted in fewer encounters with shy terrestrial mammals.

Firstly, the employment of up to three people to collect data. We used a local guide (to spot animals) plus up to two expedition team members (to record data), but more than one extra person may cause too much noise and therefore cause mammals to move before being recorded. Although great care is taken to minimise noise by keeping transects clear of debris and having a space between the spotter and assistants, it is most likely to be quiet-moving, terrestrial mammals such as deer and collared peccaries that escape detection. As we are seeing in the results, it is these animals that appear to be showing decreases in abundance. In the future even more care will be taken to clean up trails before walking them and a greater distance will be kept between the animal spotter (guide) and the data recorders (expedition team members) to address this problem.

The second experimental concern is the employment of up to five local guides over the four year study period. Different guides will have had differing abilities to spot mammals or bias towards spotting arboreal mammals over terrestrial mammals. It is also likely that four years is still too short a period to see significant changes in populations and that 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). We conjecture from the data collected that the majority of bush meat and remaining mammal species are show trend towards increasing abundance since the cessation of logging activities, although after four years this increase is still not large enough to be statistically significant in most species. This suggests that although hunting at the site has had a negative impact on mammal populations, their recovery is still possible.

Many studies have demonstrated that hunting has a negative impact on mammal populations (Perez 1999, Naughton-Treves et al. 2003) and in some case can cause local or global extinction (Bodmer et al. 1997). Local extinctions did not occur at the study site and populations appear to be recovering 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.

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 (see Fig. 2.5a below). The leases on these concessions are renewed yearly (subject to the approval of management plans) for a further 40 years. This marks a change in the nature of the extraction process for the area from one of short-term exploitation to long-term management that will be handed to the next generation.

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 illegally cut mahogany from further upriver inside the Alto Purus National Park. 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 as potential source areas for dispersal of mammals will be over-hunted causing local extinctions.

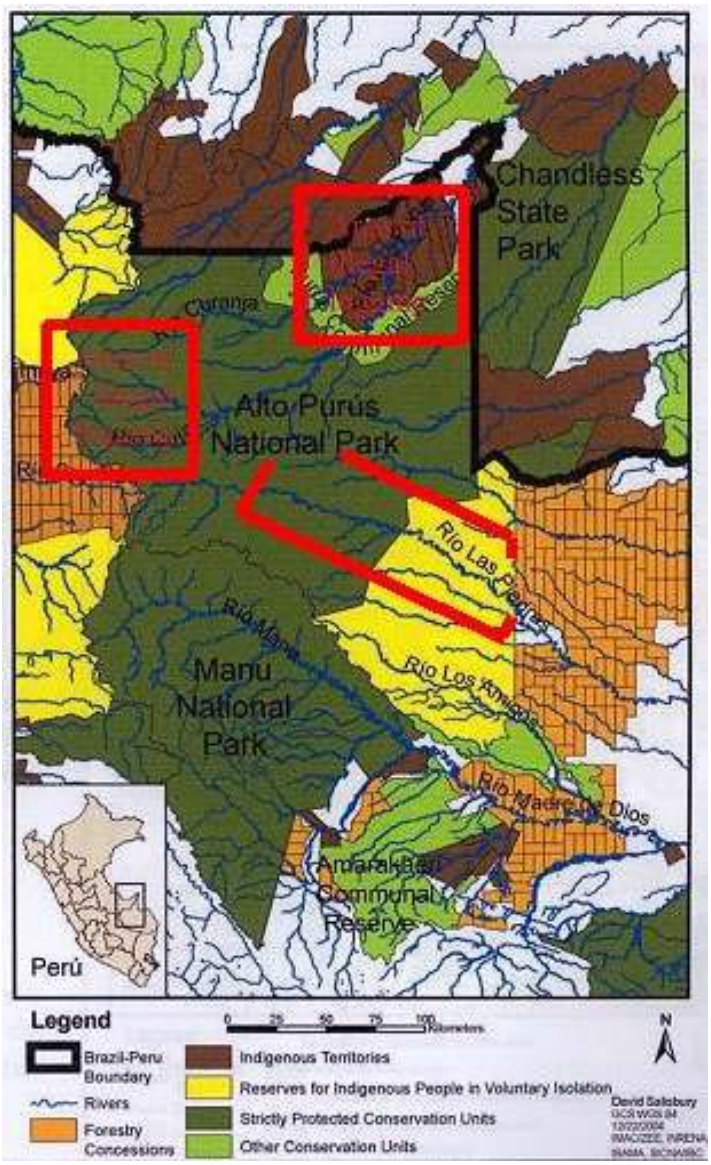


Figure 2.5a. Areas of illegal logging (red boxes) in and around the study site.

Wildlife management could bring benefits not only to the conservation of species, but also to concessionaries as it would enable annual harvests of bush meat 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. This study case occurred purely by chance, rather than as a result of a wildlife management plan, but it demonstrates the sustainability of such a system and as such could be used as a management model. The only way to assure viable populations of mammals for conservation of species and bush meat consumption is through continued monitoring programmes at control sites (such as in this study) and with the co-operation of woodcutters inside concessions.

Only by working with woodcutters can any positive outcome be achieved. Results from surveys such as this can then be used to implement realistic hunting quotas that ensure the long-term survival of game species.

Recommendations for wildlife protection in River Las Piedras;

- Establishment of small reserves within each logging concession to act as source areas for mammals. Such reserves should overlap with neighbouring concession reserves to provide a larger protected “source” area for a successful source-sink dispersal system. Undisturbed blocks of 200 hectares or 10% of the concession area has been suggested by Blockhus et al (1992).

- Establishment of an NGO to monitor impacts of logging inside concessions and reserves.

- Inform woodcutters about the benefits of wildlife management within their concession.

- Encourage local authorities, particularly INRENA (government institute of natural resources) to take a more active role in regulating concessionaries.

- Prevent loggers from entering Alto Purus National Park.

Recommendations for future expedition work

Future work must continue collecting invaluable population data and will begin looking at the behavioural responses of hunted mammals, particularly primates to human presence.

2.6. References

Blockhus, J. M., M. Dillenbeck, J. A. Sayer, and P. Wegge. 1992. Conserving Biological Diversity in Managed Tropical Forests. Gland, Switzerland and Cambridge, United Kingdom: IUCN (International Union for Conservation of Nature and Natural Resources) Forest Conservation Programme/ ITTO(International Tropical Timber Organization).

Bodmer, R.E. 1988. Ungulate management and conservation in the Peruvian Amazon. *Biological Conservation* 45: 303-310.

Bodmer, R., Eisenberg, J. & Redford K. (1997) Hunting and the likelihood of extinction of Amazonian mammals. *Conservation Biology* 11: 460-466.

Bourlière, F. 1985. Primate communities: their structure and role in tropical ecosystems. *International Journal of Primatology* 6 (1): 1-26.

Emmons, L. H. (1984) Geographic variation in densities and diversities of non-flying mammals in Amazonia. *Biotropica* 16(3): 210-222.

Fimbel, R.A. et al. (2001) The cutting edge: conserving wildlife in logged tropical forests. Columbia University Press

Hammer, M. and Tatum-Hume, E. (2003) *Surveying monkeys, macaws and other wildlife of the Peru Amazon*. Expedition report available from www.biosphere-expeditions.org/reports.

Lacher, T.E. Jr. (2004) Tropical ecology assessment, and monitoring initiative. Primate monitoring protocol. *Conservation International, Draft protocol*.

Naughtin-Treves, L et al. (2003). Wildlife survival beyond Park boundaries: the impact of Slash-and-Burn agriculture and Hunting on Mammals in Tambopata, Peru. Conservation Biology 17: 1106-1117

Novaro, A.J. et al. (2000) Effect of hunting in source-sink systems in the Neotropics. *Conservation Biology* 14: 713-721.

Perez, C. A. (1999) Effects of subsistence hunting on vertebrate community structure in Amazonian forests. *Conservation Biology* 14: 240-253.

Perez, C.A. 1999. General guidance for standardizing line transect surveys of tropical forest primates. *Neotropical Primates* 7: 11-16.

Perez, C. A. (1995) Population status of White-lipped *Tayassu pecari* and Collared Peccaries *Tayassu tajacu.* In: Hunted and unhunted Amazonian forests*. Biological Conservation* 77: 115-123

Raez-Luna, E.F. (1995). Hunting large primates and conservation of the Neotropical rainforest. *Oryx* 29 (1): 43-48

Schulte-Herbruggen, B and Rossiter, H. (2003) *A socio-ecological investigation into the impact of illegal logging activity in Las Piedras, Madre de Dios, Peru*. Expedition report available from www.savemonkeys.com.

Tatum-Hume, E., Müller, M., Schmidt, K. and Hammer, M. (2003) *Surveying monkeys, macaws and other wildlife of the Peru Amazon*. Expedition report available from www.biosphere-expeditions.org/reports.

Terborgh, J. 1983. Five new world primates: a case study in comparative ecology, 1st edition, Princeton University Press, New Jersey.

Robinson, J. G and Bennett E. L. Carrying capacity limits to Sustainable hunting in tropical forests. From Biological limits to sustainability

Appendix 1

Table showing the density estimates of the most frequently encountered mammal species for 2006. Densities were calculated using the program distance version 3.5. Distance models were chosen that minimised the amount of variance in the density estimates.

Species	Density (per sqkm)	% coeffcient of variance	Lower confidence interval	Upper confidence interval
Spider monkey	11.13	27.57	6.49	19.09
Red howler monkey	8.37	28.27	4.79	14.61
Brown capuchin monkey	10.28	28.55	5.88	17.97
Saddleback tamarin	69.08	18.58	47.89	99.66
Spix guan	11.76	33.62	6.13	22.72

3. The impacts of boat disturbance and season on red and green macaw geophagy: implications for the tourist industry and estimating abundance in southeastern Peru

A.T.K. Lee
Manchester Metropolitan University, John Dalton Extension Building,
Chester Street, Manchester, United Kingdom. M1 5GD, a.t.lee@mmu.ac.uk

3.1. Introduction

In Amazonia many fauna species are habitually and directly impacted upon by local human populations through subsistence and commercial hunting for bush meat and skins (Peres 1990, 1996, 1999); persecution of pest species (Rabinowitz & Nottingham 1986), and capture of species for the exotic pet trade. Indirect impacts include selective logging (Johns et al. 1987, Wallace et al. 1996), the alteration or destruction of habitats through conversion of forests to agriculture and anticipated global warming (IPCC 2001), and tourism through erosion; water, air and soil pollution; introduction of alien species and diseases; disruption or destruction of feeding and/or breeding habitats; and redistribution or reduction of wild populations (Kirkby et al. 2004).

The tourism and hospitality industry in general contribute a significant percentage of developing country GDP. In 2000, 193 million tourists visited developing countries leaving revenues of US$ 145 billion in the process (WTO 2002). The fastest growing tourism sectors in developing countries are nature-based tourism and eco-tourism, and the tour operators making the most of this demand are those offering visits to protected areas such as national parks and reserves which have the greatest concentrations of rare, charismatic and photogenic fauna (Kirkby 2002). Among these are parrots and macaws, which often form the focus of many tours carried out to the Peruvian Amazon (e.g. Rainforest Expeditions 2006). Many parrot species congregate in large numbers at exposed river banks to eat clay (Munn 1994, Brightsmith 2004), where they are vulnerable to hunters and other human disturbance (Burger & Gochfeld 2003). These “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).

Geophagy, the intentional consumption of soil, is widespread and well documented for mammals and the parrot and macaw family (Gilardi et al. 1999, Diamond et al 1999, Brightsmith 2004, Brightsmith and Aramburu 2004). The soils 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) with various sites reporting 18 to 20 species (Terborgh et al. 1984, Valdez 1995, Walker 2003), including the near threatened Amazonian parrotlet *Nannopsittaca dachilleae* and the endangered blue-headed macaw *Primolius couloni* (Birdlife International 2005a, b).

As most clay licks regularly visited by tourists are along river edges, they are subject to various sources of disturbance including tourist activity, mining activity, farming activity and passing boat traffic. The impacts of boat traffic for shoreline birds are well documented (Vermeer 1974, 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 (Rogers and Smith 1995), with varying degrees of habituation (Burger 1998). The impacts of boat traffic on the feeding activity of macaws and parrots at a clay lick in Manu showed that different types of boat activity can affect feeding in different ways, with a greater negative impact from boat traffic by native Indians, who are known to hunt the macaws, compared to research traffic (Burger and Gochfeld 2003). A study into the impact of tourism on the number of birds in the vicinity of a clay lick in the Tambopata region recorded a decreased number of the larger parrot and macaw species with increasing motorised boat traffic, whereas smaller species like dusky-headed parakeet *Aratinga weddellii* were not significantly affected by boat traffic by (Clegg 2004). Previous Biosphere Expeditions studies along the Las Piedras River have shown that birds, especially red and green macaws *Ara chloroptera,* regularly display anti-predatory responses (flushes) to approaching boats (Tatum-Hume et al. 2003, Tatum-Hume et al. 2005). If birds stop visiting clay licks, this will have severe consequences for the tourism industry and highlights the need for proper conservation practices and for studies into sources of disturbance to clay lick activity.

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

3.2. Methods

Study sites

The research was undertaken at two sites in the Tambopata region of the Madre de Dios Department, Peru. The primary site for which results are presented is the Piedras Biodiversity Station (Piedras), roughly 60 km northwest of the town of Puerto Maldonado. The base camp (S 12^{o} 05.663' W 69^{o} 52.852') is surrounded by a conservation concession of 5000 ha situated east of Manu National Park and south-east of the Alto Purus Reserve. The principal forest type is sandy-soiled high forest (terra firme), associated with stands of *Bertholettia excelsa* (Brazil nut or castanya). Average annual rainfall is 2500 mm per year, with most rain falling between October and April (Tatum-Hume et al. 2005). Monitoring was conducted at this site (Piedras) during January and February 2006 (rainy season) and June to August (dry season), when monitoring was conducted principally by team members from Biosphere Expeditions.

Comparative data were collected at a second study site 86 km south of the Piedras study site on the Tambopata River, called Posada Amazonas (Posada). The base camp (12^{o} 48' S, 69^{o} 18' W) is a community-owned lodge, adjacent to a community reserve of about 4,000 ha that was established by members of the native community of Infierno in the early 1990s, bordering the Tambopata National Reserve. The site is roughly 25 km from the town of Puerto Maldonado. The surrounding forest is a mixture of terra firme and floodplain forest associated with the Tambopata river (which is about twice as wide as Las Piedras river). Average rainfall is about 2810 mm per year (Pearson & Derr 1986). The surrounding area is made up of a mix of floodplain and terra firme forests (Brightsmith and Aramburu, 2004). Studies are being conducted at this site year-round by the Tambopata Macaw Project, and selected data for June, July and August are presented here for comparative purposes.

Neither site has had a history of hunting in the immediate vicinity for several years, although hunting does continue on the edges of the protected areas at both sites. Piedras was part of a logging concession between 1994 and 1999, and then the access point for Brazil nut extraction from 1993 to 2000 (Tatum Hume et al. 2005). 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 mahogany *Swietenia macrophylla* 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 in conjunction with Biosphere Expeditions (Tatum-Hume et al. 2003). Since 2002 the area has been protected by the declaration of the conservation concession.

Tambopata has a longer history of settlement and hunting, and since the end of the 1990s attitudes of the local communities have changed somewhat and a reduction in hunting has been reported by the mayor of the community (Juaneco Pesha, personal communication). However, hunting for macaw soup still continues with at least one red and green macaw *Ara chloroptera* being reported shot last year, and an observation this year of an attempt to drown what was thought to be an injured red and green macaw *Ara chloroptera*. There is also extensive logging for the principal nesting tree species (*Dipteryx* spp) for the charcoal and "parqued" industries. The Tambopata river has become a popular international tourist destination due to its accessibility by air from the major tourist hubs of Lima and Cuzco and the nine major lodges along this river generate substantial boat traffic, all of which passes the clay lick at Posada.

Clay lick monitoring

The three clay licks monitored during this study are described below:

1. The Piedras lick (also known as clay lick 2) is an exposed river bank of the Las Piedras river close to the port of embarkation to the base camp, where no macaws had been observed prior to 2005 (Tatum-Hume et al 2005). The riverbank where feeding takes place is about 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^{o} 03'04.4" W069^{o} 31'45.4". The lick is 0.5 km from the research station. An observation blind was positioned 108 m away on the opposite river bank, 20 m from the river's edge beyond a reed bank. Monitoring was undertaken from daybreak until 15:30 or until such time that all macaws had disappeared from the area for a significant period of time and it was reasoned that they would not return. Monitoring of this lick was conducted in January and February 2006, and from June to August, principally by members of Biosphere Expeditions.

2. Early morning monitoring was conducted at a parrot clay lick (also known as clay lick 1) on the Las Piedras river for early morning periods only from June to July. Although substantial macaw activity was observed there up to 2005 (Tatum-Hume et al. 2005) observations from January and February earlier in the year showed that most macaw activity was concentrated at clay lick 2, so no late morning monitoring was conducted there. On three occasions during the Biosphere Expeditions study a boat was sent up while there was no activity at clay lick 2 to see if there were birds at clay lick 1, but no birds were observed on any of these excursions.

Clay lick 3, which was monitored intermittently during 2005, due to roadside hawk *Buteo magnirostris* activity and reduced parakeet activity as a consequence, appeared to be abandoned during 2006. Therefore no rigorous monitoring was done at this clay lick.

3. The Posada clay lick is an exposed bank of clay on the south side of the Tambopata river. The clay lick consists of several sections of exposed clay, used in varying degrees by parrots and macaws. The section where macaws are observed feeding is roughly 4 m high and 8 m wide. An observation blind is 35 m from this lick, and is frequently occupied by tourists in the early and late morning. Monitoring has been undertaken at this site from before daybreak until 17:00 for 10 days each month since January 2006 by members of the Tambopata Macaw Project.

Information recorded for parrot and macaw activity:

The monitoring protocol follows that described by Brightsmith (2004), with modifications for flushes, and has generally been used in previous Biosphere Expeditions studies (Tatum-Hume et al. 2004, Tatum-Hume et al. 2005). A summary of the monitoring protocol is as follows:

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 to check for danger. In many cases birds slowly descend 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. This was recorded in order to record occasions when species were interested in feeding and was of special importance for days when no feeding was subsequently observed.

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. The 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; “partly cloudy” when cloud cover was between 25-75% and as “rain” if precipitation was recorded in the area of the clay lick.

6. A “max count” was recorded at the end of each day’s feeding bout, representing the maximum number of birds recorded at any one time in the vicinity of the clay lick (in the trees as well as on 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 (also known as an anti-predatory response). Flushes were classified as follows: 0 – no reaction, 1 – increase in alarm calls, 2 – slow dispersal of birds to the vicinity of the clay lick, 3 – minor flush (up to 75% of birds take flight, but remain in the area), 4 – major flush (up to 100% of the birds take flight, but remain in the area), 5 – complete flush (100% of the birds take flight and leave the area completely for a time period of at least ten minutes). Any reason for the flush was noted if known (birds of prey, boats, vultures, mammal or people activity).

7. All boats passing in 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 (using the flush categories described above).

8. Activity of perched red and green macaws in the vicinity of the clay lick was recorded as described in Tatum-Hume et al. (2005).

Parrot and macaw census

An aim of this study was to calculate parrot and macaw abundance in relation to morning activity and clay lick use.

Variable distance line transects

Line transects were chosen as the preferred methodology for monitoring parrot and macaw abundance following recommendations that this method is suitable for large, colourful and sparsely encountered species like parrots and hornbills (Bibby et al. 1998) and after a trial on the methodologies was conducted at Piedras to compare the methodologies (Tatum-Hume et al. 2005). At Piedras, transects were conducted along a 4300 m long transect (transect A) along which long-term monitoring has been taking place and along a 4000 m long transect cut by Biosphere Expeditions team members (transect C). Surveys were carried out during the months of January, February, June, July and August.

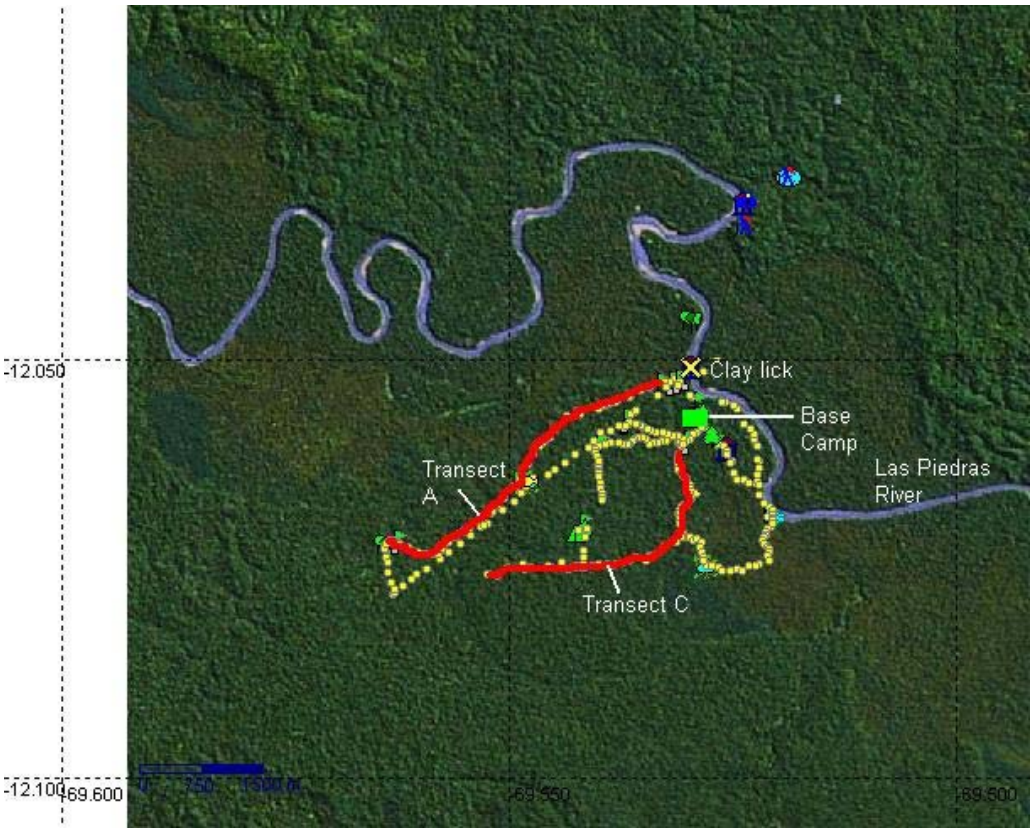


Figure 3.2.4a. A satellite image of the study area showing the location of transects A & C, base camp & clay lick.

At Posada transects were conducted along three transects, two of 5000 m length, and one of 2000 m length, which run through a mix of floodplain and terra firme forest. However, surveys were mostly only done on one transect of 5000 m during January and February. Surveys were initiated at dawn and conducted at a speed of around 1 km/h.

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

1. Time and position to the closest 100 m marker along the transect.

2. Species.

3. Whether birds were heard only, seen only, heard then seen or seen then heard.

4. Whether birds were flying or perched, or perched then flying or flying then perched.

5. 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 an undeterminable distance away or at a distance greater than 100 m, then no distance was recorded.

6. Activity of perched birds, if seen, including information on any fruit or plant parts being eaten.

7. Group size for birds seen. The average group size was inserted for encounters with perched birds where group size was not known or could not be reasonably guessed. In cases where no data were available from transects, these data were calculated from group sizes recorded passing the tower where afternoon transects were recorded. This method was used in preference to using only averages calculated from the tower as there was the probability of repeat counts of local groups of birds. Group sizes might change over the day due to clay lick-related activity and tower surveys were only conducted in the afternoon so the data on group sizes from transects were used in preference, even though some group sizes may well have been misjudged by observers.

8. Flight bearing for flying birds to the closest 10 degrees.

9. Weather every 15 minutes. Cloud was recorded as 0%, 25%, 50%, 75% or 100% or as rain or fog. Wind was recorded as none (no wind or imperceptible breeze that moves only palm fronds), light (heavier leaves and small branches moving) or heavy (strong wind moving larger branches and dislodging debris from the tree tops).

Tower monitoring

Afternoon monitoring of psittacids was conducted from a wooden tower of 15 m height on the edge of a terra firma forest terrace overlooking mature floodplain forest by Biosphere Expeditions team members from June to July 2006 following the protocol described in Tatum-Hume et al. (2005).

3.3. Results

Clay lick monitoring

At Piedras, 36 days of monitoring was conducted at clay lick 2 during January and February and 31 days through June, July and August. Comparative data were collected at Posada for 20 days during January and February and 29 days in June, July and August.

The parrot clay lick 1 was monitored on 16 fair weather days (excluding days where rain fell for most of the early morning). Feeding occurred on nine days, but only four species were observed on the lick in 2006, compared to six species observed for the same period in 2005 (Table 3.3.1a). No mealy parrots or chestnut fronted macaws were observed feeding, and there were fewer yellow crowned parrots. Dusky-headed parakeets and orange-cheeked parrots were recorded in higher numbers in 2006.

Table 3.3.1a. Parrot activity at clay lick 1, Piedras, in terms of average daily number of parrot minutes observed for the June-August period for 2005 and 2006.

	Blue-headed parrot	Dusky-headed parakeet	Orange-cheeked parrot	Yellow-crowned parrot	Mealy parrot	Chestnut-fronted macaw
2005	141.6	23	0.6	27.6	4.6	0.4
2006	52.2	107.5	9.7	3.4	0	0

Like 2005, the red and green macaw feeding accounted for most of the feeding recorded (Table 3.3.1b) for the period between June and August. The feeding at clay lick 2, Piedras, was higher compared to 2005 (when average feeding per monitored period was 123 parrot minutes). However, during that year more red and green macaw feeding was observed at clay lick 1, where average feeding per monitored period was 171 parrot minutes. Combined feeding is thus close to 400 for 2005, but it is doubtable whether this is significantly lower overall compared to the comparable period for 2006 (when average daily feeding was 589 parrot minutes), as monitoring was generally halted at around midday during 2005, and feeding probably occurred after this time.

Scarlet macaws and red and green macaws were both observed at clay lick 2. Average daily feeding for red and green macaw feeding was significantly higher between seasons (January-February compared to June-August) for both Piedras ($t=3.555$, $p<0.001$) and Posada ($t=3.355$, $p<0.005$). Average daily feeding was also significantly higher for Piedras compared to Posada for both the January to February period ($t=5.139$, $p<0.001$) and June to August period ($t=2.919$, $p<0.05$). The average number of macaws in the vicinity of the clay lick was twice as high during the wet season compared to the dry season at both sites, but feeding was six times lower at Posada during the dry season compared to Piedras where feeding was half that of the dry season but where the amount of feeding per bird recorded in the area (maximum count) was roughly the same. The highest maximum count at Piedras was 115, while for Posada it was 45.

Table 3.3.1b. Red and green macaw activity at the two study sites in terms of numbers of birds recorded in the area (maximum count) and average index of red and green macaw feeding activity (parrot minutes) per day for the two sites for the two time periods.

	Average minimum number (maximum count) per day		Average parrot minutes per day		Feeding / maximum count (minutes)	
	Piedras	Posada	Piedras	Posada	Piedras	Posada
Jan, Feb	70.3	25.9	1193	372	16.97	14.36
Jun, Jul, Aug	33	12.8	589	59	17.85	4.61

At Piedras there is still the same amount of feeding per bird if we assume the maximum count number is an accurate representation of the total number of birds that were at the lick for low and high season. This is not an unreasonable assumption given that the number of birds is not very high and work with radio-collared red and green macaws from the Los Amigos river system (roughly 100 km west of the Piedras study site) shows that radio-collared birds are in the vicinity of the lick for up to six hours (El Proyecto AREAS – Amazonia 2006). However, that study reports that birds spend on average four to six minutes on the lick although no mention is made on how these results are obtained. It may well be that this is the average amount of time an individual bird will perch on the clay lick, ignoring the fact that many birds may make multiple visits to the clay lick and thus parrot minutes relative to the maximum count are a better index of how much time is spent on the clay by individual birds overall. We are confident of this as with the low number of birds at Posada it is easier to follow the activity of individual birds on the clay lick, some of which have been seen to remain feeding for periods of over half an hour. Daily average feeding per bird for Posada is similar to that seen for Piedras for January to February, but average feeding per bird is nearly four times lower for the June to August period (Table 3.3.1b).

Boat traffic passing the clay licks along the rivers

Boat traffic on the Tambopata river is ten times that of boat traffic observed on the Las Piedras river for the June to August period (Table 3.3.2a). Boat traffic on the Tambopata river use predominantly outboard motors (traffic associated with lodges), while nearly 90% of the boats on the Las Piedras river had peke-peke engines (Table 3.3.2b). Boat traffic is twice as heavy along the Tambopata river during the June to August period compared to the January to February period, coinciding with the tourist high season.

Boat traffic was lower on the Piedras river during 2006 dry season (71 boats, 10 carrying wood during 31 days of observation, 0.34 boats per hour) compared to 2005 (113 boats, 23 of which carrying wood during 25 days of observation, 0.77 boats per hour). Boat traffic was also lower for the dry season compared to the wet season (135 boats, 35 of which carrying wood, 1.87 boats per hour). This is to be expected as the rainy season is when it is easier to take wood downriver and is also the season when more Brazil nut extractors are working along the river system.

Table 3.3.2a. Total type of boat traffic on the Las Piedras (Piedras) and Tambopata rivers (Posada).

Type of Boat	Piedras				Posada			
	Jan - Feb		Jun - Aug		Jan – Feb		Jun – Aug	
Canoe	1	1%	2	3%	0	0%	0	0%
Outboard	10	7%	6	8%	202	49%	581	72%
Peke-peke	123	91%	63	88%	213	51%	230	28%
Raft	1	1%	1	1%	0	0%	0	0%
Total	**135**	**100%**	**72**	**100%**	**415**	**100%**	**811**	**100%**

As per 2005, more boats were recorded travelling downriver (Table 3.3.2b) at Piedras. The reduced boat activity together with fewer boats recorded carrying wood may indicate a decrease in logging activity, as the river was never considered too low for the extraction of the log rafts. No data exist for comparable boat traffic for previous years at Posada.

Table 3.3.2b. Direction of boat traffic on the Las Piedras (Piedras) and Tambopata rivers (Posada) for the June to August period 2006.

Direction of travel	Piedras		Posada	
Down river	47	66%	414	51%
Up river	24	34%	397	49%
Total	**71**	**100%**	**811**	**100%**

The impacts of boat traffic on feeding

34% of boats passed Piedras when no birds were in the surrounding trees, compared to 49% at Posada. 92% of boats passed the Piedras lick while no birds were on the lick, compared to 84% at Posada.

There are substantial differences in the reaction of birds between the study sites (Table 3.3.3a). No boats pass the Piedras lick without causing a complete flush, while nearly 60% of boats passing the Posada clay lick elicit no reaction from the birds on the lick or the trees. Only 11% of boats passing the Piedras lick elicited no response from birds in the trees around the lick, 53% caused a complete flush. In general boats have a far greater impact on birds at the Piedras site compared to Posada. There is no correlation between flush intensities between the sites for either tree flushes (Pearson correlation = -0.210, p=0.689) or colpa flushes (Pearson correlation = -0.06, p=0.991).

Table 3.3.3a. The impacts of boat traffic on birds on and around the clay licks at Piedras and Posada for the June to August monitoring period. The data from Piedras represent mostly red and green macaws, while those presented for Posada includes red and green macaw and parrot activity from the early morning.

Flush type	Flushes from trees				Flushes from clay lick			
	Piedras		Posada		Piedras		Posada	
No reaction	5	11%	267	64%	0	0%	75	59%
Increase in alarm calls	2	4%	62	15%	0	0%	11	9%
Gradual dispersal	0	0%	25	6%	0	0%	3	2%
Minor flush (50-75%)	3	6%	22	5%	0	0%	4	3%
Major flush (75-100%)	12	26%	23	5%	0	0%	14	11%
Complete flush (100%) leave the area	25	53%	21	5%	6	100%	21	16%
Total	**47**	**100%**	**420**	**100%**	**6**	**100%**	**128**	**100%**

To account for the differences in the widths of the river, the boats passing the Posada lick were classified into zones depending on their distance from the face of the clay lick. The river was divided into five zones of roughly 50 m each. Table 3.3.3b shows that boats travelling closer to the clay lick were more likely to elicit a response from feeding birds, while hardly any boats travelling in the last two zones caused flushes. On average, 50% of the boats travelling in zones 1 and 2 (up to 100 m from the clay lick) caused no response from feeding birds. In contrast, boats passing on the Las Piedras river which all pass within 100 m of the lick cause complete flushes on all occasions.

Table 3.3.3b. The differences in flush rates of birds from the clay lick at Posada in relation to boat distance from the clay lick.

Flush type	Distance:				
	0-50 m	50-100 m	100-150 m	150-200 m	>200 m
No reaction	48%	53%	58%	69%	86%
Increase in alarm calls	5%	13%	10%	0%	14%
Gradual dispersal	5%	0%	2%	8%	0%
Minor flush (50-75%)	5%	0%	4%	8%	0%
Major flush (75-100%)	19%	17%	6%	8%	0%
Complete flush (100%)	19%	17%	20%	8%	0%
Sum 2-5	**48%**	**33%**	**32%**	**31%**	**0%**

The impact on daily feeding patterns as a result of boats causing birds to leave the area does not seem to impact daily feeding patterns at Piedras, with a similar peak in feeding observed from 09:00 to 10:00 in 2005. Although boat traffic tends to be highest from 11:00 to 12:00, a fair proportion of feeding still occurred around this time.

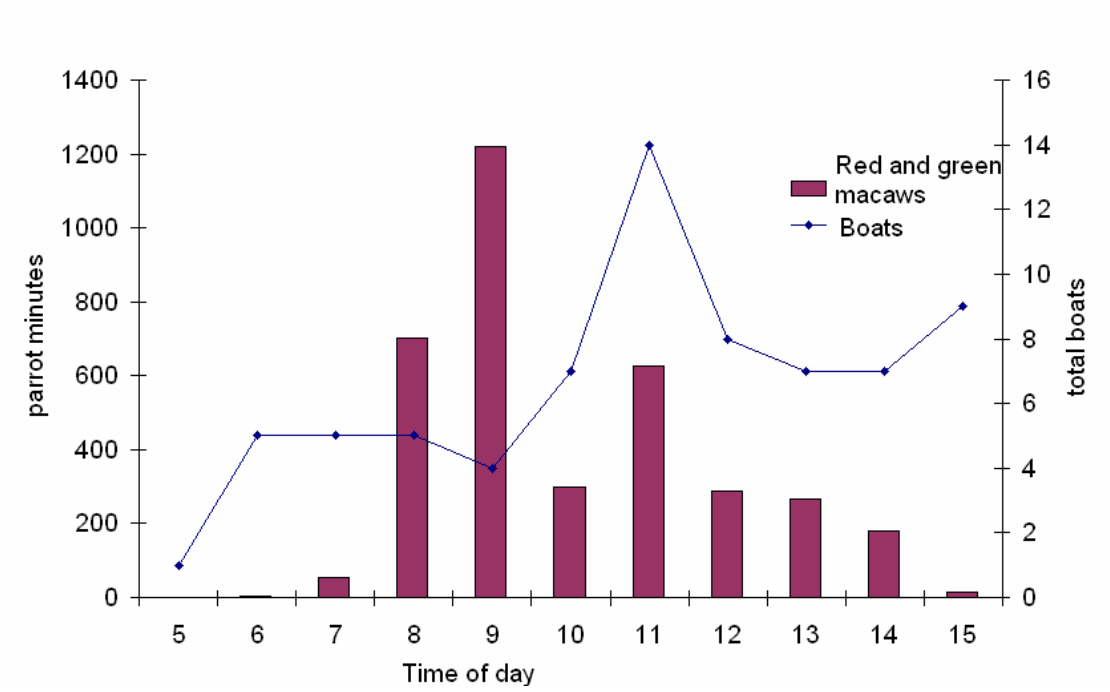


Figure 3.3.3a. Total number of boats against macaw feeding, grouped into hour intervals for Piedras, June - August. There is no correlation between the total numbers of macaws that fed and the time boats passed the clay lick at an hourly level (p=0.780, Pearson correlation).

The gap for the 10:00 period (as seen in Figure 3.3.3a) cannot be explained by boat traffic or even by the direction of boat travel (assuming that boats travelling upriver would make more noise, but boats travelling upriver are evenly dispersed across the time period). In addition, there were no extra flushes during for this period, and no unusual disturbance factors were recorded (of the 22 disturbance factors recorded during the study, only one was recorded for the 10:00-10:59 period, and three for the 9:00-9:59 period).

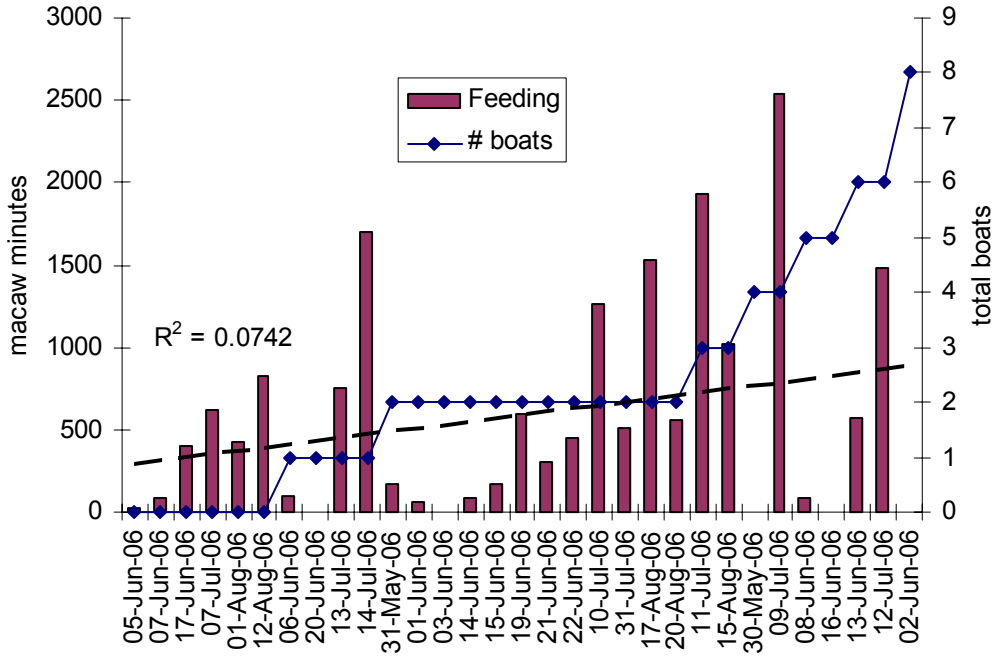


Figure 3.3.3b. Total daily feeding of red and green macaws in relation to increasing boat traffic activity at the Piedras clay lick for June to August. There is no significant correlation between daily boat traffic and daily feeding (p=0.662, Pearson correlation), and also no correlation between daily boat traffic and the number of feeding intervals (p=0.783, Pearson correlation).

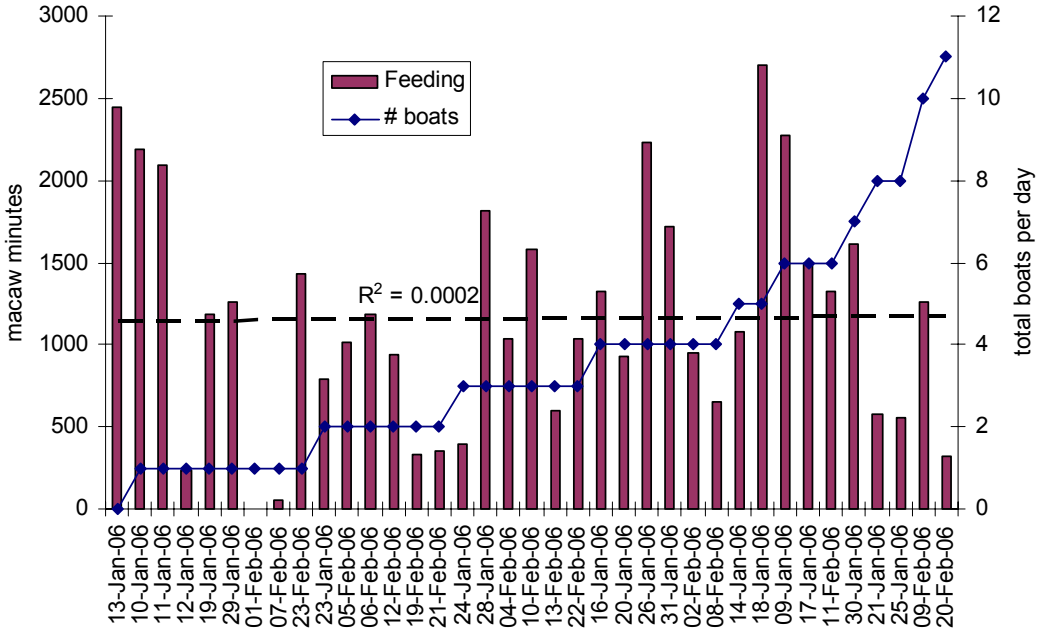


Figure Figure 3.3.3c. Total daily feeding of red and green macaws in relation to increasing boat traffic activity at the Piedras clay lick for January to February. There is no correlation between daily boat traffic and the number of parrot minutes recorded (p=0.904, Pearson correlation) and there is no correlation between daily boat traffic and the number of feeding intervals (p=0.683, Pearson correlation).

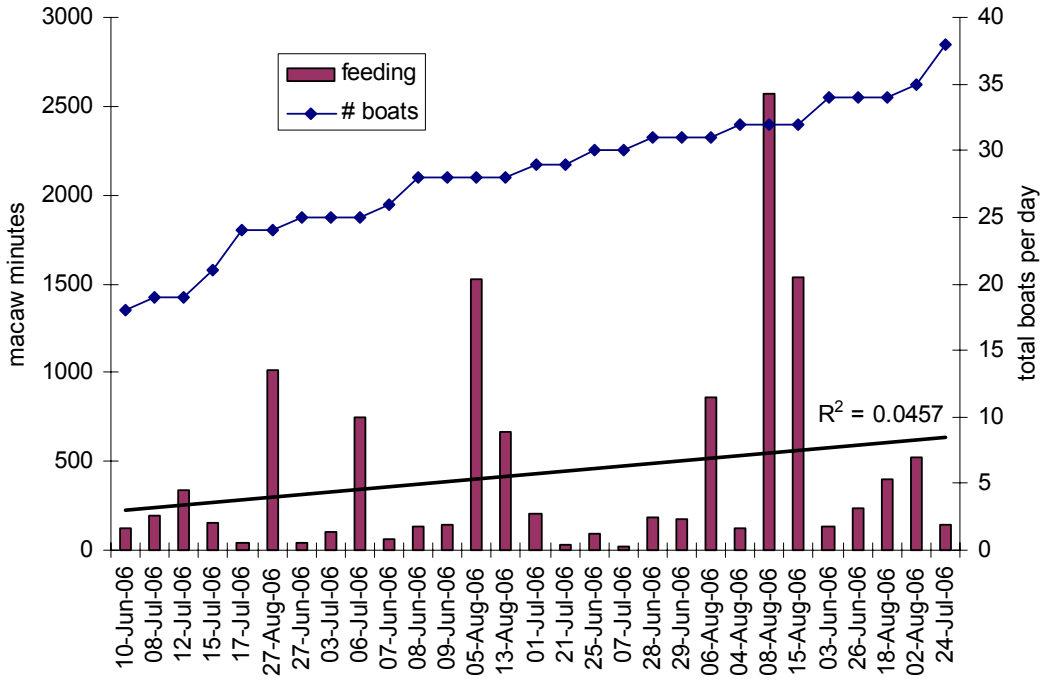


Figure 3.3.3d. Total daily feeding of red and green macaws in relation to boat traffic activity at the Posada clay lick for June to August. There is no correlation between daily boat traffic and the number of parrot minutes recorded (p=0.410, Pearson correlation).

There is no correlation between daily boat traffic and the daily feeding observed at either site, and at Piedras, there is no correlation between daily boat traffic and the daily feeding between seasons. Although a declining trend in the number of feeding intervals was observed during 2005 at Piedras, this was not observed at all during 2006, and in fact, there is even a weak (non-significant) trend for the June to August monitoring period for an increase in daily feeding with increase in daily boat traffic.

Red and green macaw behaviour at the Piedras clay lick from June to August

The activity of red and green macaws around clay lick 2 at Piedras was recorded 3311 times, and overwhelmingly consists of doing nothing classifiable, around 57% of the total time (Table 3.3.4a). This is higher than for the same lick for 2005, when “Nothing” was recorded 44% of the time, but is similar to clay lick 1 (the predominant clay lick for red and green macaw activity during 2005) at 54%. Although superficially it appears that the macaws were engaged more in other activities during 2005, recording during that year generally finished around midday, when birds were still engaged in preening and other activities up to 50% of the time, while this drops off from 12:00 to 15:00 (Figure 3.3.4a) during which time birds are recorded doing nothing up to 70% of the time.

Table 3.3.4a. Red and green macaw behaviour in the trees around clay lick 2 at Piedras during June and July 2006.

	Total observations 2006	2006 clay lick2	2005 clay lick2	2005 clay lick1
Nothing	1906	57.6%	43.5%	54.2%
Preening	571	17.2%	18.5%	17.2%
Calling	243	7.3%	3.0%	1.8%
Moving	172	5.2%	7.8%	6.4%
Allo-preening	172	5.2%	10.1%	7.2%
Flying	134	4.0%	5.1%	6.3%
Branch biting	67	2.0%	4.9%	1.6%
Hanging	21	0.6%	1.9%	1.8%
Sleeping	17	0.5%	3.2%	1.9%
Fighting	5	0.2%	0.2%	0.0%
Aggression	3	0.1%	0.1%	0.7%
Grand Total	**3311**	**100%**	**100%**	**100%**

Similar patterns of activity were observed in the types of behaviour and activities recorded for both the Piedras clay licks and between the years. The Pearson correlation between activity in 2006 at clay lick 2 and clay lick 2 in 2005 is 0.979 (significant at the 0.01 level). The Pearson correlation between activity in 2006 at clay lick 2 and clay lick 1 in 2005 is 0.991 (significant at the 0.01 level).

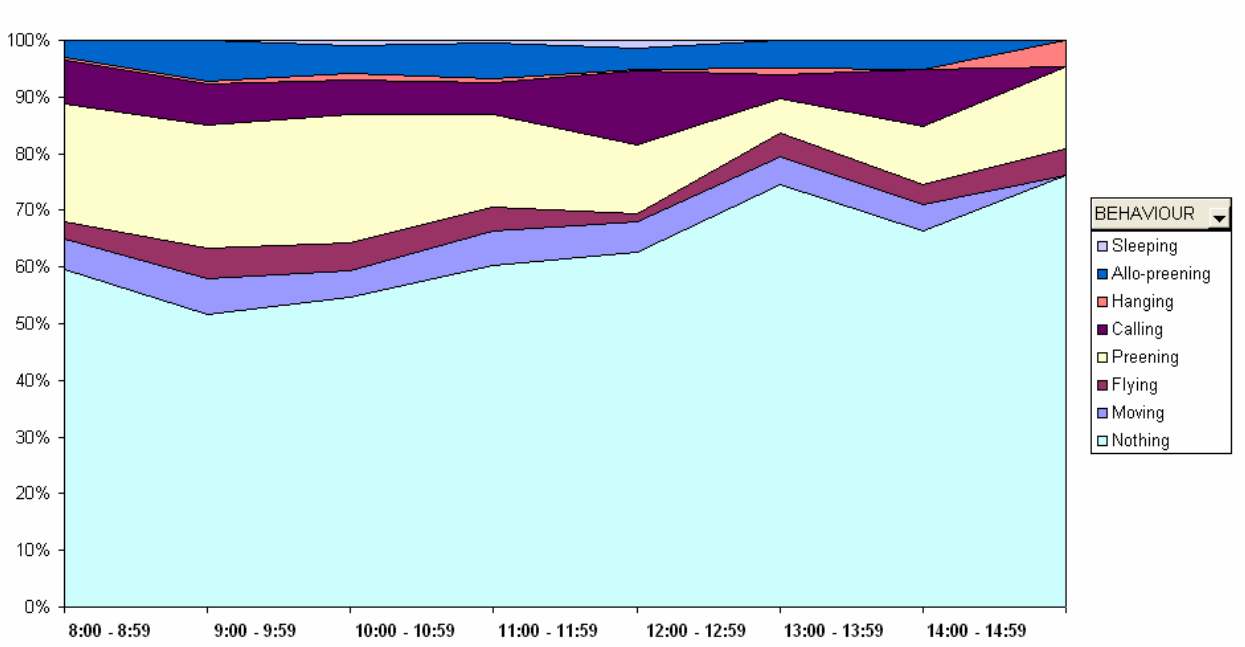


Figure 3.3.4a. Chart showing the proportion of activities that birds are engaged in as the day progresses, showing lots of preening until midday, after which birds become less active (50% of birds recorded as doing nothing at 9:00, compared to 70% at 15:00). Scratching has been lumped into preening activities, and being allopreened has been included in allopreening for in this chart.

Tower monitoring

A total of 16 afternoon surveys were conducted from the tower at Piedras during June and July by members of Biosphere Expeditions, recording a total of 170 groups of flying or perched birds. Slightly fewer birds were recorded on days that were overcast, i.e. with a cloud index of 100% (Figure 3.3.5a).

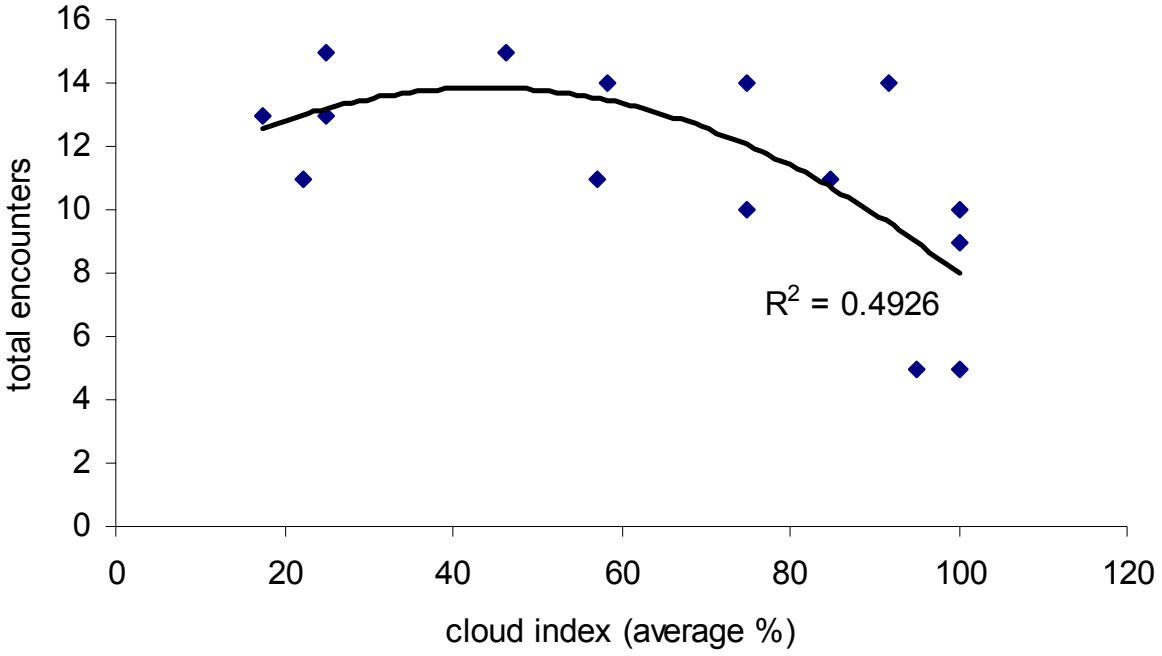


Figure 3.3.5a. Total number of observations of parrots and macaws in relation to percentage cloud cover for surveys conducted from the observation tower at Piedras.

The most commonly recorded species for both 2005 and 2006 was cobalt-winged parakeet, followed by blue-headed parrot and white-bellied parrot. Black-capped parakeet and white-eyed parakeets were recorded more during 2006 than in 2005, while dusky-headed parakeets and mealy parrots were recorded more in 2005 than 2006. Neither of the two species associated with *Mauritia* palm swamps (aguajales) – blue and yellow macaw and red-bellied macaw were observed during 2006.

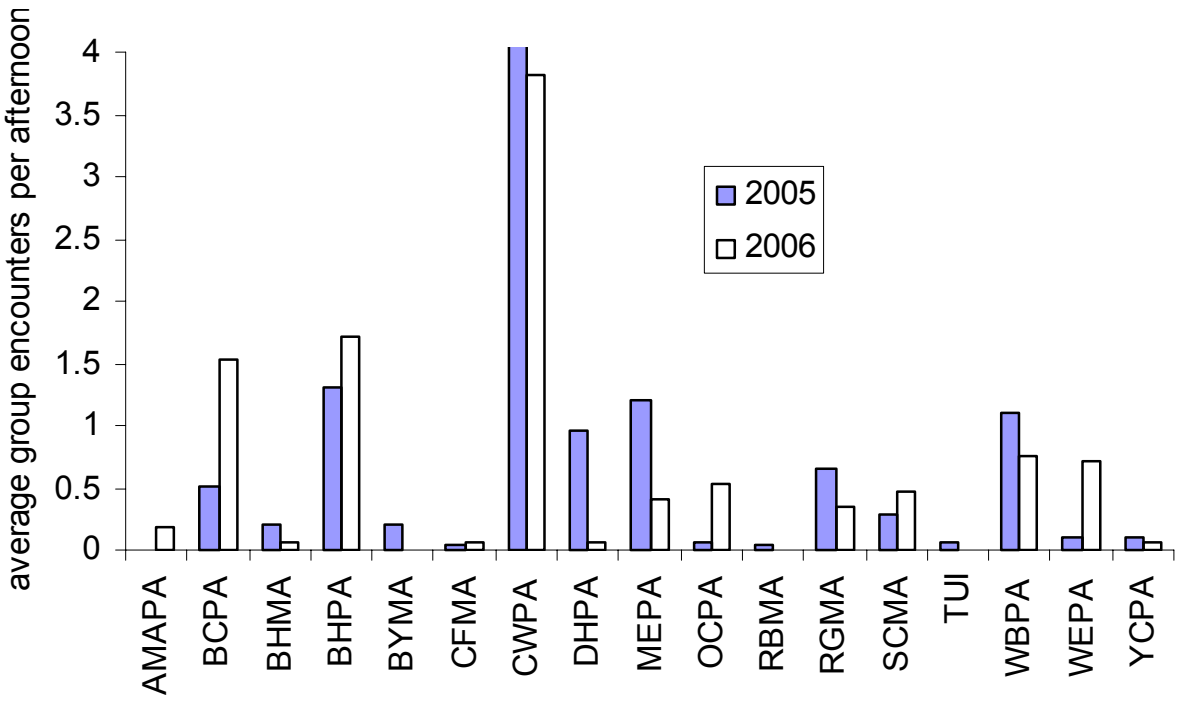


Figure 3.3.5b. The average number of encounters per afternoon with groups of parrots and macaws from the observation tower at Piedras for the period June to August for 2005 and 2006. Key: AMAPA – Amazonian Parrotlet, BCPA – Black-capped Parakeet, BHMA – Blue-headed Macaw, BHPA – Blue-headed Parrot, BYMA – Blue-and-yellow Macaw, CFMA – Chestnut-fronted Macaw, CWPA – Cobalt-winged Parakeet, DHPA – Dusky-headed Parakeet, MEPA – Mealy Parrot, OCPA – Orange-cheeked Parrot, RBMA – Red-bellied Macaw, RGMA – Red –and-green Macaw, SCMA – Scarlet Macaw, TUI –Tui parakeet, WBPA – White-bellied Parrot, WEPA – White-eyed Parakeet, YCPA – Yellow-crowned Parrot.

Average group sizes recorded in the following table were used for calculations of abundance using the program DISTANCE for results from transects where groups of birds were detected perched but no visual sighting was achieved.

Table 3.3.5a. Average group sizes for groups of parrots and macaws and two raptors observed from the observation tower at Piedras during June and July 2006.

Species	# observations (n)	Average group size	Standard deviation
Amazonian parrotlet	3	11.0	9.5
Black-capped parakeet	25	4.2	3.4
Blue-headed macaw	1	3.0	
Blue-headed parrot	27	2.1	1.0
Chestnut-fronted macaw	1	3.0	
Cobalt-winged parakeet	59	5.4	4.0
Dusky-headed parakeet	1	2.0	
Harpy eagle	1	1.0	
Mealy parrot	6	2.2	1.0
Orange-cheeked parrot	8	1.9	0.4
Red and green macaw	4	2.5	1.0
Scarlet macaw	8	2.5	0.9
Slate-colored hawk	1	1.0	
White-bellied parrot	12	5.1	4.4
White-eyed parakeet	12	3.3	1.4
Yellow-crowned parrot	1	2.0	

Variable distance line transects

The results presented here are from 16 transects totalling 68.5 km on transect A and 13 surveys totalling 52 km on transect C for a total of 120.5 km surveyed during the June to August 2006 period. A subset of the total number of transects conducted are presented as early analysis showed clear observer bias by one of the four principle guides who recorded far less per transect given the same overall weather and time conditions and the results from those transects are omitted from further analysis. Average starting time was 5:50 and average end times were 9:55 and 9:39 for A and C respectively due to their slightly different lengths. An average of 4 hours 3 minutes per transect was spent on A, while the average time on C was 3 hours 50 minutes. To compare abundances between seasons, transects were conducted along the A transect only during January and February 2006. A total of 24 transects making a total sample effort of 88.4 km was conducted during that period. The sample effort at Posada was 120 km for surveys conducted from June to August, and 108 km for January to February.

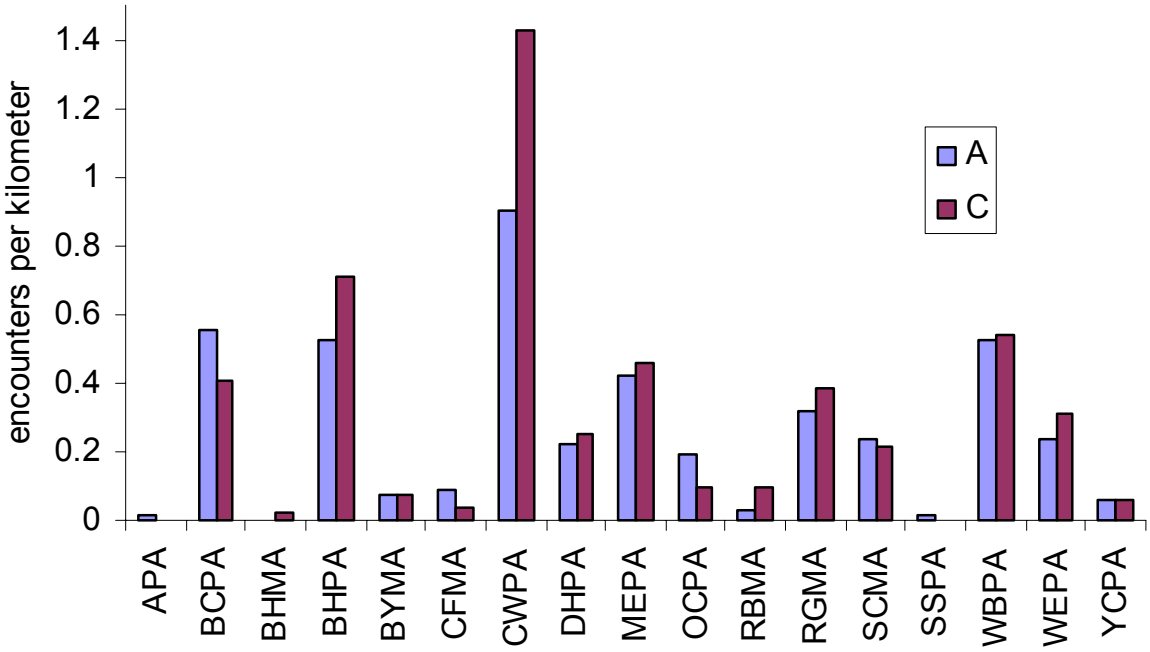


Figure 3.3.6a. Encounters per kilometre for all 17 psittacid species encountered for the two transects A and C (flying and perched encounter types combined). Key: APA – Amazonian Parrotlet, BCPA – Black-capped Parakeet, BHMA – Blue-headed Macaw, BHPA – Blue-headed Parrot, BYMA – Blue-and-yellow Macaw, CFMA – Chestnut-fronted Macaw, CWPA – Cobalt-winged Parakeet, DHPA – Dusky-headed Parakeet, MEPA – Mealy Parrot, OCPA – Orange-cheeked Parrot, RBMA – Red-bellied Macaw, RGMA – Red –and-green Macaw, SCMA – Scarlet Macaw, SSPA – Scarlet-shouldered Parrotlet, WBPA – White-bellied Parrot, WEPA – White-eyed Parakeet, YCPA – Yellow-crowned Parrot.

There is no difference between A and C in terms of overall encounters (t=1.551, p=0.14, paired samples test), and the results have been pooled for subsequent analysis. The most commonly recorded species were cobalt-winged parakeets, blue-headed parrots, black-capped parakeet and white-bellied parrots. The least commonly recorded species were Amazonian parrotlet, the endangered blue-headed macaw and scarlet-shouldered parrotlet. Cobalt-winged parakeets were more common on the C transect compared to the A transect.

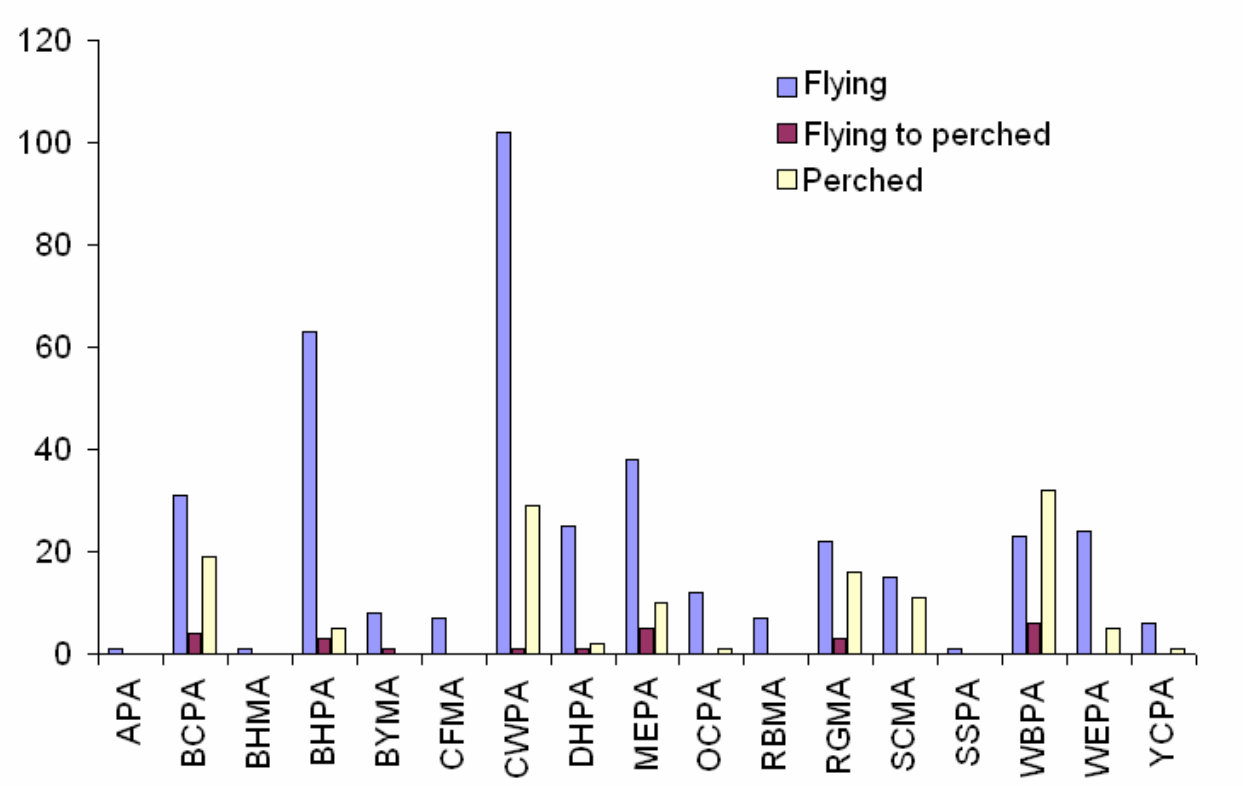


Figure 3.3.6b. Total types of encounter (flying, perched, flying and then perched) for the various psittacid species encountered during transects. Key: APA – Amazonian Parrotlet, BCPA – Black-capped Parakeet, BHMA – Blue-headed Macaw, BHPA – Blue-headed Parrot, BYMA – Blue-and-yellow Macaw, CFMA – Chestnut-fronted Macaw, CWPA – Cobalt-winged Parakeet, DHPA – Dusky-headed Parakeet, MEPA – Mealy Parrot, OCPA – Orange-cheeked Parrot, RBMA – Red-bellied Macaw, RGMA – Red –and-green Macaw, SCMA – Scarlet Macaw, SSPA – Scarlet-shouldered Parrotlet, WBPA – White-bellied Parrot, WEPA – White-eyed Parakeet, YCPA – Yellow-crowned Parrot.

The most common species encountered flying was cobalt-winged parakeet, followed by blue-headed parrot and mealy parrot. The most commonly encountered perched species were white-bellied parrot, cobalt-winged parakeet and black-capped parakeet. The least encountered species were Amazonian parrotlet, scarlet-shouldered parrotlet and blue-headed macaw, none of which were encountered perched. We have no clear reasons for why some birds are recorded more flying than perched. Possibilities include that they do fly more (possibly travelling over the study site to other areas), and that they vocalise more when they fly compared to when they are perched, especially in the case of blue-headed parrot (it is not thought that transects are an efficient method for measuring the abundance of this species). Species which have louder calls and which travel in larger groups are more likely to be recorded due to the increased volume of calls. No effort has been made yet to understand the vocalisations of birds during flight and while at rest to understand the repercussions on encounters and abundance estimates.

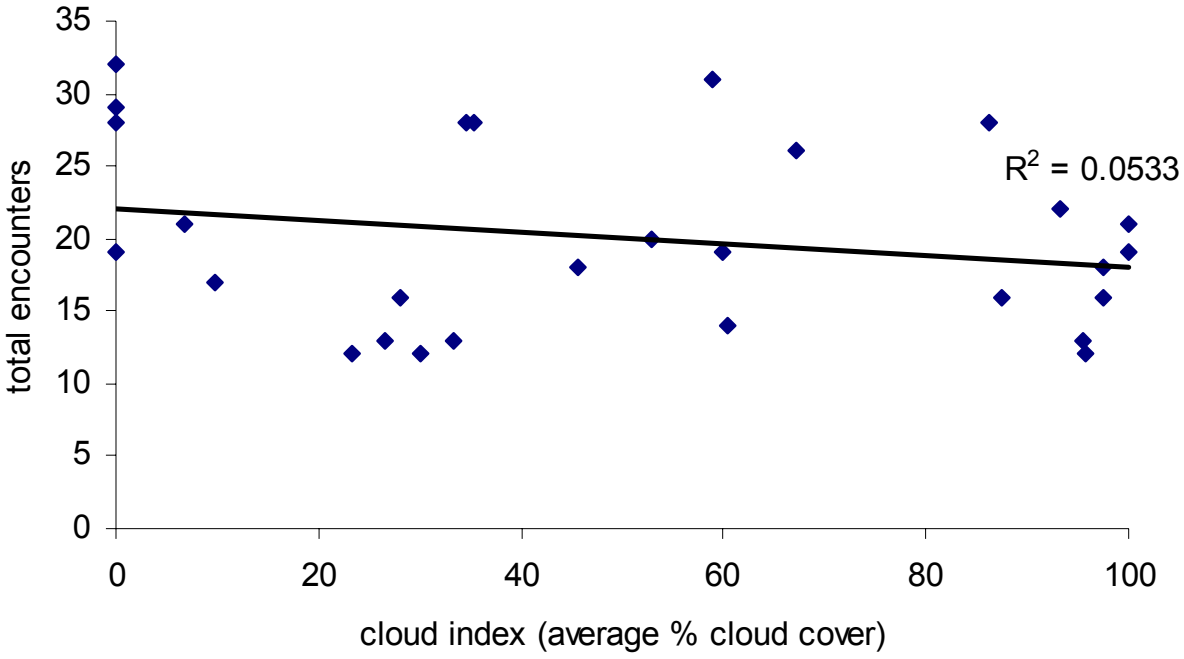


Figure 3.3.6c. The impact of cloud cover on total encounter rate per transect.

Although weather conditions varied from clear sunny days to completely overcast days during the survey period, there is no change in overall encounter rate with extreme cloud conditions. There is a weak trend towards decreasing encounter rates with increasing cloud cover, but this could also be due to completely overcast days being associated with cold fronts, where a combination of cold weather and wind may decrease flying and calling activity.

The impact of time of day on macaw and parrot encounters

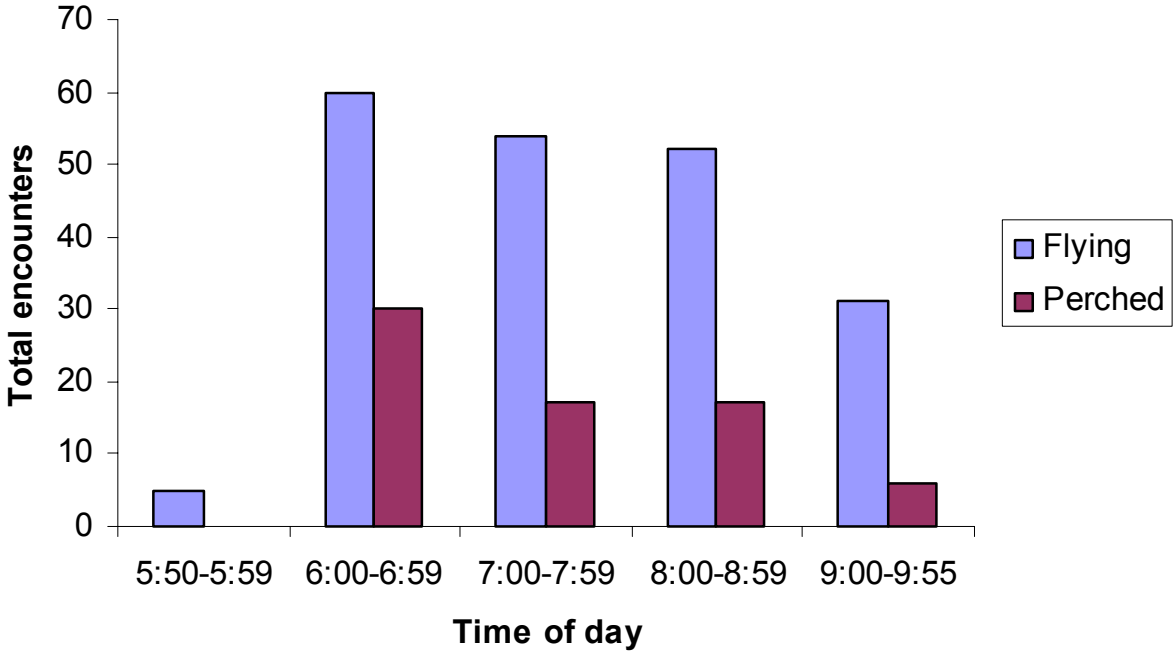


Figure 3.3.7a. Total number of encounters with all species of psittacid combined for transects A and C at Piedras for June to August, showing a decrease in encounters of both perched and flying birds as the morning progresses.

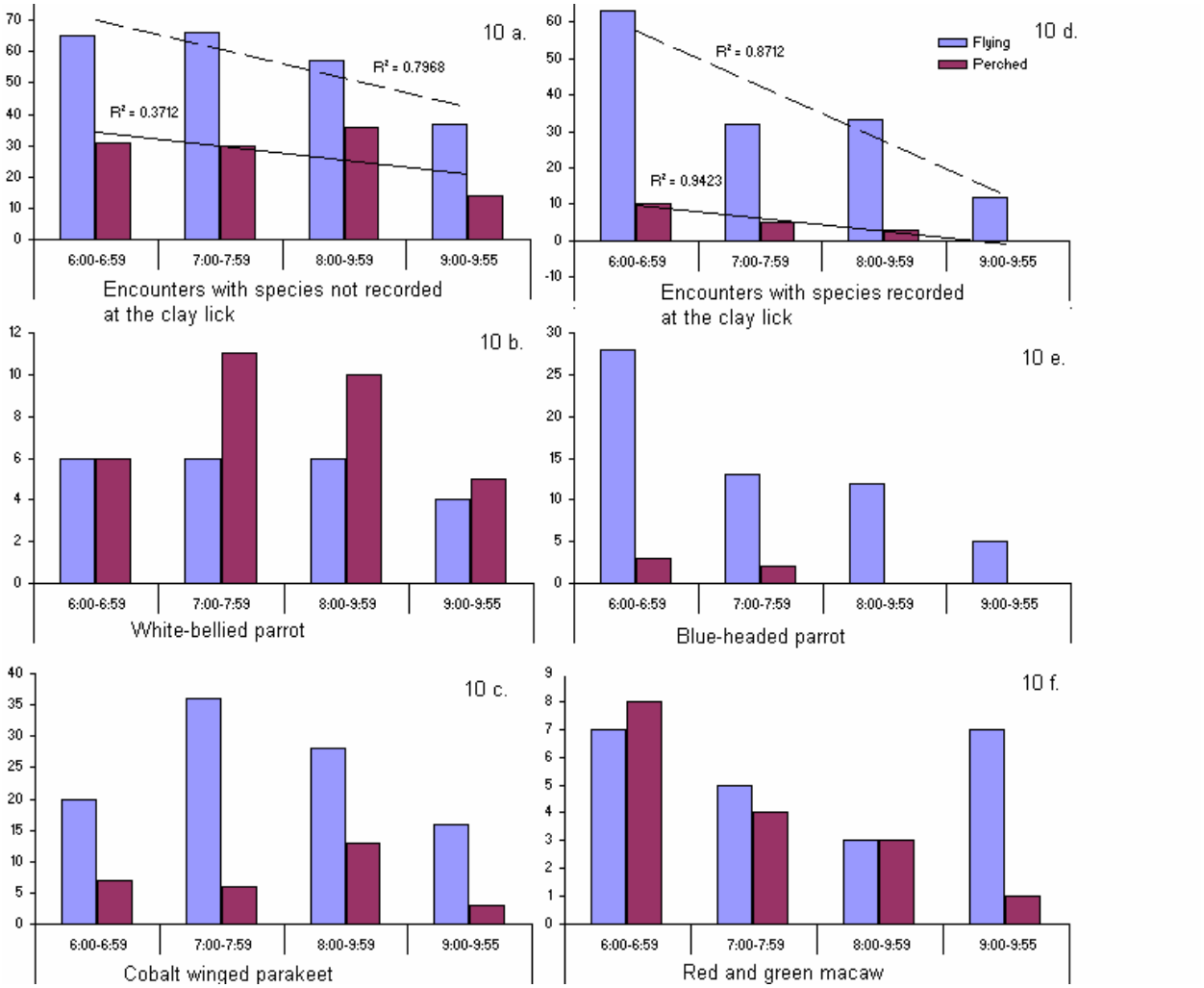


Figure 3.3.7b. Total encounters with flying and perched birds in relation to time of day for groups of parrots and macaws recorded at the clay licks and those not recorded at the clay licks. a. Encounters with species not recorded at the clay lick (cobalt-winged parakeet, black-capped parakeet, white-bellied parrot, red and green macaw, scarlet macaw, blue-headed macaw). b. Encounters with white-bellied parrot, a species not observed at the clay licks. c. Encounters with cobalt-winged parakeets, a species not encountered at the clay licks during the early morning. d. Encounters with all species recorded at the clay lick in the early morning (blue-headed parrot, yellow-crowned parrot, dusky-headed parakeet, mealy parrot and chestnut-fronted macaws). e. Encounters with blue-headed parrot, a species frequently seen at the clay licks from June to August. f. Encounters with red and green macaws, seen on the clay licks from 09:00 until 15:00.

There is a difference in encounter rate during the morning for those species that visit the clay lick and those that do not. During the first hour of the day when species are flying to the clay licks, encounter rate with flying birds is high and then drops off quickly over the course of the morning, compared to species that do not visit the clay lick in the early morning. These species show only a gradual decrease in the rate of encounters over the morning. Despite many birds recorded at the clay lick and a trend to show that birds are flying to and from the clay lick, encounter rate with this group of birds is still higher during the first hours of the day. The rate of encounter with birds that do not use the clay lick is more constant over the course of the morning.

The impact of distance along transect

To examine the possible impacts of starting the transect from either end and not in the middle, the average time of encounters (Table 3.3.8a) shows that encounters with birds for the middle two kilometers was half an hour to an hour later in the morning compared to the first and last kilometres. Assuming that there are more encounters in the early morning compared to the late morning, it might be presumed that this would result in a higher encounter rate for the first and last kilometres of the transect compared to the middle. However, this is not observed (Figure 3.3.8a)

Table 3.3.8a. Average time of all encounters with target species on the two transects at Piedras in relation to distance along the transect in kilometres.

km	Average time of encounters	
	Transect C	Transect A
1	7:09:15	7:00:25
2	7:47:53	8:06:12
3	7:49:51	8:03:24
4	7:09:39	7:32:41

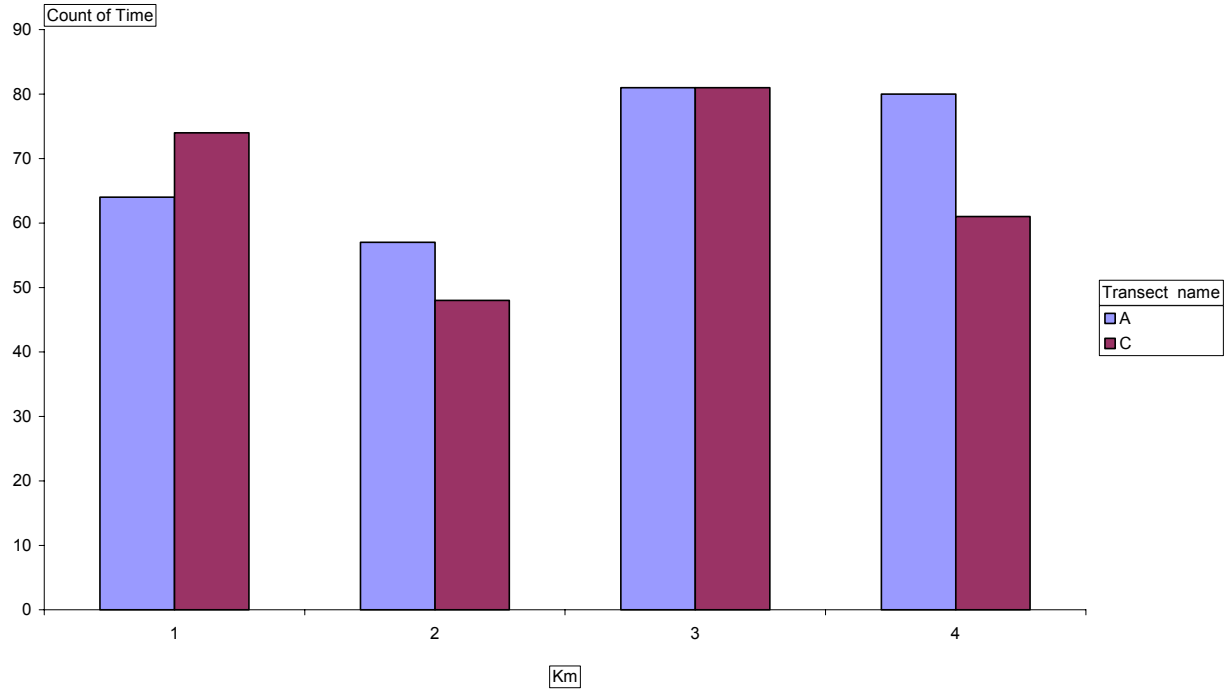


Figure 3.3.8b. The impact of the monitoring regime on total encounters for the two transects at Piedras. There is no difference in the total number of encounters between the transects or between the kilometre sections.

Abundance calculations for selected species at Posada and Piedras

For species for which more than ten perched encounters were obtained during transects, we used DISTANCE 3.5 release 5 (Buckland et al., 1993) to estimate densities at two survey sites (Piedras and Posada), and for two time periods (Piedras January-February, Piedras June-August). We chose DISTANCE models that minimized the amount of variance in the density estimates as models that fit well to the data tend to contribute little to overall variance estimates and we are using relatively small data sets with unstable variances associated with them (Kinnaird et al., 2003). Due to evidence of perpendicular distance lumping at the Piedras site, results were analysed as grouped data using five intervals of 22 m, while analyses at the Posada site were based on exact distances. The best model for each species was chosen using the lowest Akaike Information Criterion (AIC).

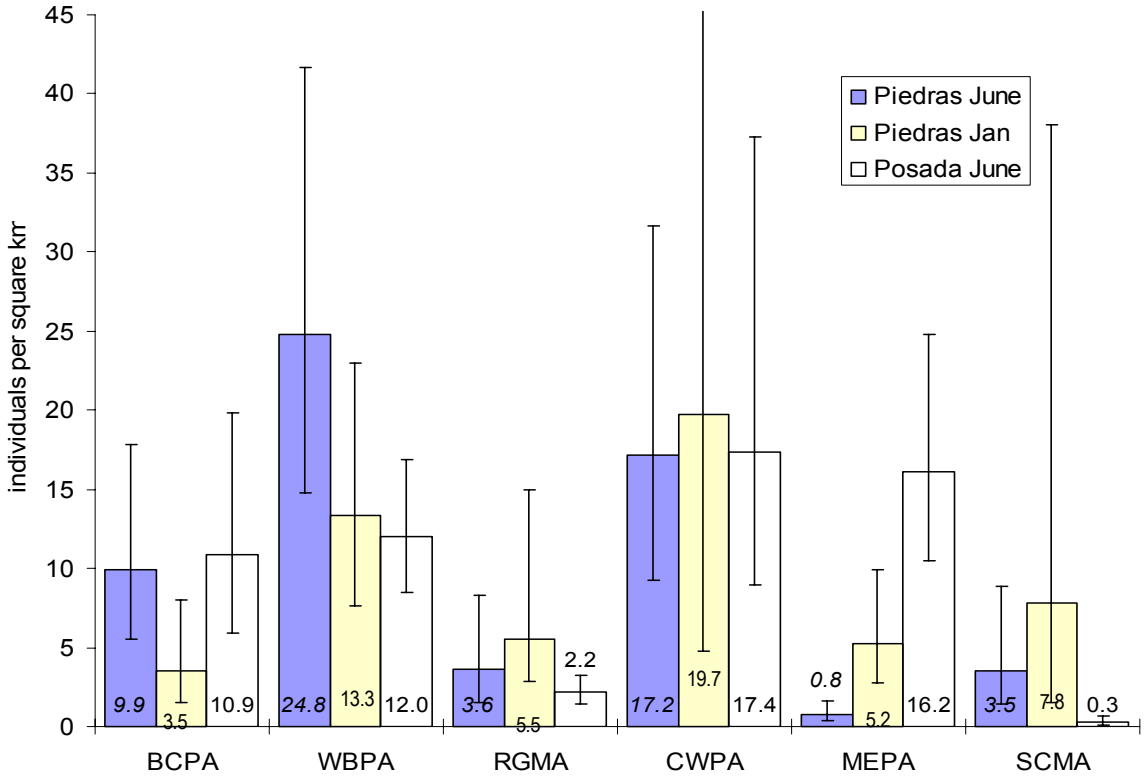


Figure 3.3.9a. Abundance (individuals/km^2) of the six psittacid species for which sufficient data existed for calculations using the program DISTANCE (Buckland et al. 1993) for the Piedras study site and Posada study site. Key: BCPA – black-capped parakeet, WBPA – white-bellied parrot, RGMA – red and green macaw, CWPA – cobalt-winged parakeet, MEPA – mealy parrot, SCMA – scarlet macaw.

Few mealy parrots were encountered during June and early July in Piedras, so their overall abundance is significantly lower compared to Posada for the same time period and also much lower than the value calculated for the same period during 2005 (4 individuals/km^2). Mealy parrot abundance was calculated as 30 individuals/km^2 at Posada for January and February, much higher than for Piedras (although confidence in that figure is low due to suspected underestimation of distances to some perched birds). This species has been shown to migrate distances of up to 200 km in Guatemala in a study using radio-collared birds (Bjork 2004), and it is suspected that the widely varying abundances reported here are influenced by regional parrot movements.

Results for the large macaws are in line with previous studies in Peru (Munn 1998, Lloyd 2004) that suggest an average of 2 individuals/km^2. The higher abundance for Piedras in January cannot be explained by the transect being close the clay lick with the associated very high numbers of birds visiting the lick at that time of year, as analysis by kilometre section shows more encounters in the last two kilometres of the transect furthest from the clay lick. The abundance of red and green macaws at Posada for January and February compared to the same site for the June to August period was 1.6 individuals/km^2, a non -significant decrease in abundance. Scarlet macaws are also in higher abundance during January and February at Piedras compared to the June to August period, and at significantly higher density at Piedras than Posada for both seasons (scarlet macaw abundance for Posada in January February is 0.6 individuals/km^2).

Black-capped parakeets and white-bellied parrots were recorded more in the June to August period compared to January and February. It is suspected that observer bias may have something to do with this as an observer not present for the wet season monitoring recorded more of these species compared to observers who were. The abundance estimations for afternoon transects for white-bellied parrots from 2005 was 17 individuals/km^2, so results are in the expected range for the area. However, 16 individuals/km^2 were recorded for black-capped parakeet for afternoon transects in 2005 (much higher than for 2006). Whether that is due to the species being more active in the afternoon or other factors is unknown.

3.4. Discussion

Seasonal patterns in clay lick use

The results presented here for both sites confirm seasonal changes in geophagy patterns as reported from another clay lick in the region (Brightsmith 2004), linking clay lick use to patterns of rainfall, fruit availability and breeding season. Clay lick use is higher during the wet season and lowest during the dry season for both sites monitored here.

The impacts of boat traffic on red and green macaw activity at clay licks

The impact of boats passing the Piedras clay lick on red and green macaws elicits significant anti-predator responses from the birds in the area. However, evidence here indicates that birds in the vicinity of the clay lick that want to feed are able to do so despite the activity of boat traffic. There may be a "critical limit" to boat traffic passing the clay lick, as during 2005 when boat traffic was twice as high (but still low compared to Posada) there was a trend towards decreased feeding with increasing daily boat traffic.

At Posada, where boat intensity is extremely high, red and green macaws still visit the vicinity of the clay lick in the low season in the proportion suggested would be natural by the ratio of birds at Piedras between the high season and low season. In general, boat traffic does not appear to have a great impact on macaw activity in terms of anti-predatory or flush responses, or even on a daily scale in terms of feeding on days when relatively fewer boats are passing the clay lick. However, this may be concealing the underlying impact that boat traffic may be having here in terms of individual feeding, which is substantially lower compared to both Piedras and feeding observed in January and February. It was frequently observed that boats of tourists travelling upstream would stop close to the clay lick, while excited tourists would make noise and take photos. Eventually even the most persistent of macaws would eventually leave in extreme cases. A complicating factor here is that the clay lick is also intensively visited by tourists who enter the hide close to the clay lick during this period, and extracting the impact of tourist visitation from boat traffic is difficult. Since the boats are associated with tourist activity, in general it can be said that this important economic activity is having an impact on overall feeding along the Tambopata river. It is hoped that the reduction observed in feeding for this period does not have any critical implications for the general well-being of the species and that managers will take the appropriate steps to reduce this impact.

Abundance and clay lick use

Of the species which use the Piedras clay lick in the early morning, only the mealy parrot was encountered on transects sufficient times in order to calculate abundance with any confidence. Compared to 2005, both feeding on the clay lick and abundance were lower. As encounters with this species increased towards the end of July and August, it is presumed that the species had a delayed arrival in the form of seasonal migrations compared to 2005.

Dusky-headed parakeets, the most commonly observed species on the clay lick were only encountered twice perched during transects in the June to August period. Yellow-crowned parrots and orange-cheeked parrots were only encountered once. Although blue-headed parrots were heard often, they were only encountered perched on transect five times. On the other hand, white-bellied parrot and black-capped parakeet are not observed on the Piedras clay lick, but appear common, as does cobalt-winged parakeet (although this species is seen feeding later in the morning on occasion). Comparing abundance results from 2006 (when transects were only done in the morning in terra firme forest) to 2005 (when transects were done in the afternoon through a mixture of terra firme, floodplain forest and seasonal swamp) the influence of vegetation types and location of transects through appropriate habitat looks to be very important when aiming to monitor other members of the parrot family.

With red and green macaws, at Posada there are two individuals per square kilometre. So in a five km by five km area we would expect to find 50 macaws. Should this be centred over a clay lick, then that number of macaws is close to the highest maximum count figure of 45 recorded for January and February (see Table 3.4.3a below). Similarly, at Piedras, if the calculations are correct and there are between four or five macaws per square kilometre then 25 km^2 would contain between 96 and 120 individual macaws, which is also close to the highest maximum count observed for January and February (115). To observe the highest maximum counts, this means that all macaws within just 2.5 km of the clay lick need to visit the clay lick on a given morning at the same time. Whether this represents the actual “catchment” area for a clay lick is unlikely as of course transects were conducted in the morning and from 8:00 onwards macaw numbers are building up at the clay licks, but it still shows a relationship between density and the maximum number of macaws observed at a clay lick. This has important implications for the use of clay licks as a tool for estimating the abundance of these large macaws.

Table 3.4.3a. A hypothetical diagram representing the relation between red and green macaw abundance and the highest maximum count observed at a clay lick, where each square represents a square kilometre.

Posada scenario					Piedras scenario				
2	2	2	2	2	5	5	5	5	5
2	2	2	2	2	5	5	5	5	5
2	2	Colpa	2	2	5	5	Colpa	5	5
2	2	2	2	2	5	5	5	5	5
2	2	2	2	2	5	5	5	5	5
Total			**48**		**Total**			**120**	

For the purposes of clarification of the relationship between these variables, let us say that the maximum count is a good representation of the total number of birds (#birds) and call the total parrot minutes recorded for a species Total Minutes:

Total Minutes / #birds = feeding per individual

Feeding per individual from results presented here is 15, a constant which we will call "fpi". Thus for sites where we have not recorded a maximum count (#birds), we can calculate this as follows:

#birds = Total Minutes / fpi

Abundance calculations from transects for different sites can be represented as:

Abundance = X individuals / km^2 (for example where X = 2 for Posada and 5 for Piedras)

When this is multiplied by 25 we get a total number of birds that is roughly equal to the highest maximum count (#birds) recorded at a clay lick, so:

#birds = 25 individuals / 25 km^2

So, should maximum counts be conducted at clay licks during peak seasons for red and green macaws, then the abundance can potentially be calculated without the need for doing transects.

It is recognised that using the highest maximum count could make the above calculation prone to error should sample size be low. However, it is also noted that a similar relation exists between the average maximum count observed and the density of birds found in 15 square kilometres and the above relationships can be adjusted accordingly.

We look forward to testing this relationship at other sites and to extending it to other species in the future.

Recommendations for action and further studies

The impact of boat traffic on clay lick activity has been demonstrated in several management reports of lodges along the Tambopata river. We are happy to report that by and large guidelines are being followed and a distance of at least 50 m is now observed by boat drivers and guides with tourists. Daily interaction of participants of the Tambopata Macaw Project with lodge staff also aids in communicating this message. However, certain recommendations are yet to be implemented. For instance the access to the observation blind at Posada is easily observed by birds perched in the trees around the clay lick, and it is thought this is the cause for low bird attendance when tourists are behind the blind. The recommendation was made that a roof be constructed along this access way, but its construction is still pending.

Reports of our findings will be given to Peru's Institute for Natural Resources (INRENA) to highlight the need to create regulations for boat behaviour in the vicinity of clay licks, mimicking restrictions currently imposed on fishing, hunting and collection activities.

Abundance surveys have highlighted several areas of importance. Firstly, the need to have trained, consistent, accurate principal observers or guides is paramount. Guides need to be better trained in the basic principles of variable distance line transects to reduce observer bias, which was seen to impact some surveys. Secondly, there is a need to conduct surveys along more transects running through different habitats, which has not been done at Piedras to now due to the difficulty of opening, accessing, maintaining and monitoring transects through floodplain or seasonal swamp type habitats. If we are to extend the above formula to other species, we need to know species abundance in different habitats. For the calculations of abundance of species, which are hard to detect on transect, like blue-headed parrot, monitoring from tree or canopy tops is recommended following Bjork 2004.

Another important area of development is studies to test the use of the clay licks as a population monitoring tools. Undoubtedly the formula presented here needs refining and checking. It is suggested that an improvement on the "max count" methodology could be made to more rigorously record the number of the target species every 10 or 15 minutes in order to increase the confidence in the ultimate maximum count for a particular day's observation.

Species in danger of extinction, like the blue-headed macaw *P.couloni*, which are known to use clay licks in certain parts of their range, would benefit greatly from further research into clay lick use as a population monitoring tool. The sample effort to open and monitor a transect network great enough to provide baseline population density is substantial, but would provide information that is notably absent for many species in the neotropics due to the complications traditionally involved in these studies. Using simple, cheap methodologies such as transects and clay lick monitoring means that some of the funds raised by groups like Biosphere Expeditions for conservation and research can be used for the direct employment of local community members, and it is the education and benefits for local people in which lies the future success of research and conservation projects in developing countries like Peru.

3.5. Acknowledgments

The studies at the Las Piedras Biodiversity Station were sponsored by Biosphere Expeditions, with the assistance of the above mentioned expedition team members. A big thank you to the volunteers who braved the mosquitoes and flooding of the wet season at Piedras: Marjorie Sorenson, Megan Melick, Morgan, Mary, Blake and of course to Emma Hume for leading the research there.

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3.6. References

Bibby, C., Jones, M. and Marsden, S. (1998) Bird Surveys, Expedition Field Techniques. Expedition Advisory Center, London.

BirdLife International (2005a) Species factsheet: Primolius couloni. Downloaded from http://www.birdlife.org on 5/8/2005

BirdLife International (2005b) Species factsheet: Nannopsittaca dachilleae. Downloaded from http://www.birdlife.org on 21/8/2005.

Bjork, R. (2004) Delineating Pattern and Process in Tropical Lowlands: Mealy parrot Migration Dynamics as a Guide for Regional Conservation Planning. PhD Dissertation. Oregon State University.

Bright, A., Reynolds, G.R., Innes, J. and Waas, J.R. (2004) Correlations between human-made structures, boat-pass frequency and the number of New Zealand dabchicks (Poliocephalus rufopectus) of the Rotorua Lakes, New Zealand. New Zealand Journal of Ecology 28(1): 137-142.

Brightsmith, D.J., and Aramburú, R. (2004) Avian geophagy and soil characteristics in Southeastern Peru. Biotropica 36(4) 000-000.

Brightsmith, D.J. (2004) Effects of weather on avian geophagy in Tambopata, Peru. Wilson Bulletin 116:134-145.

Buckland, S.T., Anderson, D.R., Burnham, K.P. & Laake, J.L. (1993) Distance Sampling: Estimating Abundance of Biological Populations. London: Chapman & Hall.

Burger, J. (1998) Effects of motorboats and personal watercraft on flight behaviour over a colony of common terns. The Condor 100:528-534.

Burger, J. and Gochfeld, M. (2003) Parrot behaviour at a Rio Manu (Peru) clay lick: temporal patterns, associations, and antipredator responses. Acta Ethologica 6:23-34.

Diamond, J., K. D. Bishop, and J. D. Gilardi. (1999). Geophagy in New Guinea birds. Ibis 141:181-193.

El Proyecto AREAS – Amazonas. WWF research using radio telemetry techniques in south east Peru. Electronic resource http://www.proyectoareas.org. Accessed September 2006.

Galicia, E. and Baldassarre, G.A. (1997) Effects of Motorized Tourboats on the Behavior of Nonbreeding American Flamingos in Yucatan, Mexico. Conservation Biology 11(5): 1159.

Gilardi, J. D., S. S. Duffey, C. A. Munn, and L. A. Tell. (1999). Biochemical functions of geophagy in parrots: detoxification of dietary toxins and cytoprotective effects. Journal of Chemical Ecology 25:897-922.International Panel on Climate Change (2001) IPCC summary for policymakers. Climate Change 2001: Impacts, Adaptations and Vulnerability, a Report of Working Group II (Cambridge Univ. Press, Cambridge)

Hammer, M. and Tatum-Hume, E. (2003) Surveying monkeys, macaws and other wildlife of the Peru Amazon. Expedition report available from www.biosphere-expeditions.org/reports.

Johns, A. D. & J. P. Skorupa (1987) Responses of rainforest primates to habitat disturbance: A review. Intern. J. of Primatology, 8:157-191.

Kinnaird, M.F, O'Brien, T.G., Lambert, F.R. and Purmiasa, D. (2003) Density and distribution of the endemic Seram cockatoo Cacatua moluccensis in relation to land use patters. Biological Conservation 109:227-235.

Kirkby, C.A. (2002) Estanderes ecoturisticos para la Reserva Nacional Tambopata, el Parque Nacional Bahuaja Sonene, y sus Zonas de Amortiguamiento, Madre de Dios, Peru. WWF-OPP, Lima.

Kirkby, C.A., Lee, A., Nuñez, A., Arizabal, W., Guidice, R., Langford, M. & Tailby, K. (2004) Fauna Forever Tambopata: The conservation status of and tourism impacts on Neotropical rainforest wildlife in Tambopata, Peru. A report for the Tambopata Reserve Society.

Munn, C. A. (1992) Macaw biology and ecotourism, or when a bird in the bush is worth two in the hand. Pages 47-72 in S. R. Beissinger, and N. F. R. Snyder, editors. New World Parrots in Crisis. Smithsonian Institution Press, Washington.

Munn, C. A. (1994) Macaws winged rainbows. National Geographic 185(1): 118-140.

Munn, C.A. (1998). Adding value to nature through macaw-orientated ecotourism. Journal American Veterinary Medical Association 212:1246-1249.Pearson, D. L., and J. A. Derr. 1986. Seasonal patterns of lowland forest floor arthropod abundance in southeastern Peru. Biotropica 18: 244-256.

Peres, C. A. (1990) Effects of hunting on Western Amazonian primate communities. Biological Conservation, 54: 47-59.

Peres, C. A. (1996) Population status of white-lipped Tayassu pecari and collared peccaries T. tajacu in hunted and unhunted Amazonian forests. Biological Conservation, 77: 115-123.

Peres, C. A. (1999) General guidelines for standardising line transect surveys of tropical forest primates. Neotropical Primates.

Rabinowitz, A. R. & B. G. Nottingham Jr. (1986) Ecology and behaviour of the jaguar (Panthera onca) in Belize, Central America. J. Zool. London (A) 210:149-159.

Rainforest Expeditions (2006) Electronic resource http://www.perunature.com. Accessed September 2006.

Rodgers, J.A. and Smith, H.T. (1995) Set-back distances to protect nesting bird colonies from human disturbances in Florida. Conservation Biology 9(1): 89-99.

Schulte-Herbruggen (2004) Illegal logging in the Alto Purus Reserved Zone along the Las Piedras river in Madre de Dios, Peru. Available from www.savemonkeys.com. Accessed 15 August 2005.

Tatum-Hume, E., Müller, M., Schmidt, K. and Hammer, M. (2003) Surveying monkeys, macaws and other wildlife of the Peru Amazon. Expedition report available from www.biosphere-expeditions.org/reports.

Tatum-Hume, E., Lee, A., Fothergill, C. and Hammer, M. (2005) Surveying monkeys, macaws and other wildlife of the Peru Amazon. Expedition report available from www.biosphere-expeditions.org/reports.

Wallace, G. N. (1993) Visitor management: lessons from the Galapagos National Park. In: K. Lindberg and D. Hawkins (eds) Ecotourism: A guide for planners and managers. The Ecotourism Society. North Bennington, Vermont.

Terborgh, J. (1983) Five New World Primates: a study in comparative ecology. Princeton University Press, Princeton, NJ

Terborgh, J., J. W. Fitzpatrick, and L. H. Emmons. (1984) Annotated checklist of birds and mammals species of Cocha Cashu Biological Station, Manu National Park, Peru. Fieldiana (Zoology, New Series) 21:1 - 29.

Terborgh, J.W., Robinson, S.K., Parker, T.A. III., Munn, C.A. and Pierpont, N. (1990) The structure and organisation of an Amazonian forest bird community. Ecological Monographs 60: 213-238.

Valdez, U. (ed) (1995) Reporte Tambopata. Centro de Datos para la Conservación - Universidad Nacional Agraria La Molina., Lima, Peru.

Vaughan, C., Nemeth, N.M., Cary, J. and Temple, S. (2005) Response of a Scarlet Macaw Ara macaw population to conservation practices in Costa Rica. Bird Conservation International 15: 119-130.

Vermeer, K. (1973). Some aspects of the nesting requirements of Common Loons in Alberta. Wilson Bulletin 85(4): 429-435.

Walker, B. (2003) Birds recorded within the Manu Biosphere Reserve, Departments of Cusco and Madre de Dios. Peru. Electronic resource http://www.duke.edu /~manu /home /list_of_species /birds.htm. Accessed May 2004.

World Tourism Organisation (2002) Tourism Trends. WTO, Madrid.

4. Preliminary investigation into the diversity of fish species found in streams and the river near the Piedras Biodiversity Station

Emma Tatum-Hume
Las Piedras Biodiversity Station

4.1. Introduction

The aim of this study was to begin documenting the aquatic life around the Piedras Biodiversity Station in order to produce a species list and guide for the area. Fish species are poorly documented in the southeast region of Peru and no previous work has been carried out in the Las Piedras river basin.

4.2. Methods

Stream trapping was carried out between March and August 2006, with the most intensive collection period between 28 May and 23 June. Fish were collected from five different streams at eleven sampling points and were caught using handheld nets. Once collected the fish were transferred to the station in buckets and held in a fish tank before being photographed and released back into their stream of origin.

River fish were caught using static lines and hooks. Bananas, worms, smaller fish or grasshoppers were used as bait.

4.3. Results

29 species were collected, 16 of which have been identified (see Table 4.3a) and 13 are awaiting identification.

Photographs of all fish collected can be found on a Yahoo photo album https://login.yahoo.com/config/login_verify2?.src=ph&.done=http%3a//uk.photos.yahoo.com/ph//my_photos&.intl=uk (login name: piedrasfish, password: catfish). This album contain the fish found during the expedition and will be updated periodically.

Table 4.3.a. List of fish species identified.

Family	Species	Common name (English)	Common name (Spanish)
Killifish	*Aphyolebias boticarioi*		
			
Killifish	*Rivulus christinae*		
	 male	 female	
Tetras	*Monkhausia santaefilonenae*		Sardina
			
Tetras	*Pyrrhuliba vittata*	Banded pyrrhulina	Sardina
			

Tetras	*Carnegiella mysersii*	Myersi hatchetfish	Sardina

Chichlids	*Aequidens tetramerus*

Chichlids	*Bujurquina* sp.	Bujurqui

Chichlids	*Crenicichla* sp.

Loricariidae *Ancistrus* sp. Bristlenose

Loricariidae *Hemiodontichthys acipenserinus*

Loricariidae *Rineloricaria* sp. Whiptail catfish

Other *Synbranchus marmoratus* Marbled eel

Other *Gymnotus* sp. Knife fish Macana

Catfish *Callichthysis callichthysis*

male

female

Catfish *Imparfins* sp.

Catfish *Microglanis* sp. Bumblebee catfish

4.4. Discussion

It has been estimated that around 600 species of fish can be found in the river Madre de Dios and its tributaries (Goulding et al. 2003). Many species are likely to be undescribed and new to science (Goulding et al. 2003). This survey is just beginning to explore the species of the area and surveys need to continue primarily in streams and lakes, where fish were easier to catch, in order to continue the inventory for the area.

4.5. Acknowledgments

Many thanks to Lance Peck from gonewild Peru for his continuing help in identifying the fish we catch.

4.6. References

Goulding, M. et al. (2003) Amazon headwaters – Rivers, wildlife and conservation in southeastern Peru. Amazon Conservation Association.

www.fish.mongabay.com – General information on aquarium tropical fish

www.gonewildperu.com – Photographs of many of the species found throughout the department of Madre de Dios made by a private collector, exporter and professional photographer (no work carried out in Las Piedras river).

5. Expedition leaders' diary: Peru 2006 (kept by David Moore)

18 May

Still a week or so to go before slot one arrive at our meeting point in Puerto Maldonado, Im sending out our first diary entry which will keep you abreast of all happenings in the 2006 expedition.

I'm David, your expedition leader, and tomorrow Ill be flying out to Peru to meet up with Emma, our local biologist, to finalise preparations for the arrival of this years first Biosphere team.

Today has been spent with Matthias (aka Dr. Hammer) at the Biosphere office in Germany packing up some of the equipment were taking (solar panels, binoculars, spotting scopes, rangefinders etc.) and testing out the satellite phone which well be using for communications from the Amazon basin. Weve also installed some GPS tracking and mapping software on to the laptop to aid us in creating a more detailed map of our study site. Tomorrow morning I'm off to Frankfurt airport and Lima. I look forward to meeting you all soon!

23 May

This next instalment of the Peru diary comes via the satellite link at our jungle base camp where we're finishing preparations for slot one's arrival on Sunday.

Along with the sorting out and testing of equipment, the last few days have been a good opportunity to get familiar with the trails around base and to get to know the staff and helpers we'll be working with over the next month.

As you'll soon be here to discover the sights and sounds of the rainforest yourselves, I won't detail the birds and animals we've come across in the last few days. Though the opossum we discovered hopping around the garden last night, this morning's Southern Amazonian red squirrel and a rare sighting of five coati (big tree-climbing racoons with a pointy snout and a huge bushy tail) are already on my list of favourites.

After unloading the boat under the sweltering heat on Sunday, yesterday was cold and rainy. Today it's warm and sunny, so be prepared for all weathers!

Most of us here at base are heading down to Puerto Maldonado tomorrow and I'll be staying at the Wasai lodge, so no doubt I'll meet most of the incoming team members there. We're planning to go out for dinner on Saturday night, so if you'd like to join us, let's meet in the lobby at 19:00. If you prefer to rest or prepare for next day's departure, no worries, we'll see you in the same place for our 07:00 departure on Sunday.

28 May

With the water a little higher than expected, we made good progress up the river on Sunday, with a plentiful supply of caimans and turtles on the riverbanks as well as a brief sighting of a couple of capybara (the world's largest rodent) as we approached the camp. We stopped off to buy some pumpkins on route and caught our first glimpse of a rainforest farm with it array of banana trees, papayas, star fruit and caconas.

Far from the relative bustle of Puerto Maldonado, everybody seems to be tuning in quickly to life in the jungle. Jane and Phil were this morning's parrot watch team and were up even before the howler monkeys, ready to leave for the 'colpa' at 4:45.

Yesterday was our introduction day about the project as a whole and the research activities in particular before launching in to the activities today. We split up in to a couple of groups for a kind of orientation walk, following the trails down from terra firma to the floodplain forest below.

Alan, a guest biologist here, showed us some of the familiar trees, palms and birds of the area and we came across coatis, a tayra, squirrel monkeys and the small saddleback tamarins who often hang out behind the lodge. Emma's group had their first close encounter with marauding peccaries and sensibly had their eye on a suitable escape route up the nearest tree as the animals circled round quite close. The last few years of research here have shown the monkey populations to be increasing (probably since the loggers have disappeared) and there was no shortage of sightings yesterday with a red howler monkey and brown capuchins to add to the list. Being able to identify these different species is obviously pretty useful when doing the mammal transect in the first light, though for the first few days we're glad for the help of Antonio and J-J, two of our local guides.

It's now approaching lunch time on our first full day of research activities. With the teams returning from the morning activities, the word from the clay lick is of dusky-headed parakeets and blue-headed and orange-cheeked parrots. Also the first sighting of deer, both red and grey brocket deer on the mammal transect. Some of us took a long hike down along transect C to take GPS coordinates which we'll eventually download on to the satellite image and create a map of the area. Oh, our first snake sighting too... a yellow-tailed cribo (not dangerous apparently, but it was a few feet long). Oh, and our first jaguar spoor too!

As you can imagine in such a biodiversity hotspot as this, there's loads to see and learn about.. Fortunately all the team members seem to be avidly keeping their own journals so they won't be relying on me to detail every unusual bird, beast or frog we see! (Though I'd like to make a special mention to last night's crested forest toad who was very obliging for the cameras and made it on to our 'Most impressive moment of the day' list.) This afternoon will see the first of the fishing activities and the tower observation - I'll let you know how we get on in the next diary entry!

2 June

Everybody has had a good chance to try their hand at the different activities and time is going by quickly (even though it doesn't always feel that way when sitting in the hide waiting for the parrots to come down and feed!).

The weather changed around noon on Wednesday with grey rain clouds and a drop in temperatures. While the Tower and GPS teams cancelled their afternoon sessions, the fish team decided to venture out and see what they could find.

The collecting, photographing and eventually cataloguing of fish is a new project this year which will hopefully result in a booklet detailing the species found in this area, similar to one we have on amphibians from a previous year. We're advancing pretty well so far (catfish, killifish, knife fish and numerous others with only their Latin names). Phil seems to be the main fish identifier man while Ralf has the right equipment and know-how for the photography. Fortunately our fears that the rain may be signalling the start of a friaje (cold snap) proved unfounded, and by evening time it had improved enough to go on our planned night-walk, a good chance to spot animals by torchlight (such as the rice rats, wolf spider and a vine snake).

Yesterday activities were able to continue as normal. Things have been fairly quiet on the clay licks, and though the parrots were down feeding this morning, the macaws got no closer than small groups in the trees overhead. Voters are making their way down the river for the Peruvian general election on Sunday - perhaps their noisy peke peke boats passing on the river are disturbing the birds and preventing them from coming down.

Our GPS attempts at mapping the rainforest have been proving quite successful, so we've been able to see the exact position of the jungle trails on the satellite map for the first time. Emma, JJ and the local guides have been quite surprised to see that some of the trails run so close. Anyhow, as a result we've been able to plan for a new mammal and bird transect, so a few of the team members set to work early this morning with their machetes.

Meanwhile the early start paid off for Frank and Sibille in this morning's transect team as they saw our first ocelot of the year while setting off from base!

Last night we decided to do a night-ride along the river in search of caiman. Most of the animals tend to duck under water or slide off the sandbanks as we approach, so we mainly contended ourselves with riding along the river by moonlight. Just as we were about to turn back, however, we came across one very obliging dwarf caiman who allowed the boat to pull right up beside him to give us all a good view of his speckled scales and nice set of gnashers. (I think Sibille gave the loudest squeal when he made a split-second dive in to the water, but the whole boat definitely rocked for a moment).

5 June

The most exceptional event of the last few days must be this morning's jaguar sighting from the mammal colpa. Although we are not conducting any of the research activities from this spot this year, we decided to do a sleep over on both Saturday and Sunday nights with the team members taking it in turns to stay awake and watch for animals. While Saturday's team came back fairly unimpressed, last night's team saw a jaguar at 03:15 this morning - not bad for what is only their second week in the jungle! I think this is only the second time we've encountered this animal during a Biosphere Expeditions slot.

Saturday afternoon offered another exceptional sighting in the form of a Harpy Eagle, the world's biggest eagle. It's an endangered species in Peru and needs a territory of about 1000 sq km to ensure a sufficient supply of monkeys and sloths as prey. I wasn't there to observe this surprise visitor either, but Phil tells me it was sufficiently exciting to elicit funky dance moves from Emma on top of the observation tower. Along with last Friday's ocelot sighting, more than our fair share of good luck!

It's not all about rare and exotic sightings, however. Our observation work at the two bird clay licks continues every day, sometimes without a parrot or a macaw in sight. Colpa one was very quiet this morning, though we had a red squirrel and nine blue-headed parrots feeding from colpa no.2. The red-and-green macaws also started to gather in the trees overhead but preferred to rest their heads under their wings and sleep rather than come down and feed. Although we called off our official watch when the rain increased, Emma and Alan have just returned from the river and report three of them down feeding on the lick.

Yesterday being our 'day off', we walked over to the tree top platform in the morning, harnessed ourselves in and were hoisted 27 metres up to get a great view over the top of the canopy. In the afternoon some of us took the boat down to the waterfall a few hundred metres downstream while others took off on a bird-spotting walk through the jungle. Bird ID skills must be improving as they were even able to recognise the yellow-rumped cacique, a small bird who specialises in imitating the calls of other birds. Perhaps Antonio helped them, I'm not sure…

Despite the odd shower, the weather has been favouring us and we're about to leave for our afternoon activities. The fishing teams have been a bit quiet the last couple of days even coming back empty handed from a line-fishing attempt last Friday. This evening's plan is for a night-fish at the waterfall, so let's hope this will mark a change in their fortunes...

8 June

The mixed weather meant we played around with the timings of our activities, though all in all we managed to continue pretty much as planned. The early morning transects had to be called off because of rain, but with it clearing up later we were even able to walk transect B on the other side of the river and get a good GPS reading. The new tracks especially can get slippy in the rain (Val seems to have perfected the best way to slide) and yesterday's team discovered you have to watch out for the wasps. But there are plenty of rewards too, such as the black and white hawk eagle and our first anteater sighting.

Another night walk proved interesting too: one team spotted an olingo (furry monkey-like racoon), while the other saw night monkeys, the only wide-eyed nocturnal monkey.

Yesterday we were able to observe macaws feeding, not on the main colpa but on a new clay face just to the right of it (perhaps they are moving feeding places?). I'm about to go over with Phil and Jane to relieve this morning's observation team, so we're hoping for some last-day action.

Failing action on the clay lick, there's always tonight's planned bash to celebrate Ralf's 40th birthday. We're hoping the cacona juice will provide a suitable mixer for the Pisco (Peruvian tipple). Happy Birthday Ralf! Looking forward to meeting the new team members, ready for Sunday's journey upstream.

14 June

Slot two kicked off to an interesting start with torrential (well, pretty heavy) rain throughout Saturday night. Several layers of clothing and raincoats were needed for the trip upriver as well as steady legs for descending the muddy bank to the boat. We stopped again at Don Carlos' farm to pick up yuka and by early afternoon the rain had eased off.

Despite some of the lowest temperatures so far (around 19º), the monkeys (spider, night, capuchins and tamarins) put in some appearances on Monday, and yesterday the activities kicked off for real. A great morning on the clay lick - 42 blue-headed parrots on clopa I and a close-up view of a large capybara ("definitely bigger than a small hippo" Ralf tells us) with her two infants on the beach in front. Then over 30 red-and-green macaws on colpa II with groups of twelve or thirteen feeding for nearly an hour. Even a solitary macaw came down for the second shift along with a blue-headed parrot. 13:30 is no time for a parrot to be feeding on clay, so we're not sure what he was up to. Perhaps he did it for a dare?

Meanwhile the transect groups spotted our first sloth (typically hanging upside down) as well as monk saki monkeys and a razor-billed curassow.

After a full day out in the field and early starts today we turned down Alan's night-walk option last night. Venturing out alone, he was barely gone for 10 minutes before reappearing rather pleased with himself having seen an ocelot and a paka. I daresay we'll make it out tonight.

With temperatures now back up in the high 20s and our first sustained sunshine today, we're busy charging up our batteries and computer so that the data-enterers can make progress and I can hopefully send this while the satellites are in range!

18 June

Being a small group we've been hard at work and this first week has flown by. We're glad of a rest day today. Nicole is making the most of it, canoeing out on the river with Antonio while the rest of us are relaxing at the lodge having just survived the platform hoist.

Things have been as unpredictable as ever on the clay licks. The macaws didn't feed till really late on Thursday, skipped Friday and then came out early yesterday. We're also seeing more and more parrots (mostly blue-headed) on the macaw colpa, especially early in the morning. From tomorrow we're going to start observing early there as well. The endangered Amazonian parotletts were spotted feeding on the clay late on Wednesday afternoon.

Klaus has been enjoying the challenge of the new rougher transect C. It was on this transect that Nicole and Laura had a great encounter with over 70 squirrel monkeys and then a mother peccary with her babies crossing the path about three metres in front of them.

We've been alternating our regular tower observations and macaw transects with a couple of renewed attempts at fishing. We came back very proud of ourselves after trying the net in a few of the streams leading in to the Las Piedras river, convinced of discovering at least four or five new species. Unfortunately our selection failed to impress, most of them already identified. Least appealing was the small eel-like canerou, although these were only the less noxious dead-flesh-eating kind.

With such clear sunny weather (despite misty mornings hampering parrot colpa efforts) we've finished off the remaining GPS tracking, with readings of transects A and B. The batteries are hooked up to the solar panels, hopefully giving us enough power to progress with the data entry that is gradually building up.

Despite the power of positive thinking the jaguar did not return to the mammal colpa last night (at least not while we were still awake), though we've in fact found jaguar scat in a couple of places over the last week. But the torch light did show up the rear end of a paca disappearing behind a log and that's almost as good!

1 July

I should really have written this last diary entry about a week ago during one of my mammoth layovers on the return from Peru, but I thought I would wait to hear how everybody is getting on after leaving the jungle and settling back in to their relevant civilisations!

Hopefully by now Ralph will have had a chance to sift through his thousands of photos - surely there must be at least one or two good ones? I'm about to look on your website to check for any incriminating material. I hope Laura enjoyed Machu Picchu and that Nicole hit the jackpot in Vegas (if your poker is as good as your scrabble, you should be in the penthouse suite by now.) Daryl must now be back from the Galapagos Islands while Jane, slot 1's very own Shakira, will be preparing for her next adventure in the Altai. Hope you've now mastered the Spanish pluperfect and that you're brushing up your Russian for next month.

This last diary entry is to say thank you to everybody involved in this year's project. We were small teams and I think we worked very well together to collect this important data for Alan and Emma - hopefully the rotas were arranged so that you didn't have to slog along transect C too many times! We were lucky to have such a great team driving, guiding and cooking for us, and even the computer settled down and did a good job by slot 2, so we were able to input the considerable amount of data. Then of course, all in all the unpredictable parrots and macaws performed pretty well, as did the *ferocious* peccaries, Frank and Sybille's jaguar and the ocelot. I never did quite see the latter, but that gives me a good excuse to return another year!

I'll be going on-line soon to www.imagestation.com/album/?id=2107450775 to make some small offerings from my photo collection (including day 1 frog and the dwarf cayman). Best wishes to everybody, all the best for the future and hope to see you for another adventure somewhere sometime soon!