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EXPEDITION REPORT

Expedition dates: 8 November – 4 December 2009
Report published: June 2010

Icons of the Amazon: jaguars, pumas, parrots and peccaries in Peru.

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Abstract

The impact of hunting on a primate community: We present the results of a long term (7-year) transect monitoring study conducted at a lowland Amazon rainforest site on the Las Piedras River, southeastern Peru. Prior to the study the area had been the site of timber extraction activities with associated hunting. Large bodied mammals, including primates, were primarily targeted. Standardized line transects were conducted along the same routes during a period when the area was protected by the declaration of an ecotourism concession. No species had been hunted to extinction, and nine primates were encountered (including the nocturnal *Aotus nigriceps*). The three largest primates all showed significant year on year increase in encounter rates, but only *Ateles belzebuth* showed a significant increase in density estimates for the later half of the survey period. This increase can be explained by natural fecundity scenarios. We predict future long term population trends for the primate assemblage in the light of increased human activity in the area. This study highlights the impact of small-scale hunting on a primate community and on a positive note shows that recovery after a hunting event is possible.

Macaw behaviour: Red-and-green macaws (*Ara chloropterus*) are one of the most common members of the parrot family observed at large, riverside claylicks in southeastern Peru. Although considered common and widespread in aviculture, little is known about their social interactions in the wild. Claylicks provide an ideal setting at which to study wild bird behaviour. We observed macaws around three claylicks in the lowland Amazon. Macaw behaviour differed significantly on the surface of the claylick compared to the surrounding vegetation. The canopy level was associated more with preening and inter-pair bonding interactions like allopreening. Aggression increases closer to, and on the claylick, although a high degree of submissiveness appears to accommodate bird proximity on the claylick itself. Vigilance does not decrease with increasing flock size, possibly due to the social nature of the birds. All trends in behaviour point to the importance of the claylick as a site for social interactions in the daily lives of one of the Amazon's most beautiful birds.

The impact of mammal claylick presence: The role of mineral sites (claylicks) on spatial movements of terrestrial Neotropical mammals has not been quantified. We created two track-trap arrays of 49 track traps each, one located on a claylick and a control away from a claylick. Track traps were checked every second day, weather allowing. The array with a claylick had higher species richness and track encounter rate compared to the control. Mammals that use claylicks were found significantly more often in the claylick array. Although more samples are needed to make results conclusive, this exploratory experiment suggests that the presence of a claylick does spatially influence keystone mammal species on a small scale, with characteristics similar to piospheres associated with waterholes in arid environments.

Jaguar and Puma presence: an exploratory study. An eleven day long sampling was conducted to determine the feasibility of a long term jaguar and puma survey in an ecotourism concession in the Department of Madre de Dios, Peru. A Research Station was used as start point for surveys with volunteers recruited by Biosphere Expeditions. The concession was located at the margins of the Las Piedras river, which drain from the Andean foothills through the Amazon forest. Three camera-traps and 26 track-traps were employed to detect presence of pumas and jaguars over nine 2x2 km cells covering 3,056 ha. Track-traps were checked three times and all occasions had prints of cat. Information on the presence of the cats provided by the teams surveying under other sampling designs added up to the track-trap design revealed vestiges of these cats almost on a daily basis, a sign of good habitat conditions for these cats. Under the track-trap design, a total of 18 traps (69%) had either puma or jaguar tracks prints, some of them on more than one occasion. Puma and jaguar tracks were simultaneously found in a single track-trap only once, but shared 8 track-traps (44%) of all track-traps on different occasions, suggesting a spatial overlap but a temporal separation in trail use. The results are encouraging, showing that the habitat is still in very good condition and ideal to study the biology of species in their natural system, and particularly on the effectiveness of current concession models to maintain optimal biodiversity levels.

Resumen

Impacto de cazaría en una comunidad de monos: Presentamos los resultados de un estudio de largo plazo en las bosques tropicales en un área de estudio en el sureste de Perú en el Río Las Piedras. El área estaba utilizado para sacar madera hasta comienzo el estudio, cuando fue declarado una concesión de conservación. Mamíferos grandes, además monos, estaban cazados. Transectos estandarizado utilizando las mismas rutas año tras año estaban utilizado para un censo de monos. Ningún de los nueva especies (con el mono nocturno *Aotus nigriceps*) estaba cazado hasta extinción. Había más encuentros de los tres monos más grandes año tras año, pero solamente el mono arana *Ateles belzebuth* se encontraba con mayor densidad durante los últimos tres años. Ese incremento puede ser por fecundidad natural por parte de los monos. Discutimos los resultados con predicciones de patrones de población con mayor actividad humano en el área. El estudio resuelto que cazaría de escala pequeña puede impactar una comunidad de monos, pero que también es posible que con tiempo se puede recuperar.

Comportamiento de guacamayos: El guacamayo cabezon (*Ara chloropterus*) es uno de la mas común de las especies de loro que se encuentra cerca tierras salados de las orillas de ríos (o colpas) del sureste de Perú. Aun común en cuativario, existe poco información sobre interacciones sociales en su estado silvestre. Colpas son sitios ideales donde se puede monitorear comportamiento de aves silvestres. Hicimos monitoreo de guacamayos alrededor de dos colpas en bosque de lluvia de la Amazona. Comportamiento de guacamayos estaba significante diferente entre aves en los árboles y aves en la misma colpa. La posición del ave en la vegetación alrededor de la colpa también puede tener impacto en su comportamiento, con aves más alto observado más acicalándose y acicalando parejas. Agresión es elevado con proximidad de la colpa y en la colpa misma, pero los guacamayos aguantan la presencia de vecinos con signos de sumisión. Niveles de vigilancia no bajan con el aumento de guacamayos alrededor de la colpa, posiblemente porque son muy sociales. Tendencias de comportamiento demuestra que colpas son muy importante para la vida social de una de las mas hermosa aves de la Amazonia.

El impacto de la presencia de una colpa de mamíferos: El impacto de sitios de tierra salada (colpas) por los movimientos de mamíferos terrestres, son poco estudiados. Hicimos dos áreas de trampas de huellas, cada uno con 49 trampas, un ubicado encima una colpa, y la otra alejado de una colpa (el control). Estaban chequeado cada dos días, dependiente del clima. El área con la colpa tenía más biodiversidad y más abundancia de huellas en las trampas. Mamíferos que utilizan colpas estaban significativa mas abundante en el área con la colpa. Aun mas áreas son necesarios para ser seguro de los resultados, esa experimento indica que la presencia de una colpa impacta las movidas de mamíferos claves de la región en una escala pequeña, en la manera que una fuente de agua tiene un impacto del medio ambiente en áreas secas.

La presencia de jaguar y puma: un estudio exploratorio: Se condujo un estudio de once días para determinar la factibilidad de un programa de monitoreo a largo plazo en una concesión de ecoturismo en el Departamento de Madre de Dios, Peru. Una estación de investigación sirvió como base de monitoreo con voluntarios de Biosphere Expeditions. La concesión se encuentra en las orillas del rio Las Piedras que empieza su viaje por la selva amazónica en los cerros andinos. Se utilizaron tres trampas de camera y 26 trampas de huellas para detectar la presencia de pumas y jaguares en nueve parcelas de 2x2 km cubriendo 3,056 ha. Las trampas de huellas se chequearon tres veces y se encontraron huellas de gato en las tres ocasiones. Equipos de voluntarios emplearon otras formas de monitoreo para complementar el monitoreo por trampas de huellas. Sus datos sobre la presencia de gatos revelaron vestigios de gato casi diario. Eso significa que el hábitat se encuentra en buen estado para estos gatos. Se encontraron huellas de o puma o jaguar en 18 trampas (69%), algunos de ellas mas de una vez. Se encontraron huellas de puma y jaguar juntas en la misma trampa solamente una vez, pero se encontraron 8 trampas compartidas (44 % de todas las trampas) en varias ocasiones. Eso significa que los territorios de puma y jaguar se cruzan pero que hay una separación temporal en el uso de las trochas. Los resultados dan esperanza, mostrando que el hábitat se encuentra todavía en muy buen estado y que es ideal para estudiar la biología de especies en su ecosistema natural, y especialmente la eficaz de los modelos de concesión para mantener altos niveles de biodiversidad.

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Continued...

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 and the following sections, 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.

1. Expedition Review

M. Hammer (editor)
Biosphere Expeditions

1.1. Background

Biosphere Expeditions runs wildlife conservation research expeditions to all corners of the Earth. 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. Expeditions are open to all and there are no special skills (biological or otherwise) required to join. Expedition team members are people from all walks of life and 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.

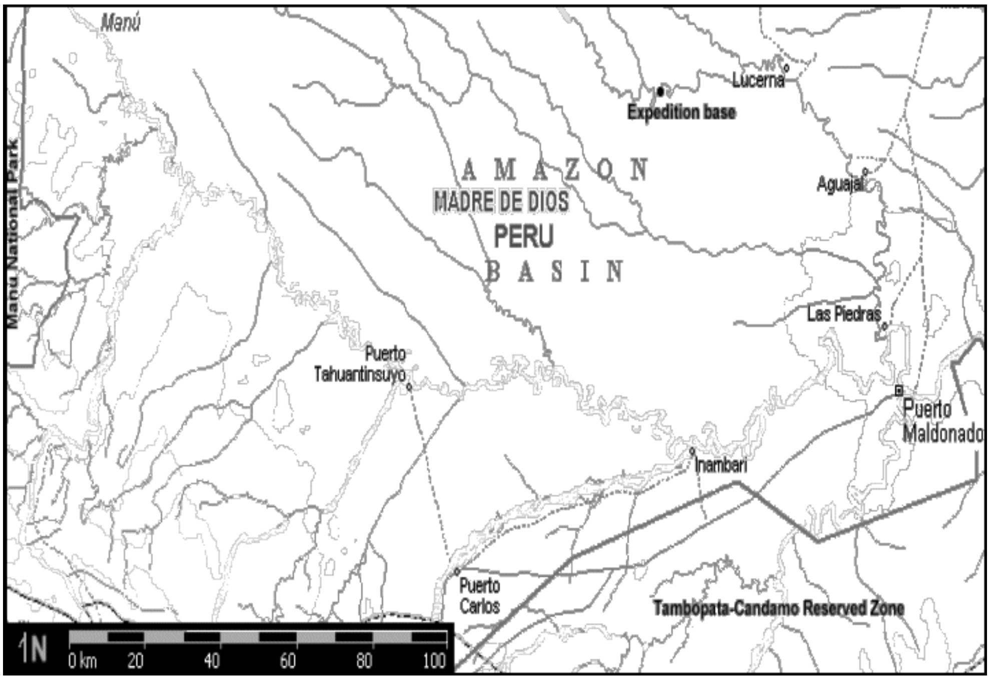
This expedition report deals with a survey of iconic wildlife species in one of the best conserved remaining regions of the Amazon basin with vast areas of unbroken canopy, which ran from 8 November to 4 December 2009. The aim of the survey was to gain a better understanding of the ecological importance of natural clay licks as this information will assist in the development of an environmentally sensitive and sustainable management strategy. The project built on one of Biosphere Expeditions' longest running studies, with the focus changing to better understand the importance of mineral licks in the lives of macaws and peccaries, as well as the top-end predators puma and jaguar. Once we understand how the clay lick ecology works, strategies for their sustainable use in eco- and nature tourism can be developed that will benefit local people and wildlife and provide strong incentives to protect more natural habitat that is currently threatened by unsustainable and short-term gain logging, gold mining and oil & gas exploration.

1.2. Research Area

Flag and location of Peru and study site.

An overview of Biosphere Expeditions' research sites, assembly points, base camp and office locations is at Google Maps.

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 Rio Piedras is located between the two.



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

In terms of biological diversity, the research area is amongst the richest in the world. The area's ecosystems hold several world records in flora and fauna species numbers and are recognised as one of the planet's biodiversity hotspots. 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. It has recently also been identified as the largest uninhabited and untouched rainforest 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'.

1.3. Dates

The expeditions ran over a period of four weeks divided into two two-week slots, each composed of a team of international research assistants, scientists and an expedition leader. Slot dates were:

2009: 8 - 20 November **|** 22 November - 4 December (12 nights).

1.4. Local Conditions & Support

Expedition base

The expedition was based in a remote region along the Las Piedras river. Base camp was a large, comfortable jungle lodge / research station made from local materials with twin rooms, showers and toilets. By and large team members paired up to share rooms. All meals were prepared for the team and vegetarians and special diets were catered for.

Field communications

Mobile phones did not work in the remote research area. Base camp had a radio for emergency communication with Puerto Maldonado. The expedition leader sent an expedition diary to the Biosphere Expeditions HQ every few days and this diary was then distributed to team members and appeared on the Biosphere Expeditions website at www.biosphere-expeditions.org/diaries for your friends and family to access.

Transport & vehicles

Team members made their own way to the Puerto Maldonado assembly point. From there they travelled six to seven hours by boat to base camp. Once at base, most studies were conducted on foot. Boats were also used for transport where necessary. All transport, boats and vehicles were provided from the expedition team assembly point onwards and back.

Medical support & insurance

The expedition leader was a trained first aider, and the expedition carried a comprehensive medical kit. Further medical support was provided through a medical post in the Colpayo community, about three hours by boat. The nearest hospital was in Puerto Maldonado, about six hours by boat. Safety and emergency procedures were in place. All team members were required to carry adequate travel insurance covering emergency medical evacuation and repatriation. There were no serious medical incidences in 2009.

1.5. Expedition Scientist

Alan Lee is a graduate of Manchester Metropolitan University. His undergraduate studies in biology were conducted in South Africa, where he grew up. After working as a game ranger for one of South Africa's most exclusive lodges, Mala Mala, he moved to England for a change in career direction and for travel opportunities, that to date have taken him to every continent except Antarctica. He first came to Peru in 2002 where he worked as a guide at Explorer's Inn, and then joined the Tambopata Macaw Project. From 2003-2004 he supervised teams of volunteers on a project looking at the impacts of tourism on large mammal wildlife. In 2005 he was scientific adviser for the Biosphere Expedition to Las Piedras. During 2006 as part of his ongoing research into the impact of clay licks on parrot abundance, he was project manager for the Tambopata Macaw Project at Posada Amazonas and Refugio Amazonas.

1.6. Expedition Leader

This expedition was led by Andrew Stronach. Andrew was born in Scotland, studied Engineering and then flew aircraft for the Royal Air Force before working in wildlife. Surveys of wild plants, birds and marine mammals led him into anti-wildlife crime work that has become his passion and taken him all over Britain and Cyprus. He has taken part in expeditions to Belize, Honduras and Sulawesi, surveying coral reefs and rainforest. Due to a rare allergy to offices, Andrew is almost always found outdoors, whether it is working in the highlands of Scotland, trekking in some remote national park on one of his many foreign travels or dangling from a rope on a rock face.

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 (with countries of residence in parentheses):

8 November – 20 November 2009

Helge Eek (Norway), Paul Holian (UK), Mary Marshall (Australia), Thomas Keating (USA), Monique Kors (UK), Simon Mozley (UK), Bernhard Schmidt (Germany), Markus Schmidt (Germany), Catherine Smith (USA), Michael Smith (USA).

22 November - 4 December 2009

Joss Ainsworth (UK), Ricardo Bastiaan (The Netherlands), Helen Fewster (UK), Avril Gilding (Australia), Simon Mozley (UK), Maria Rosa Almas Rodrigues (Portugal), Matt Treat (USA), Rebecca Winlow (UK).

Also: journalist Lawrence Mackin (Ireland).

Throughout the expedition: Paula GIvan of the Heart of the Healer Foundation coordinated supplies, pre-trip arrangements and activities around the research base. Aldo Ramirez was an able guide throughout the expedition, assisted on occasion by JJ Duran. Angel ‘El Profe’ worked hard to maintain bridges and trails. The expedition also hosted two ecotourism students from Puerto Maldonado’s Technical Institute – Ana Miluska Fernández Huesembe and Evangelina Quenta Tuni. Alan Lee was generously assisted by Anja Kirchdorfer. Peter Cowen was present as a potential research science candidate. Fantastic food was prepared by Gloria Duran, with assistance from Meli Duran.

1.8. Expedition Budget

Each team member paid towards expedition costs a contribution of £1130 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	20,009
Expenditure	
Base camp and food includes all meals, lodging, base camp equipment, boat transport	5,998
Equipment and hardware includes research materials & gear, etc. purchased in UK & Peru	498
Biosphere Expeditions staff includes salaries, travel and expenses to Peru	3,252
Scientific & local staff includes salaries, travel and expenses, gifts	6,832
Administration includes permits, registration fees, sundries, etc.	298
Team recruitment Peru as estimated % of PR costs for Biosphere Expeditions	3,240
Income – Expenditure	- 28*
Total percentage spent directly on project	**100%**

*This means that in 2009, the expedition ran at a loss and was supported over and above the income from the expedition contributions by Biosphere Expeditions.

1.9. Acknowledgements

This study was conducted by Biosphere Expeditions which runs wildlife conservation expeditions all over the globe. Without our expedition team members (who are 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 members of the Friends of Biosphere Expeditions and donors, Land Rover, Swarovski Optik, Cotswold Outdoor, Globetrotter Ausrüstung and Snowgum for their sponsorship.

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 Expeditions website www.biosphere-expeditions.org.

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

2. Spider monkey (*Ateles belzebuth chamek*) recovery after a hunting event: a long term study of a primate community in southeastern Peru

Lee, A.T.K[1]., Tatum-Hume[2], E. & Kirkby, C[3].
Department of Environmental & Geographical Sciences, Manchester Metropolitan University, Chester Street, Manchester, M1 5GD, UK. [2] Las Piedras Biodiversity Station. [3] Project Fauna Forever, Casilla 128, Puerto Maldonado, Peru

2.1. Introduction

Primates play a varied and important role in many aspects of Neotropical rainforest ecology; from predation to frugivory and folivory (Terborgh 1986). Highly mobile primates such as spider monkeys *Ateles* spp are important seed dispersers (Bourlière 1985). The only spider monkey to occur in south-eastern Peru is the white-bellied spider monkey *Ateles belzebuth chamek*, although the species is entirely black and was formerly grouped with the black spider monkey *Ateles paniscus* (Froehlich et al. 1991). They form large social groups (up to 40 members), but usually split into small parties of 1-9 to feed. Party size decreases when fruit becomes scarce (Symington 1988). Spider monkeys, one of the two diurnal primates never observed in associations with other primate species, were very rare throughout a forest mosaic in western Brazil (Haugaasen and Peres 2009). They have a low reproductive rate, giving birth at 4-5 years and have young only every 3-4 years. When disturbed, they may threaten a human by standing on a branch and stamping and shaking the vegetation, making them easy targets for hunters.

Primates are good indicators of low-level disturbance and hunting, as they play an important role in the livelihood of native peoples as a source of dietary protein (Peres 2000). In Amazonian forests, hunting is one of the most important causes of large-vertebrate population decline in areas that otherwise remain undisturbed, whether or not they are formally protected (Peres 2000). Hunting is often the most important threat to wildlife even in forests affected by selective logging (Thiollay 1989), fragmentation (Peres 2001), and under-story fires (Barlow and Peres 2006). The largest indirect effect of selective logging along the Las Piedras River is bush meat hunting, which occurs around all logging camps (Schulte-Herbruggen and Rossiter 2003).

The Las Piedras drainage basin contained some of the last commercially viable stands of big-leafed mahogany *Swietenia macrophylla* and cedar *Cedrela odorata* in Peru, which were highly sought after on the international markets (Blundell and Gullison 2003). As trees were cleared from the area and local authorities clamped down on illegal activities in 2005, the impact of loggers were diminished and in some cases logging concessions abandoned (Tatum-Hume 2006).

The survey site was part of a large logging concession between 1994 and 1999, when 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. Each logging camp on the Las Piedras River had an average of nine workers each of whom consumed 313.2 g of bush meat per day (Schulte-Herbruggen and Rossiter 2003). It is estimated that 5992 kg of bush meat was consumed over the extraction period, the equivalent of 799 spider monkeys *Ateles belzebuth* or 198 white-lipped peccary *Tayassu pecari*, two of the preferred bush meat species (Tatum-Hume 2006).

Since 2002 the study site has been protected from logging and hunting activities as part of an ecotourism concession and we provide here the results of a long-term transect study to determine trends in population recovery in the local primate community.

Objectives

1. Determine changes in yearly encounter rates for the diurnal monkey assemblage at a study site on the Las Piedras River.

2. Determine changes in monkey density for the following a six year period of hunting.

2.2. Methods

Monkey surveys were conducted within a conservation concession, ecotourism concession and brazil nut concession currently administered by Fundacion Corazon del Curandero (The Heart of the Healer Foundation) and previously administered by Tambopata Expeditions (see figure 2.1a). The study base was the Las Piedras Biodiversity Station (LPBS) located at S 12º05.663' W 69º52.852'. The concession lies north of the 1.09m ha Bahuaja-Sonene National Park, east of Manu National Park, and south of Alto-Purus community reserve. Major forest types are floodplain and tierra-firme (Salmón et al. 2003). The concession is located on the Las Piedras river, a low-gradient white-water river that meanders through a 2 km-wide floodplain and is flanked by terraces up to 30 m high. Vegetation is humid subtropical rainforest. Rainfall for the region ranges between 1600 and 2400 mm and temperatures between 10ºC and 38ºC (Räsänen 1993).

Floodplain transects were located in mature forest and tierra-firme included no-longer flooded terraces of the Holocene floodplain of these rivers and ancient Pleistocene alluvial terraces (Räsänen 1993). Variable-width line transect surveys were used to estimate the densities of the focal species following the methods of Peres (1999) and Bibby et al. (1998). Morning surveys were conducted from half an hour after daybreak, which varied from 05:30 in December to 06:15 in July, finishing at 11:00 at the latest. Generating precise density estimates usually requires considerable survey effort to obtain sufficient sample sizes (see Buckland et al. 1993, Buckland et al. 2001). Revisiting survey sites, rather than setting up new ones, has obvious advantages as a means of increasing sample sizes and is used commonly in distance sampling (Buckland et al. 2001, Rosenstock et al. 2002) and proved to be the only option available with limited resources that compounded problems of accessing additional potential sites.

Three transects of two kilometre length were located in floodplain forest types, and three transects of up to four kilometre length were located in tierra-firme forest. Floodplain forest transects were of shorter length due to the extent of this forest, which generally extended no more than this distance from the Las Piedras River, while areas of tierra-firme were far more extensive. Total length of transects was 16 km. 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, and weather conditions every 15 minutes. Where possible the perpendicular distance was measured using a Leica rangefinder to achieve the greatest accuracy.

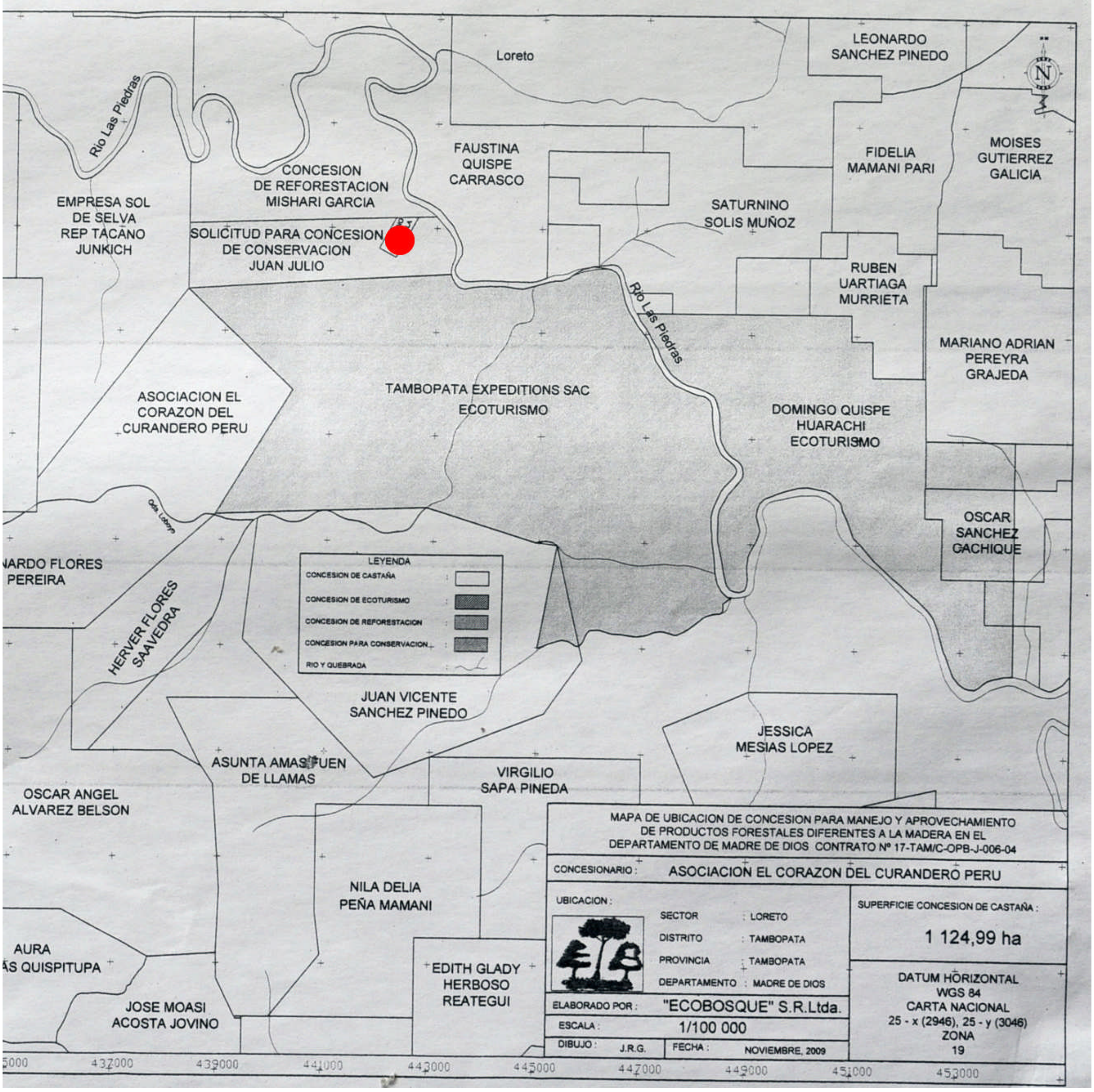


Figure 2.1a. A map of the expedition base (red dot) in relation to the concession where surveys were conducted (Tambopata Expeditions SAC). Apart from an ecotourism concession to the east of the Las Piedras River and a reforestation concession to the north, all other lands surrounding the concession are Brazil nut concessions.

Table 2.1a. Summary of transects, with name, type of forest, and transect length.

Transect	Forest type	Length (km)
B	Floodplain	2
CC	Floodplain	2
RIVER	Floodplain	2
A	Tierra-firme	4
C	Tierra-firme	4
MAMMAL	Tierra-firme	2

Surveys were carried out in all seasons by two or more observers. Most of these were led by Alan Lee and Emma Tatum-Hume. Supplementary observation was taken by part-time field assistants. Observers were trained in species identification and visual and aural distance estimation by testing them and then confirming the distance to observed target species and other random objects with a tape measure or rangefinder.

Density estimates were produced using the DISTANCE 5.0 program (Thomas et al. 2006). For software settings, we followed the recommendations of Buckland et al. (2001) and those used by others for estimating densities from similar rainforest environments (Kinnaird et al. 1996, Marsden 1999). For all species, groups were entered as clusters and distance data were grouped into automatic distance bands by the software. Models were fitted using the automated sequential selection and the Akaike's Information Criteria (AIC) stopping rule. A sequential testing of the key functions and series expansions were examined to fit detection functions to the data. Key functions (uniform, half-normal and hazard key) with the cosine, simple polynomial and hermit polynomial adjustment terms were tested, as suggested by Buckland et al. (2001).

A variety of truncation distances were tested and it was generally found that truncating the greatest 5% of distances for observations usually gave the best model fits, but for species with low encounter rates (<30) or best described by the uniform model truncation, was based on the largest observed distance. Truncation distances were chosen based on the lowest AIC function when selecting the best model among those with the same truncation distances and other input parameters, following Buckland et al. (2001). Significant differences between groups were determined using Z-tests where degrees of freedom were greater than 30.

Group encounter rates were generally too low (<20) to calculate density estimates with confidence for each year. To improve density estimates and coefficients of variation, results were grouped into two periods – 2003 to 2005 and 2006 to 2009. For each period sampling was undertaken during four years (no sampling was conducted in 2007). Sampling distances for these two periods were 489 km and 288 km respectively.

2.3. Results

727 km of transects were conducted at the LPBS from 2003 to 2009. 636 groups of eight species of diurnal monkey were encountered. Night monkey *Aotus nigriceps* was also encountered, but is not considered further here as night transects were conducted only sporadically. There were significant differences in the number of individuals encountered per year for the three largest monkey species (Table 2.3a), and the area's smallest species (saddle backed tamarin). The most commonly encountered troops were saddle-backed tamarins, followed by brown capuchin monkeys. Squirrel monkeys were encountered in the largest mean group sizes.

Table 2.3a. Sample effort, mean monkey group size, and mean group encounter rate per year for transects conducted at the Las Piedras Biodiversity Research Station from 2003 to 2009. Body mass (Wt) is the upper range from Emmons (1997).

Species	Hunters Rank ++	Wt (kg)	Year / km sampled	2003 / 177	2004 / 150	2005 / 112	2006 / 105	2008 / 99	2009 / 84
Alouatta seniculus *	3	11.1	Grps / km	0.1	0.11	0.04	0.09	0.13	0.11
Red howler monkey			Grp size	3 ± 2	2 ± 2	2 ± 2	4 ± 2	3 ± 2	4 ± 2
Ateles belzebuth **	4	10.4	Grps / km	0.05	0.08	0.15	0.2	0.11	0.19
Spider monkey			Grp size	4 ± 3	4 ± 3	2 ± 2	3 ± 3	4 ± 3	7 ± 7
Cebus apella *	3	4.50	Grps / km	0.18	0.15	0.3	0.23	0.2	0.23
Brown capuchin monkey			Grp size	3 ± 2	5 ± 3	4 ± 3	5 ± 3	5 ± 4	6 ± 4
Cebus albifrons	2	4.30	Grps / km	0.06	0.05	0.09	0.04	0.07	0.05
White-fronted capuchin monkey			Grp size	4 ± 2	10 ± 6	5 ± 4	8 ± 7	8 ± 6	17 ± 22
Pithecia monachus	2	2.50	Grps / km	0.05	0	0.05	0.05	0.07	0.06
Saki monkey			Grp size	3 ± 1	±	3 ± 2	2 ± 2	3 ± 2	5 ± 3
Callicebus moloch	0	1.40	Grps / km	0.05	0.07	0.04	0.07	0.1	0.09
Dusky titi monkey			Grp size	3 ± 1	4 ± 2	2 ± 1	2 ± 1	3 ± 2	2 ± 1
Saimiri sciureus	0	1.40	Grps / km	0.02	0.06	0.07	0.09	0.06	0.09
Common squirrel monkey			Grp size	18 ± 14	16 ± 9	15 ± 14	33 ± 30	21 ± 15	19 ± 25
*Saguinus fuscicollis**	0	0.44	Grps / km	0.22	0.14	0.29	0.29	0.23	0.21
Saddle-backed tamarin			Grp size	5 ± 2	7 ± 4	5 ± 3	5 ± 2	6 ± 4	7 ± 5

++ Degree of hunter preference on a scale of 0 (always ignored) to 4 (never ignored) (Peres and Lake 2003).
For individuals per kilometre between years: * significant difference at 0.05, ** significant difference at 0.01 (Kruskal-Wallis tests)

There was a significant higher monkey encounter rate for the combined period 2006 – 2009 compared to the 2003 to 2005 period (Table 2.3b). Individual encounter rates were highest during 2009 for spider monkey, brown capuchin and saki monkey compared to any previous year of sampling (Figure 2.3a). Patterns of encounter for white-fronted capuchin monkey, saddle-backed tamarin and squirrel monkey remained stable or displayed stochastic patterns with no clear patterns of increase or decrease. Red howler monkey encounter rates were unchanged from 2008 after a three year increase.

Table 2.3b Primate relative abundance, measured as individuals per kilometre (mean ± standard deviation) for eight species of monkey grouped into two survey periods. Results of Mann Whitney-U tests are provided.

Species	2003 - 2005	2006 – 2009	U	Z	p
A. seniculus *	0.19 ± 0.48	0.33 ± 0.59	4806	-2.13	0.03
A. belzebuth **	0.32 ± 1.04	0.73 ± 1.24	4067	-4.04	0.00
C. apella *	0.84 ± 1.44	1.16 ± 1.47	4632	-2.14	0.03
C. albifrons	0.42 ± 1.43	1.02 ± 4.75	5485	-0.15	0.88
P. monachus	0.08 ± 0.26	0.16 ± 0.44	5035	-1.87	0.06
C. moloch *	0.20 ± 0.72	0.21 ± 0.48	4921	-1.99	0.05
S. sciureus *	0.87 ± 3.03	2.00 ± 5.00	4828	-2.29	0.02
S. fuscicollis	1.14 ± 2.06	1.34 ± 1.71	4785	-1.79	0.07
All monkeys	4.05 ± 4.59	6.95 ± 7.49	3930	-3.56	0.00

Trends in terrestrial mammal relative abundance for the survey history are provided in Table 2.3c and appendix II to complement this report and provide participants with an overview of the information they collected, but will not be discussed further here as the information will serve as the focus of a chapter in future reports.

Table 2.3c. Relative abundance (individuals / km) of terrestrial mammals and large bodied birds recorded on transect. Results of Mann Whitney-U tests are provided. Significant changes at the 0.05 level are indicated by *, changes at the 0.01 level indicated by **

Species	Mean ± SD		U	Z	p
	2003-2005	2006-2009			
Collared peccary *	0.05 ± 0.23	0.16 ± 0.50	5039	-2.01	0.04
White-lipped peccary	1.26 ± 4.74	3.36 ± 9.35	5079	-1.65	0.10
Grey brocket deer *	0.01 ± 0.06	0.04 ± 0.16	5168	-1.96	0.05
Red-brocket deer	0.03 ± 0.11	0.04 ± 0.12	5259	-1.07	0.28
Pale-winged trumpeter	0.22 ± 0.66	0.36 ± 0.81	5145	-1.22	0.22
Razor-billed curassow **	0.01 ± 0.07	0.06 ± 0.15	4988	-2.59	0.01
Common piping guan **	0.03 ± 0.11	0.11 ± 0.22	4618	-3.25	0.00
Spix's guan **	0.34 ± 0.53	0.65 ± 0.63	3823	-4.01	0.00
Bolivian squirrel	0.08 ± 0.18	0.06 ± 0.13	5403	-0.39	0.69
Southern Amazonian red squirrel	0.50 ± 0.90	0.35 ± 0.40	5216	-0.72	0.47
Brown agouti	0.11 ± 0.22	0.06 ± 0.14	5031	-1.45	0.15
Green acouchy **	0.01 ± 0.08	0.08 ± 0.23	4922	-3.09	0.00
Coati	0.05 ± 0.28	0.00 ± 0.03	5440	-0.77	0.44
Tamandua	0.01 ± 0.08	0.01 ± 0.05	5484	-0.34	0.74
Tayra	0.01 ± 0.09	0.00 ± 0.00	5412	-1.31	0.19

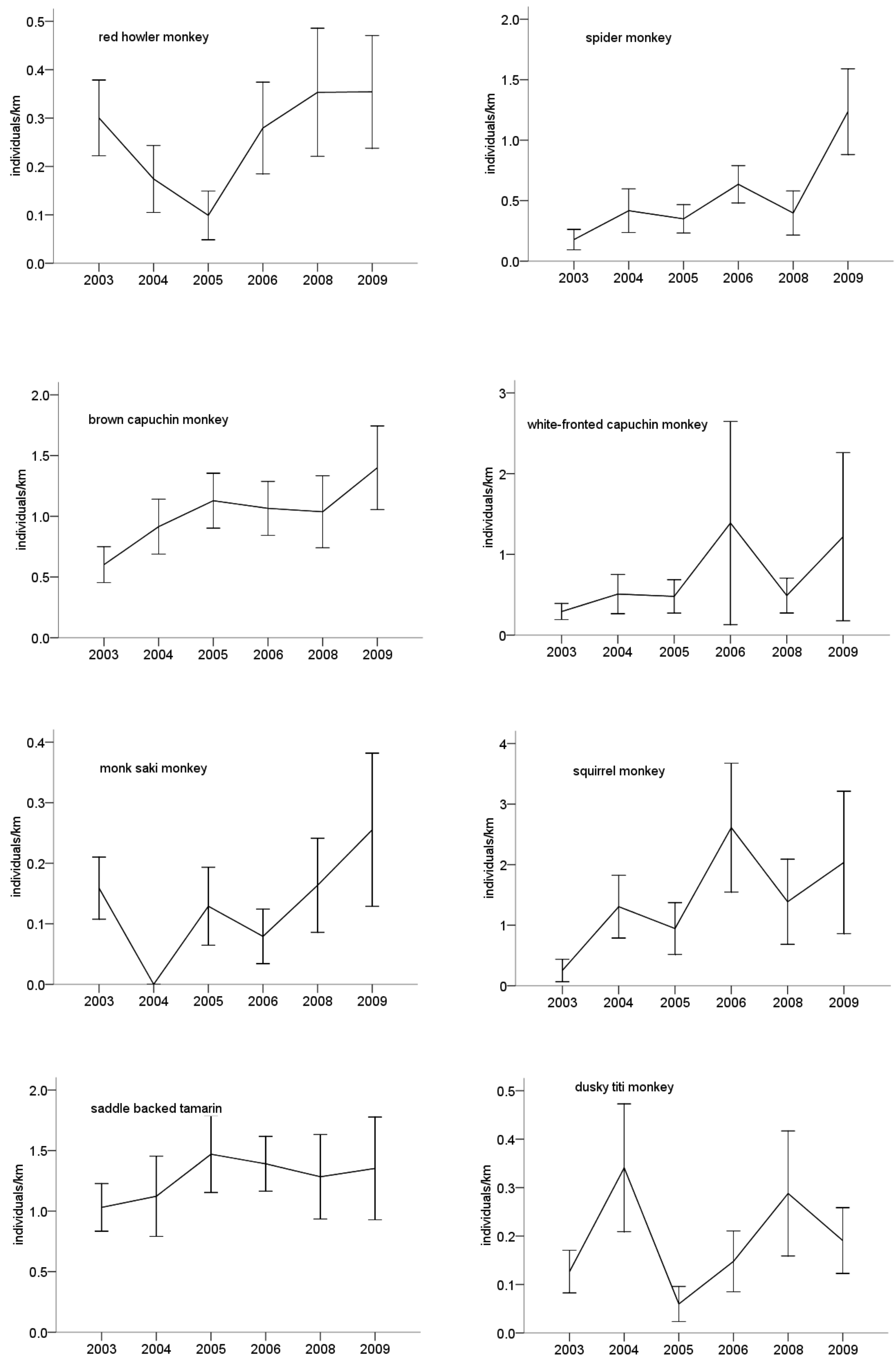


Figure 2.3a. Encounter rate (individuals per kilometre) for the eight species of diurnal monkey encountered at LPBS. Error bars represent standard error.

Density estimates

There was a significant difference between sampling periods for spider monkeys only (Table 2.3d), although all the large monkeys had higher densities for the more recent survey years. Only for tamarins and brown capuchin monkeys was percent covariation below the recommended 20% (Marsden 1999). Z-tests are sensitive to variation and thus further significant density increases may have occurred in the other large-bodied species. Saddle-backed tamarins were recorded at the highest density and are probably the most common monkey species in the survey area. Saki monkeys had the lowest density and are the rarest species in the survey area. Brown capuchin monkeys were the most common of the species targeted by hunters, for both sampling periods. Dusky titi monkey was the only species to record lower densities for the 2006-2009 period compared to the 2003-2005 period

Table 2.3d Density estimates for two sampling periods 2003-2005 and 2006-2009. N = number of groups, D = density (individuals per square kilometre), SE = standard error, % = percent covariation, Z = Z scores between year groups, * = p < 0.05, Grp # = group size, POP = predicted population of the brazil nut and ecotourism concessions (based on 2006-2009 population density estimates and protected area size of 5000ha).

	2003 – 2005					**2006 – 2009**					
	N	**D**	**SE**	**%**	**Grp #**	**D**	**SE**	**%**	**Z**	**Grp #**	**POP**
A. seniculus	69	**3.1**	0.7	22.2	3.6	**5.7**	1.4	25.1	-1.62	4.1	285
A. belzebuth *	85	**5.7**	2	35.5	3.4	**15.7**	3.9	24.6	-2.3	4.5	785
C. apella	151	**12.5**	1.9	15	4.1	**17.8**	3	16.6	-1.5	5	890
C. albifrons	43	**6.8**	2.2	32.1	5.3	**12.3**	6.3	51.1	-0.82	10.3	615
P. monachus	32	**1.3**	0.4	31.6	3	**2.1**	0.6	29.3	-1.18	3.3	105
S. sciureus	44	**25**	13.2	52.7	15.3	**47.2**	18.6	39.4	-1.19	20.1	2360
C. moloch	48	**5.6**	2.3	40	3.2	**4.9**	1.5	30.6	0.25	2.4	245
S. fuscicollis	164	**42.8**	9.5	22.2	5.5	**49.6**	9.3	18.7	-0.51	6	2480

2.4. Discussion

Implications for spider monkey recovery

Since 2003 there has been a significant increase in spider monkeys. Spider monkeys are very vulnerable to hunting activities. This study suggests that spider monkeys were heavily affected by hunting activities. Although we will never know original population levels, the dramatic population increase would suggest that the population was reduced dramatically by hunting activities. Spider monkeys are locally extinct on the lower Tambopata river in areas located closer to the region’s largest population centre, Puerto Maldonado, as these areas are more accessible to hunters. Sites where monkeys occurred have still not been recolonised since the designation of the area's protected status in 2000.

Emmons (1997) suggests spider monkey troop size can be as many as 20 to 40 individuals, with shared home ranges of up to 250 ha. This suggests that an area of prime monkey habitat may have as many as 16 individuals per sq kilometre, very close to our calculated density of 15 ind / km^2. If the population density was 5 ind / km^2 in 2003, given that females first give birth at 4 – 5 years old and then have young only every 3 – 4 years (Emmons 1997), then with natural recruitment and assuming no mortality and a population ratio of two males, two females and one juvenile, it is unlikely that the population would be 12 ind / km^2 by 2009 (scenario 1 below). This would imply population migration from outside the survey area, a possibility given that the surrounding land is divided into brazil nut harvesting concessions where hunting and illegal wood extraction is known to occur and so monkeys may be fleeing persecution. However, if there are three times as many adult females as males in a troop (Emmons 1997), then it is possible with maximum recruitment that 15 ind / km^2 is the consequence of natural fecundity (scenario 2). These scenarios are simplistic, but offer reasonable explanations for the spider monkey population recovery.

Scenario 1 – Spider monkey recruitment scenario with even male, female ratio and one juvenile in 2003.

	Female:				
	A	B	offspring from 2003 C	offspring from 2006 D	Total
	Offspring:				
2003	**C**				5
2004		1			6
2005					6
2006	1		**D**		8
2007		1			9
2008					9
2009	1		1	1	12

Scenario 2 – Recruitment scenario with 3 females to 1 male from 2003.

	Female:						
	A	B	C	offspring 2003 D	offspring 2005 E	offspring 2006 F	Total
					Offspring:		
2003	**D**						5
2004		1					6
2005			**E**				7
2006	1			**F**			9
2007		1					10
2008					1		11
2009	1		1	1		1	15

The primate assemblage

In terms of species number and composition, the primate assemblage at LPBS is similar to those documented at other western Amazonian forest sites, where as many as 14 sympatric primate species can be found (Terborgh 1986). 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).

Red howler monkeys, brown capuchins and white-fronted capuchins have all shown a small but not statistically significant increase in abundance since 2003. Many studies have demonstrated that hunting has a negative impact on mammal populations (Peres 1999, Naughton-Treves 2002) and in some cases 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. 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, hunting only occurred over a relatively short period of time on a non-commercial basis.

Species accounts

Red howler monkeys are the only species of howler monkey in Peru, occupying the middle and upper levels of mature and disturbed rainforest (Emmons 1997). Our mean group size (3) is at the lower end of the given range of 3 – 9. In habitats where there are few other monkey species, they can reach densities of over 100/km^2 (Emmons 1997). Our density estimates of 3-6/km^2 are reasonably low. As they are quiet and slow-moving, their inactivity makes them inconspicuous and it is possible that in the case of this species that the density sampling assumption of g(0) = 1 i.e. all animals on the line of the transect are detected, is not true. We would expect howler monkey numbers to remain stable or increase slightly in future surveys, subject to natural fluctuations, which may have occurred during the course of this survey during 2004 and 2005. Howler monkeys are predated on by harpy eagles (Piana 2007). Harpy eagles have been seen consistently at the survey site over the years of the study, and in 2004 a harpy eagle was observed feeding on a howler monkey. However, harpy eagle populations may have decreased and are predicted to decrease in the near future as they nest in large trees which are currently being targeted by woodcutters in the region, and as settlers moving in from the Interoceanic highway to the east shoot the birds to protect livestock (Fernandini, personal communication).

The omnivorous brown capuchin monkeys forage for fruit, eggs, nestlings and small mammals in the middle to lower canopy and take fruit from the upper canopy (Emmons 1997). They are one of the most commonly seen monkeys in the Amazon. Our mean group size (4 - 5) is at the lower end of the given range of 5 – 20, usually 10. Although they are noisy, where hunted they can be difficult to approach as they give alarm calls and flee silently. Our density estimates of 12 – 17 are reasonably high and suggest territory size of 25 – 100 ha. We predict that the brown capuchin monkey population is stable and will remain relatively unchanged in future surveys.

White-fronted capuchin monkeys appear to share a niche in terms of canopy use and diet with brown capuchin monkeys. They are reportedly found in larger groups (7 – 30), and with a mean group size of 10, this species was found in the second largest groups after squirrel monkeys in this study. The species is apparently naturally absent from much of the expected range in south-eastern Peru. Group encounter rate was generally low, and troop sizes fluctuated greatly. This species may have faced direct persecution from Brazil nut collectors as they are one of the only species capable of cracking open the hard outer nut casing to get to the nuts. We speculate that range sizes are large, and that there may be some complicated group structure, with troops splitting and joining at various intervals. Although we do not expect density to increase, a lack of any clear trend means more data on this species are needed to understand population trends.

Saki monkeys reportedly favour tierra-firme forests (Emmons 1997), and were absent from transects through floodplain forest in our study. Saki monkeys are not found south of the Madre-de-Dios river. Our mean group size (3) is within the given range of 2 – 8. Saki monkeys are stealthy and quiet and will sit motionless in dense leafy vegetation. As a consequence, our density estimates (possibly the first calculated for the species) may well underestimate the true abundance of this species. Although not registered on transects during 2004, the species has been encountered more frequently from 2005 onwards. There is only one breeding female per troop, and she gives birth every two to three years. This may explain why population increase was the lowest of the hunted monkey species after brown capuchin. We expect saki monkeys to become more frequent in future surveys.

Squirrel monkeys spend much of their day ranging through both primary and secondary floodplain rainforest looking for insects (Emmons 1997). Squirrel monkeys have territories between 100 – 500 ha (Emmons 1997). Our mean group size (23) is just below the given range of 25 – 100. At calculated densities, this would suggest a troop per 50 ha. The percentage increase between 2006-2009 and 2003-2005 is 89%, not much different from howler monkeys (84%) or white-fronted capuchins (81%) and is well below spider monkeys (175%). We do not expect future surveys to see any further increase in squirrel monkeys.

Dusky titi monkeys live in family groups of up to five individuals, usually in the middle or lower levels of dense forest (Emmons 1997). In areas where they are hunted they are stealthy, but usually common (Emmons 1997). Our mean group size (3) is within the given range of 2 – 5. We do no expect changes in population levels of this species in the future.

Saddle-backed tamarins are the most commonly seen tamarin in Peru and the most widespread species, occupying mature, disturbed and secondary lowland rainforest (Emmons 1997). Saddle-backed tamarins have territories between 16 – 100 ha (Emmons 1997). Our mean group size (6) is within the given range of 2 – 12. We would thus expect between 38 to 6 individuals per square kilometre. Our density estimates of 42 – 49 are somewhat higher, and we assume that saddle-backed tamarin territories for the concession area are smaller (14 ha) and that the population is at carrying capacity. In other studies, tamarins have been found to be more abundant in areas where large species populations have been compromised (Kirkby et al. 2000). We would expect tamarin numbers to possibly decrease in the future in the face of spider monkey and other large monkey recovery.

Conclusion & recommendations

Under the conservation management policies of the company administering the three concessions associated with LPBS, all species that were targets of hunting (including large bodied birds) by previous extraction concessions have recovered. Although the mahogany and cedar booms are more or less over at the time of writing, the demand for hardwood is soaring. Species such as ironwood *Dipteryx micrantha* and tornillo *Cedrelinga cateniformis* provide in-demand timber wood. The demand for these woods is being driven by economic growth in China. The impacts are being felt in the forests to the south of the conservation concession, where during the survey there was substantial timber harvesting from designated Brazil nut concessions and thus most likely illegal.

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. 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 could be further enhanced by a comparison of an undisturbed community of primates, such as those found in the Tambopata National Reserve at the Tambopata Research Centre. Future surveys should increase the number of unique transects sampled, and should in addition conduct afternoon transects where possible in order to increase the sampling size. A behavioural study following troops of saki and howler monkeys with special emphasis on movements and vocalisation patterns would help create a co-efficient to improve density estimates by determining a multiplier for g(0) (Bächler and Liechti 2007).

2.5. References

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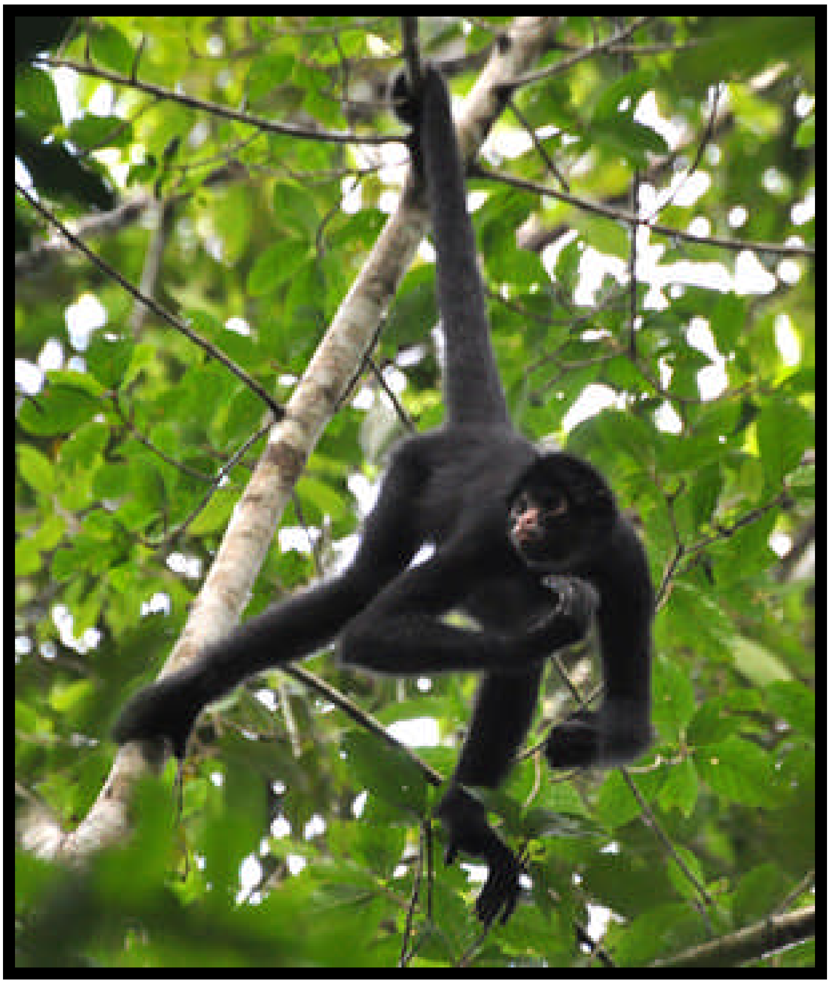
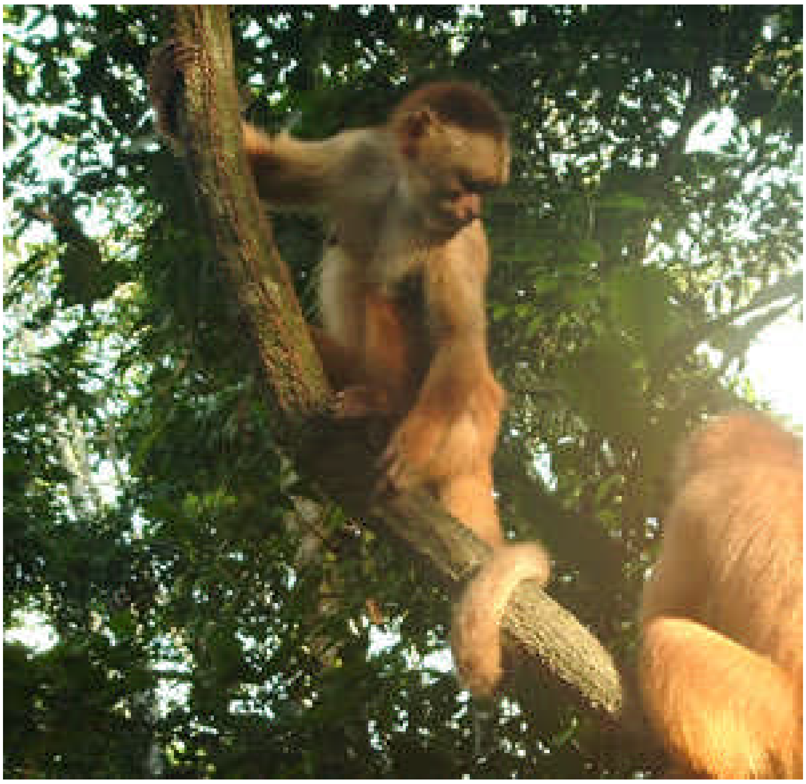
Appendix I: A Photo Guide to the monkeys at Las Piedras Biodiversity Station, Tambopata. Photos by Alan Lee unless otherwise credited.

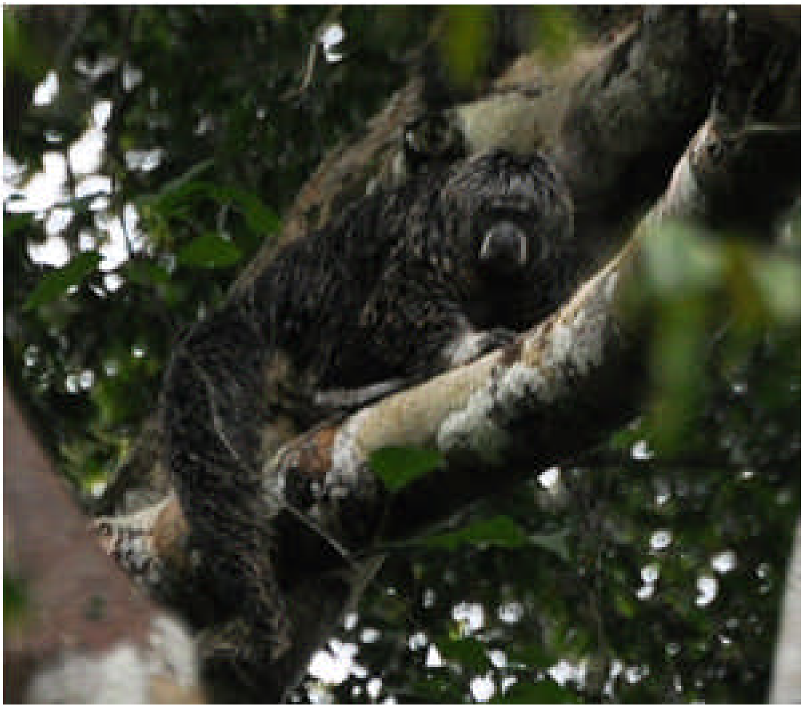
Red howler monkey
Alouatta seniculus



Spider monkey
Ateles belzebuth chamek


Brown capuchin monkey
Cebus apella


White-fronted capuchin monkey
Cebus albifrons
Photo courtesy Fauna Forever Tambopata



Saki monkey
Pithecia sp.

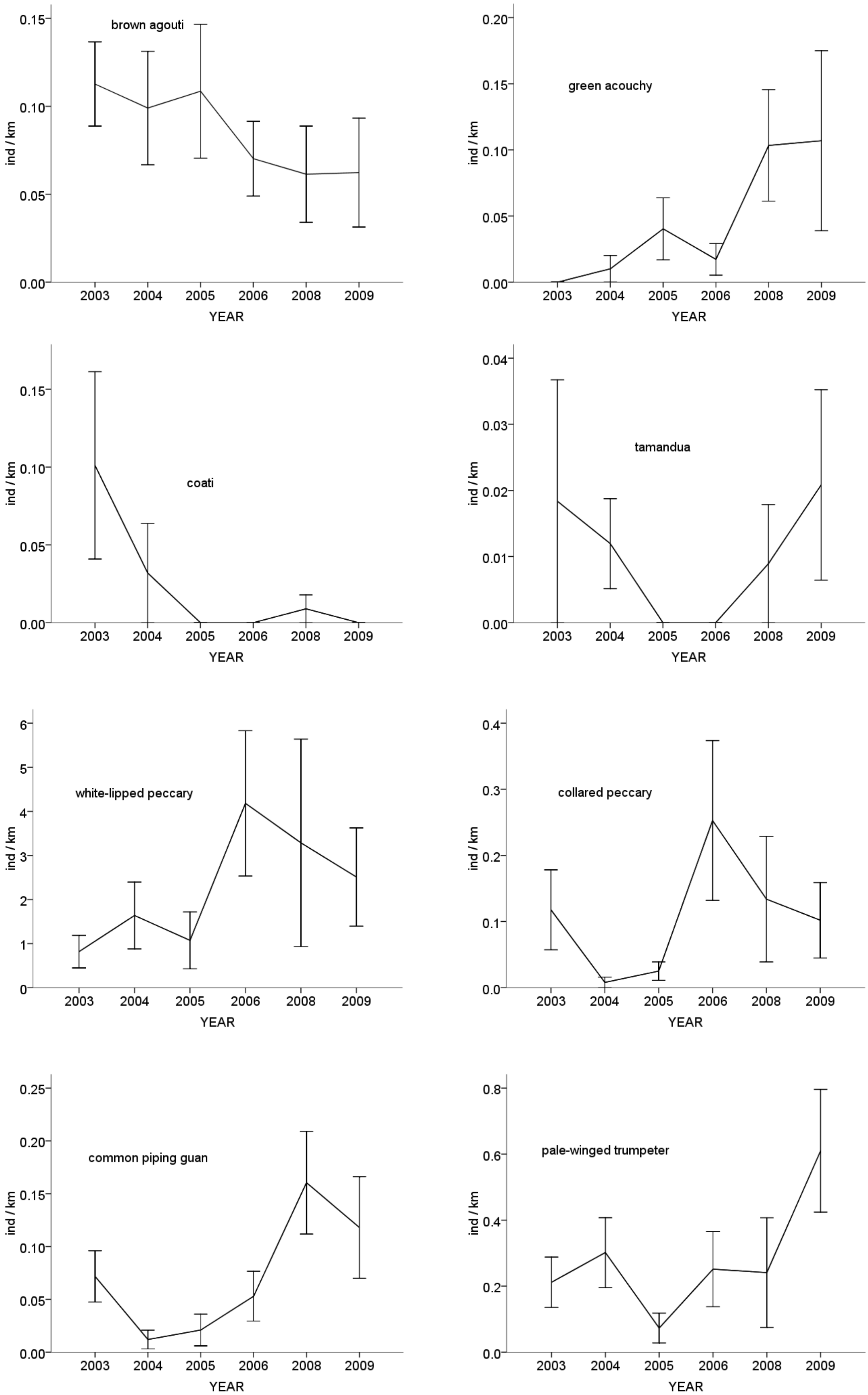
Squirrel monkey
Saimiri sciureus

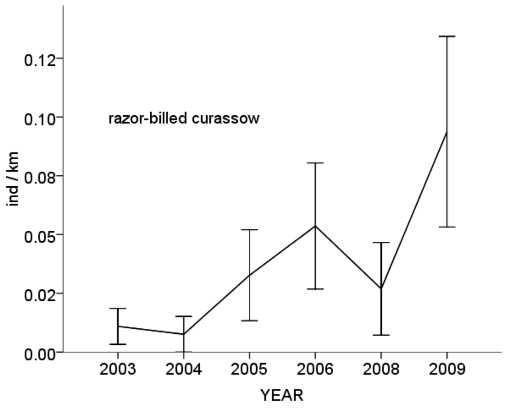
Dusky titi monkey
Callicebus moloch

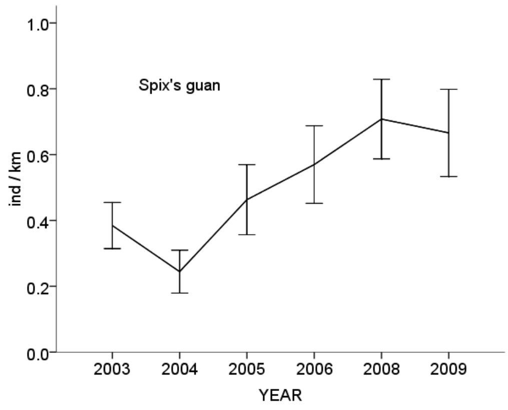
Saddle-backed tamarin
Saguinus fuscicollis

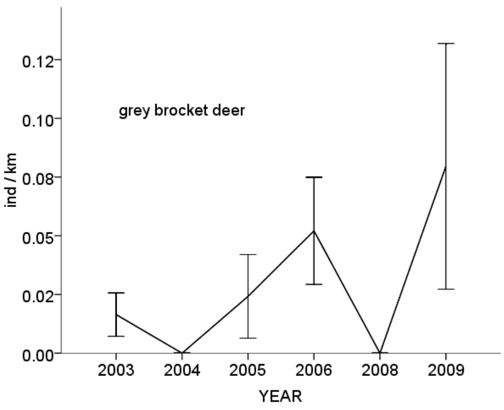
Night monkey
Aotus nigriceps

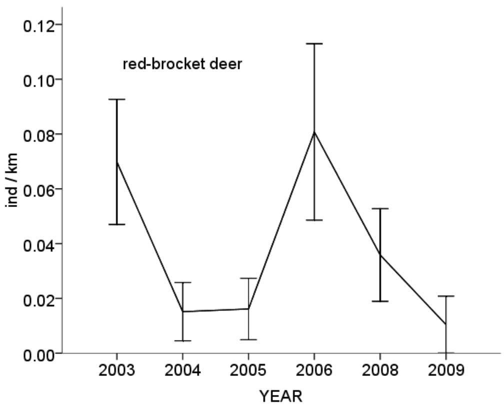
Appendix II: Relative abundance of 15 non-primates including terrestrial mammals and large-bodied bird species at the LPBS for the survey period 2003 – 2009.




razor-billed curassow
ind / km
0.00
0.02
0.05
0.08
0.10
0.12
2003
2004
2005
2006
2008
2009
YEAR


Spix's guan
ind / km
0.0
0.2
0.4
0.6
0.8
1.0
2003
2004
2005
2006
2008
2009
YEAR


grey brocket deer
ind / km
0.00
0.02
0.05
0.08
0.10
0.12
2003
2004
2005
2006
2008
2009
YEAR


red-brocket deer
ind / km
0.00
0.02
0.04
0.06
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0.10
0.12
2003
2004
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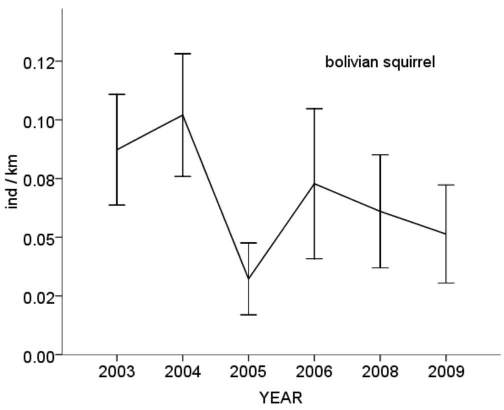
YEAR


bolivian squirrel
ind / km
0.00
0.02
0.05
0.08
0.10
0.12
2003
2004
2005
2006
2008
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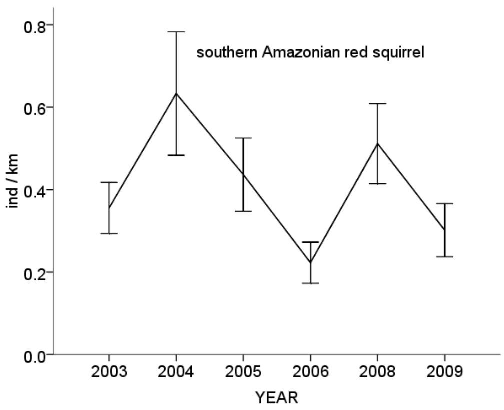
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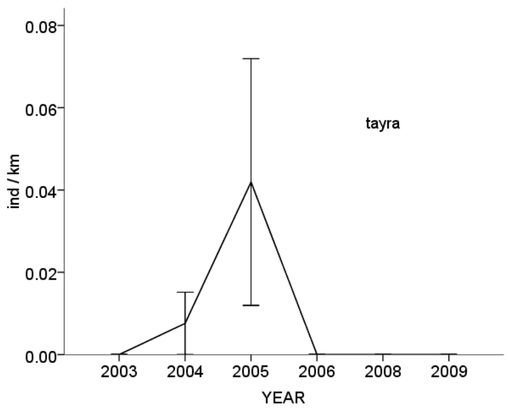
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3. The impact of a mammal claylick on spatial patterns of terrestrial mammal presence: preliminary results from a small track-trap array experiment

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3.1. Introduction

Geophagy, the intentional consumption of soil, has been reported for many vertebrate taxa (Mahaney and Krishnamani 2003), especially mammals (Krishnamani and Mahaney 2000, Mills and Milewski 2007, Kikouama et al. 2009). Exposed areas of soil where mammals come to eat dirt on a regular basis have been reported from South America (de Oliveira et al. 2006), Africa (Klaus et al. 1998) and Asia (Clayton and MacDonald 1999). These are known variously as licks, salt licks, mineral licks, clay licks or, in Peru, as colpas. Many reasons have been put forward to explain geophagy (Klaus and Schmid 1998, Mills and Milewski 2007), the most common of which appear to be dietary mineral supplementation, especially sodium (Ayotte et al. 2006), and the fact that soil serves as a buffer against dietary toxins (Brightsmith et al. 2008, Klein et al. 2008).

The western Amazon, and southeastern Peru in particular, have the highest concentrations of claylicks in South America (Brightsmith et al. 2009, Lee et al. 2009). The Las Piedras river drainage basin may have one of the highest concentrations of mammal claylicks in Peru's department of Madre-de-Dios (Brightsmith et al. 2009). Analysis of soil consumed by parrots shows that it is high in sodium relative to the parrots' regular diet (Powell et al. 2009). Montenegro (2004) analysed tapir diet in northern Peru and showed that sodium requirements cannot be met through the browse and fruits tapirs eat. She suggests that tapirs in that region therefore depend on sodium from mineral licks. In addition, fruits have a much lower concentration of sodium than browse. These deficits probably also extend to the largely frugivorous peccaries and deer.

In Brazil, white-lipped peccary closely followed by jaguar, monopolised Buritizal forests, whereas collared peccary followed by a puma exploited the other available high-ground forest types (Pontes and Chivers 2007). Fluctuations in food supply regulated the dynamics of the two species of peccaries, which ultimately determined the whereabouts of the large cat predators (Pontes and Chivers 2007). The presence of a claylick can influence spatial patterns of distribution of its users (Holdo et al. 2002, Bravo et al. 2008). As a consequence, human hunters in Peru are known to visit claylicks on their hunting excursions (Montenegro 2004). Whether the same is true of large cats has not been shown to date, although radio-tracking fixes of female jaguars in Brazil suggested a pattern of spatial avoidance among females during the wet season (Cavalcanti and Gese 2009). With predation risk, prey species greatly restrict their use of available habitats and consumption of available food resources, so effects of top predators consequently cascade down to the trophic levels below them (Ale and Whelan 2008).

This is the first study that we are aware of that aims to determine the influence of claylicks on the spatial dynamics of Neotropical terrestrial mammals.

Objectives

1. Compare terrestrial mammal species richness in an area with and without a claylick.

2. Determine patterns of spatial autocorrelation in relation to the presence of a mammal claylick.

3.2. Methods

The study site, the Las Piedras Biodiversity Station, is described above. The concession area has two large mammal claylicks, one of which is 2.7 km from the study base. Previous observations here have confirmed the presence of the four large ungulate species: tapir, white-lipped peccary, collared peccary and red-brocket deer and various rodents including paca, agouti and acouchy (described in Hammer and Tatum-Hume 2003). The survey was conducted from 6 November 2009 to 4 December 2009.

In order to record track presence, two arrays of seven parallel access lines of 300 m length and spaced 50 m apart were created. The first array created (COLPA) was located so that the centre of the array was on a known mammal claylick (Figure 3.2a). The second array (CONTROL) was located 1 km east on the same stream that run through the claylick array (Figure 3.2b). Before the location of the second array was chosen, extensive surveys were conducted to ensure no large mammal claylick existed in the array. These surveys did find smaller rodent claylicks along some stream banks in other areas of the concession, and in addition, located the first sign of Neotropical otter recorded for the concession.

Access lines were cut in a grid system and avoided the use of existing trails wherever possible, as cats and other species are known to use these. Track traps were arranged in each trail (see Appendix 1), spaced 50 m apart. Each array took one day to cut access lines, with the help of six people, plus additional manpower to mark and measure. A second day was generally needed to create the track traps (49 per array). Each track trap in each array was then checked every second day, weather allowing (arrays were checked after at least 24 hours with no rain). Only tracks that could be identified to species or genus level are considered here.

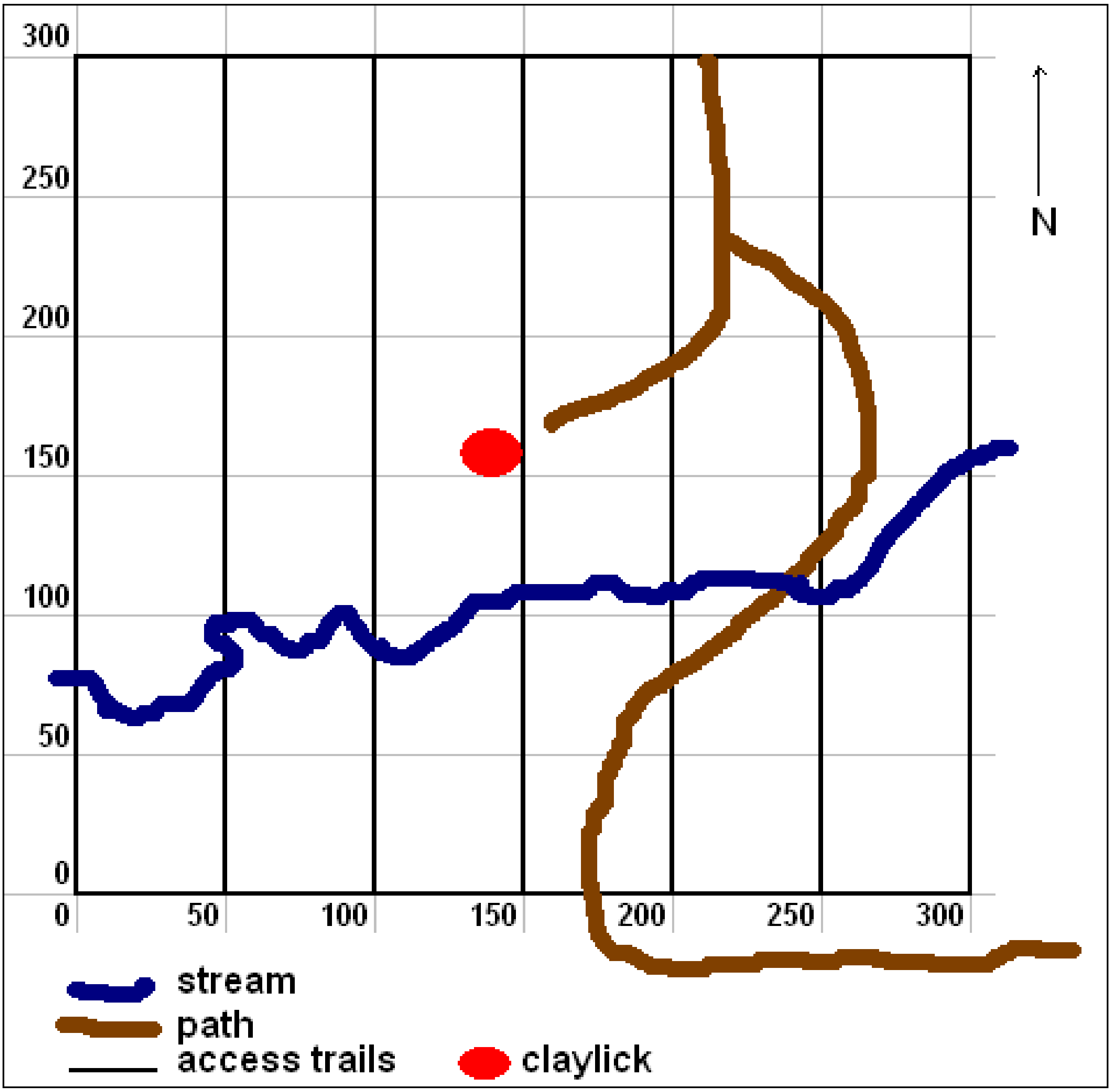

Figure 3.2a. Map of the colpa track trap array, showing access lines to the track traps, which were located on the intersection of grid lines and named accordingly (e.g. track trap at X, Y coordinated 50, 50). X and Y coordinates are in meters.

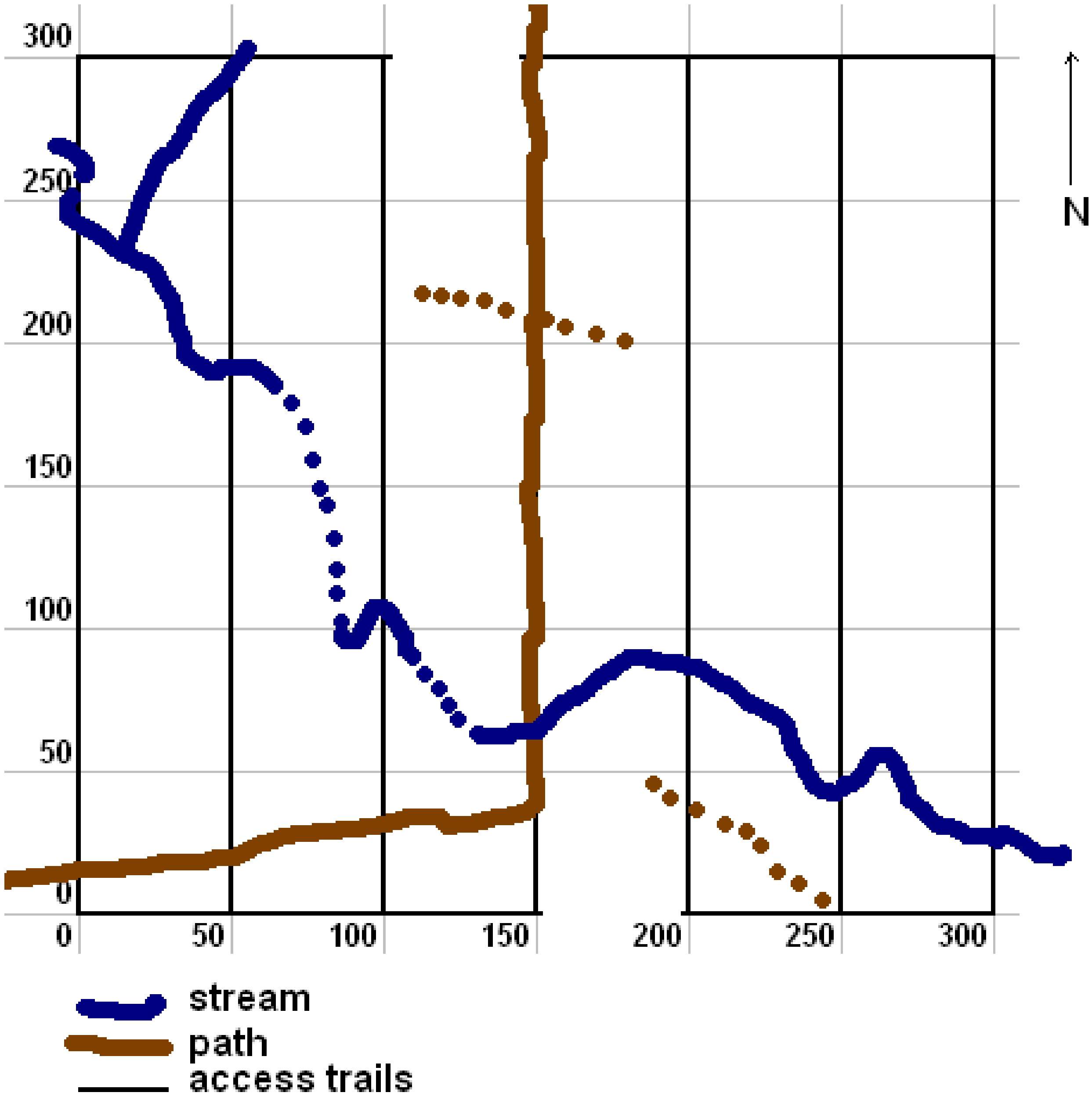

Figure 3.2b. Map of the control track trap array. X and Y coordinates are in meters.

3.3. Results

The colpa array was checked on a total of six days, while the control array was checked on four days. Results will only be considered during four days at each array, being the period from 19 November to 3 December in order to keep results comparable, as increased sampling period could bias species richness. Ninety tracks of target species that could be identified were recorded. A large number of pale-winged trumpeter, tinamou species, tortoise and small rodent tracks were also registered, but will not be considered further here being outside the scope of the current study. Mean number of tracks registered per day per array (excluding non-target species) was 19 for the colpa, and 12 for the control. Species that use the claylick were encountered more than three times as often in the colpa array (Table 3.3a).

The most commonly recorded species was white-lipped peccary, which was registered exclusively in the colpa array. Paca, the second highest registration, was also recorded 2.5 times more often in the colpa array. The only claylick user to be recorded in the control array that was not recorded in the colpa array was tapir. Anecdotally, tapir use this mammal claylick very rarely.

Ocelot was the most common non-claylick user recorded (Table 3.3a), and was the species with the highest number of registrations in the control array. Jaguar was recorded on only one occasion, in the colpa array.

Table 3.3a. Total number of registrations of tracks in two track trap arrays, for four trap days each. Species are subdivided into those that have been recorded eating soil at claylicks during previous observations (Hammer and Tatum-Hume 2003) and those that have not.

Species	Colpa	Control	Total
Claylick users			
Brown agouti	2	2	4
Green acouchy	2	1	3
Paca	10	4	14
Guan / Curassow	7	0	7
Tapir	0	1	1
Red brocket deer	1	1	2
Collared peccary	4	4	8
White-lipped peccary	17	0	17
Claylick user subtotal:	**43**	**13**	**56**
Non-claylick users			
Armadillo	3	4	7
Grey brocket deer	6	3	9
Giant anteater	1	1	2
Giant armadillo	0	2	2
Jaguar	1	0	1
Ocelot	8	5	13
Non-claylick subtotal:	**19**	**15**	**34**
Grand Total:	**62**	**28**	**90**

The highest number of registrations of species that are known to feed at claylicks were recorded at the track traps located in close proximity to the mammal claylick (Figure 3.3a). On no occasion was more than one set of tracks of claylick-using species found in the control, despite habitat and trail variables being similar.

COLPA	0	50	100	150	200	250	300
300	3	0	0	0	1	0	1
250	2	1	0	2	1	0	0
200	0	0	2	3	0	0	0
150	2	0	2	3	2	0	2
100	3	1	1	0	0	0	1
50	2	1	3	1	1	0	0
0	0	0	0	2	0	0	0

CONTROL	0	50	100	150	200	250	300
300	0	1	0	0	1	0	0
250	1	0	0	0	0	0	0
200	0	0	0	0	0	0	0
150	0	1	0	0	0	0	1
100	1	0	0	1	0	0	0
50	0	1	1	0	0	1	1
0	0	0	0	1	0	1	0

Figure 3.3a. The number of encounters with species that use claylicks at two track trap arrays, COLPA and CONTROL. Grid reference 150 150 represents the location of the mammal claylick in the colpa array. Results represent cumulative results from four survey days at each array.

3.4. Discussion

Species assemblage

White-lipped peccary tracks were recorded in the colpa array on almost all days, and were usually present in multiple track traps as herd sizes in the area were large (± 50 individuals) and usually spread over a large area. White-lipped peccary have been recorded at the claylick since 2003 (Hammer and Tatum-Hume 2003). Visits were recorded every two to three days, although multiple herds may have been involved. At a long term camera trapping project in the neighbouring Amigos and Malinowsky river systems the white-lipped peccary and the red brocket deer had a similar frequency of 16.1 visits per 100 days and 17.1 visits per 100 days respectively (Tobler et al. 2009).

Unusually, tapir tracks were never recorded in the colpa array, despite being the most frequent visitor at all licks on the Amigos and Malinowsky with an average visitation rate of 52.8 visits per 100 days (Tobler et al. 2009). Collared peccary on the other hand was only observed on three occasions during 434 camera days on the Amigos and Malinowsky, and although encountered at low frequencies on the concession, was recorded at the colpa at Las Piedras. The grey brocket deer was never seen at any of the licks during this survey, and was also not recorded at claylicks at the Amigos and Malinowsky (Tobler et al. 2009). The grey brocket deer is a tierra-firme forest specialist, where claylicks are rare or absent altogether.

The influence of a claylick on mammal spatial distribution

White-lipped peccary clearly use the area around a claylick more on their movements to and from the claylick, compared to the control area. We were unable to draw any conclusions on the impact of jaguar as a result of the presence of claylicks, due to the small sample of arrays, compounded by their small size. However, ocelot tracks were encountered more frequently in the colpa array and may perhaps be visiting the area due to the large number of rodent species (brown agouti, green acouchy and paca), which visit the claylick. For instance, paca was one of the most common visitors of the region’s claylicks (Brightsmith et al. 2009). Visual observations of mammal claylicks show that visitors rarely spend much time in the vicinity after eating, and disperse quickly into the surrounding forest. In addition, visitation rates with people present in the observation blind appear to be lower than would be expected from the track record from days when no people are present, suggesting that claylick visitors are very wary of predators or unusual conditions around the claylick.

The track trap array provides promising results, as track traps are an effective and cheap way to record species presence on a large scale. Challenges include preparing and placing track traps adequately, and tracks can be washed out by rain and so need to be checked frequently.

Recommendations for future research

The original study design was to place track trap arrays at two known claylicks, to find a third claylick for a third claylick array, and then create three control claylicks. The aim was to determine if there were spatial patterns in jaguar hunting patterns, as this flexible predator has been shown to vary activity and hunting patterns temporally based on prey availability. The original design was to have arrays based on a 1 km grid, with track traps 100 m apart. However, it became abundantly clear soon after initiating the creation of the first array that this was not feasible due to the difficulty in opening up transect lines. In order to implement such a study design, a dedicated team of experienced machete wielders would need to be sent to the study site at least a week in advance. Expedition members would need a day in order to check the entire array, possibly broken into an afternoon and morning shift. Team members could identify tracks using the guide attached at Appendix II together with the track trap guides available at the study site. If in doubt, broad grouping could be used, e.g. the two peccary species could be grouped, as could deer. Such a study would be very useful for elucidating the extent of spatial influence of claylick not only on ungulates and other claylick users, but on their predator species too.

3.5. Acknowledgements

Special thanks to the crew who helped create the arrays – JJ Duran, Aldo Ramirez, Angel El Profe, and Andy Stronach. Thanks to Andy for leading exploratory excursions to look for new claylicks, and for providing photos of tracks encountered. The report was improved with comments by Marcelo Mazzolli.

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Appendix I: How to make a track trap in tierra-firme sandy-soiled forests.

Step 1: Clear the forest floor or trail of all loose debris, leaves, branches etc. Using a machete as necessary remove vegetation.

Step 2: Dig deeply into the forest floor, using a sharp instrument such as a machete, aiming to break through the roots, which are in the surface and loosen the soil to a depth of 2 – 3 cm.

Step 3. Remove all roots and organic matter from the soil by scrapping the soil into a pile in the middle of the track trap.

Step 4: Smooth the soil, which should now be loose and as free of roots as possible, to an extant of 1 m x 1m. The soil must be firm, but not compacted. If the soil is too loose or too firm, tracks will not show or be difficult to interpret.

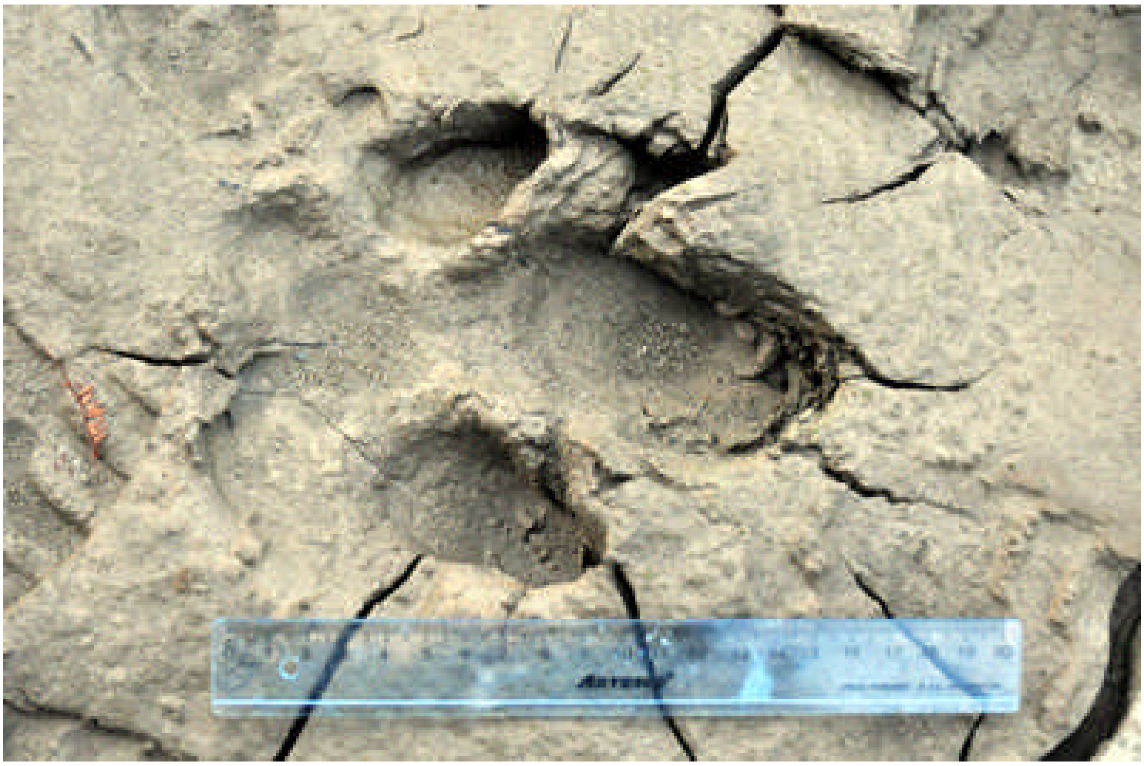
Appendix II: Some terrestrial animal tracks of the Las Piedras Biodiversity Station.

Jaguar: 9-10 cm long. Main pad is very large compared to toes. Toes and pad close together. Back foot narrower than front foot (front foot is on the left in the photo).

Puma: up to 8 cm long. Main pad is more angular, toes are more pointed and slightly spread out compared to jaguar.

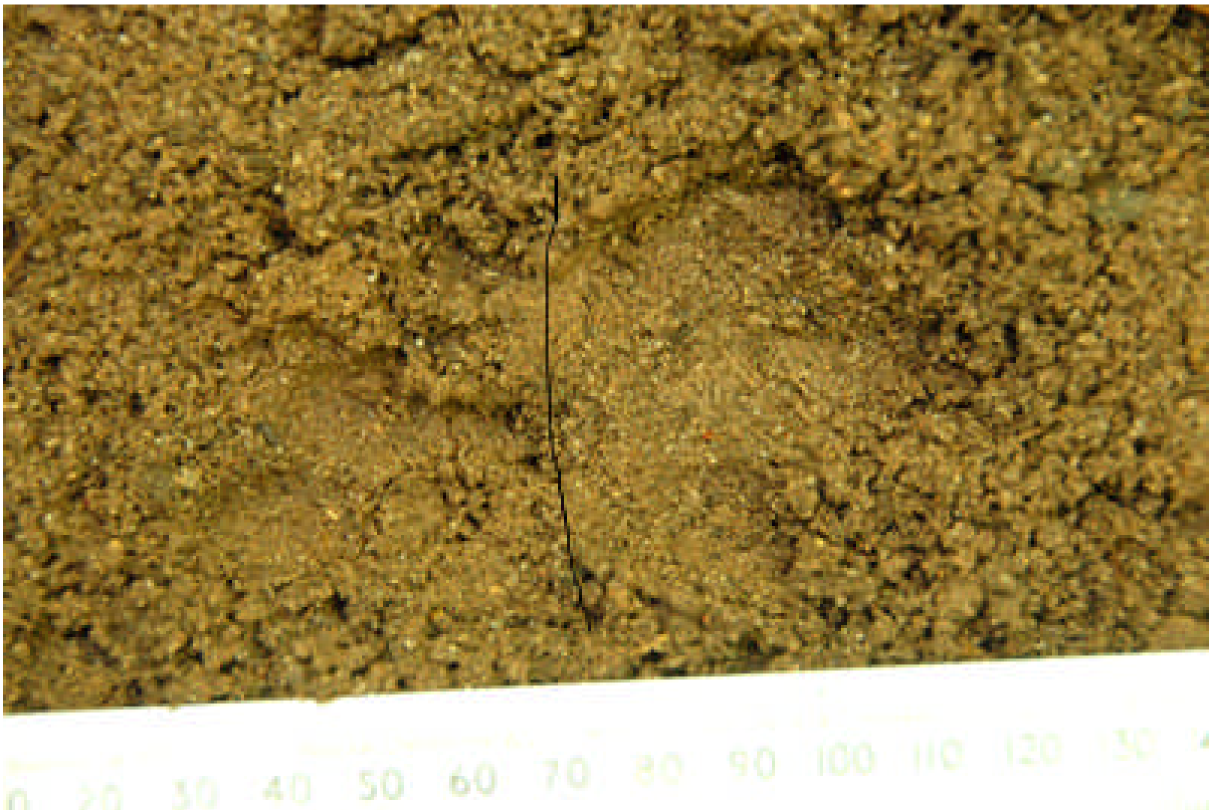
Ocelot: Up to 5 cm long. Roundish appearance. Difficult to distinguish from smaller margay, where hind foot and front foot are roughly the same size and both rounded.

Tapir: Largest rainforest track – 15 cm or more. Three broad, forward pointing toes.



Capybara: Up to 10 cm, three or four toes visible, more pointed than tapir and abundant along river edges
.

Armadillo: 3-4 cm. Front foot (on left of black line) shows two disjointed parallel claws, while back foot (right of black line) has a three toed impression (like a miniature tapir).



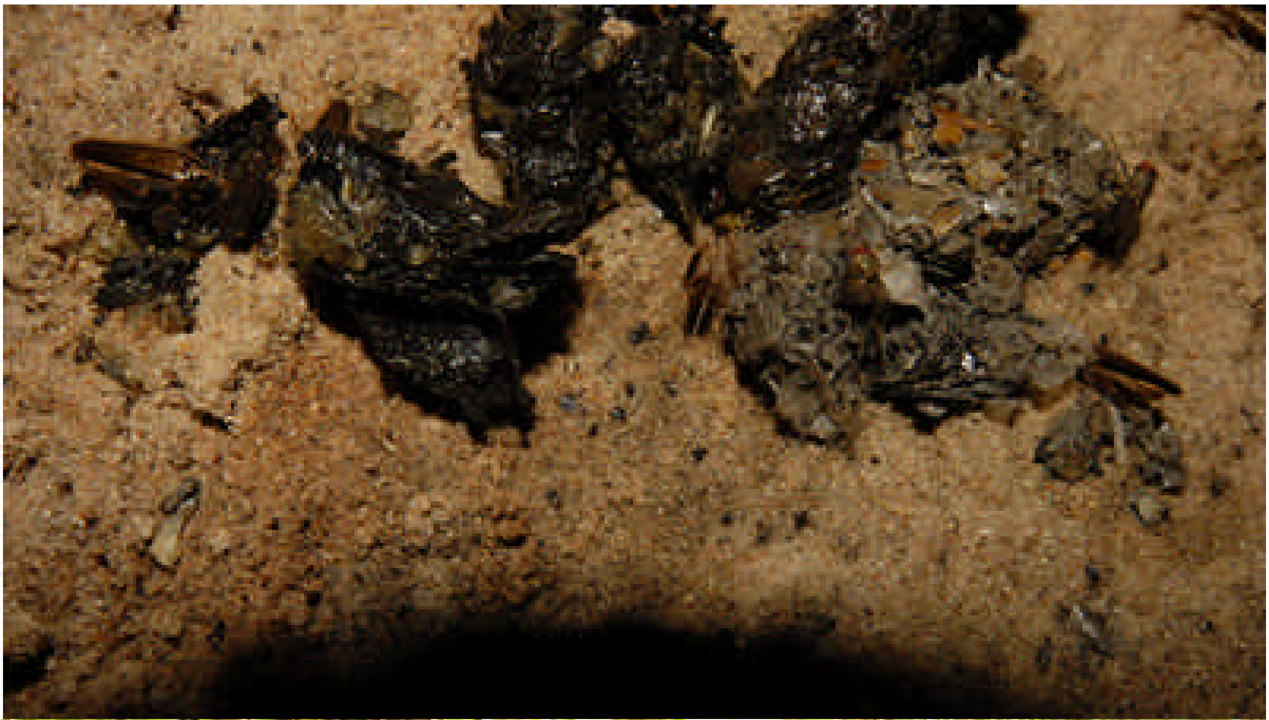
Giant armadillo: Up to 10 cm. Hind foot (featured) is superficially similar to tapir, but more squat with middle toe very blunt. Front track dominated by the large claw.

Paca: Up to 4 cm. Very commonly encountered track with uneven, long pointed toes, especially along streams and the claylick. Here the hind foot is superimposed on the front foot. Brown agouti is smaller (2-3 cm) with a distinctively long middle toe. Green agouchy is similar, but ±1.5 cm long.

Pale-winged trumpeter: This large, common, terrestrial bird is found in groups of up to eight birds and tracks are often found in track traps. Tracks with three toes pointing forward, one toe pointing backwards.

Yellow-footed tortoise: Tracks of this common terrestrial reptile are close set on left and right side respectively; with left and right tracks separated between 10 – 20 cm. Hind legs drag, indicating direction of travel.

Neotropical otter: Scat, full of fish scale and bits of crab, and track of Neotropical otter were found along a small stream by Andy Stronach, the first evidence of this species at the study site.



photos by Andy Stronach

4. Population level patterns of social behaviour of wild red-and-green macaws at claylicks in southeast Peru

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4.1. Introduction

Red-and-green macaws *Ara chloropterus* are the second largest of the seventeen macaw species after the hyacinth macaw (*Anodorhynchus hyacinthinus*), weighing 1230 g and measuring up to a meter from head to tail (Forshaw 2006). In South America they are found in lowland Amazon rainforest and temperate deciduous forest, with a large range of over eight million square kilometres (Figure 1). They are classified as Least Concern by the IUCN (IUCN 2008), although populations have been reduced in parts of their range due to overharvesting for the pet trade (Juniper and Parr 1998). They are widespread in captivity (the aviculture name is green-winged macaw), as they are socially interactive with both people and other parrots (Abramson et al. 1995).

These macaws have been the focus of few studies in their natural habitat and so little information exists regarding red-and-green macaw ecology. They are regarded as common in lowland Amazon rainforest, with published abundance for the species ranging from 1.8 to 8 individuals per square kilometre (Terborgh et al. 1990, Haugaasen and Peres 2008). Like most of the macaws, red-and-green macaws are known to eat unripe fruits and seeds, which may give them a competitive advantage over other frugivores, such as monkeys (Norconk et al. 1997). They are known seed predators, particularly of trees of the Lecythidaceae (Brazil nut) family (Trivedi et al. 2004, Haugaasen 2008). Although social while foraging, couples defend nest sites viciously (Wilson and Brightsmith 2003). The species nests in cliffs in Bolivia, but in Peru they predominantly nest in natural cavities in ancient *Dipteryx micrantha* trees, with the breeding season lasting from November to March (Brightsmith 2005). During this period large numbers are seen on geophagy sites (here-on referred to as claylicks) where birds descend in large multi-species flocks to consume clay along exposed river banks (Brightsmith 2004). Despite being one of the most common large species of parrot seen at claylicks across South America (Lee et al. 2009), few publications exist regarding the species social behaviour in the wild.

Research on the behavioural characteristics of wild parrots may be important in establishing management and conservation guidelines, both in the wild and in captivity (Enkerlin-Hoeflich et al. 2006), yet social behaviour of most psittacine species has not been studied in natural habitats (Seibert 2006). Claylicks offer an opportunity to observe several species of parrot interacting. Patterns of behaviour emerging from small scale studies (e.g. Shaw 2008) have not painted a complete picture of the role of claylicks in the social lives of the parrots, or how temporal and population variables impact upon inter and intra species interactions. A study of a claylick in Manu, southeastern Peru, showed red-and-green macaws to be more aggressive than scarlet macaws *Ara macao*, which they outnumbered (Burger and Gochfeld 2003). Red-and-green macaws are larger than scarlet macaws, and a correlation between size and aggression between smaller parrot species has been reported (Shaw 2008). However, aggression levels may also depend on group size, since the medium sized blue-headed parrot *Pionus menstruus*, the most aggressive parrot feeding in the early morning in Manu, was also the most common (Burger and

Gochfeld 2003). Agonistic behaviours between breeding macaws can have fatal consequences for chicks caught up in the battle for nesting sites (Wilson and Brightsmith 2003, Renton 2004). It is still speculation whether claylicks act to establish a social hierarchy among macaws that help reduce the need to fight for nesting sites, but the claylicks may be serving a purpose more than the supplementation of dietary sodium and the adsorption of dietary toxins (Brightsmith et al. 2008).

During initial red-and-green macaw behaviour observations carried out at Las Piedras river with the help of Biosphere Expeditions, changes in patterns of behaviour were observed through the course of the day (Lee 2006). This report delves deeper into the social interactions of macaws around claylicks in an attempt to better understand these magnificent birds and the role of these unique resources to the natural lives of wild macaws.

Figure 4.1a. Range map of red-and-green macaw distribution in South America, modified from Forshaw (2006).

Objectives

1. Determine daily trends in major behaviour categories around a claylick.

2. Determine how flock size and nearest-neighbour birds impact on parrot behaviour.

3. Compare bird behavior changes in relation to a bird’s location: on the claylick or in the vegetation.

4.2. Methods

Study area

The Madre-de-Dios department of southeastern Peru is on paper one of the best protected areas of the Amazon in South America, with five protected areas covering over a third of the department (Figure 4.2a). The study area lies at the boundary between tropical moist and subtropical wet forest. Average elevation is 250 m asl and average rainfall 3200 mm (Brightsmith 2004).

Surveys were conducted at three parrot claylicks: Las Piedras, Colpa Hermosa and the Tambopata Research Center (TRC) in the Tambopata district (Figure 4.2a).

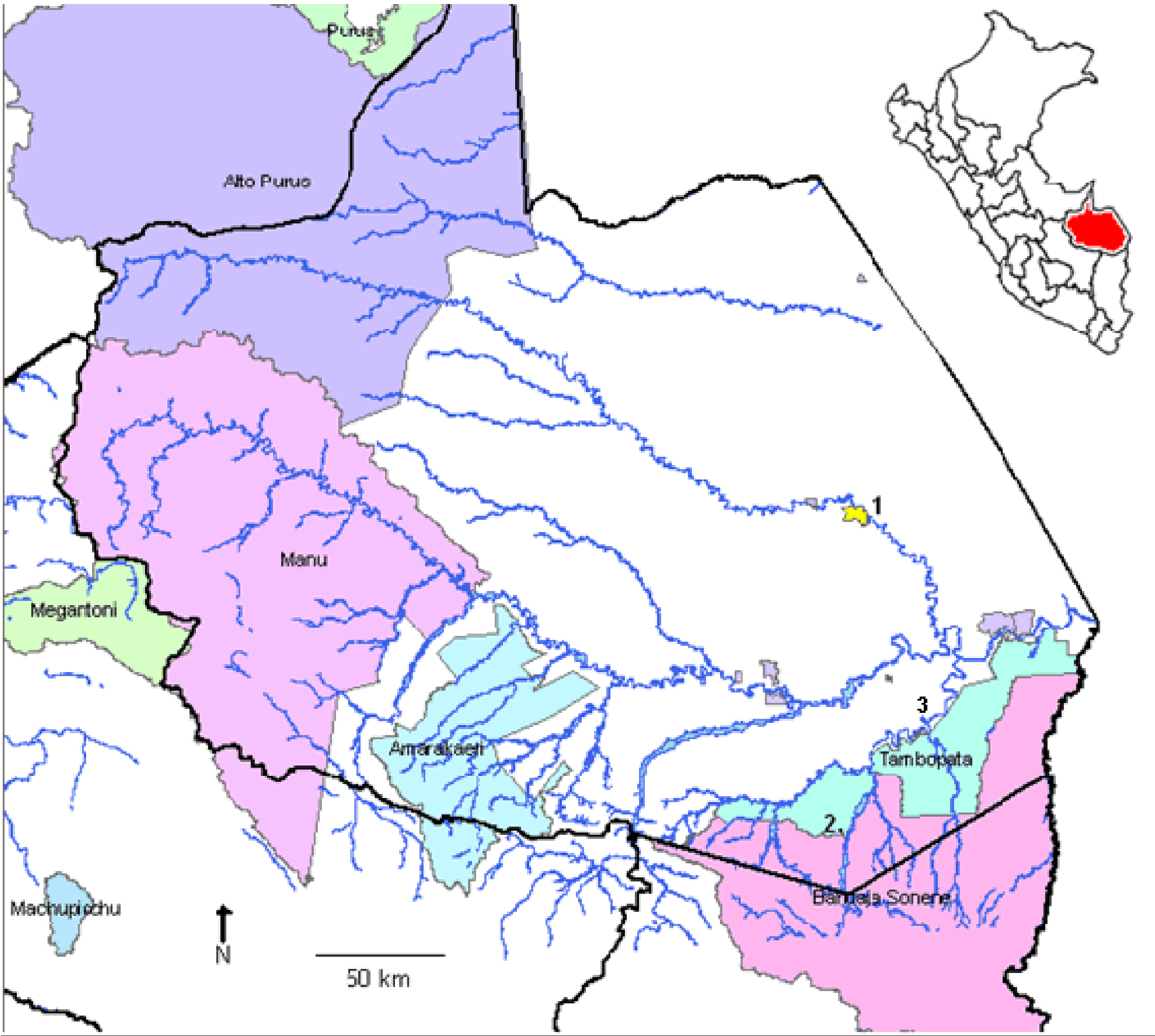

Figure 4.2a. Map of the protected areas of the Madre-de-Dios department, southeastern Peru, showing the location of the Las Piedras tourism concession (1), the Tambopata Research Centre (2) and Colpa Hermosa (3). National parks are in pink and national reserves in green/blue.

At Las Piedras the expedition base used by Biosphere Expeditions was the Las Piedras Biodiversity Research Station (Piedras) (S 12º06' W 69º52'). Located on the Las Piedras river, the area has been used by Biosphere Expeditions since 2002 (Hammer and Tatum-Hume 2003). The area is protected by an ecotourism and Brazil nut concession and boasts high biodiversity (Hammer and Tatum-Hume 2003). The claylick is a 20 m wide and 15 m high section of fluvial sediments of the western bank of the Las Piedras River. Observations were conducted for 15 days, from 26 November to 17 December 2008 and for 15 days from 10 November to 2 December 2009, at the main macaw claylick at the Las Piedras Biodiversity Research Station. Observations were carried out from 05:00 until 14:00, when most of the birds had disappeared from the area of the claylick.

Colpa Hermosa (S 12° 48, W 69º18) is located on a reserve of the Infierno community, who are mostly Ese-eja people. The claylick is protected as an attraction for the community's lodge, Posada Amazonas. The claylick has been monitored since 2004 by the Tambopata Macaw Project, and studies have shown that birds prefer areas with elevated concentrations of sodium (Brightsmith and Munoz-Najar 2004). Behaviour observations were carried out from January 2009 to December 2009, from daybreak to 17:00 on 74 days at Colpa Hermosa. Monitoring was conducted from a blind 30 – 60m from the claylick. The use of the blind meant that observation of birds perched high in the vegetation was mostly impossible.

TRC (S 13º07, W 69º36) is located on the border of the Tambopata National Reserve (275,000 ha) and the Bahuaja-Sonene National Park (537,000 ha). The TRC claylick is a 500 m long, 30 m high cliff along the western edge of the upper Tambopata River, formed by the river's erosion of uplifted Tertiary age alluvial sediments (Räsänen et al. 1995). A total of 28 bird species have been seen eating soil from this lick and the lick may be visited by up to 1700 psittacines of 17 species per day (Brightsmith 2004). Observations were conducted from an island from positions between 80 – 150m from the claylick. Observations were carried out for 65 days from 26 June 2009 to 7 January 2010 at the Tambopata Research Centre, where observations were conducted from 05:00 until 17:00 as birds remained in the area for a much longer period of time.

Behaviour monitoring

Using a telescope, a bird was randomly selected and observed carefully for 60 seconds every five minutes. Efforts were made to follow the same individual for the duration of its stay in the area of the claylick. In effect, this proved to be impossible due to the movements of the birds in the vicinity. Therefore the results reflect the behaviour of a group rather than of the individual birds. A note was made should subsequent observations involve the same individual.

One observer described what the bird was doing to another person acting as recorder, who ticked all the boxes for the activity that that bird was involved in. Once a behaviour category was ticked during the minute's observation, it was not ticked again, providing simple binomial data for the bird behaviour.

The maximum number of birds of the same species that were present within beak reach of the target bird was recorded. The number of the same species in the area of the claylick was recorded, being all the birds that are in the field of view and not just those perched in the vicinity of the target bird including birds in the trees, claylick and flying. The position of the bird was recorded as in vegetation or on the surface of the claylick.

Weather was recorded as in order of importance: rain, fog, cloud, sun (a clear shadow cast in the area of the claylick or clear skies if before sunrise).

The following behaviour categories were recorded (photos are available in Lee (2009)):

Vigilant. Bird actively looking around; head movement notable, often with head twisted at 90 degrees from the body. From November 2009 onwards at Las Piedras vigilance was ranked from 0 (asleep) to 5 (only vigilant), with 1 being resting 2 being mostly resting, 3 being intermediate OR the score given if the bird was mostly engaged in another activity e.g. preening, 4 mostly vigilant.

Resting. Bird perched, usually looking forward, maybe looking slowly around, but not doing any of the following activities below. Bird was in this position for more than 10 seconds before this behaviour was recorded.

Panting. Beak open and tongue moving up and down.

Headshake. This is normally a quick movement of the head.

Sleeping. Eyes closed or head tucked beneath wing for long period of time

Walking. Bird moving along a branch or between branches, or on the claylick.

Calling. Bird obviously vocalizing – beak was open and call could be heard.

General Calling. Recorded when there was doubt as to whether the target bird was vocalising or not, but when vocalization could be heard that may have involved the target bird.

Begging. Juvenile birds emitting a slow “erp, erp, erp…” noise, accompanied by fluffed up head feathers.

Regurgitation. A rapid up and down movement with the head to move food from crop to beak. This was sometimes followed by allo-feeding.

Playing. Bird or birds engaged in robust movements, involving hanging upside down, squawking, gentle lunging.

Hanging. Bird hanging upside down, almost bat-like, from a branch or liana.

Aggression. Bird lunging quickly, with beak open, at another bird. If the aggression was not towards the same species, then a note of the species involved was made.

Submission. Bird retreats from an aggressive bird, either backing away or flying off.

Fighting. Two birds engaged in an elevated aggressive encounter, typically with loud strident calls, lots of wing flapping.

Wingstretch. Bird opens wing/s in a stretch and does not fly away, a behaviour associated with part of the preening process.

Preening. Bird grooming itself with its beak. From November 2009 onwards preening was ranked from 0 to 5 based on 10 seconds of intervals of the minute where preening occurred, i.e. 0 = no preening 1 = less than 10 seconds preening 2 = up to 20 seconds preening, up to 5 = 50 seconds or more spent preening.

Allopreening. Bird grooming or being groomed by another bird (includes simultaneous allopreening and non-simultaneous allopreening).

Scratch. Bird using its foot to groom.

Branch biting. Bird using its beak to bite the branch it is on.

Eating seed/fruit. Any feeding behaviour observed in the trees around the claylick, including leaves.

Eating clay (on lick or in trees). Bird is either on the claylick or is perched in the vegetation with a lump of clay.

Defecation. Observed bird defecates.

Analysis

Results are binomial and presented as proportions of observations where a behaviour was observed. Chi-squared tests were performed to determine differences in proportional observed behaviour between trees, clay and nests using FC-statistics. Linear regression was performed to determine the influence of time of day on macaw behaviour for those where trends were displayed. Spearman’s correlation was used to test the relation between the mean number of birds in the area of the claylick and the proportion of birds observed eating clay.

4.3. Results

5117 minutes of observation were conducted during 180 days of observation on red-and-green macaws. The greatest numbers of observations were conducted at Las Piedras, and the lowest number at Colpa Hermosa. Proportional behaviour comparisons between sites were made with 4203 minutes of observation conducted before 14:00 (being the time when surveys were completed at Las Piedras, as few birds were present after this time). Proportional display of behaviours between claylicks was compared for the pre-14:00 time period only, as time of day can have an impact on observed behaviour (Lee 2009). Although an effort was made to distinguish juveniles from adults, only 15 registrations of juveniles were made and so no distinction in analysis is made here.

The greatest proportion of observations of birds on the claylick was at Hermosa (27%), and the lowest at TRC (3%) – Table 4.3a. This was because Hermosa had the best view of the claylick, and little view of high vegetation, while at TRC a parallel study counting birds on the claylick had priority over behaviour observations. Tests for comparing proportional behaviour for birds on the claylick at TRC are thus not presented.

Table 4.3a. Total number of minutes of observation at three claylicks of Madre-de-Dios, including the percentage of observations conducted on birds on the claylick (as opposed to in the vegetation), and the number of observations carried out before and after 14:00.

Claylick	% observations on clay	Post 14:00	Pre 14:00	Total
Hermosa	28%	404	803	1207
Piedras	16%	2	2210	2212
TRC	3%	508	1190	1698

There were no significant differences between behaviours observed on the claylick between the three claylicks (Table 4.3b). There were significant differences in vigilance, panting, calling and playing recorded for birds in the vegetation between the three sites. Vigilance at TRC was lower compared to the other two sites, while resting and playing were higher. Panting was lowest at Hermosa. Short flights were highest at Hermosa.

Behaviour differences between claylick and vegetation included vigilance (higher on the claylick), resting (higher in the vegetation), sleeping (only in the vegetation), playing (higher in the vegetation), aggression and submission (higher on the claylick), and all preening related activities were higher in the vegetation.

Table 4.3b. Summary of scored behaviours recorded for three claylicks, comparing scores for claylick and vegetation. p values for claylick represent results of X^2 tests between Hermosa and Piedras, while p values for vegetation represent X^2 results testing between all three claylicks. p values in bold are significant at the 0.05 level.

	Claylick					Vegetation				
Behaviour	**Herm-osa**	**Pied-ras**	**TRC**	**CLAY Total**	**p**	**Herm-osa**	**Pied-ras**	**TRC**	**VEG Total**	**p**
Vigilant	61.9%	67.1%	53.1%	64.2%	0.73	62.1%	61.2%	27.1%	49.1%	**0.00**
Resting	2.8%	2.3%	15.6%	3.3%	0.79	23.7%	17.9%	40.3%	26.9%	**0.01**
Panting	1.4%	3.4%	6.3%	2.7%	0.65	7.3%	19.8%	21.0%	18.0%	**0.03**
Headshake	4.1%	2.0%	0.0%	2.7%	0.65	6.6%	14.2%	5.9%	9.9%	0.09
Sleeping	0.0%	0.0%	0.0%	0.0%		1.0%	1.9%	4.5%	2.7%	0.27
Walking	12.4%	24.5%	6.3%	18.6%	0.07	25.3%	17.9%	19.8%	19.9%	0.49
Calling	8.3%	7.0%	12.5%	7.8%	0.96	12.0%	16.6%	4.2%	11.4%	**0.03**
General calling	0.9%	2.3%	6.3%	2.0%	0.81	5.1%	5.5%	8.0%	6.3%	0.67
Begging	0.0%	0.0%	0.0%	0.0%		2.4%	0.2%	0.0%	0.5%	0.12
Regurgitation	0.5%	0.0%	0.0%	0.2%		2.3%	0.0%	0.3%	0.5%	0.18
Playing	1.8%	0.7%	0.0%	1.1%	0.92	3.3%	1.2%	12.7%	5.7%	**0.00**
Kissing	0.0%	0.6%	0.0%	0.3%		1.9%	3.2%	6.1%	3.9%	0.30
Hanging	1.4%	2.3%	0.0%	1.8%	0.99	4.7%	1.1%	6.2%	3.6%	0.17
Aggression	4.6%	8.4%	6.3%	6.8%	0.44	3.7%	1.4%	0.7%	1.5%	0.28
Submission	0.9%	4.0%	0.0%	2.6%	0.34	1.9%	0.9%	0.6%	1.0%	0.67
Fighting	0.5%	1.3%	0.0%	0.9%	0.93	1.2%	0.5%	1.0%	0.7%	0.87
Wing-stretch	5.0%	1.7%	0.0%	2.9%	0.36	3.5%	2.8%	3.8%	3.3%	0.92
Preening	2.8%	3.4%	3.1%	3.1%	0.87	24.4%	41.4%	35.8%	36.4%	0.11
Allopreening	1.4%	0.0%	6.3%	0.9%	0.75	5.4%	8.3%	10.7%	8.6%	0.42
Scratching	4.1%	5.7%	3.1%	4.9%	0.62	14.5%	25.0%	11.9%	18.5%	0.06
Branch biting	0.0%	2.3%	0.0%	1.3%		4.5%	4.2%	6.8%	5.2%	0.68
Eat seed/fruit	0.5%	0.0%	0.0%	0.2%		0.3%	0.5%	3.6%	1.6%	0.11
Eat clay in trees	6.4%	4.4%	3.1%	5.1%	0.75	4.0%	1.5%	1.2%	1.9%	0.35
Eat clay on lick	86.7%	88.6%	65.6%	86.5%	0.95	6.6%	0.8%	0.0%	1.5%	
Defecation	0.0%	3.0%	9.4%	2.2%		2.8%	2.0%	1.6%	2.0%	0.83
Short flight	15.6%	19.4%	6.3%	16.3%	0.64	17.6%	11.7%	5.2%	10.3%	**0.03**
Flight away	4.1%	8.1%	28.1%	7.6%	0.39	5.8%	8.3%	9.5%	8.3%	0.63

Results of ranked vigilance and preening scoring

Hourly trends in vigilance patterns (from 0 sleeping to 5 vigilant only) are represented in Figure 4.3a below for the Las Piedras claylick for the November – December 2009 period. Overall, vigilance was highest from 05:00 to 07:00 with over 80% for ranks 4 (mostly vigilant) and 5 (vigilant only). Upwards of 20% of birds were vigilant only for any given hour. However, more resting and sleeping states are noted from 08:00 onwards, and over 20% from 09:00 to 11:00.

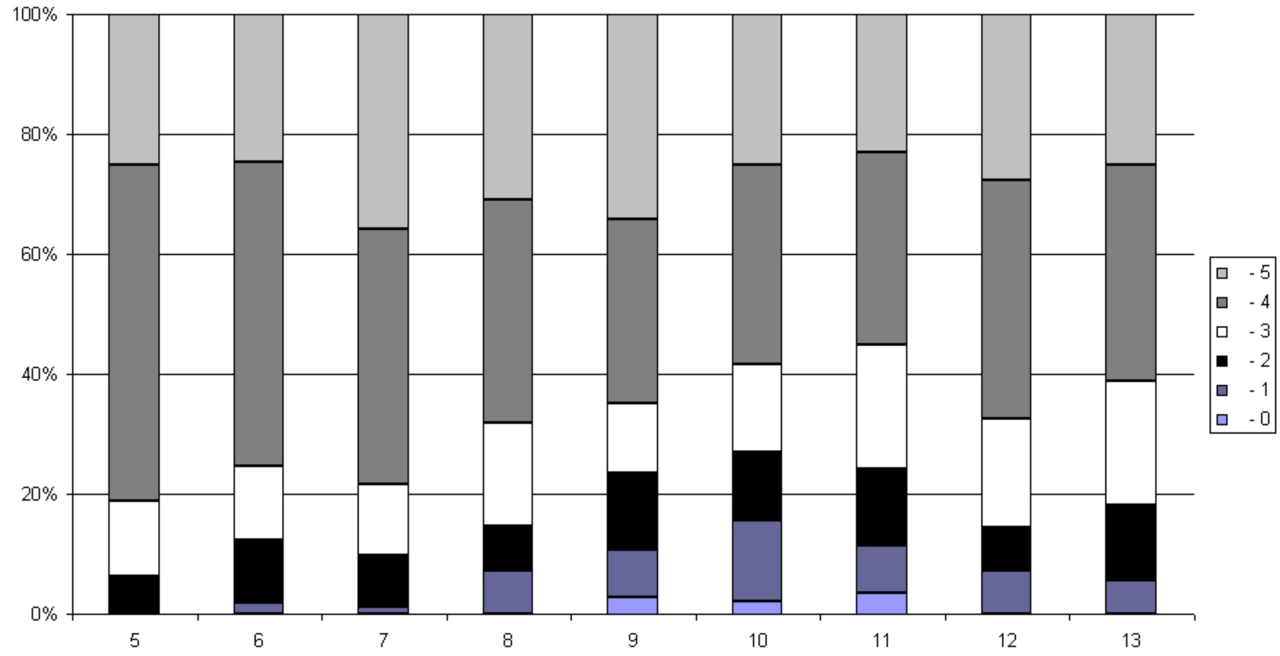

Figure 4.3a Ranked vigilance scores per hour as a percentage of all vigilance scores, for Las Piedras claylick only – where this activity was conducted. Vigilance state 3 here excludes cases where other activities predominated (by excluding all cases where summed scores for other activities exceeded 2).

Hourly trends in ranked preening scores for the Las Piedras claylick for the November – December 2009 period are presented in Figure 4.3b. Most intensive preening is observed from 06:00 to 07:00, with preening levels over 50%. Preening sessions lasting longer than 10 seconds were observed in over 20% of birds from 07:00 onwards.

Trends in behaviour in relation to bird proximity and flock size

All observations were used to examine behavioural trends in relation to number of birds within beak reach (Table 4.3c) and in relation to the number of birds in the area or flock size (Table 4.3d). These results are presented for combined results where there were no significant differences between sites, or for sites for which there was no significant difference between behaviours.

Of the social activities, submission, aggression and fighting increased on the claylick with increasing numbers of birds in close proximity. These behaviours were also recorded more with increasing numbers of birds in the area. In the vegetation, allopreening and playing decreased in relation to increasing numbers of birds in close proximity and with numbers of birds in the area.

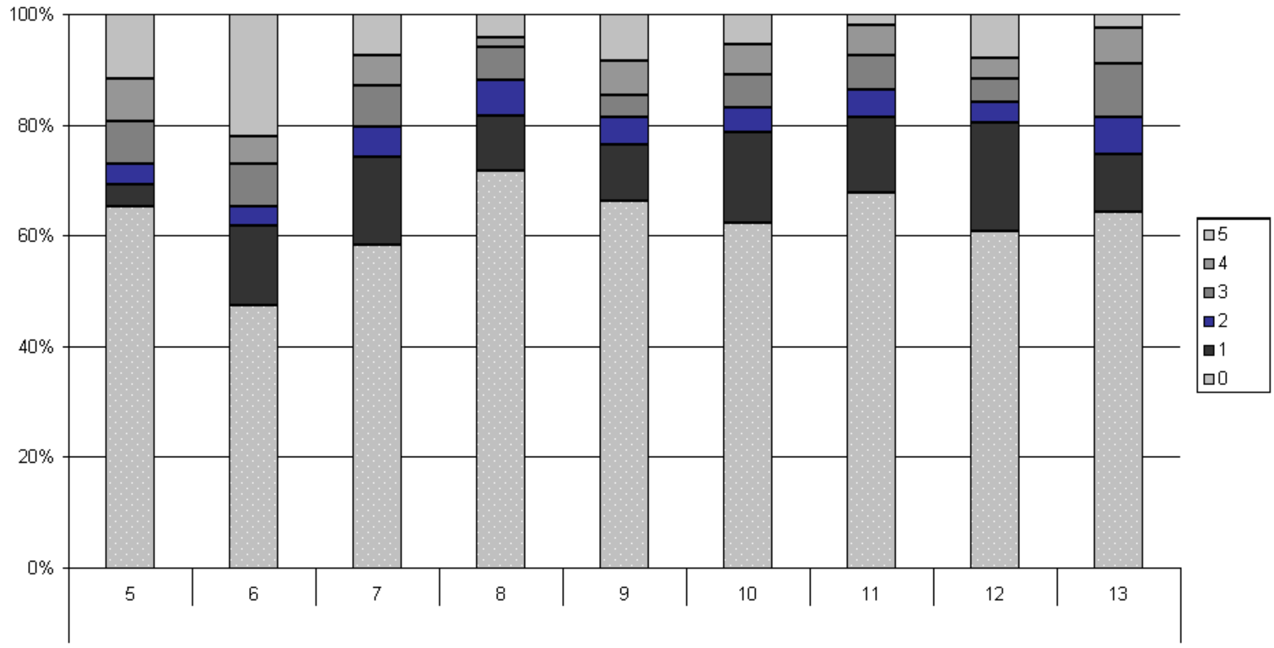

Figure 4.3b. Ranked preening scores per hour as a percentage of all preening scores, for Las Piedras claylick only – where this activity was conducted. Scores are as follows: 0 – no preening 1 – less than 10 seconds preening 2 – up to 20 seconds, 3 – up to 30 seconds, 4 – up to 40 seconds, 5 – up to a minute.

Vigilance on the claylick remained consistently high, independent of neighbours. However, vigilance in the vegetation decreased with increasing number of neighbours. Conversely, vigilance increased with increasing numbers of birds in the vicinity of the claylick. Calling on the claylick increased with number of birds in close proximity, but decreased in the vegetation. Calling decreased with number of birds in the area.

Table 4.3c. Proportions of major activities on the claylick (Clay) and in the vegetation (Veg) in relation to number of birds in close proximity (#). Number of birds above 2 were grouped (>2).

	N		*Aggression*		*Fighting*		*Allopreening*		*Playing*		*Submission*	
#	Clay	Veg.	Clay	Veg.	Clay	Veg.	Clay	Veg.	Clay	Veg.	Clay	Veg.
1	236	1363	9%	13%	1%	2%	3%	23%	2%	17%	4%	2%
2	95	124	13%	4%	2%	2%	1%	14%	2%	5%	4%	5%
>2	48	39	13%	13%	2%	5%	4%	10%	0%	8%	2%	8%
			Vigilance		Calling		Preening		Branch biting		Eating clay	
0	299	2495	60%	55%	4%	13%	3%	32%	1%	5%	85%	2%
1	236	1363	65%	39%	8%	9%	7%	39%	1%	6%	85%	2%
2	95	124	66%	43%	11%	4%	3%	32%	0%	6%	95%	2%
>2	48	39	63%	41%	10%	18%	0%	26%	0%	5%	85%	10%

Allopreening decreased with increasing flock size, but the trend for preening and scratching was not as clear. Branch biting decreased with flock size, while eating clay increased.

Table 4.3.d. Proportions of major activities on the claylick and in the vegetation in relation to number of birds in the area of the claylick (flock size).

#	*N*	*Aggression*	*Fighting*	*Allopreening*	*Playing*	*Submission*	*Short flight*
<10	3749	1%	1%	8%	6%	1%	8%
11-20	715	3%	0%	7%	3%	1%	11%
21-30	264	3%	2%	6%	2%	2%	14%
>30	389	6%	1%	4%	3%	3%	12%
		Vigilance	Calling	Preening	Scratching	Branch biting	Eating clay
<10	3749	42%	12%	30%	16%	75%	2%
11-20	715	57%	10%	35%	17%	32%	2%
21-30	264	61%	12%	32%	18%	11%	5%
>30	389	69%	9%	22%	13%	21%	5%

4.4. Discussion

Daily trends in activity at claylicks

Red-and-green macaws start to arrive in the area of the claylick from early morning (07:00) onwards. The first birds to arrive normally do so in pairs, although they do not necessarily perch close to each other during this period. When they do, allopreening behaviour is frequently observed, while the rest of the time is spent predominantly calling. Most of the birds arriving in the early morning tend to perch high in the trees, in positions that presumably offer them good vantage points from which to look for predators. In addition, vocalizations also tend to be higher when there are fewer birds in the area and in close proximity, so this period could be a "recruitment" period, letting macaws from further away know that the area is safe.

Once enough birds have been recruited to the area of the claylick, they start to drift to the lower vegetation above or around the claylick. As birds move towards the claylick, they come into closer contact and chances of aggressive encounters increases. On the claylick, it is clear that the primary purpose for landing on the clay is for clay consumption, with nearly 90% of observations actively including the consumption of soil. Vigilance is high, and preening and resting are at much lower levels. However, aggressive interactions are much higher. Few aggressive approaches give way to fights, instead a corresponding degree of submission is displayed, with birds making way for new birds on the claylick, and a high degree of near neighbour tolerance displayed. Although no predator attacks were observed of birds on the clay, several different species of raptors were observed in the area of the claylick. At Piedras, an orange-breasted falcon *Falco deiroleucus* was observed attacking a pair of red-and-green macaws in flight over the river; while at TRC a black-hawk eagle *Spizaetus tyrannus* was observed attacking a blue-and-yellow macaw *Ara ararauna* perched in the trees above the claylick. Neither attack resulted in the capture of a macaw. However, the need for constant vigilance is clear.

Once macaws have finished feeding, at Piedras, most dispersed in flocks in indeterminate directions into the surrounding forest. At TRC, individuals were often still observed in the vicinity of the claylick, where couples were observed playing and allopreening.

Vigilance

There was an increase in vigilance with increasing numbers of birds in the vicinity of the claylick, while there was a decrease in vigilance for birds in the vegetation with increasing number of birds in close proximity. A decrease in vigilance has been recorded for red-rumped parrots *Psephotus haematonotus* and galahs *Cacatua roseicapilla* from Australia with increasing flock size (Westcott and Cockburn 1988) and this was thought to relate to predation. We thus propose that while vigilance decreases with nearest neighbours, as expected from the predations protection theory, vigilance for the group increases with increasing flock size due to the need to follow neighbours, i.e. for social reasons. No change in vigilance was reported from a small claylick in relation to number of birds in the vicinity for a range of smaller species from southeastern Peru, including dusky-headed parakeet *Aratinga weddellii*, mealy parrot *Amazona farinosa*, chestnut fronted macaw *Ara severus* and white-eyed parakeet *Aratinga leucophthalmus* (Shaw 2008). However, these species are in the vicinity of the claylick for only a very short time and the priority for these birds would be to scan for predators, eat clay and leave. In contrast, macaws spend much more time in the area of the claylick, and there is a relatively high degree of social interaction.

Comfort behaviour and sleep

Sleep, preening and other body maintenance behaviours are sometimes collectively known as comfort behaviours (Bergman and Reinisch 2006). Not only do these behaviours normally occur when the birds are comfortable and at ease, but the behaviours appear to be comforting and soothing to the birds (Bergman and Reinisch 2006). Sleep was observed only very rarely, while resting and preening were two of the largest recorded behavioural states for red-and-green macaws. Sleep and rest occupy the major part of a 24-hour day (Bergman and Reinisch 2006), while grooming occupies the largest amount of some wild parrot's waking hours after foraging (Snyder et al. 1987, Rowley 1990). Preening was highest in the early morning, when fewer other birds were around and with fewer birds in closer proximity. Birds may be making the most of the quiet period before other birds arrive in the vicinity of the claylick in order to groom. When other birds are in the vicinity, more time is subsequently spent interacting. Birds may be more vulnerable to aggression from other macaws when in a preening position. Birds appear to be comfortable preening in the company of a mate, when allopreening also occurs.

Affiliative relationships - amicable social behaviour

Affliliative behaviours in birds consist of allopreening, allofeeding, maintenance of close proximity and reproductive behaviour (Seibert 2006). Allopreening is an appeasement behaviour and is the most important mechanism for maintenance of the pair bond (Hardy 1963). Conflict resolution in the form of reconciliation has been shown for red-and-green macaws in captivity (Wanker et al. 2006). In red-fronted macaws *Ara rubrogenys*, an increased amount of time spent allopreening in the early breeding period probably indicates the importance of maintaining the relationship between the pair members during the breeding period, when copulations and courtship feeding were also seen (Pitter and

Christiansen 1997). No copulations were observed among the red-and-green macaws, but an incident of scarlet macaw mating was observed outside the observation period at a scarlet macaw nest. Allofeeding, closely associated with copulation in some parrots (Skeate 1984), was observed at very low levels.

There are implications for changes in bird behaviour with the number of surrounding birds for captive birds in a cage setting. Birds in a caged environment may be less able to obtain respite from companion birds that may be needed for a bird to feel comfortable with an extended preening session. This may result in poor feather condition and secondary problems, for instance feather plucking or parasite infestation. In contrast, since preening was higher at the onset of the social event at the claylick compared to around the nests, solitary birds may also preen less with negative health consequences.

Agonistic behaviour

Agonistic behaviours, including aggression and submission, are associated with the establishment of dominance relationships. Higher ranking individuals may have greater access to feeding sites, lower visibility to predators and increased mating opportunities (Seibert 2006). In red-and-green macaws aggression would be related to mate defence or gaining access to preferred areas of the claylick. Aggression between neighbouring red-and-green macaws was rare, and chasing of individuals was seen on very few occasions. This may mean that the birds at each claylick were familiar with each other as once relationships are established there is consistency in social interactions, resulting in fewer or less intense aggressive assertions of dominance (Seibert 2006). Agonistic encounters are observed more frequently when relationships are unclear, such as the introduction of new individuals. Agonistic behaviour is frequent in budgerigars *Melopsittacus undulatus* in captivity, which in the wild show few agonistic encounters and no peck order or dominance hierarchy (Wyndham 1980). As it was not possible to identify individuals in this study, we were unable to determine if a dominance hierarchy existed. No evidence of peck order has been observed in flocks of red-fronted macaw, except for a breeding pair that seemed to be socially superior to non-breeding birds (Pitter and Christiansen 1997). Aggression may be reduced among red-and-green macaws by the spreading out of the pairs when perched in the vegetation. Galahs also space themselves out when roosting and feeding (Rowley 1990). Levels of aggression between sites were the same, although at TRC many of these encounters involved scarlet macaws.

Dealing with heat and insects

Although temperatures in the tropical sun easily pass 35^{o}C, birds are observed at the claylicks even at the hottest times of the day. During this time, the rate of panting increased, and this behaviour must be important for thermal regulation. When no feeding on the claylick was going on, birds would also disappear into the depths of the foliage of the surrounding trees, presumably in order to seek shelter from the sun. Around the nests, panting rate was lower since most nests are below the level of the upper canopy, and presumably are better shaded. However, although heat may not be as much of an issue, insects do seem to bother birds at the nests more, evidenced by a much higher rate of headshaking and scratching. Birds at the claylick seem to avoid bothersome insects by moving more and flying between perches more regularly. Bot flies are well documented parasites of parrot chicks and negatively impact on their growth (Seixas and Mourão

2003). There seems to be little chance of avoiding insects around the nest, and this may be an added attraction for spending extended periods of time at the claylicks.

Claylick activity

That there appears to be a threshold for feeding to commence with the number of macaws in the area has not been established previously, but our observations show little feeding when fewer than ten birds are in the area. In addition, most feeding takes place in close proximity to other macaws, where some birds display dominance, but where the overall social interaction observed is one of submission – i.e. birds appear to accommodate each other's presence on the claylick.

Summary

Conserving claylicks is essential for the social functioning of red-and-green macaw populations. Once numbers drop below a critical threshold, birds will be less likely to feed, less likely to interact, and so less likely to maintain a social hierarchy. Without this social hierarchy, there is less competition for nesting resources, meaning that there are fewer constraints on the species fitness, which could lead to a weakening of species genetic pool and the introduction of deleterious traits. In addition, anecdotal evidence suggests that macaws can form bonds that may help protect nesting birds against possible intruders, be they other macaws or predators. As such, we urge the utmost attention to the conservation of macaw claylicks across south eastern Peru for the ongoing survival of one of the region's most iconic bird species. The scope of this study needs to be extended to investigate the trends emerging here, as well as to account for behaviour change with seasons, interactions with other bird species, and there is the need to extend this survey to other bird species.

4.5. Acknowledgements

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5. Jaguar and puma preliminary survey in the Las Piedras Biodiversity Station (LPBS), department of Madre de Dios, Peru

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5.1. Introduction

The Madre de Dios Department in Peru, 8.5 million hectares in size, harbors 7.8 million hectares of natural forest in the western Amazon (Grupo La Republica 2004), within the most diverse terrestrial ecoregions in the world (Olson and Dinerstein 2002). Much of these forests in Madre de Dios may be considered pristine habitat, and are believed to be amongst the forest blocks that will survive the forecast of 50% decline on Amazon forest surface predicted to take place in 20 years (Nepstad et al. 2008).

This is relevant for jaguar populations, as very few habitats will be able to maintain viable populations of jaguars in the future (Sanderson et al. 2002) without requiring management aimed to minimize inbreeding depression.

However, illegal logging and mining has spread widely, and with them an environmental impact that poses a threat to the future of the area. In an attempt to promote a monitored occupation of land and a more sustainable use of the forest resources, the government has published forest law number 27308 (in June 2000) modifying rules for forest concessions.

The study area, located by the Las Piedras river, has begun to operate under these new concession rules, but in the past and up to the year 2000 it was used for timber extraction under the old regulation. In 2002 logging ceased and the area converted into an ecotourism and Brazil nut concession.

It is under these conditions that a preliminary survey on the occurrence of jaguar and pumas was conducted to estimate the viability of a long-term study of these large cats under the Biosphere Expeditions volunteer scheme.

5.2. Material and methods

Study area

The study area is located in the department of Madre de Dios, in southeastern Peru, bordering with Brazil and Bolivia to the east. It is considered to be in the Southwest Amazon moist forests (Ecoregion NT0166 – WWF 2010)

Major forest types are seasonally flooded and non-flooded lowland rainforest. The climate is classified as Afa (Kottek et al. 2006).

It took about eight hours by boat from Puerto Maldonado to the Las Piedras Biodiversity Station (Fig. 5.2a).

Figure 5.2a. Team heading to the study area by boat, an eight hour journey.

Sampling

A basic grid of 2x2 km was overlaid on the study areas' trail system in order to provide organised spatial units to analyze presence of jaguars and pumas at a representative scale – the cat species have large home ranges (over 10,000 ha), thus the scale of analysis should be at least larger than this for adequate sample size. By drawing a line around the sampled trail systems, we end up with a polygon 1,650 ha in size. But if we consider the area of the cells sampled, we arrive at a figure of 3,056 ha, demonstrating one of the advantages of using a grid system for analysis. These numbers also highlight the experimental nature of the current study, as larger areas should be sampled to obtain meaningful results representative of a large cat population.

Two main trails were used to systematically diagnose the presence of these large cats, the Brazil Nut trail (BNT) and the Waterfall trail (WT) (Fig. 5.2b). In combination, they covered completely or partially nine of the 2x2 km grids cells. Each grid cell was coded by a number and a letter. Additional information on the presence of the cats was provided by data gathered by the teams while they surveyed under other sampling designs. The BNT was covered by non-flooded lowland forest, whereas the WT crossed areas subject to seasonal flooding (not under flood during the period of sampling).

Sampling lasted eleven days, from 22 November to 3 December 2009. 26 track traps were spread to capture tracks of the target cats 20 on the BNT and 6 on the WT. Four camera-traps (Tigrinus, Brazil) were brought to be installed on the trails, two digital and two analog. Three camera-traps were installed on the Brazil nut trail. As the sampling time was short, the employment of camera-traps followed the indication of Juan Julio Durand, former of the concession title, who had suggested that the presence of jaguar in that area was frequent. Track traps were reviewed three times, at intervals of two to four days, configuring a history with three capture periods (see results).

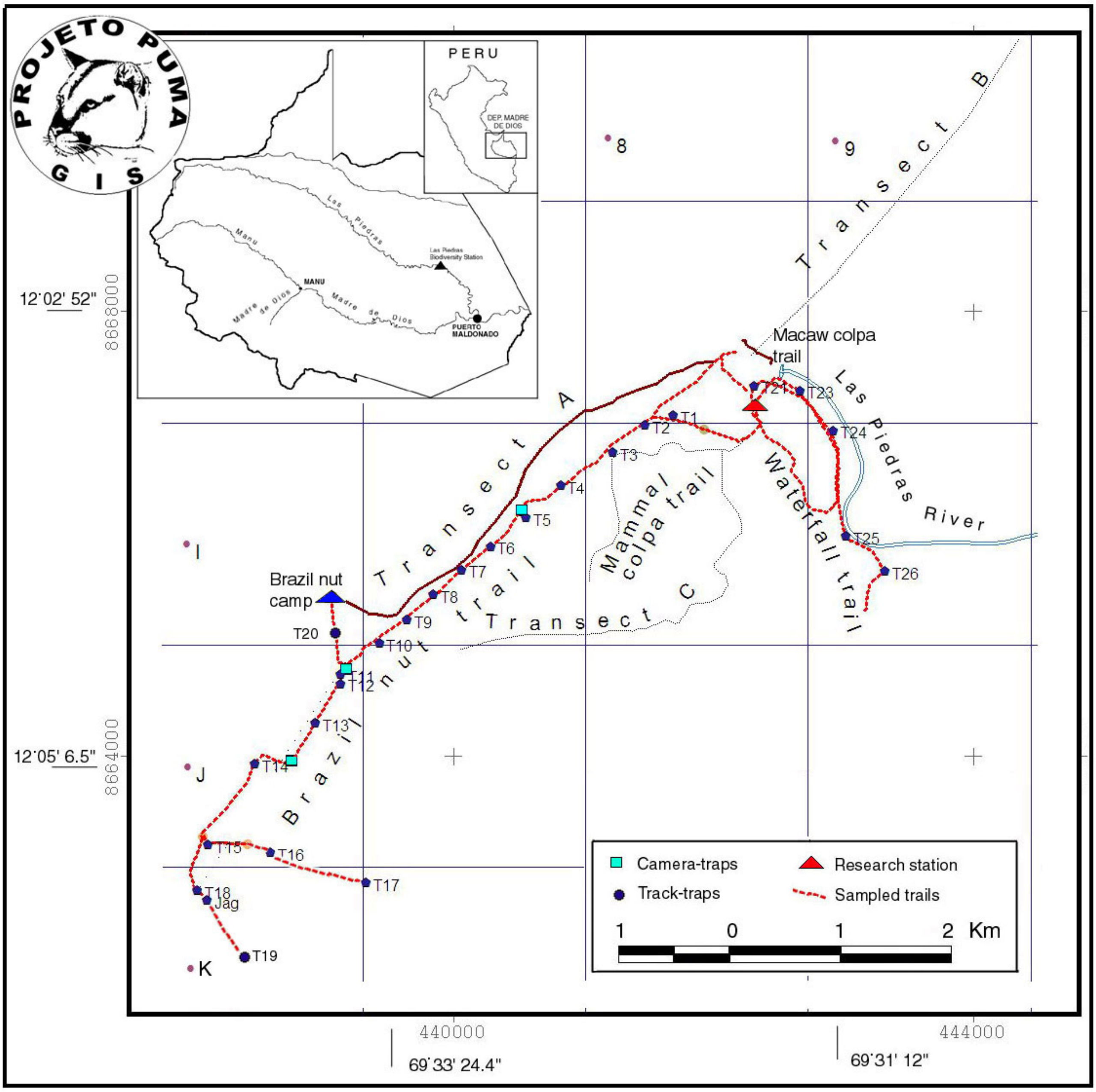

Figure 5.2b. Map of the study area. The inset (smaller) picture shows the location of the Department of Madre de Dios in Peru, and its main rivers, Manu, Madre de Dios and Las Piedras, and the main towns, Puerto Maldonado and Manu, with the location of the study area in this context. The larger image show details of the trail system, including location of camps, track and camera-traps, and 2x2 km grid with the letter and number code for grid cells. Rectangular UTM system used was SAD69. Coordinates in degrees are also shown.

5.3. Results

Track traps

A total of 18 track-traps (69%) had either puma or jaguar tracks prints (Fig. 5.3a), some of them on more than one occasion. Puma and jaguar tracks were simultaneously found in a single track-trap just once, but shared 8 track-traps or 44% of all track-traps at different occasions.

Figure 5.3a. Jaguar track found in a track-trap.

Puma tracks were recorded in 14 different track-traps occupying 4 grid cells, and jaguar in 12 track-traps distributed in 6 grid cells (Table 1). Besides that, jaguar tracks were recorded in Transect A during other surveys (unknown cell) and also when accessing the macaw colpa on the other side of the Las Piedras river (Cell H8).

Table 5.3. History of track-trap records of puma and jaguar prints.

Cell code	Track Traps	Occasion 1 25-Nov-09	Occasion 2 30-Nov-09	Occasion 3 03-Dec-09
H8	1	X	X	X
I8	2	X	X	X
I8	3	—	X	X
I7	4	X	X	Puma
I7	5	X	X	Puma
I7	6	X	X	Puma
I7	7	—	X	Puma
I7	8	X	X	X
I7	9	—	X	X
I7	10	X	Puma	X
J6	11	—	X	Puma
J6	12	Jaguar	X	Puma
J6	13	Jaguar	Jaguar	Puma and jaguar
J6	14	Jaguar	X	Puma
J6	15	X	Jaguar	Puma
J6	16	—	X	X
K7	17	—	Jaguar	X
K6	18	—	X	X
K6	19	—	Jaguar	X
I6	20	—	X	X
H8	21	Jaguar*	—	X
H8	22	Jaguar*	—	X
H9	23	—	Puma**	Jaguar ***
I9	24	—	Puma**	
I9	25	—	Puma**	
I9	26	—	Puma**	

* Seen here during the period of the previous volunteer group.
** These were revised in 01-Dec-09.
*** As informed by Aldo Ramirez (guide)

Camera-traps

Out of the four cameras, one digital camera did not work properly at the time of installation, reducing the active cameras to only three.

A revision of the digital camera on 30 November did not yield a cat photo, Batteries were changed on the same day the camera was installed back on the trail, this time with its position changed nearest to the southernmost camera-trap.

Both of the cameras in the J6 cell, at the far end of the BNT, yielded jaguar photos. The analog camera captured two different jaguars (as revealed by the different pattern of the rosettes), both of them males (scrotum visible) (Fig. 5.3b). A third male was photo-captured by the digital camera (Fig. 5.3c). As the shot captured just its left side it was not possible to see if it was a different jaguar or one that had been captured by the analog cameras.

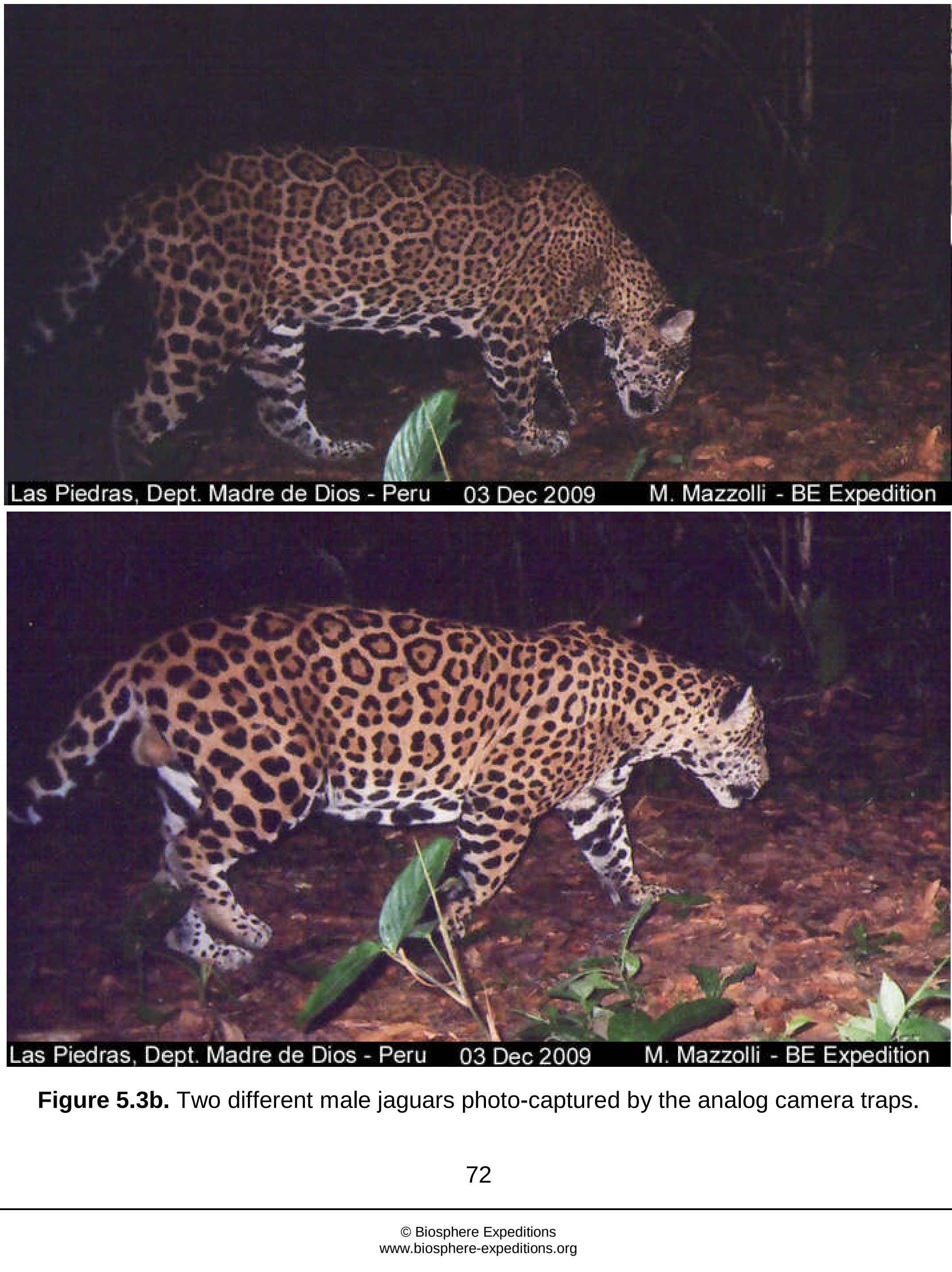

Figure 5.3b. Two different male jaguars photo-captured by the analog camera traps.

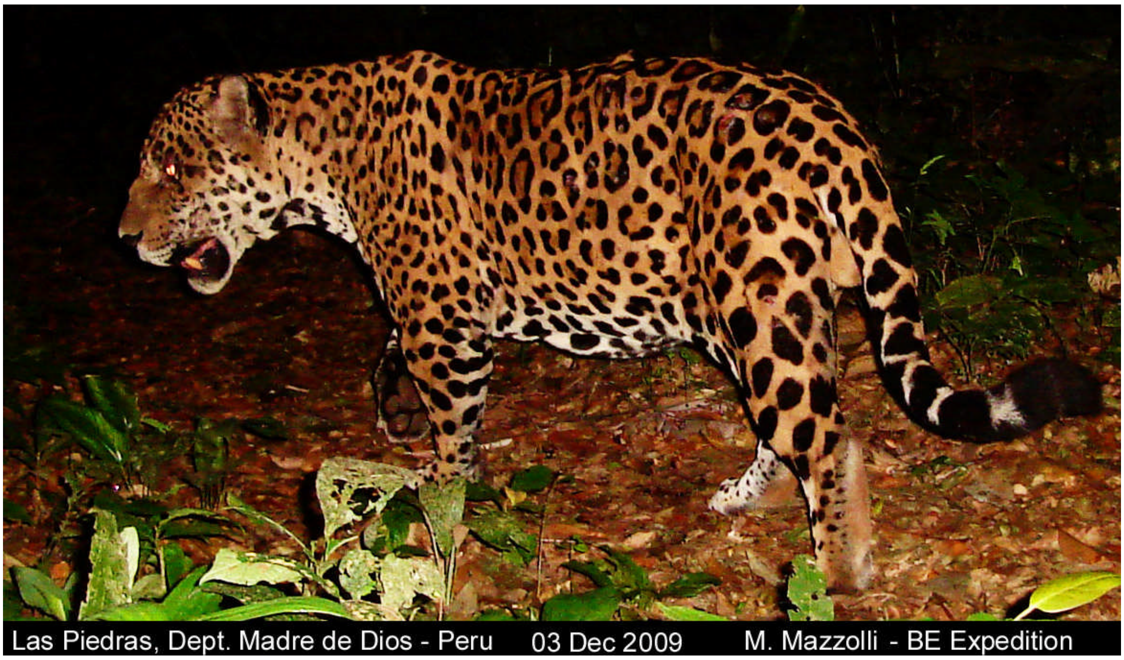

Figure 5.3c. Male jaguar photo-captured by a digital camera-trap.

Additional records of mammals

While surveying, the following species were also recorded, either by sighting (monkeys) or recorded by camera-traps or signs: red howler monkey *Alouatta seniculus*, spider monkey *Ateles chamek*, saddle-backed tamarin *Saguinus fuscicollis*, white-lipped peccary Ta*yassu pecari*, red brocket deer *Mazama americana*, brown agouti *Dasyprocta variegata*, tapir *Tapirus terrestris*, and giant armadillo *Priodontes maximus*.

Logistics and trail system

The trails used covered only one third of a single jaguar or puma territory. Nevertheless territory overlap allowed us to sample more than a single individual in the same area, as demonstrated by the photos with different individual jaguars recorded. However, this is not enough to draw conclusions that will be meaningful to communicate to a broader scientific audience. To address this problem, it is recommended that the WT is expanded by at least 2 km, that Transect B is also sampled, and that other areas surrounding the concession under other uses are also sampled.

The expansion of the WT does not pose a problem, demanding few days of work. Sampling of transect B will require that the expeditions be conducted during the dry season or at least during a drier period than in November-December as during this time the trail is partially flooded. The inclusion of other sampling areas with different land uses, such as logging, will enable expansion of the sampling area and comparison of impacts of different land tenure systems on the large cat populations, and ultimately, on the effectiveness of concession models and current country polices for the maintenance of biodiversity. One other area that may be incorporated into sampling is the road that has been recently built, which may be accessed by a 15 minute boat drive downriver.

5.4. Discussion

Logistics and trail system

The main purpose of this work was to conduct a pilot study to address the feasibility of a long-term study of jaguars and pumas in the concession area where the Las Piedras Biodiversity Station is located.

The high encounter rates of jaguar and pumas and that of other species (see other chapters in this report) show that the study area maintains most of its original characteristics, allowing these cats to exist in numbers that closely, if not completely, resembles their natural density & distribution.

The current trail system was enough for a pilot study, but it has to be expanded for a more extended study on large cats and on species with large home ranges, such as the white-lipped peccaries.

Biological outcome

Jaguar and pumas seem to be widespread in the study area, as well as their prey. There was no reason to go further and use a more rigorous protocol for data analysis on occupancy – the information acquired is quite straightforward and the extent of spatial sampling and limitation of time did not allow for speculation on any additional factor that may be affecting the distribution of the cats.

However, the relative extensive range overlap at the finest scale between jaguar and pumas were quite revealing, and perhaps particular to the conditions of the study area, and for these reasons deserve to be investigated further. Spatial segregation of jaguars and pumas has been widely reported as a standard interaction pattern between the two species, either indirectly from the interference between prey species (e.g. Mendes Pontes & Chivers 2007), or directly as an interference by jaguars while occupying the best habitats (e.g. Schaller & Crawshaw 1980).

Data collected during this study do indicate that these avoidance patterns may be derived from external conditions, such as prey or best adaptations to a particular habitat, rather than direct interference derived from mutual intolerance, and that we may thus be underestimating the cat’s ability to communicate to such an extent that allow them to share the same habitat while avoiding unnecessary and risky direct encounters. In the natural world, nothing is black and white.

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Appendix 1: Expedition leader diary by Andy Stronach.

31 October

Hello there. This is the first diary entry for the Biosphere Expeditions 2009 expedition to Peru and I am Andrew Stronach, your expedition leader.

I have now left my home in Scotland and am travelling via London, Miami and Lima and am heading for Puerto Maldonado in south-east Peru, our expedition assembly point. I have already prepared all my personal kit; I have heard it is quite wet at our expedition site this year, so am glad I have all my dry bags, sealable plastic boxes and silica gel to keep my camera kit dry ;)

I look forward to meeting you all soon and getting stuck into the survey work in our fantastic research area. If I get the time, I'll also write with another update from Puerto Maldonado before I disappear upriver. My mobile number in Peru is +51 (82) 982781440, but obviously this only works when I am in town.

Safe travels & see you soon.

7 November

Well, so far on the expedition I've seen beautiful night monkeys, sapphire spangled emeralds – hummingbirds, and yes their name is appropriate, three toed sloth, the more rare two toed sloth, an agouti, wonderfully marked green lizards, tree frogs and a host of birds; the thing is, that's only at the hotel I'm staying at :-)

I've spent the last few days printing datasheets, laminating anything that stayed still for more than a few seconds, buying medicines, liaising with people and making sure everything is organized at our research centre. Alll done.

Last night, I met Monique, Mary and Simon at Wasai; that was great, though they did just miss the night monkeys. I look forward to meeting everyone else; I will be in Wasai reception tonight (Saturday) at 1900 when I will brief everyone who wants to come along about the plans for going upriver to base (departing Wasai at 0700 after a light breakfast at 0630). Afterwards, if you would like, we can all go for dinner together.

8 November - Puerto Maldonado to Piedras Biodiversity Station

After a lovely breakfast at Wasai hotel, we, along with our modest mountain of luggage, a cooler box full of meat and dreams of jaguar sightings to come we loaded the bus and set off. Twenty minutes later we arrived at Puerto Arturo where we transferred our belongings to a longboat for the trip upriver; we also transferred an innocent bystander's crate of Coke to our boat, but she noticed so we gave it back to her :) Having crossed the Madre de Dios River, we turned north and whilst dodging logs drifting downriver, we entered the Piedras river on which we travelled for the rest of the day.

On the lower part of the river, there were small farms along the bank, but these thinned out as we moved further upstream. Every so often, we stopped for a loo break at a convenient beach; at one such stop, Mary skillfully managed to seek out the only bit of (very deep!) mud in the area, however, Tom did his very convincing 'knight in shining armour' impersonation and saved the day.

Last stop on the way was the very small community of Sabalouyo – two houses and one shop where there were biscuits and biscuits for sale; we decided to buy some biscuits. There was a lovely little dog there who was very skinny; when we left, he was not nearly so skinny; when we left, he clearly wanted to come with us; when we left, there was a considerable proportion of the team in favour of a bit of dognapping.

The wildlife on the way was fantastic and got better as we moved upriver. There was a large group of colourful Hoatzin birds perched in trees on the riverbank. Turtles dried themselves in the sun on top of logs. Butterflies of yellow, white and orange flew in great clouds over special parts of the bank. A big spectacled caiman of about 2 m ate a big catfish at the water's edge. We were very lucky to see two female red howler monkeys with two babies eating clay at a riverbank colpa as well as many parakeets on another colpa.

We arrived at Piedras Biodiversity Research Station in the late afternoon so that we just had time to carry our bags from the boat to the station, drink some of the lovely refresco that Gloria our cook had waiting for us, unpack, do the grand tour and get settled in before it got dark :) It's good to be back.

9 November - First training day

After a health and safety briefing, we learned how to use the trail maps, GPS, compass, machete, rangefinders, telescopes, binoculars and tripods. Later we split into two teams and went for an orientation walk. Cathy, Anja, Simon, Mike, Tom, Aldo and I went round the waterfall circuit noting hazards such as spiky palms on the way and practicing some of the navigation techniques we learned earlier. We saw a large group of brown capuchin monkeys high above us; lovely. After lunch, Alan, our scientist gave us a talk on mammal identification, followed by macaw clay lick survey methodology and lastly, parrot identification.

10 November - Second training day

Early in the morning, Monique, Mary, Helge, Paul and Tom went to the macaw clay lick with Alan to put into practice yesterday's training. Near the macaw colpa, there is a large sandy beach and to everyone's delight, on that beach there were very clear tracks of jaguar – that elusive and beautiful animal that many people crave to see in the wild. At the same time, Cathy, Anja, Mike, Simon, Markus, Bernhard and Aldo went with me to mammal transect A to practice surveying mammals; eagle-eyed Markus spotted a group of red howler monkeys, which were great to watch – it looked like they were quite enjoying watching us too. Mid-morning the two groups swapped tasks and headed out again. On the return from the macaw clay lick, eagle-eyed Markus struck again, spotting a three-toed sloth swimming the river; these animals are not the best swimmers, so Alan scoped it out of the water and gave it a free ride to the other side of the river – a fantastic and very rare sighting and everyone was very pleased with themselves. Walter (our boat handler) never thought to tell us about the jaguar he had seen just a little earlier! Meanwhile, on the mammal training transect, the mammals were a bit thin on the ground, so I disappeared off into the forest so the group had something to work with; not sure how that went, but it certainly entertained everyone :)

In the afternoon, Anja, Helge, Markus and Alan cleared A transect of fallen branches etc so that we will be able to sneak around quietly whilst doing the mammal transect surveys and see more animals. Aldo, Walter, Bernhard and I went to the macaw colpa and made a hide from where we will carry out our behavioural study observations; excellent team work getting the job done quickly.

11 November - The work begins….

Simon, Markus and I went off trail into the forest, searching for new colpa for Alan's study, as well as for macaw nests and parrot foraging events. The going was varied, being quite easy under closed canopy and quite close to impossible where the canopy was broken due to tree fall, letting in light and causing an explosion of tangled growth. A few times the path of least resistance was a stream; you either get soaked with sweat or with stream water – doesn't really matter which :) Somewhat surprisingly for me, we actually succeeded in finding a previously unknown colpa, though it was not regularly used.

Around the location of the only known mammal colpa at Piedras Biodiversity Station, Alan, Cathy, Mike and Bernhard started to make a matrix of trap traps. A track trap is a 1 m square area of ground, cleared of vegetation, roots, rocks, etc. so that only soft ground remains. Whenever animals stand on the track trap, they leave an impression of their feet - fairly clear tracks that can then be identified on checking. This task turned out to be somewhat more demanding and time consuming than anticipated……

12 November

Today, we continued work on the colpa matrix, cutting small trails, measuring the trail lengths and making the track traps. Whilst crossing a small stream, I noticed a dead toucan in the water, it had not been dead for long, perhaps one day; it was amazing to see the detail of its huge colourful bill (right red inside) and its lovely feathers. I took it back to the station for the others to see.

Whilst JJ had been out, he had made a great find too, a massive red-tailed boa constrictor. Its body was almost the thickness of my leg, its head looked very business like and its tail was, unsurprisingly I suppose, a fantastic deep ochre red colour.

Daylight to no light takes little time in the tropics, and once it is dark, with a clear sky, the stars are wonderful – millions of them.

13 November

Tom headed out with Alan at dawn to survey transect A for mammals; seven hours later, transect A was completely surveyed and Tom was completely ready to spend the rest of the day horizontal in a hammock :)

Aldo, Mike, Anja, Markus and I went to the colpa matrix to continue the work setting it up; Simon managed to evade the work with some concocted tale about being sick after drinking water and then later realizing it was because he had taken his anti-malaria drugs on an empty stomach – very creative…. Everyone worked hard and by the time we headed back for lunch, with almost all of the work complete; finished off by Anja and Alan in the afternoon.

At the late shift at the macaw colpa, Helge said he had his most spectacular wildlife experience of his life – over a hundred red-and-green macaws. That says a lot for Piedras, coming as it does, from a professional photographer who dedicates a large part of his career to wildlife in many remote and fantastic places around the globe.

At lunchtime, JJ produced another snake, this time a yellow-tailed cribo perhaps 2m long, and fast, very fast.

In the afternoon, I went with Mike, Simon, Markus and Aldo to repair the macaw hide that had suffered some 'modification' as a result of some particularly heavy rainfall - that and my less than perfect design perhaps. Aldo seemed to find much to laugh about whilst we worked; I don't know why, but there did seem to be a very strong correlation between Simon or Mike picking up a machete and Aldo rolling around in hysterics:) However, when we had finished, we left behind a hide guaranteed to withstand anything the rainforest could possibly throw at it; wonder if it will still be standing tomorrow!

Dinner time provided yet another wildlife spectacle as hundreds of flying termites descended on the table, along with a variety of grasshoppers, beetles, cicadas and moths - never a dull moment here. As has become the norm, Helge produced yet another camera from yet another pocket and captured the dinner table ecosystem for posterity.

14 November

Up at 04:20 and along with Monique and Simon I went to the macaw hide, which was looking indestructible and even better, it was still the right way up. After only a few minutes, mealy parrots started arriving; they were a beautiful powdery green with yellow tail and red in the wings. With their short, strong wings they are fast and strong fliers, announcing their presence with loud raucous calls. Next to arrive were the blue-headed parrots, the dusky-headed parakeets and then a single orange-cheeked parrot. It was much later that the even more spectacular red-and-green macaws arrived. First these birds land in the tops of the trees above the clay lick where they have a snooze, enjoy the view or catch up on the latest gossip from their pals. Eventually, they work their way down the trees till they are very close to the clay where one brave soul takes the decision to be the first onto the clay. Once this has been done, everyone else follows and the brown clay becomes a fantastic coloured sea of vivid blues and reds – amazing. Occasionally, a small local boat passes, this invariably causes a 'flush' where all the macaws fly from the colpa at the same time – always a wonderful and truly amazing spectacle when there are a hundred birds flying together.

14 November – continued…..

So, Simon and Aldo return from their night transect at about 23:00 with all sorts of tall tales. First there was a scorpion, next a coral snake and lastly jaguar, not one but two! They were not seen, but they were heard playing together about 20 m off the trail: Aldo decided it was time to end the survey.

15 November - day off

The morning got off to a great start with a group of dusky titi monkeys calling only 20 m behind the lodge; I got my camera and with a little persistence got some lovely shots. Next were the humming birds, which were visiting the implausibly designed heliconia flowers of red and yellow. These little birds had a few of us racing around the lodge trying to get photos of them, with variable success. Cathy, Mike, Mary and Tom went to the macaw colpa early; I'm sure I said they could have the day off and as well as the riot of red-and-green macaws, they were lucky to see six spectacular orange-cheeked parrots. After a late breakfast, Mary, Tom, Helge and I walked the waterfall loop trail at a leisurely pace, looking at the trees, ferns, insects, birds and mammals; most of which Helge photographed.

16 November

Mary, Paul and Simon had an interesting early shift on the macaw colpa with dusky titi monkeys above the colpa frightening away the macaws. Tom and I went exploring, looking for a spider monkey that JJ had a little info about – just a rough location, so off we went. The forest vegetation was quite thick so we followed a stream, sometimes up to our thighs in water. We found a few different tracks of red brocket deer, no sign of the colpa, but we had a fun time anyway.

Alan and Helge completed a night transect and were very lucky to find five snakes, all different species; a beautiful multi-coloured rainbow boa, Amazon tree boa, two species of blunt nosed tree snake, and a false coral snake with its bands of red, black and white.

17 November

Cathy, Mary, Helge, Aldo and Simon completed a mammoth survey of transect A, leaving at 05:00 and getting back for a well earned lunch at 13:00. The rewards for the effort were great though; dusky titi monkeys, spider monkeys, brown capuchin Monkeys and saddleback tamarin monkeys. At one point, they also found a jaguar scrape, but sadly, no sightings of the beautiful animal itself. Last, but certainly not least, a green swamp snake, which flattened its neck, cobra like, to make itself look bigger – fantastic.

After lunch, Alan, Eric, Mike, Markus and I went to check the track traps at the matrix around the mammal colpa. Heavy rain quickly obliterates any animal tracks in the traps and we have been getting a little bit of rain lately…… All the tracks we saw in the traps were therefore no more than a day old, and even they had had some rain on them. About 30 min after we arrived, they got some more rain on them too – oh well. We were able to discern tracks from agouti, tortoise, nine-banded armadillo, grey-brocket deer and white-lipped peccary.

In the evening, after dinner, we all got into our boat and headed upriver to look for caiman. We looked for beaches along the river's edge where caiman are found. Unfortunately, the river was quite high and there were no beaches! Four species of caiman can be found in the area, but during our search, we only found one individual, however it was the rarest – the smooth fronted. With its dark and light striped tail and perhaps about 1.5 m long, this is the largest this species of reptiles grows. We did get a very good look at the caiman though as we got very close to it – excellent! Returning downriver, we switched off the boat's engine and drifted silently in the dark with our torches off under a sky full of stars with the silhouettes of the trees on the rivers edge.

18 November

Paul and I went to check an area on C transect to see if it would be suitable as a control area for a matrix of track traps. After a 2 km walk on which we saw a fresh jaguar scrape, we arrived at a small stream that we followed South. We found fresh tracks of tapier, red brocket deer and agouti. The find of the day, however, was a resting place in the stream bank of a neotropical otter, as far as I know, never before recorded at Piedras. A little further downstream, we found what appeared to be a tiny colpa in the bank of the stream with fresh signs of use.

Meanwhile, Cathy, Mike and Alan had a great encounter with rarely sighted monk saki monkeys on transect C where they were foraging and eating fruit. Simon, Helge and Aldo reportedly had the perfect early shift at the macaw colpa. First there were 60 mealy parrots along with 20 blue-headed parrots. Later, a whopping 100 red-and-green macaws covered the colpa and surrounding trees - amazing. News of the avian spectacle obviously spread quickly as the hide was invaded by ants; doubtless there to see the macaws too :)

19 November

Cathy, Mike and I did the early shift at the macaw colpa, but the morning started off very misty; we were barely able to see across the river to the colpa for the first 30 min. Eventually, the mist cleared and mealy parrots, dusky-headed parakeets, orange-cheeked parrots and a grand total of one (!) red-and-green macaw went onto the clay to eat. However, very soon after, the birds flushed and there were no more on the clay all day and few in the trees. The highlight of the day for me was two bat falcons in the tree top above the colpa; it was a privilege to be able to be able to watch these fantastic birds for at least 15min :)

Paul, Helge and Alan made the long walk along transect A and found the remains of a freshly killed peccary, killed by a jaguar; a fantastic find and yet more tantalizing evidence of the presence of this all too elusive and enigmatic animal.

In the afternoon, Bernhard and Alan checked all of the colpa track trap matrix, finding fresh tracks of paca, agouti and many white lipped peccary.

This brings to an end the first slot of Biosphere Expeditions 2009 expedition to Peru. A very successful first slot with no time lost due to weather :) and much valuable data collected – many thanks for all your hard work and getting stuck in, even when things were difficult.

I will be staying at Piedras Biodiversity Research Station for the changeover between slot 1 and slot 2. Alan Lee, our expedition scientist will now take all slot 1 team members back to Puerto Maldonado on Friday 20 Nov 09. Slot 2 team members; Alan will be staying at Wasai Hotel and will meet you on Saturday night in reception at 19:00 for a short briefing about travel upriver and then dinner together at a restaurant if you like. Departure for the river journey will be 07:00 on Sunday morning 22 Nov 09 from Wasai hotel. I look forward to seeing you all at Piedras Biodiversity Research Station and spending the next two weeks in the rainforest with you.

22 November - team travel from Puerto Maldonado to Piedras

Whilst Alan is travelling from Puerto Maldonado to Piedras Biodiversity Research Station with Slot 2 team members, Anja, Gloria, Melissa, Angel and I stayed behind and have been preparing for the new team's arrival. Gloria, Melissa and Angel have been cleaning the Research Station from head to toe and Anja, under instructions from Alan has been cleaning transect C from start to finish, with a sweeping brush! When we carry out the mammal transect surveys, it is very important to move quietly so that we can see and record the animals before they hear us and disappear off into the forest before we even know they are there. Snapping twigs and crunchy leaves warn animals of our approach, but with Anja sweeping the whole 5 km of the transect, we will be much more able to sneak up on all sorts of animals before they detect us :)

The war between Alan and myself continues….. Alan thinks it should be compulsory for everyone to wear Wellington boots when out in the forest. He says they provide some protection against snake bite and keep your feet dry. I think all Wellington boots should be banned from existence. Jungle boots give far better grip on muddy ground so reducing the chances of a dangerous fall, provide spike protection in the sole, fit properly so that they do not cause blisters on the foot or broken skin around the top of the boot like Wellingtons can and, unlike Wellingtons that slap around on your leg, they are quiet. As it has been years since wearing Wellingtons, I thought I'd give them a go again with an open mind and walked along Anja'a lovely clear transect, however, with the Wellingtons slapping around on my leg every animal within ½ a mile must have heard me coming and I heard a few of them disappear off into the forest as I approached – never again, back to my jungle boots!

All of the team members of slot 2 arrived at Piedras, unloaded the boat and got everything to the station in record time. We did the grand tour of the station, unpacked, settled in and even did the health and safety briefing all before the first of many lovely meals from Gloria and Melissa.

23 November - first training day

First today, we split into two groups and went for an orientation walk. Walking around the trails near to the station, we got used to navigating on the trails and we also had a look at some of the hazards of the forest such as tree roots that can be easy to trip over and spike covered palms. Lastly we looked at some of the ecology of the forest such as 'devils gardens' where ants live in symbiosis with a tree. In these 'gardens', the ants kill all plants around their host tree, thereby reducing pressure on their tree, in return, the tree provides a home for the ants.

Alan covered the theory of both mammal transect surveys and macaw behavioural surveys. On the practical side, we learnt how to use machetes, GPS, rangefinders, compass, trail maps, binoculars, telescopes, tripods and Marcello's camera traps. Both Laurence and Becs were very taken with all the gadgets; perhaps an on site gadget shop next year……

24 November - second training day

Simon, Marcello and Angel headed off along the Brazil nut trail on a two day trip to set up track traps and camera traps on the trail leading to the Brazil nut farm and beyond. The Brazil nut farm, about 5 km from base, is no more than a hut where workers rest during the Brazil nut harvest; I have never been there. When our intrepid team reached the farm though, they found it was in very poor condition and full of all sorts of ants; this provided some motivation to get on and complete their two day task in one day, which they did – must have been Gloria's breakfast that gave them the energy!

Having covered all the theory yesterday, today we did the practical side of the training. Alan took half of the group to the macaw colpa to practice recording behavioural observations, whilst I took the other half of the group to one of our transects to practice recording observations of mammals, perched parrots and large-bodied birds. When carrying out mammal transect surveys, it is vital that you are as quiet as possible; with a large group like we had, that was pretty much impossible, especially as we occasionally needed to speak to clarify points about the methodology. Because of the sound we were making, we saw few animals (as expected), so in order for the team to have something to practice recording, I left the group and hid in the bushes making like an animal – something that everyone said came naturally to me. I also made an impression of a jaguar track in the sand on the trail that had everyone excited when they noticed it, everyone that is apart from Aldo our guide who was not that easily fooled, but who did struggle to stop bursting out into laughter. In the afternoon, we went to our trap track matrix to prepare the traps so that we can see if animals have walked across them. On the way back, we saw a big group of squirrel monkeys along with brown capuchin monkeys in the trees directly above the trail that we were on; we stayed and watched them for about 20 minutes, wonderful :)

25 November - slot 2 unleashed on the rainforest – if it moved we surveyed it :)

Today, I went with Angelina and Ricardo to check the suitability of an area for a new, second track trap matrix. We currently have one track trap matrix centred around a mammal colpa. Alan our scientist wants to find out if/how colpas influence the spatial distribution of jaguar and other animals; to do this we need a control matrix away from any colpa to compare data - this will be the purpose of matrix two. We followed a very meandering stream through the forest and found many tracks along its edge. Tracks of a dog, either bush dog or short-eared dog, both very rare. Five different trails of tapir, one of which was very fresh, only about 10 minutes old. Paca, agouti, agouchi and other rodent tracks were abundant. At one place we found a trail where you could see where an animal had dragged its body and tail along the ground, its foot impressions revealed it to be an otter, excellent. After hours of meandering along the stream, sometimes up to our thighs in water, we had gone a straight line distance of around 1.2 km! So I decided to leave the stream and cut directly through the forest to one of our trails and then back to the station for a well deserved lunch.

In the afternoon, Joss, Walter and I went to the macaw hide to upgrade the seating arrangements. We took with us a plank of wood, that if we had dropped it in the river, I'm sure it would have sunk. That was the heaviest piece of wood I have encountered in my entire life and I still have the dent marks in my shoulder where I was carrying it to prove it! After a bit of digging and chopping, the work was done and we were even lucky enough to see some dusky titi monkeys by the hide as we were working.

In the evening, Joss and Alan completed a very enjoyable night transect under a calm, clear and star filled sky. Many animals were encountered including olingo, bi-coloured porcupine, night monkeys, spiny rat, rice rat and no less than five different species of frogs.

26 November

Marcello and Ricardo headed off to the Brazil nut farm to make some more track traps and to check the ones already made; this went well and tracks of jaguar were found in three of the track traps :)

Six of the team were left to carry out the macaw behavioural survey whilst almost everyone else went to prepare the second track trap matrix. On the way out, we saw a group of white-bellied spider monkeys high in the trees – wonderful. On site, we split into two teams; with me, wielding machetes, were Angel and Erik, whilst Rosa and Laurence measured the length of the trails and marked the positions of the track traps. This all went very well and we finished in record time, though it was hard work. On the way back we, again, saw a big group of white-bellied spider monkeys in the trees directly above us; they were absolutely fantastic to watch, swinging around at speed apparently effortlessly. They would shake the branches, at one point covering us with a shower of buds and fine blossom. Often the monkeys would hang, only holding on with their long prehensile tails, their four limbs free.

Back at base, after the tiring machete work, I spent the afternoon carrying out a comprehensive hammock survey :) Rousing from my slumbers, I found myself in the middle of a camera club photo shoot, everyone getting every conceivable kind of group shots.

In the evening, we were treated to a spectacular display of forked lightning that for an instant turned night into day before rumbling back to darkness with ground shaking thunder.

27 November

Laurence and I went on a foraging walk, looking for feeding or nesting parrots/macaws. Just a little distance from base, we spotted a group of spider monkeys, which we followed for a little in the forest, howler monkeys called in the distance. Further along the trail, we stopped by a big ciba or capok tree where we were treated to fantastic close views of a white-throated toucan and a spix's guan. Next, we saw a small group of brown capuchin monkeys in some palms. Further, we were both amazed to find a second group of white-bellied spider monkeys and this time, they hung around, literally :) so that we were able to get some great photos. Eventually, after some time and realizing it would get dark soon, we headed back to base, but our wildlife encounters were not over yet. A large group of spix's guans hopped around in the trees above us, probably unaware of our presence in the failing light. And then, a third group of white-bellied spider monkeys, I couldn't believe our luck :) But still it was not over for us. On arriving back at the station, we were greeted by a big yellow footed tortoise at the front door; it's tough at Piedras :)

Becs, Helen and Aldo surveyed transect C and saw a group of howler monkeys - 2 males 1 female and a baby. Later they saw 2 dusky titi monkeys but apparently, highlight of the walk was seeing a swamp snake eating a frog :(

Simon and Alan checked matrix one for tracks and found: green agouchy, armadillo, jaguar and ocelot – an excellent haul.

28 November

Avril had fun on the early shift at the macaw colpa, or rather getting to and from the colpa. As she set off the immortal words 'there's not much mud, I'll be fine in my sandals' were uttered. [Just as well I was not there, I would have had words at that point….] The accidents were not too serious, I suppose. The first slip was forward, whilst going uphill, a good, full-length flat-on-the-face type mishap. On hand were two knights in fairly shiny armour, in the shape of Joss and Pete who helped Avril up the slope. Mishap number two involved a very graceful backward manoeuvre that ended with Avril flat on her bum (in the middle of the mud again of course). Avril made it back to base all in one piece, though she did look like she had just gone 3 rounds in a mud wrestling competition and I've yet to see her sit down…….

Matt, Alan and I checked Matrix 2, the traps were set yesterday; we checked 28 of them and found the tracks of a pale-sided trumpeter and an armadillo; not so many. Whilst walking round the matrix, however, we did see a group of around 30 false vampire bats, about 30 cm wingspan flying through the trees very close to us – excellent!

Becs, Simon and Aldo did transect A early in the morning and got off to a good start with dusky titi monkeys, next was the rear end of a tapir – a particularly fine and rare sighting of this elusive relative of the horse. Next was a single male red howler monkey and sighting of the day (perhaps of the expedition) about 10 saki monkeys – fantastic.

After lunch, Marcello gave a short tai chi lesson and due to the rapturous applause (mostly from the audience rather than the participants it has to be said!) he also did a little capouera lesson; no serious injuries, so that was good too.

After dinner, Becs, Helen, Laurence and Joss headed off in a very intrepid fashion, for the mammal colpa hide. The plan was to spend the night there to see if any animals visited the colpa to eat clay. Tune in tomorrow to see what happened……

29 November - day off

Our intrepid team of mammal colpa watchers arrived back in the morning having spent the entire night watching the colpa for animals visiting in the night. The mission turned out to be of somewhat limited success (a career in politics awaits me). However the team did succeed in capturing a photo of a particularly dangerous looking animal at the colpa; we have to confirm the identification, but provisionally, it was a *Panthera obscura* subspecies *Laurenceii muddyii*.

In the afternoon Becs, Walter, Matt, Ricardo and Aldo went off in the boat and Becs had her 'best day of the entire expedition'. Perhaps seeing the sky for the first time in a few days, after having been sheltered under the forest canopy, was more of a pleasure than expected. A bit of fishing was attempted, with variable success, however, Becs did catch her first ever fish. Next, a caiman was spotted on the shore and everyone got some nice photos, Walter then announced he was going to catch it, much to everyone's shock. From the boat, Walter threw a net over the caiman and then grabbed it under the throat. After having extricated the caiman from the net, it could be seen in all its glory, before being popped back into the water.

In the evening, after dinner, we all climbed aboard our boat and headed upriver in the dark. With our torches, we looked for the red eye shine of caiman. It was not long before we saw a pair of red eyes, but as we approached, they disappeared below the water. The same happened with the next pair. Our third sighting was much better, we slowly drifted up to the eyes that were on the shore and attached to a spectacled caiman just over a meter long. Obligingly, it sat there for some time and we all got a good look at it. Next, we found a caiman up a tree – that turned out to be a nightjar!

30 November - Back to the graft (!)

Becs, Joss and Simon had a day to remember on the early macaw colpa shift. Loads of macaws and parrots, but far more exciting than that, was the invasion of the hide by a few many millions of army ants. First they appeared on the outside of the mosquito net, rising up like a dark malevolent curtain on all sides. Becs and Joss were ready to make a run for it, abandoning the hide before they were carried off and cut up into millions of tiny pieces. Simon on the other hand, was made of harder stuff (or was that he had been drinking harder stuff, hmmm, not sure) and said "it'll be fine", so they stayed. Next, the ant column marched through the hide itself, a constant stream of them. For 20 minutes, the river of ants steamed through the hide as our dedicated team clung to their telescope and continued to survey the macaws – outstanding dedication to duty in the face of overwhelming superiority in numbers. Our battle-hardened team were looking forward to being relieved at 0930, but the relief never arrived – had they fallen to the insect army? 1000 came and went, as did 1030. Fearing the worst, our team were about to send out a search party to look for survivors, just as they arrived. Apparently the boat's engine had got water in it, causing the delay.

Helen, Matt and Aldo did transect C early in the morning. On the return walk, they found a tree in fruit, probably mashonaste, but I was not just filled with fruit; monkeys too. There were squirrel monkeys and capuchin monkeys which are frequently found together, but there were also spider monkeys – wonderful. But the excitement was not over for our intrepid trio; Aldo gave the swimming signal to indicate there was a patch of mud ahead, Matt went first, then Aldo and finally Helen. This was where the days' preparations, or rather inadequate preparations, :-/ came into play….. Foolishy, Helen had set off into the rainforest wearing only 2 pairs of thick wooly socks with her wellies, instead of her normal 3 pairs – unbelievable. Helen went to take a step forward, but she was unaware of the very fine adhesive qualities of Peruvian rainforest mud (see NASA report "A solution to space shuttle insulation tiles breaking free on re-entry" dated 03 June 1998) and the mud had taken a liking to her wellies and had no intention of letting them go; result, Helen stuck, semi-dangling at a jaunty 45 degree angle, completely unable to move. Matt had disappeared around the corner, but Aldo was on hand. Being the consummate Peruvian gentleman, without a moment's hesitation he started to pee himself with laughter. Having composed himself a little, like a knight in only slightly muddy armour, he then raced to the rescue, taking Helen's camera and making sure it was safe. After only a few minutes, he remembered that Helen was still stuck, so went to help her as well. After a bit of heaving and puffing, Helen was free – yippee! But her Wellie was not, boo! So, now Helen was balancing in a sea of mud, only on one leg – not the best time to get a fit of the giggles….. At least Aldo, who was supporting her was well composed; well, at least until Helen started giggling, then he was off too. After a few wobbles and near mud experiences, the two finally managed to extricate themselves and the errant wellie from the mire, making it back to safe dry ground and a happy reunion with the camera.

Wellies 0, Jungle boots 1 :)

In the afternoon, Avril, Paula and I went for walk on the waterfall loop trail and saw a tyra, at over 1 m this long black member of the mustelid family has a fantastic yellow head. Under normal circumstances it would have made the headlines for the day's diary entry, not much chance of that today.

1 December

Paula, Helen and Ricardo did the early shift at the macaw colpa. During a quiet moment, Ricardo thought it would be great to see a monkey so started searching with the telescope, he didn't find a monkey, but did find a three-toed sloth. These animals have a top speed of around ½ a km per day and have fantastic camouflage so are practically impossible to spot in the forest, this was an amazing sighting!

Helen, Simon and Alan checked Matrix 2 and found lots of tracks including quite a few ocelot and even more interestingly, giant armadillo.

Rosa, Becs and I planned to canoe down the river and check the riverside mud for tracks to photograph for a reference collection. However, the river was dangerously high and fast, there was no mud visible at the side of the river (and hence no tracks), the canoe was rotten and falling apart and I couldn't swim, but apart from that everything was good. Can't remember what the reason was, but we went for plan B instead – looking for tracks alongside a small stream. This all went fine so we now have a small reference collection of tracks :)

After dinner, Matt and I went for a walk to one of the swamps; Matt was well prepared and even selected the highest wellies available so he would stay dry – should have known better :) The walk along the trail to the swamp was great; anole lizard, a cicada shedding it skin, spiders and all sorts of insects. At the swamp, Matt tried to stay dry for a few minutes before abandoning that unlikely hope and got stuck into the business of squelching around the swamp with water well above our knees, trying our best not to fall and ruin our cameras (successfully!). There were lots of frogs, dragonflies, insects, one caiman and even a mottled owl on watch above the swamp – fantastic.

Wellies 0, Jungle boots 2.

2 December

Simon, Pete and I did transect C early in the morning and were very lucky with the animals we found; lots of perched parrots, lizards and a whopping 6 species of monkeys.

Anja and Becs went on a parrot foraging survey and failed completely to find any foraging parrots – appalling. They did see saddleback tamarins tucking into grasshoppers and a harpy eagle, but that does not count as they are not parrots.

3 December - last full day at Piedras :(

Rosa, Becs and I did the last shift :(at the macaw colpa. This was my first trip to the macaws this slot and it was wonderful to see these spectacular birds so close and for so long; a real privilege.

Before dinner, Alan and Marcello did brief presentations on the preliminary results of the expedition. We added a new species to the known list of mammals that occur in the area, the neotropical otter. White-bellied spider monkey population continues to increase since the establishment of Piedras Biodiversity Research Station and the associated cessation of hunting. A very healthy large predator population, including jaguar, puma and ocelot occurs in the area. Macaws are very vulnerable to human disturbance and claylicks were seen to be very important for social interactions.

After yet another fantastic dinner from Gloria and Melissa, we got the music on and did a bit of dancing, mostly tango :) Then, with the aid of a bottle of Pisco or two, we talked into the small hours, discussing grammar. Yes, I'm afraid it is true!

4 December - Piedras to Puerto Maldonado

Having packed our bags, we loaded the boat and set off downriver for Puerto Maldonado. Instead of staff pointing out wildlife, as on the way upriver, now, after two weeks working on the expedition, everyone was spotting and identifying all sorts of wildlife; mission completed :)

So, that ends Biosphere Expeditions' 2009 Icons of the Amazon expedition; a great expedition that I personally really enjoyed. Both groups of team members quickly gelled into great teams who did a huge amount of really useful, great work. Thanks very much to everyone for that hard work and all the fun times.

Don't forget to share your pictures via www.biosphere-expeditions.org/pictureshare and look at our Look Ahead campaign www.biosphere-expeditions.org/lookahead.

So long

Andy