REPORT

Using data on large mammal assemblage to develop a monitoring scheme for touristic activity in Cavernas do Peruaçu National Park, Brazil

Brazil, Cavernas do Peruaçu National Park, April 2007-May 2008

Overall goal: Develop a monitoring program aiming the conservation of the large mammal community, providing scientific knowledge for management actions and preventing possible impacts from tourism activity.

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Original project title: Ecology and conservation of a bush dog population in Brazil – a monitoring and educational program

Original overall aim: Develop a monitoring program aiming the conservation of a bush dog population, providing scientific knowledge for management measures and preventing possible impacts from tourism activities.

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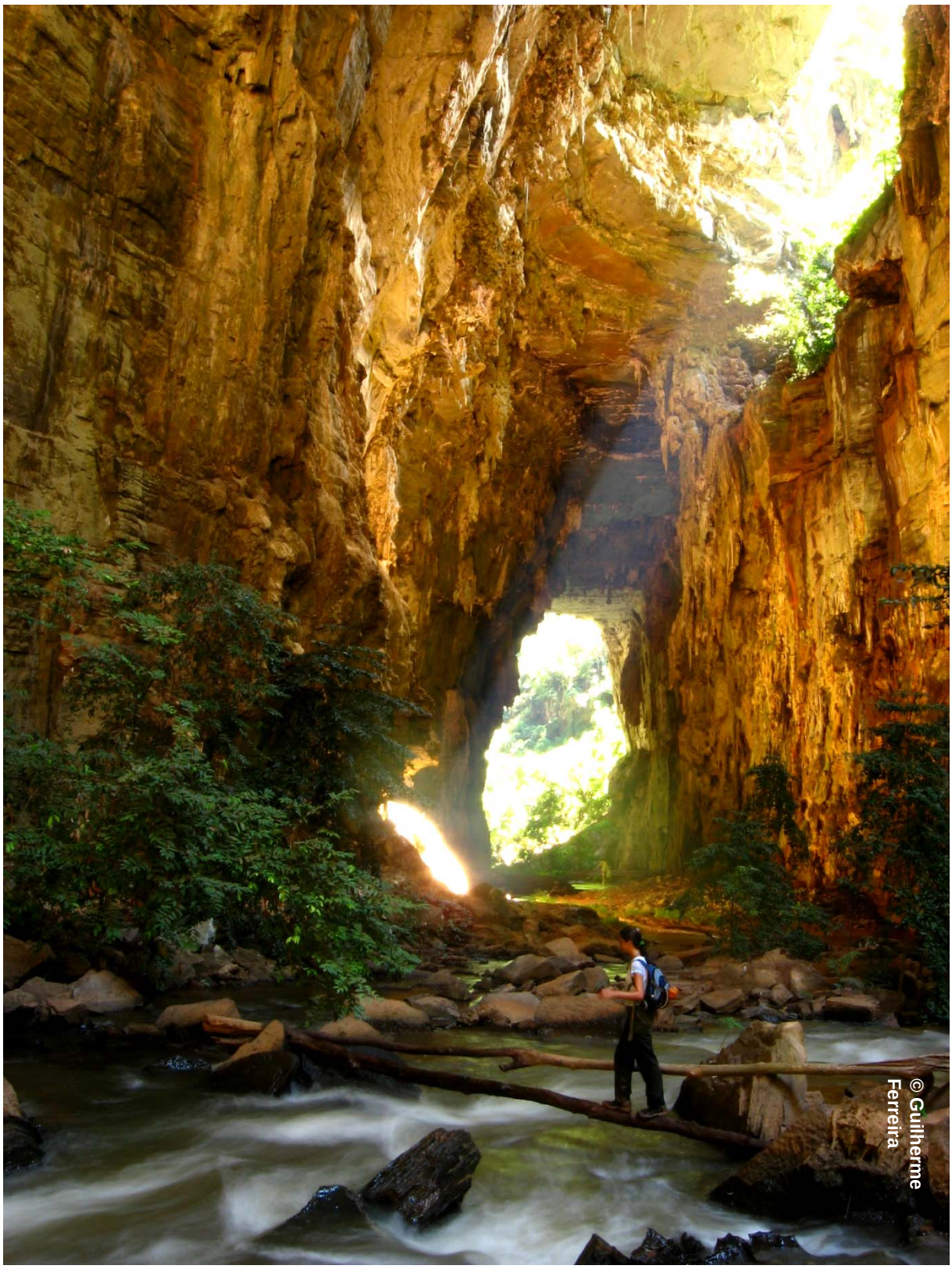
Acknowledgements

To develop this project several institutions, professionals and friends gave their contribution and must be acknowledged:

- Cavernas do Peruaçu National Park staff (Evandro, Lilian and Danilo) and Cenap/ICMBio provided important logistical support;
- IBAMA gave the permit for the team to develop research in the National Park;
- José Santana guided us through the valley and the caves in the first expedition to set the camera traps;
- The biologists Marcell Soares, Leonardo Furtado, Carlos Eduardo Benfica, Marco Tulio Araujo and Eduardo Coelho helped in field activities, Flávia Pezzini helped in outreach activities and Izabela Barata helped both in field and outreach activities.
- Flávio Rodrigues helped in project design and Leandro Scoss gave major guidance in the use of Monitor software;
- Fundação o Boticário provided part of the fuel used in the project;
- Conservation Leadership Programme funded the project and gave several opportunities of professional enhancement for team members.

SECTION 1



Researcher crossing the Peruaçu River inside the Janelão Cave

Summary

We developed a monitoring program aiming the conservation of the large mammal community, providing scientific knowledge for management actions and preventing possible impacts from touristic activity in Cavernas do Peruaçu National Park. Since the original focal species was not recorded several objectives were changed and the original overall goal was adapted, but we consider that similar results were still delivered. Ten camera-traps were used to record the mammal fauna in the Peruaçu River Valley and a statistical power analysis was performed to select the most suitable monitoring scheme. After 2940 days of camera trapping, 17 species of large mammals and 397 independent photographs were recorded. Species richness and overall relative abundance did not differ between touristic sites and non-touristic sites. Cave proximity negatively affected species richness and relative abundance while seasonality only influenced relative abundance. We can infer that Ocelot (*Leopardus pardalis*) is the most suitable mammal occurring in the valley to be used as surrogate for large mammal species richness and should be considered in a complementary monitoring scheme based on a focal species. From the power analysis we concluded that a statically robust scheme to monitor large mammal species richness in the Peruaçu River Valley should use ten camera traps placed in sites with low cave influence during eight months.

Introduction

Located in a landscape mosaic of dry forests and grasslands in the Cerrado Hotspot, Cavernas do Peruaçu National Park (CPNP – Fig. 1) harbors several species threatened with extinction and extensions of habitat that potentially support viable populations of them. The park is classified as a priority area for conservation in Brazil (MMA 1999) and has special biological importance, requiring management and conservation actions in a very short term (Fundação Biodiversitas 2005). Additionally to the biological importance, the valley formed by the main river in the park holds an extremely important speleological, geological and archaeological heritage (Fig. 2 and Appendices). With all these attributes and scenic beauty the region has a great potential for tourism that will certainly be exploited as soon as the park is opened for visitors. Nevertheless negative impacts can and do result from touristic visitation (Eagles et al. 2002) and the potential impacts of this activity on CPNP biodiversity is unknown. Regarding species these impacts can either be direct or indirect and may affect behavior, reproductive success and mortality (Roe et al. 1997). Since these impacts can only be detected if baseline data exists (Buckley 2003) nature-based touristic activities should be constantly monitored.

CPNP was planned to open for visitors in 2008, but some political and legal issues prevent the park to open for tourists until today. Nowadays tourist activity is planned to begin in CPNP in mid 2012.

Threats on biodiversity from touristic activities are of particular importance for protected areas which the main purpose is to protect species and ecosystems however they are normally difficult to measure demanding specific techniques and personnel. The institution responsible for CPNP (ICMBio) neither has the personnel nor the financial resources to implement a program to monitor potential impacts from touristic activity on biodiversity in CPNP. Nevertheless ICMBio do want that any activity that takes place in protected areas is conducted in a way that causes minimum impact. Since the Peruaçu Valley concentrates both great biodiversity and important touristic sites a monitoring scheme is needed to evaluate, prevent and mitigate potential negative impacts.

We believe that our monitoring initiative allows both the persistence of the large mammal community and the existence of an organized touristic activity in CPNP. It can function as an early warning system to alert managers that changes in biodiversity may require changes in management schemes to promote the long-term maintenance of biodiversity (Balmford et al. 2003; Yoccoz et al. 2001). Changes in management schemes are not necessarily the extinction of touristic activity, they can be simple adaptations in the way tourism is carried out in the region.

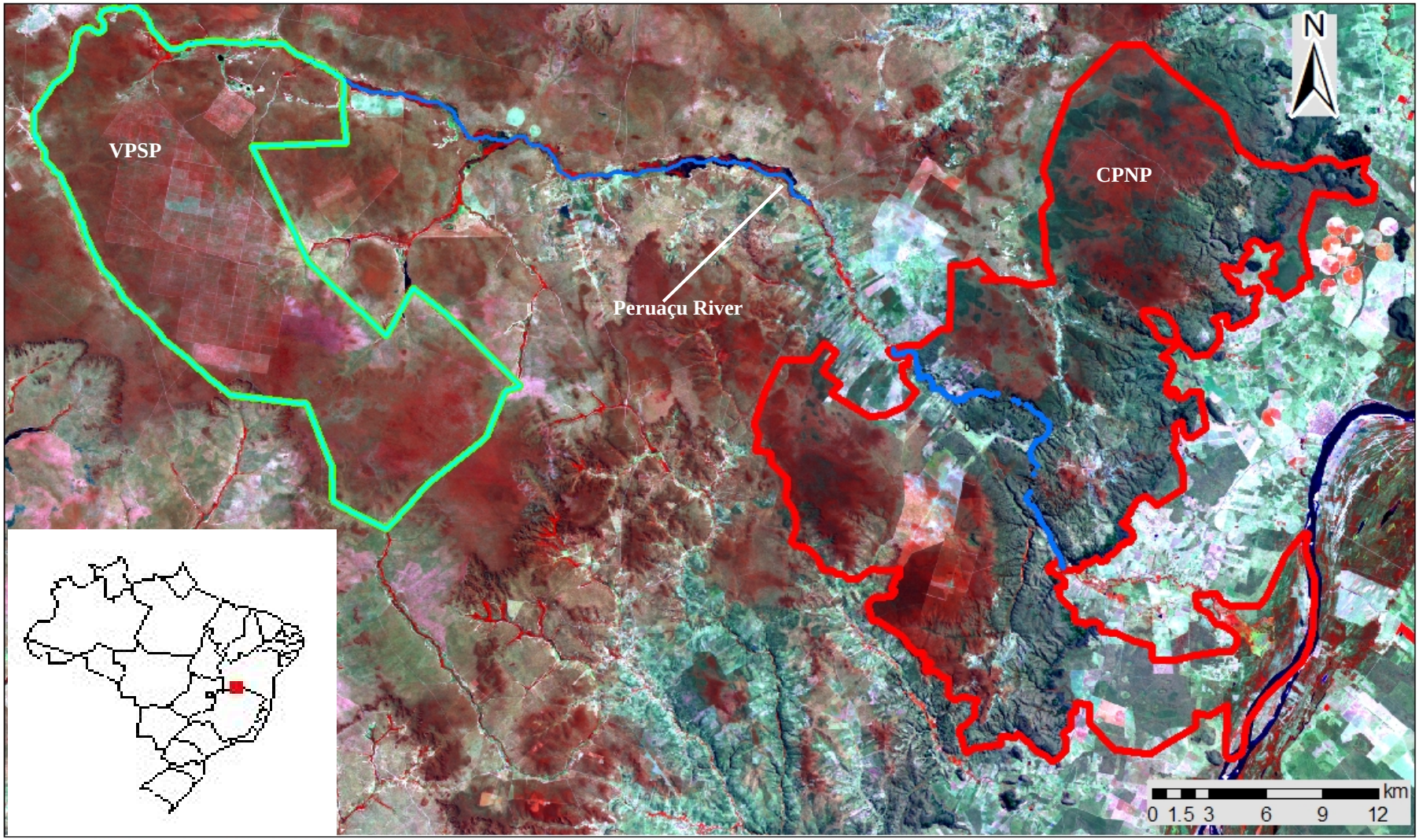


Figure 1: Location of the Peruaçu River watershed and its protected areas, Cavernas do Peruaçu National Park (CPNP; 56,800 ha) in red and Veredas do Peruaçu State Park (VPSP; 31,000 ha) in green.

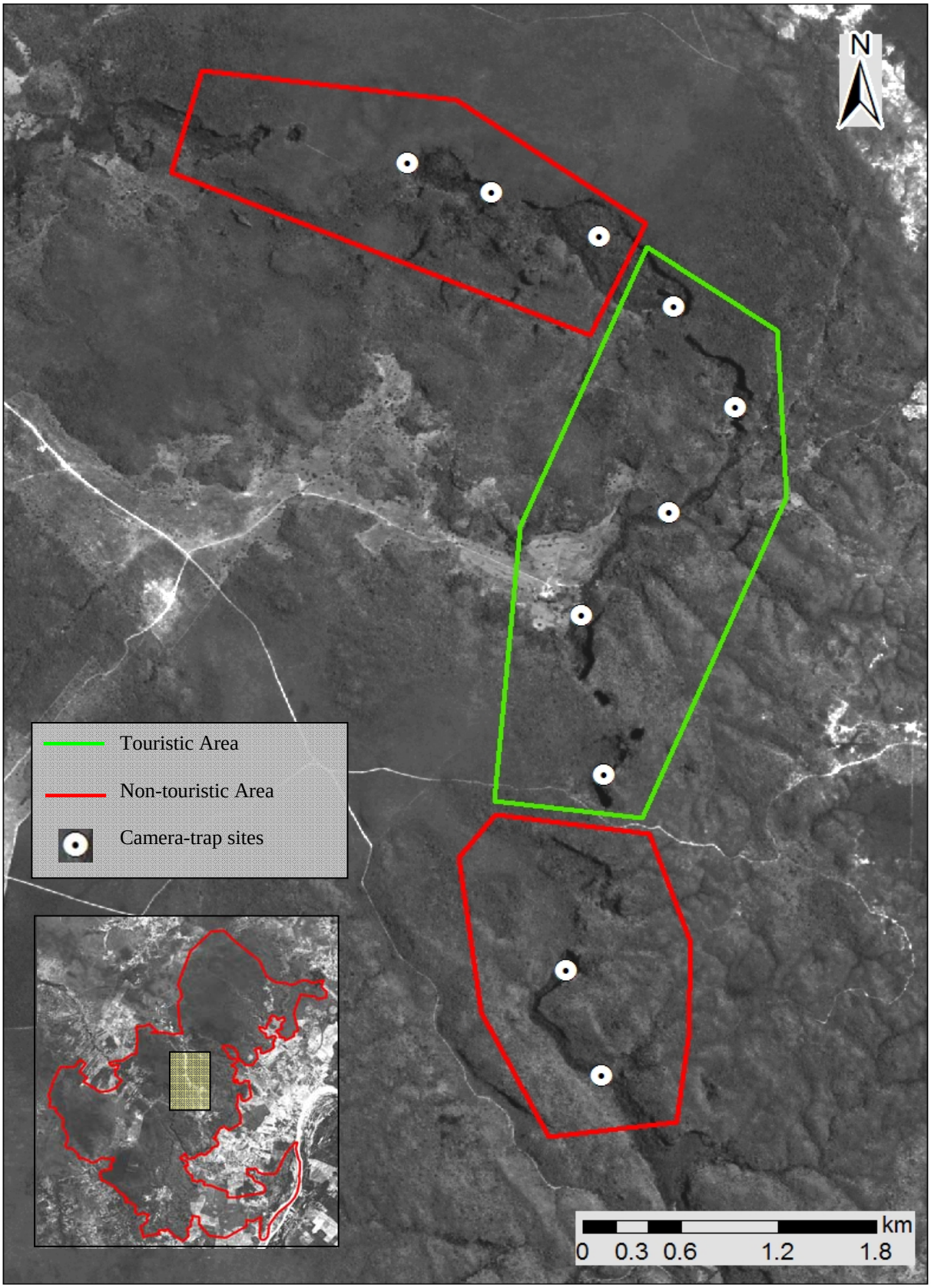


Figure 2: Detail of the Peruaçu River Valley with camera-trap sites, touristic and non-touristic areas.

Project members

Guilherme Braga Ferreira, 27

He holds an MSc degree in Ecology, Conservation and Wildlife Management. Works in Instituto Biotrópicos since 2006 coordinating projects in the Peruaçu Valley and in some parts of the Espinhaço Range. In the project he was the team leader.

Marcelo Juliano Rabelo Oliveira, 30

He holds an MSc degree in Ecology, Conservation and Wildlife Management. Also works in Instituto Biotrópicos since 2006 and conducts ecology and conservation projects, especially with felids. In the project he helped with camera-trapping, data organization and data analysis.

Raoni Araujo, 28

He holds an MSc degree in Geography, worked for two year in a Brazilian NGO and nowadays works with socio-environmental diagnosis for protected areas implementation. In the project he was responsible for the interviews with local community and the analysis from questionnaire data.

Letícia de Souza Soares, 26

She holds an MSc degree in Ecology and is now a PhD candidate in Systematics, Ecology and Evolution in the University of Missouri working with ecological interactions between parasites and hosts. In the project she helped with the development of the questionnaire for the local community and local schools.

Tatiana Maria Machado de Souza, 28

She is a veterinarian and nowadays works for the national government in ICMBio in a protected area in the Brazilian Amazon. In the project she helped with the development of the questionnaire for the local community and local schools.

Izabela Barata and Flávia Pezzini, although were not officially team members, gave great support in outreach activities conducting interviews with local residents and giving talks in local schools. Izabela's talk for school children originated an annual environmental awareness activity that reaches more than 10 schools in Diamantina (city where Instituto Biotrópicos is based).

SECTION 2

Tree emerging from the rocks in Cavernas do Peruaçu National Park

Aim and objectives

Since the original focal species (Bush dog – *Speothos venaticus*) was not recorded several objectives were changed and the original overall goal was adapted.

Overall goal: Develop a monitoring program aiming the conservation of the large mammal community, providing scientific knowledge for management actions and preventing possible impacts from tourist activity.

Objectives:

- Provide baseline data allowing the monitoring of large mammals species richness, distribution, relative abundance and activity pattern over time;
- Raise local people's interest about local biodiversity including the bush dog;
- Evaluate if ocelot abundance can be used as surrogate for large mammal richness;
- Prepare a Peruaçu River Valley map showing the spatial distribution of species richness and proposed touristic areas;
- Suggest a statistic thorough monitoring program that allows both the persistence of the large mammal community and the existence of an organized tourism activity;
- Provide park managers with scientific data to rely upon when actions concerning the large mammal community need to be taken.

Methodology

Ecological methods

Ten camera-traps Tigrinus® were used to record the mammal fauna in the Peruaçu River Valley. In order to evaluate if the large mammal fauna differed in any sense between touristic sites and non-touristic sites five camera-traps were placed in areas where touristic activity is planned in the future (Touristic Sites – TS) and the other five were placed in areas where this activity will not be allowed even after CPNP is open for visitors (Non Touristic Sites – NTS) (Table 1). Each sample site was classified as suffering high or low influence from caves. While walking through the valley to change camera-traps' batteries and film we searched for mammal footprints in mud and sand deposits by the river and in trails.

Camera-trapping was divided in two phases: 1) pilot study and 2) data collection. The first phase lasted for two months (April and May 2007) while the second phase started in June 2007 and ended in may 2008. Data from both phases were used to evaluate activity patterns and identify ocelot individuals which were identified by its pelage pattern. Since we only had one camera per site we identified individuals for left flank photographs as well as right flank photographs. For all other analyzes data from the second phase only was used. For most analyzes (except activity patterns) record was defined as the photograph of a species in a given camera-trap site in one day. A Relative Abundance Index (RAI) was used to permit

comparisons between sites with different sample efforts. In this index the number of records are divided by the sample effort and multiplied by ten. RAI was calculated for each species as well as for parameters evaluated (NTS x TS; Dry season x Wet season; High cave influence x Low cave influence). The software EstimateS 7.5 (Colwell 2005) was used to obtain the estimated richness through the Jackknife I procedure and confidence intervals (CI) were calculated to verify if the differences were statistically significant. To evaluate the similarity between the mammal assemblage in each sample site we used the hierarchical cluster analyzes from the software Statistica 6 using two different data sets: 1) species presence/absence data and, 2) Species RAI. We used UPGMA as the linking method and Euclidian distance as the distance measure (Quinn & Keough 2007). We used t test to evaluate variation in RAI (both the overall RAI and RAI for species with 20 records or more) for TS and NTS, for dry and wet season as well as for low and high cave influence. When assumptions for regular t test were not met we used the t test with separated variances. The Spearman Correlation was used to compare ocelot data (ocelot RAI, ocelot records and number of individual ocelots) with the mammal community data (jackknife I value, number of species recorded and overall RAI). We divided the river valley in nine segments to evaluate mammal footprints data. This information was only considered for overall species richness and species distribution. For more details on data collection and analysis refer to the preliminary report (Ferreira *et al*. 2010).

Table 1: Camera-trap site details

Site ID	Touristic area	Cave influence	Trap effort (days)
NTS1	no	low	209
NTS2	no	low	246
NTS3	no	low	340
NTS4	no	low	268
NTS5	no	high	246
TS1	yes	high	344
TS2	yes	low	335
TS3	yes	low	303
TS4	yes	high	309
TS5	yes	low	340

A comum recommendation to enhance a monitoring program is the utilization of a statistical power analysis. The software Monitor v. 11.0 (Gibbs & Ene 2010) was used to evaluate the statistical power of different monitoring protocols for CPNP. Statistical power is a measure of the confidence with which a statistical test can detect a particular effect when an effect does exist (Beggs 2000). According to Quinn & Keough (2007) power analysis is a usefull tool for

designing an experiment (or a monitoring scheme). The design type used in the software was route regression and the measure type was log-normal. Input data for simulations was the mean number of species recorded in 60 days of camera-trapping in each camera-trap site and its standard deviation obtained using the software EstimateS 7.5. Results from preliminary power analysis in which data from all camera-trap sites was used in simulations showed extremely low probabilities of detecting variation in species richness. This happened because of the large differences in species richness between sites with high and low cave influence. Thus we performed simulations considering data only from camera traps in low cave influence sites (see table 1 for site description). To simulate the effect of increasing the number of camera traps three new values for species richness were created based on the mean species richness and standard deviation from real low cave influence sites.

Social science methods

To raise awareness and communicate about conservation issues three main approaches were used:

1) Two slightly different questionnaires were developed to evaluate local people and student's perception about Cavernas do Peruaçu National Park, tourism in the region, natural resources conservation and knowledge about the bush dog (*Speothos venaticus*). One adult in each house in the Fabião I village was interviewed by team members. An explanation about the project and its objectives were made before the interview (conducted as an informal chat) actually began. For two local schools a questionnaire was printed for each student between 9-16 years old. The students themselves answered the questions during class;
2) A group of well illustrated presentation about regional ecosystems, amphibians and environmental health and CPNP mammals with special emphasis on bush dog was delivered for local students;
3) We hosted a workshop with local teachers using the problem tree approach to identify the main problems and potential solutions for socio-environmental issues in the Fabião I village. Before the workshop we gave a presentation about the project and a biologist from ICMBio who, by that time, worked in CPNP gave a talk about the National Park.

Outputs and Results

After 2940 days of camera trapping 17 species from five orders of medium and large sized mammals and 397 independent photographs were recorded (Table 2). Sites with high and low species richness were found in both types of use, touristic sites (TS) and non-touristic sites (NTS) (Table 3). Eleven species (64.7%) are shared between NTS and TS while six species are exclusive to one of the two types of site, three to each one. Seven species were recorded in only 20% or less of the sites and can be considered to have a restricted distribution in the valley. In the other hand four species can be classified as wide spread in the valley being recorded in 70 or 80% of the sites. There was no species recorded in all sites.

Table 2: Mammal species recorded by camera traps in Cavernas do Peruaçu National Park

Species	Common name[1]	Weight (kg)[2]	Diet[2]	Status[3]	Records
Pilosa					
Myrmecophaga tridactyla	giant anteater	22-40	in	NT/VU/VU	3
Tamandua tetradactyla	collared anteater	3.5-8.5	in	LC/LC/LC	5
Cingulata					
Dasypus spp*	nine-banded armadillo	2.5-6.3	om	LC/LC/LC	16
Carnivora					
Cerdocyon thous	crab-eating fox	4-9	om	LC/LC/LC	28
Nasua nasua	South American coati	3-7.5	om	LC/LC/LC	5
Procyon cancrivorus	crab-eating racoon	3.5-7.5	om	LC/LC/LC	29
Conepatus semistriatus	striped hog-nosed skunk	1.5-3.5	in	LC/LC/LC	23
Eira barbara	Tayra	2.7-7	om	LC/LC/LC	27
Lontra longicaudis	neotropical otter	5-15	fi	DD/NT/VU	4
Leopardus pardalis	Ocelot	8-15	ca	LC/VU/VU	84
Puma yagouaroundi	Jaguarondi	4-9	ca	LC/LC/DD	7
Puma concolor	Puma	30-120	ca	LC/VU/VU	4
Artiodactyla					
Pecari tajacu	collared peccary	17-30	om	LC/LC/VU	51
Mazama gouazoubira	gray brocket deer	13-23	fo/fr	LC/LC/LC	20
Rodentia					
Kerodon rupestris	rock cavy	0.9-1	fo	LC/LC/NT	5
Hydrochoerus hydrochaeris	Capybara	35-65	fo	LC/LC/LC	1
Cuniculus paca	spotted paca	5-13	fr/fo	LC/LC/LC	85
Total					397

om = omnivore; in = insectivore; fo = folivore; fi = fish specialist; fr = frugivore; ca = carnivore
* For common name, weight and status we considered *D. novemcinctus*
[1] IUCN 2009
[2] Marinho-Filho *et al.* 2002
[3] Global status (IUCN 2009) / National status (Machado *et al.* 2008) / State status (Fundação Biodiversitas 2008)

Table 3: Camera trap site richness and composition in Cavernas do Peruaçu National Park

Species	Sample sites										Site occupancy (%)
	NTS1	NTS2	NTS3	NTS4	NTS5	TS1	TS2	TS3	TS4	TS5	
M. tridactyla	-	-	-	-	-	-	X	-	-	-	10
T. tetradactyla	X	X	-	-	-	-	-	-	-	-	20
Dasypus spp.	X	X	-	-	-	-	-	-	-	-	20
C. thous	-	-	-	-	-	-	X	X	-	-	20
N. nasua	X	X	-	-	-	-	-	X	-	-	30
P. cancrivorus	-	-	X	X	X	X	X	X	-	X	70
C. semistriatus	X	X	X	-	-	-	X	-	-	-	40
E. barbara	X	X	-	X	-	-	X	X	-	X	60
L. longicaudis	-	-	-	-	-	X	X	-	-	-	20
L. pardalis	X	X	X	-	-	X	X	X	X	X	80
P. yagouarondi	-	-	X	-	-	-	X	X	-	-	30
P. concolor	-	X	-	-	-	-	-	X	-	-	20
P. tajacu	X	X	X	-	X	-	X	X	X	X	80
M. guazoupira	X	X	X	-	X	-	-	X	-	-	50
K. rupestris	-	-	-	-	X	-	X	-	X	-	30
H. hydrochaeris	X	-	-	-	-	-	-	-	-	-	10
C. paca	X	X	X	X	X	-	X	-	X	X	80
Observed richness	10	10	7	3	5	3	11	9	4	5	
Estimated richness (Jackknife I)	11.99 (±2.8)	11.07 (±2)	7.85 (±2)	3.55 (±1.5)	6.65 (±2.7)	3.7 (±1.9)	12.48 (±3.2)	10.69 (±3.0)	4.96 (±2.2)	5.58 (±2.1)	

Estimated species richness was only statistically different for the low and high cave influence comparison. Low cave influence sites had about nine species more than those sites with high cave influence (Fig. 3b). Richness estimated for NTS and TS were almost the same with minor differences between them (Fig. 3a), seasonality also had no influence in species richness (Fig. 3c).

Overall RAI was not statistically different when comparing NTS and TS. In contrast overall RAI was larger in the dry season rather than in the wet season and was also larger in sites with low cave influence opposing to sites with high cave influence (Table 4). When analyzing RAI values in NTS and TS for each species independently five out of eight species showed statistical differences between the two kinds of sites. *Cuniculus paca*, *Eira barbara* and *Mazama gouazoubira* had higher values in NTS while *Leopardus pardalis* and *Cerdocyon*

thous were more frequently recorded in TS. Seasonality affected RAI in half of the species evaluated. *Cuniculus paca*, *L. pardalis* and *M. gouazoubira* was more frequently recorded in the dry season while only *Pecari tajacu* was more recorded in wet season. Cave influence had a great effect over RAI. Almost every species was remarkably more recorded in sites with low cave influence, with extremely low p-values. *Procyon cancrivorus* was the only species that did not show a significant difference in RAI for cave influence.

Table 4: Relative Abundance Index values in each parameter evaluated for most recorded species in Cavernas do Peruaçu National Park

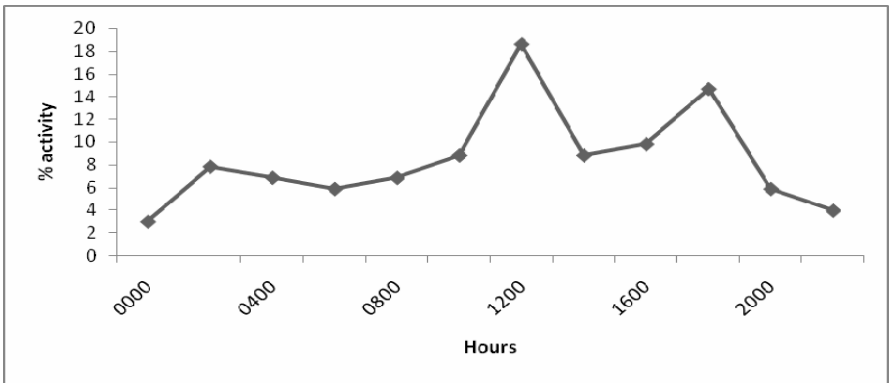
	Type of use			Season			Cave influence		
Species	NTS	TS	p	Dry	Wet	p	Low	High	p
C. thous	0.000	0.172	**>0.001**	0.125	0.072	0.15	0.137	0	**>0.001**
P. cancrivorus	0.107	0.092	0.68*	0.165	0.048	**0.003**	0.102	0.088	0.72*
C. semistriatus	0.107	0.055	0.12	0.094	0.065	0.38*	0.112	0	**>0.001**
E. barbara	0.145	0.049	**0.01**	0.079	0.101	0.51*	0.132	0	**>0.001**
L. pardalis	0.183	0.368	**0.001**	0.416	0.185	**>0.001**	0.357	0.122	**>0.001**
P. tajacu	0.130	0.208	0.09	0.086	0.239	**>0.001**	0.24	0.022	**>0.001**
M. guouazoubira	0.115	0.031	**0.009**	0.047	0.083	0.21	0.093	0.011	**>0.001**
C. paca	0.390	0.208	**0.004**	0.361	0.233	**0.04**	0.387	0.066	**>0.001**
Overall	1.428	1.287	0.33*	1.572	1.181	**0.009**	1.773	0.389	**>0.001**

Bolded p-values are statistically significant
Most p-values are for t-test with separate variances while asterisk (*) means regular t-test

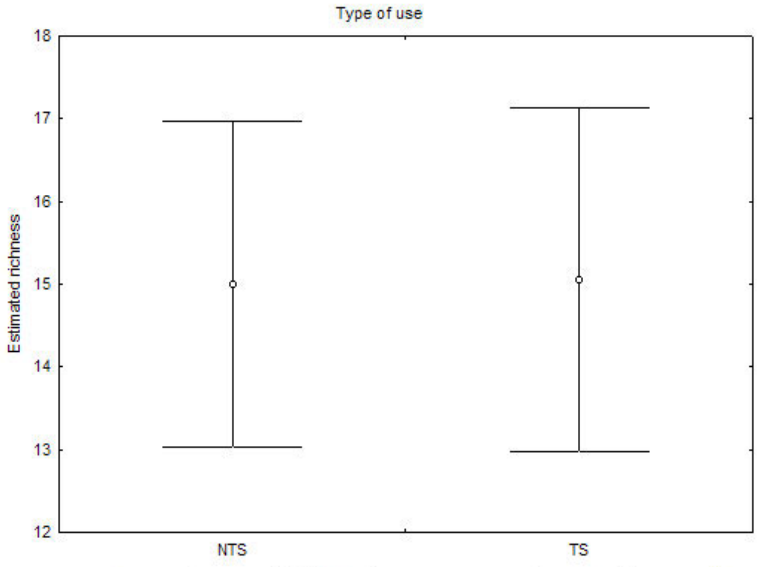
Non-touristic sites and TS did not form two separate groups in cluster analyzes (Fig. 4). Groups that can be observed are apparently defined by species richness, especially low species richness in sites with high cave influence that formed an inner group in the diagrams.

Activity pattern was defined for eight species and for half of these species was possible to define activity pattern in each class of use (see Section 4 – raw data). *Tayassu pecari*, *M. gouazoubira*, *E. barbara* and *L. pardalis* showed substantial activity during day time. Indeed the number of ocelot records obtained during day time is surprisingly high. Out of 103 records 60 were between 0600 and 1700, with a peak around 12:00 (Fig. 5).

Figure 5: Ocelot (*Leopardus pardalis*) activity pattern in Cavernas do Peruaçu National Park



a)



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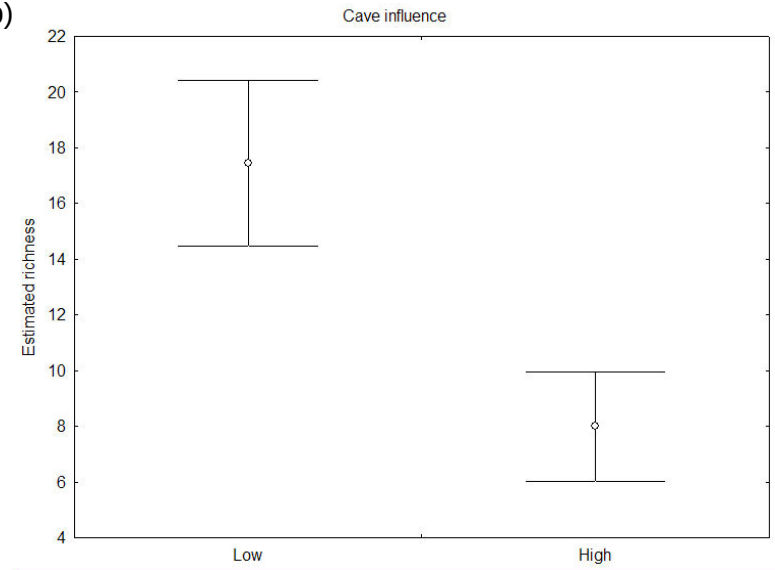

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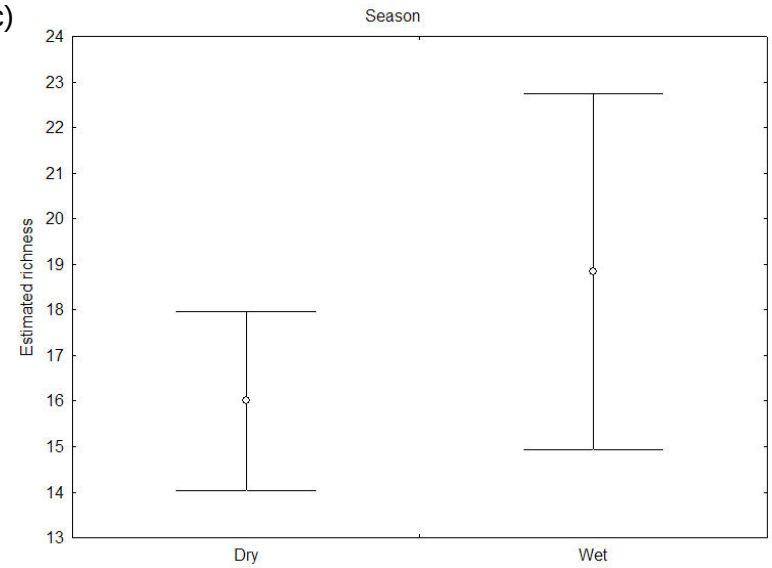


Figure 3: Estimated species richness (Jacknife I) of large mammals for each parameter evaluated. a) Type of use; b) Cave influence; c) Season. Horizontal lines are confidence intervals. NTS = Non-touristic sites; TS = Touristic sites

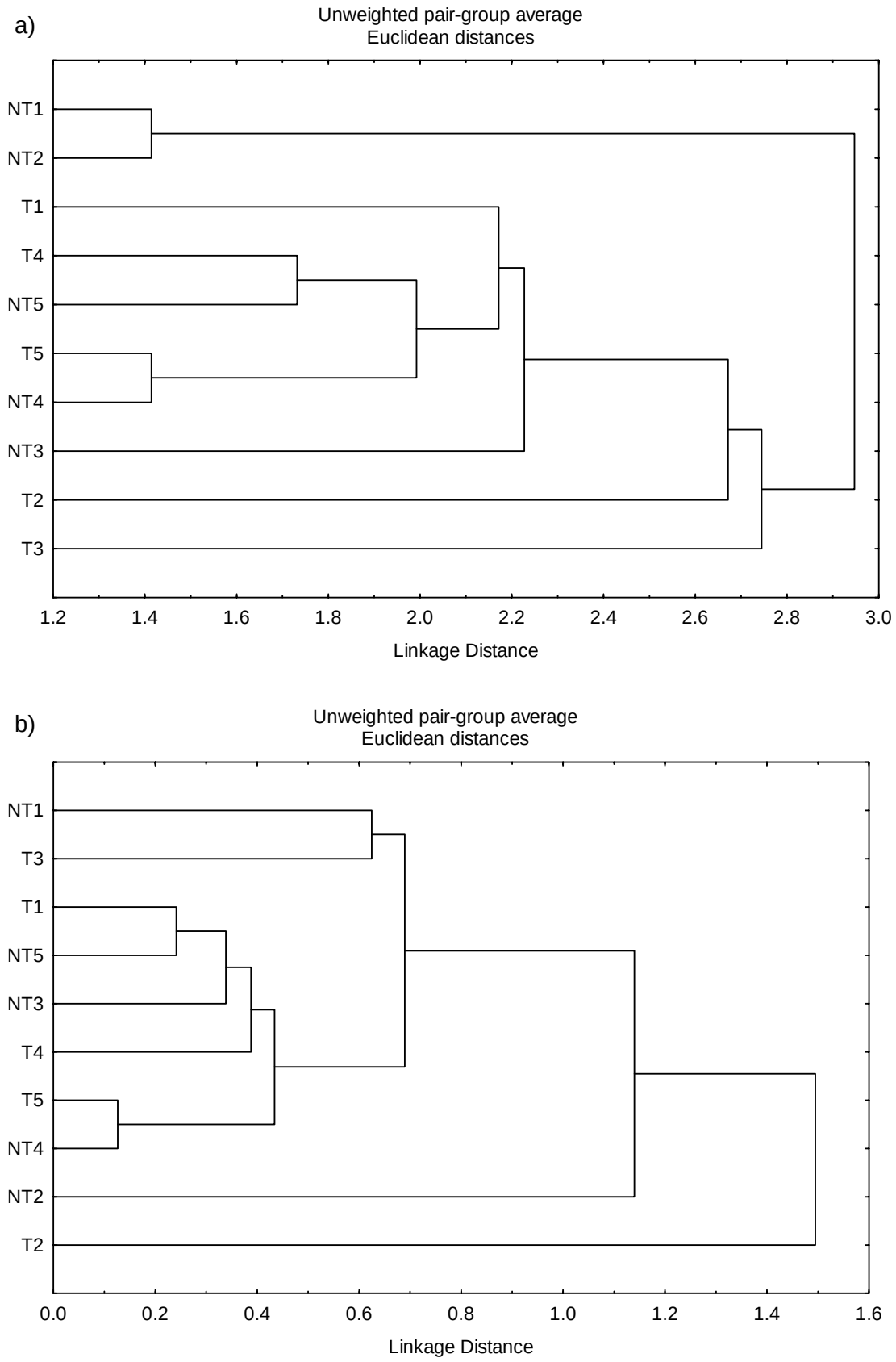


Figure 4: Cluster analyzes. a) Large mammal species presence/absence; b) Large mammal species Relative Abundance Index. NT = Non-touristic sites; T = Touristic sites

Eleven ocelots' individuals were identified using 39 right flank photographs and the same amount was identified using 60 left flank photographs. The mean number of records per individuals was 3.54 for right side and 5.45 for left side. In four photographs we were not able to identify individuals. Correlations results suggest that ocelot is a good surrogate species for the large mammal community in CPNP (Table 5). Ocelot relative abundance and number of ocelot individuals per site are good predictors for species richness and overall relative abundance.

Table 5: Sperman Correlation results for comparisons between ocelot parameters and large mammal community parameters

Ocelot parameter	Large mammal community parameter	Spearman rs (p)
Ocelot RAI	Jackknife I	0.79 **(< 0.01)**
Ocelot records	Jackknife I	0.71 **(< 0.05)**
Ocelot individuals	Jackknife I	0.78 **(< 0.01)**
Ocelot RAI	Sobs	0.80 **(< 0.01)**
Ocelot records	Sobs	0.73 **(< 0.05)**
Ocelot individuals	Sobs	0.80 **(< 0.01)**
Ocelot RAI	Overall RAI	0.75 **(< 0.05)**
Ocelot records	Overall RAI	0.65 **(< 0.05)**
Ocelot individuals	Overall RAI	0.75 **(< 0.05)**

Bolded p-values are statistically significant.
RAI = Relative Abundance Index; Sobs = species observed

Overall the different monitoring schemes tested provided high probabilities of detecting 10% and 8% changes in species richness but when smaller variations are to be detected higher sample efforts are needed (Table 6). The cost of each scheme refers to the total amount of money needed to implement the monitoring program including equipment, field and personnel costs. Since equipment acquisition would happen only in the first year of implementation and for subsequent replacement of camera traps, the following years of monitoring activities tends to be at least 50% cheaper than the first year.

Table 6: Probability of detecting variation in large mammal species richness in different monitoring schemes for Cavernas do Peruaçu National Park

Variation	6 months		8 months		10 months		12 months	
	7 cameras	10 cameras	7 cameras	10 cameras	7 cameras	10 cameras	7 cameras	10 cameras
-10%	**0.973**	**0.995**	**0.991**	**0.991**	**1.000**	**0.999**	**0.999**	**0.998**
-8%	**0.996**	**0.982**	0.704	**0.979**	**0.974**	**0.990**	**0.974**	**0.998**
-6%	**0.956**	0.691	**0.918**	**0.992**	**0.993**	**0.977**	**0.956**	**0.998**
-4%	0.595	**0.941**	0.881	**0.966**	**0.991**	**0.979**	**0.932**	**0.994**
-2%	0.102	0.868	0.762	0.727	0.629	0.877	**0.940**	**0.986**
2%	0.558	0.843	0.407	0.820	**0.972**	**0.949**	**0.962**	0.864
4%	**0.964**	**0.956**	0.897	0.864	**0.965**	**0.983**	**0.917**	**0.994**
6%	0.686	**0.971**	**0.978**	**0.979**	**0.996**	**0.986**	**0.935**	**0.991**
8%	**0.986**	**0.977**	**0.965**	**0.971**	**0.997**	**0.990**	**0.996**	**1.000**
10%	**0.992**	**0.995**	**0.985**	**0.996**	**0.984**	**0.998**	**1.000**	**0.996**
1st year cost (US$)	7550.00	9500.00	8550.00	10500.00	9550.00	11500.00	10550.00	12500.00
3 years cost (US$)	13550.00	15500.00	16550.00	18500.00	19550.00	21500.00	22550.00	24500.00

Probability values above 90% are bolded.

Social Sciences

More than 60 students were present at the talks about regional biodiversity and ecosystems at the Fabião I public school (Fig. 5).

Figure 5: Students attending one of the talks at Fabião I Public School, surroundings of Cavernas do Peruaçu National Park

Sixty-eight students answered the questionnaires and 38 different houses, therefore 38 adults, were interviewed in the Fabião I village. Overall the results show that both students and local residents recognize the value and importance of nature in their lives

(see Section 4 – raw data). They also have positive feelings about the CPNP and are well informed about its objectives. From the percentages in some question it is possible to infer that adults are better informed than local students about regional environmental issues. The students' answers to questions 7 and 9 (Section 4 – raw data) shows an interesting contradiction or a lack of linkage between environmental health and human well-being and is a good example of the incomplete knowledge about environmental issues. More than 80% of the students attribute a high value to the Peruaçu River (Question 7) but only 37% consider that water quality of the river which provides water to their houses has high interference in their lives (Question 9). Another surprising data is that almost 60% of adults interviewed have already heard something about the bush dog – a species that is normally not known even by experienced people who works in the bush – and 32% of adults said that they got to know the species through this project.

Ten teachers attended the workshop to develop the problem tree (Fig. 6). From the problem tree assembled emerged causes, consequences and possible solutions for regional socio-environmental issues that are listed below (very broad topics were omitted):

Causes

- Deforestation, poaching, forest fires;
- Lack of efficient public policies and support from municipality government;
- Absence of garbage collection service and lack of orientation regarding garbage destination;
- Lack of knowledge and information.

Consequences

- General socio, economic and environmental unbalance;
- Fauna and flora extinction;
- Unfertile and poor soils;
- Destruction of river and streams;
- Displacement of animals from its natural habitats;
- Human migration seeking better conditions.

Possible solutions

- Enhance partnerships;
- Insert environmental education activities in the school curriculum;
- Negotiate with the local government the implementation of garbage service;
- Approximation between school community and the National Park;

- Development of a project for valorization of local culture;
- Mobilization of the local community to clean water bodies;
- Talks and workshop for the local community;
- Construction of a small place to commercialize local products.

Figure 6: Workshop for school teachers at Fabião I village

Achievements and Impacts

Although it represents only half of CPNP large mammal richness, the number of species recorded in the project is satisfactory since the species accumulation curve almost reached the asymptote. We had no expectation to record every species that occur in CPNP since we concentrated effort in a relatively small area of the national park and virtually in only one of the many habitat types available

It is noteworthy the large number of ocelot (*Leopardus pardalis*) records which allows the monitoring of this species to evaluate the potential impacts touristic activities might have on the Peruaçu River Valley. Besides the large number of records, three other features make ocelots a good target species to complement the monitoring scheme based on the large mammal community: 1) ocelots had a significant larger RAI in TS than in NTS (thus more likely to be affected by tourists); 2) had a peak of activity during day hours (time of the day in which tourists will be visiting the national park) and; 3) due to its pelage patterns ocelots can be individually identified in photographs providing a new parameter to be monitored: number of individuals or density.

Track search can be used as a complementary method to camera-trapping only to assess overall species richness and distribution (see Section 4 – raw data). Due to variation in the water level, the amount of adequate substrate for footprints varied each month invalidating any between-month comparison. Nevertheless this method can provide better information on Neotropical otter (*Lontra longicaudis*) – a data deficient and regionally threatened species – distribution in the valley than camera-trapping.

Since tourism activity in CPNP is not allowed yet and occurs only in especial situations it is not likely that the large mammal community is being affected by it. Thus sites with high and low species richness are found in both tourist and non-tourist areas. Also estimated richness was almost identical for both NTS and TS. Similarly a high proportion of species are shared between these two types of use. Species exclusive to one of the two types were either recorded only a few times or in a few sites which means that the exclusivity dues more to the rarity or restricted distribution of the species in the valley than to any other effect caused by sporadic visitors. In the same way the difference observed for overall RAI in NTS and TS is not statistically significant. Cluster analyses corroborate with this hypotheses. The groups formed had no relation with tourist use or not. In both data sets (species presence/absence and species RAI) species richness apparently is the main feature determining the clusters, especially low species richness. Sites with high cave influence that are also the sites with lower richness are grouped together. In fact, cave influence had a great effect over

the large mammal community in CPNP. It affected species richness, overall RAI and RAI for seven out of eight species evaluated. Lower values for theses parameters were found in sites with high cave influence. Caves are known to be low-productivity places since the primary productivity is virtually absent. As well documented in a wide array of environments diversity is normally influenced by energy availability (Gaston 2000), thus low-energy sites are not expected to have great diversity. These findings allow us to infer that visitors inside the caves should not be a major problem for the large mammal community as a whole (although it is a potential problem for the invertebrate – see Ferreira & Horta 2001 – and also for the bat community). In the other hand visitors using trails and pathways to access the caves are likely to affect the mammal community especially those species more active during the day. These findings have major implications for the park's management and should be considered when planning tourist routes in the valley.

Water availability has a great potential to influence the distribution and abundance of animal in arid and semi-arid ecosystems. Species most affected by this feature should be those that do not have physiological adaptations to cope with water scarcity (Wolff 2001). Since none of the species recorded show any characteristics considered adaptive in semi-arid climates (Marinho-Filho et al. 2002; Mares et al. 1985) and the study area is located in a region where the dry season last for five to six months with virtually no rain, it is reasonable to infer that the gallery forests associated with the Peruaçu River act as a refuge in the dry season at least for some species. These species tend to concentrate their activities in this habitat probably because resources – especially water – are scarce in other habitats during the dry season. The importance of gallery forests to mammal fauna has already been shown in other studies (e.g., Johnson et al. 1999; Redford & Fonseca 1986). This finding reinforce the need for especial protection of the gallery forests, besides act as refuge they also have a great potential to work as biodiversity corridors linking natural vegetation remnants. Peruaçu Valley gallery forests, if protected and well managed, can connect CPNP with Veredas do Peruaçu State Park, located in the upper part of the watershed.

The lowest cost to detect a 2% decline in species richness with a probability higher than 90% is reached at the 12 months and seven camera traps scheme. Nevertheless we believe that a scheme which provides probabilities above 90% to detect a 4% decline is acceptable and should be used in CPNP. According to our simulations this scheme would be an eight months survey using ten camera traps in sites with low cave influence. Considering that equipment normally works properly for at least 24 months, surveys of such scheme could be conducted annually for three years (24 months of

sampling) at an estimated total cost of US$ 18,500.00. Although the cost of such a scheme is almost the same as the 12 months and seven camera traps scheme it is 33% shorter in its length. A quicker scheme is preferable because provides information faster and the equipment is likely to last longer (i.e. can be used in more surveys).

As assessed by interviews and questionnaires the local community already shows some degree of commitment - or at least awareness – about nature conservation and therefore they should be considered as potential partners in any nature related initiatives in the region. We believe that students' environmental knowledge can be enhanced. There is an opportunity to do so working close to local schools since this was cited by teachers as one of the possible solutions in the problem tree workshop. During the interviews it was possible to note that the positive feelings towards CPNP are related to the development of economic opportunities within the tourism sector after the park is opened for visitors. Since there are great expectations related to tourism activities and our project has the potential to affect these activities, a good communication must be established between researchers and community members involved in the tourism sector. Members from the local community are important stakeholders and have a major role to play in the development of low impact tourism in the Peruaçu Valley.

Although some topics that emerged from the problem tree are broad and some are related mainly to the public sector the activity generated a good picture of the way school teachers realize the environmental issues in the Peruaçu Valley. More important the problem tree showed how conservationists and park managers can work with the school community.

SECTION 3

Peruaçu River in the dry season – the main water source in the region

Conclusion

Due to its rarity bush dog is not a suitable species to be monitored in CPNP, nevertheless it is necessary to continue the effort to record this elusive and poor known canid in the region.

We certainly have baseline data on species composition, richness, distribution, relative abundance and activity pattern that can be used as a reference scenario for data collected after tourism is allowed in CPNP.

Simulations showed that it is feasible to monitor species richness in the Peruaçu Valley through several years with high probabilities of detect changes if it happens. We suggest that an adequate scheme to monitor large mammal species richness in the Peruaçu River Valley should use ten camera traps placed in sites with low cave influence during eight months. The protocol that we recommend can be implemented by one researcher and one field assistant working only 20 days in the field per year at an estimated annual cost of about US$ 6,200.00. A monitoring scheme would be more robust and reliable if it uses data on both the mammal community as a whole and on key species. From our dataset we can infer that Ocelot (*Leopardus pardalis*) is the most suitable mammal occurring in the valley to implement a complementary scheme based on a focal species.

Since cave proximity negatively influenced mammal community, tourists inside the caves should not be a major problem for these species (although it may be a threat for other taxonomic groups). But the length of the routes to touristic sites should be as short as possible, leading directly to the caves and avoiding gallery forest areas. Peruaçu River Valley is more intensely used by the mammal fauna during the dry season probably acting as a seasonal refuge for this community. Thus especial attention should be paid to touristic activity in the months of winter vacation, June and July, when the number of visitors will certainly increase.

Problems encountered and lessons learnt

We had two important problems during the project: 1) the target species (Speothos venaticus) was never recorded and 2) a new governmental institution was created to manage Brazilian protected areas, the associated changes jeopardized our communication and awareness raising actions.

The reasons why bush dogs were chosen as the target species are stated in the preliminary report (Ferreira *et al.* 2010). Even though the target species was not recorded we still have baseline data to monitor potential touristic impacts and consequently can deliver similar results using different species and parameters. We decided to use species richness as one of the monitoring parameters and selected the ocelot (*Leopardus pardalis*) as the new target species for a monitoring program based on a focal species. Since ocelot was the second most recorded species we have enough data to use four different monitoring parameters related to this species: 1) relative abundance; 2) number of individuals recorded per site; 3) site occupancy and; 4) activity pattern.

Since we are still able to delivery similar results we consider that the ecological methods were adequate to the objectives. Although bush dogs were not recorded camera trapping is probably one of the best methods to record the species if present. The other one is a trained dog, but this depends on adequate training and a permit to take the dog inside protected areas.

In the original project we planned to use CPNP council meetings to reach local stakeholders and a small project to take local people to visit the park. These activities had IBAMA, the former institution responsible for CPNP, as an important partner. After the creation of the new institution (ICMBio) in 2007 the council meetings never happened again and the project to take people to the field did not work out. Indeed we joined CPNP staff in a pilot field visit with locals but due to the institutional changes a second visit did not take place (Fig. 7). It is important to note that the new institution (ICMBio) and staff did not have anything against the project. Unfortunately they were adapting to the new changes and by that time were not able to perform additional activities. We consider ICMBio an important partner if a successful monitoring program is to be implemented in CPNP. In fact we have a good relationship with CENAP (a biodiversity research center inside ICMBio) and a researcher from this institution is now part of the project's team. With all these changes we decided to concentrate our communication activities in the local schools having the students as the main stakeholders and important "multiplier agents".

Main lesson learnt: Never start by monitoring the rarest animal, you will never get enough data!

Figure 7: Pilot field visit with local community

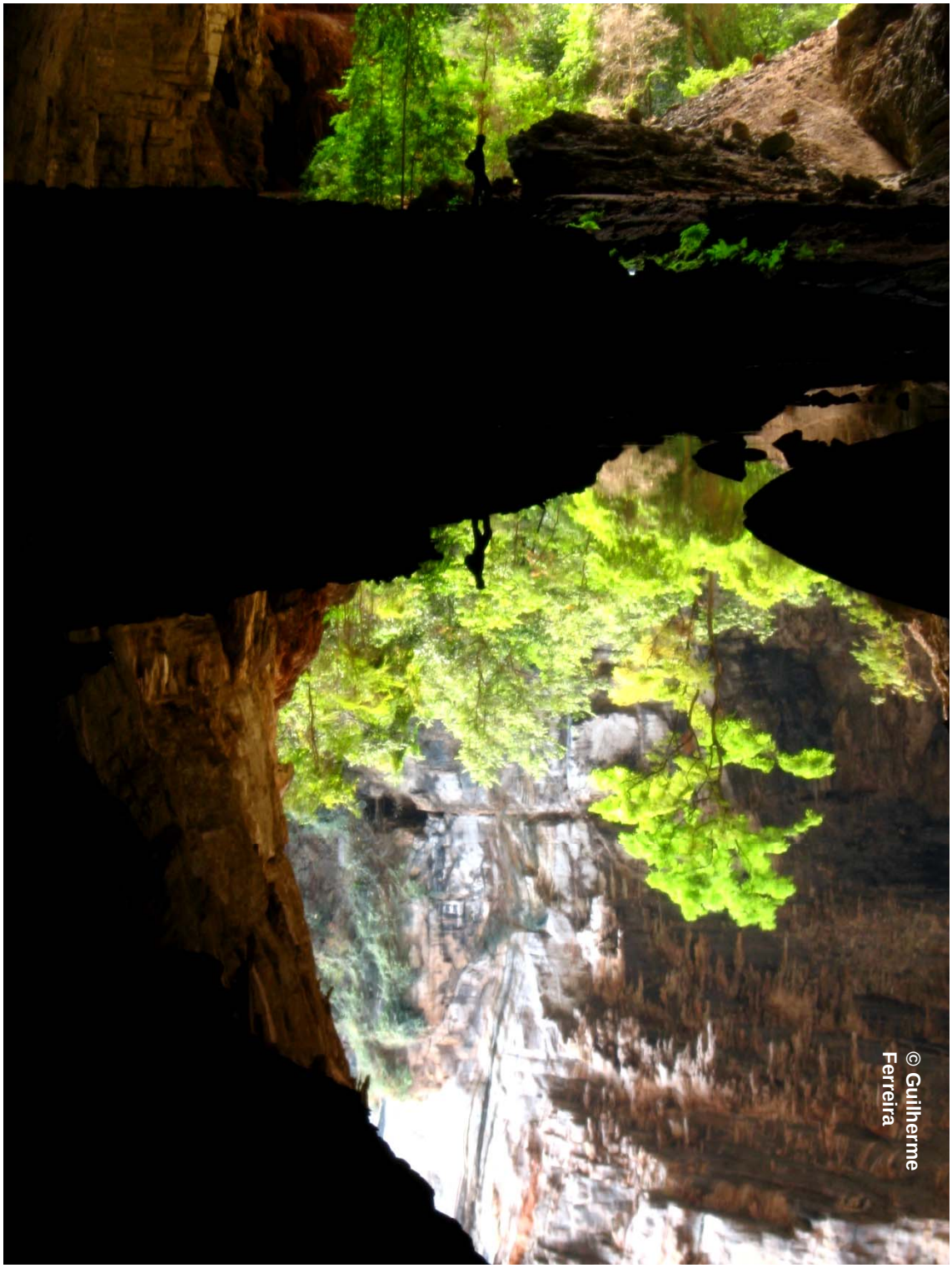
In the future

Based on our findings during the CLP project two projects are being carried on (otter feeding ecology in CPNP and an evaluation of the seasonal use of riparian habitats by large mammals in the Veredas do Peruaçu State Park, in the upper Peruaçu River). Another project funded by Pathera Fund is going to begin in June 2011 and will estimate ocelot abundance in CPNP aiming the acquisition of more baseline data and the improvement of the monitoring scheme. A researcher from CENAP (a research center inside ICMBio) and former biologist in CPNP is part of the team in this new project. This will certainly improve our communication with the governmental agency and may help to transform our recommendations into actions. We have secured funds to implement and improve the monitoring scheme suggested here for the next 12 months and we intend to maintain it for several years after the park is opened for visitors.

Since riparian habitats are key habitats for biodiversity in the Peruaçu Valley and are quite threatened outside protected areas we intend to develop a project involving ecosystem services provided by Peruaçu River riparian habitats and local communities' welfare. If the environmental quality of the riparian ecosystem in the upper Peruaçu River decreases the lower part of the valley including CPNP, its caves and its biodiversity is condemned in the long term. We thus intend to link human health with ecosystem health by organizing community events where the importance of riparian environments for humans and animals will be highlighted. In these events seedlings of native trees will be distributed for local residents and a group of voluntary doctors will give some advices on basic health.

For our former target species, the bush dog, we believe that efforts to confirm its presence in the region must continue. Our currently camera-trap initiatives in the region, although have other main objectives, has the potential to eventually record the species. Only after this confirmation specific conservation actions can be developed.

SECTION 4



Reflex of researcher in the entrance of a cave in Peruaçu Valley

Appendices

Full account of income and expenditure

Itemized expenses	Total CLP requested[1] (USD)	Total CLP used (USD)
PHASE I - PROJECT PREPARATION		
Administration		
Bank account maintenance and fees	200.00	190.00
General office equipment	60.00	72.58
Desktop computer	850.00	0.00
Equipment		
12 Tigrinus camera traps	2.880.00	2.842.10
GPS Garmin Map 60	430.00	684.21
AA alcaline batteries	690.00	176.00
D alcaline batteries	830.00	245.00
35 mm negative photograph film	550.00	340.00
All-wheather backpacks (dry sac)	28.00	58.95
Tigrinus programmer	50.00	0.00
AA rechargeable batteries	18.00	0.00
9v batteries	14.00	0.00
Drinking water	70.00	0.00
Positive photograph films	30.00	0.00
PHASE II - IMPLEMENTATION EXPENSES		
Transportation, food and accomodation		
Fuel	900.00	1.070.00
Field vehicle maintenance	900.00	1.750.00
Food for team members and local guides	1.600.00	1.654.15
Bus tickets	0.00	145.63
Ocasional accomodation for team members in town	0.00	94.73
Other items		
Photograph film development	1.030.00	0.00
Bait to attract animal to camera traps	60.00	0.00
Outreach activities and workshops		
Photocopy service	30.00	52.78
Folder printings	430.00	0.00
Project poster printing	100.00	0.00
Snacks and soft drinks for workshop	100.00	0.00
PHASE III - POST-PROJECT EXPENSES		
Administration		
Administration	300.00	0.00
Report production and results dissemination	100.00	0.00
Development of positive photograph film	20.00	0.00
Total	**12.270.00**	**9.376.13**

[1] Refers to the total amount requested. The amount actually received was US$ 9300.00 representing 75% of total requested.

Papers published or manuscripts proposed based on project data

Poster to be presented on the 10th Brazilian Ecology Congress next September – Effect of seasonality over large mammal richness and relative abundance in riparian habitats in the Peruaçu Valley, Northern Minas Gerais.

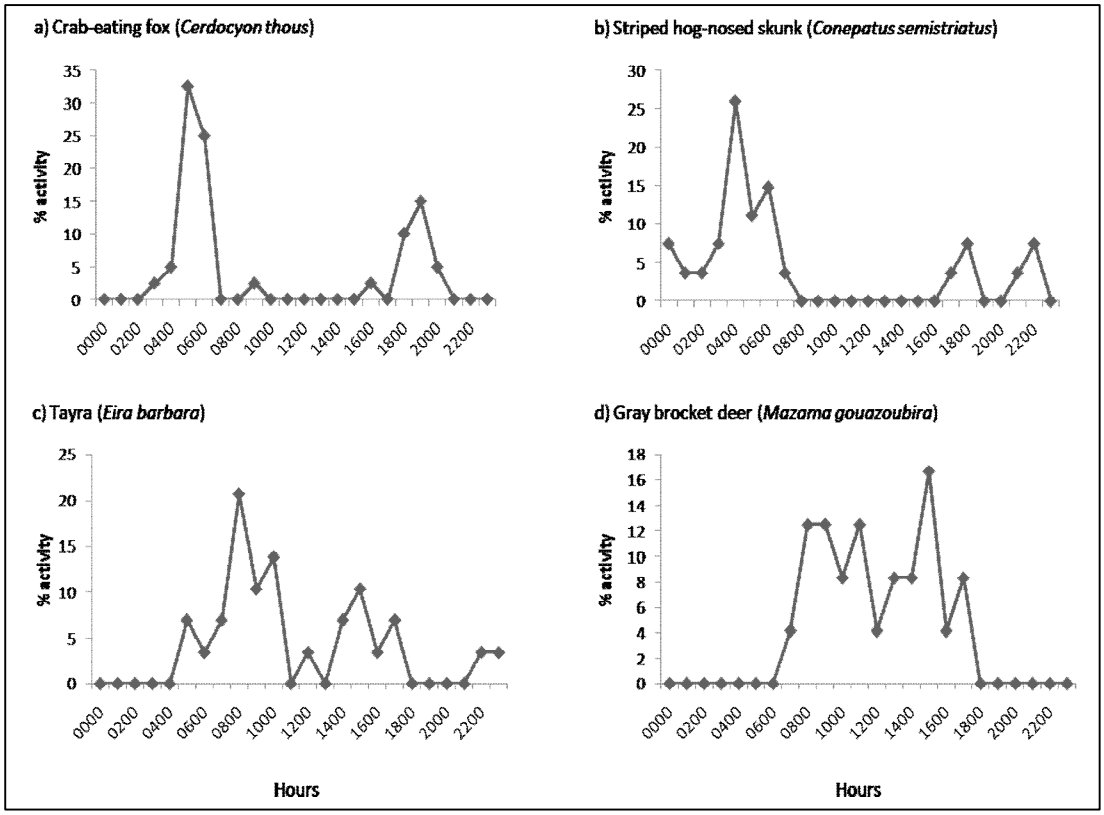
A research note and two papers are in development to be submitted to Journal of Mammalogy, Journal of Tropical Ecology and Journal of Wildlife Management (or similar periodic) respectively: 1) "unusual ocelot activity pattern in Cavernas do Peruaçu National Park, southeastern Brazil"; 2) "seasonal use of gallery forest by a large mammal community in a semi-arid region"; 3) "monitoring potential negative impacts from touristic visitation over large mammal fauna – a case study with camera traps in the neotropics"

A final course monograph on Neotropical otter (*Lontra longicaudis*) feeding ecology in CPNP will be presented in July 2011 in the University of Jequitinhonha and Mucuri Valleys (UFVJM), Diamantina, Minas Gerais. Although this theme is not directly linked with the original project part of the data was collected during CLP funding.

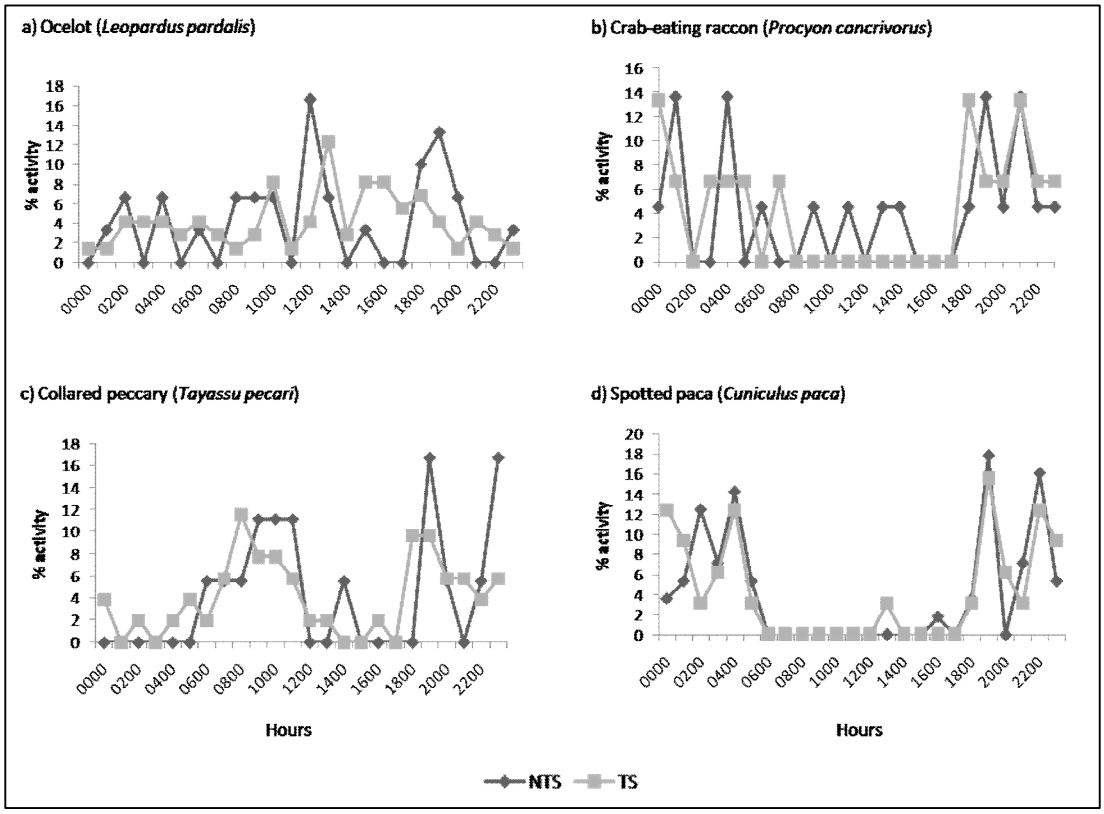
Additionally camera trap photographs obtained in this project were used in a communication material of CPNP developed by ICMBio.

Raw data

Activity pattern of four large mammal species in Cavernas do Peruaçu National Park



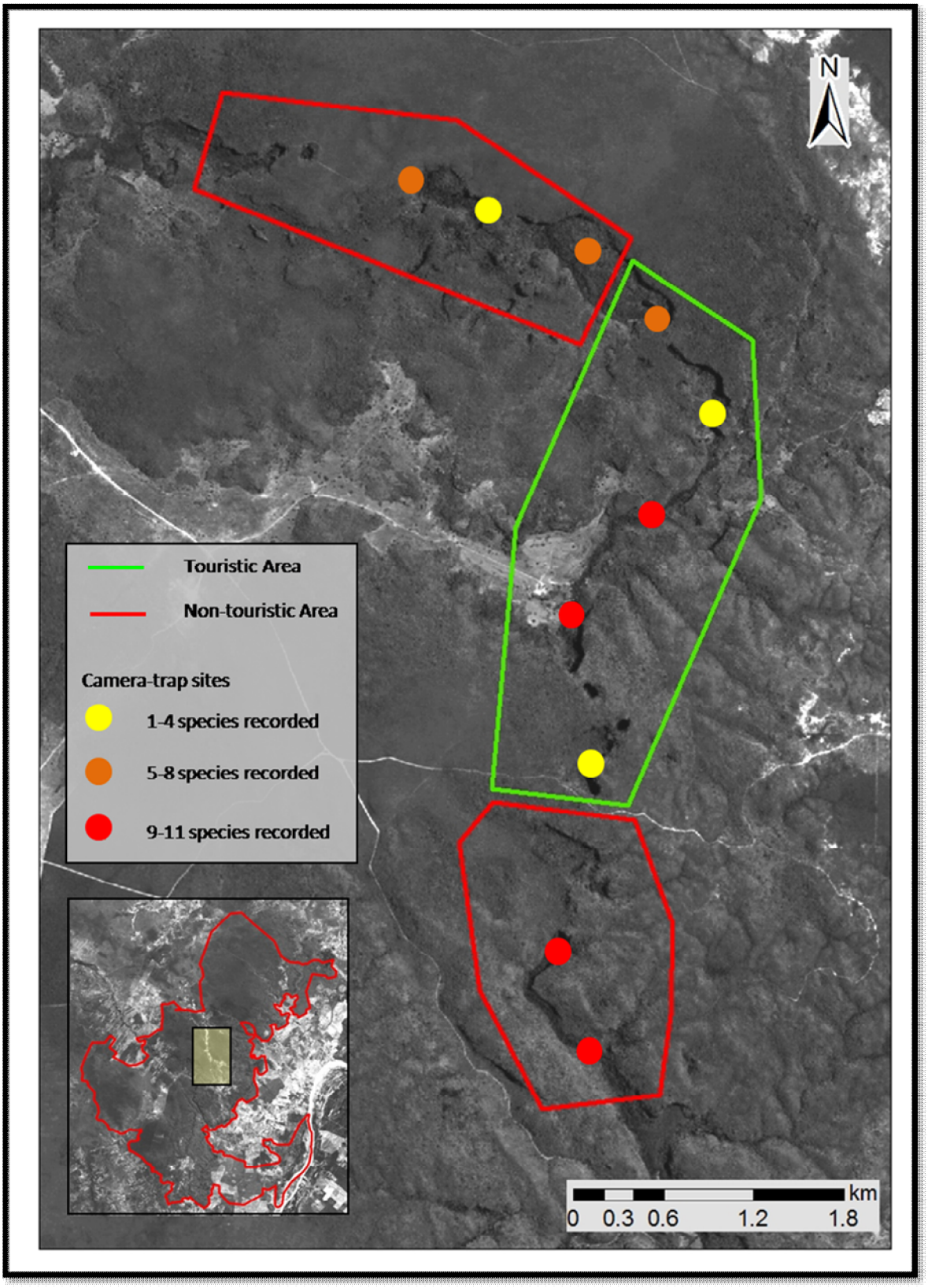
Activity pattern of four large mammal species in non-touristic sites (NTS) and touristic sites (TS) in Cavernas do Peruaçu National Park



Species recorded by footprints in each segment of the river valley

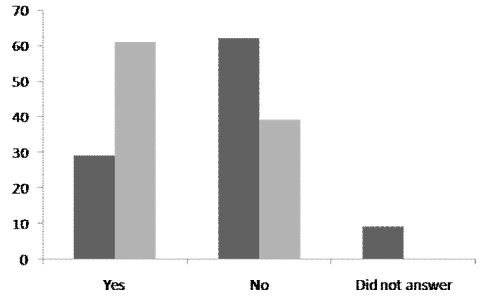
Species	Valley segments								
	NTS1-NTS2	NTS2-TS1	TS1-TS2	TS2-TS3	TS3-TS4	TS4-TS5	TS5-NTS3	NTS4-NTS5	NTS5-Silu
P. cancrivorus		X	X		X		X		X
L. longicaudis	X	X	X		X	X		X	X
L. pardalis			X	X	X				
small felids					X				
P. concolor	X	X							
P. tajacu					X		X	X	X
Mazama spp.	X				X		X	X	
H. hydrochaeris	X	X							
C. paca	X		X		X		X	X	

Spatial distribution of large mammal species richness in the Peruaçu River Valley

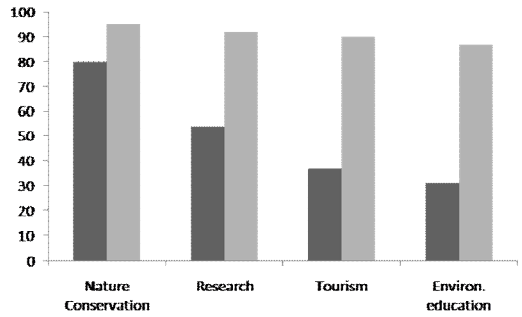


Results from the questionnaires with local students and interviews with local residents at Fabião I, surroundings of Cavernas do Peruaçu National Park

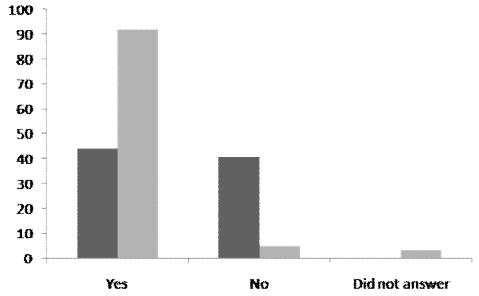
1) Do you know Cavernas do Peruaçu National Park?



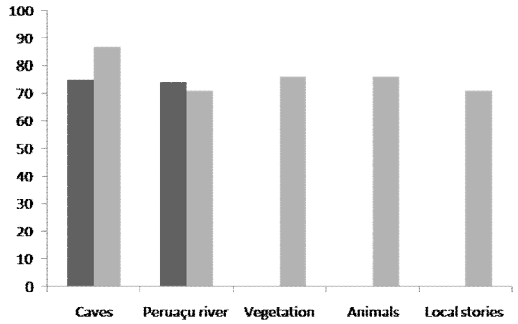
2) What are the objectives of Cavernas do Peruaçu National Park?



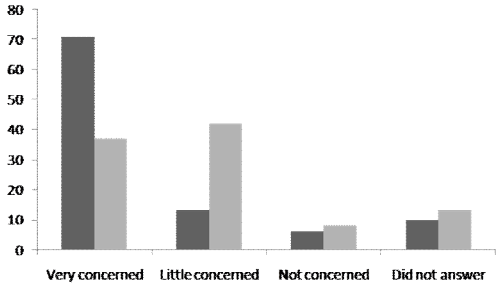
3) Do you think your community can benefit from the existence of the National Park?



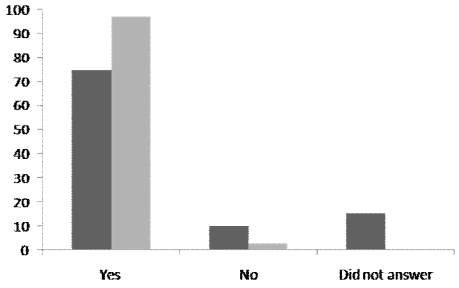
4) What does attract tourists to the National Park ?



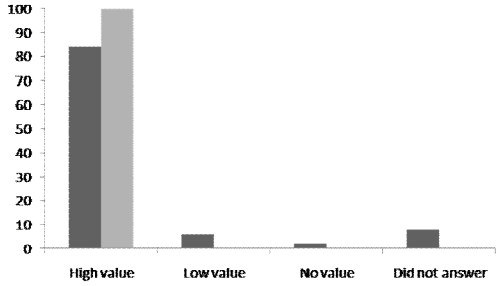
5) Are people visiting to the region concerned about nature conservation?



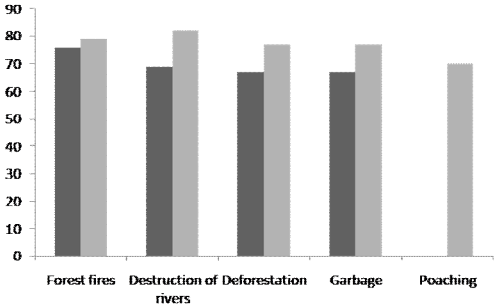
6) Do you think it is important to conserve nature in the region where you live?



7) The Peruaçu River to you and your family has:



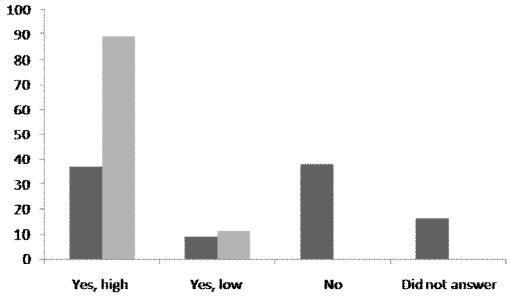
8) What are the main environmental problems in your region?



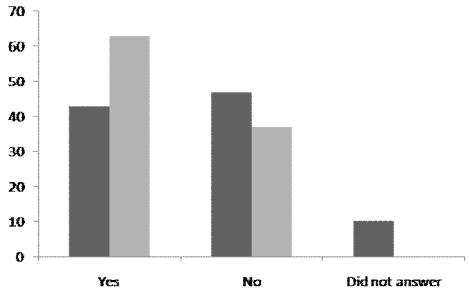
■ Students ■ Local residents

Results from the questionnaires with local students and interviews with local residents at Fabião I, surroundings of Cavernas do Peruaçu National Park (cont.)

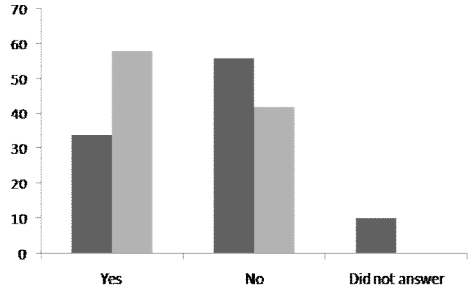
9) Do you think Peruaçu River water quality has interference in your life ?



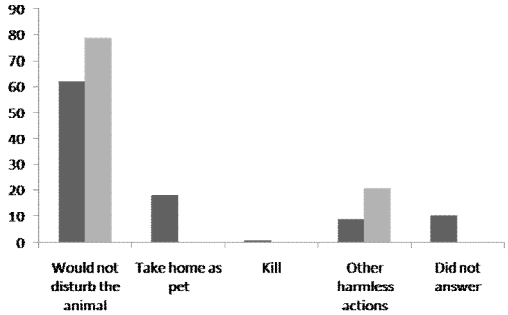
10) Are there animals and plants disappearing in your region?



11) Have you ever heard about the bush dog?

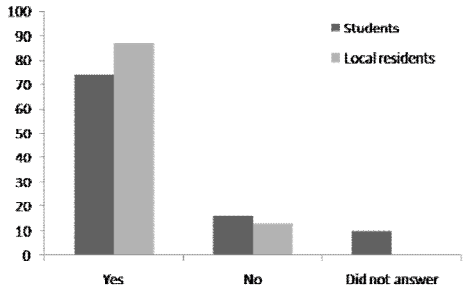


12) If you find a wild animal what would you do?

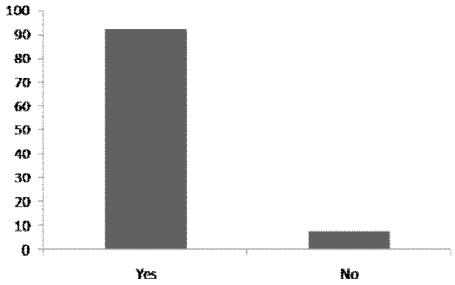


Students Local residents

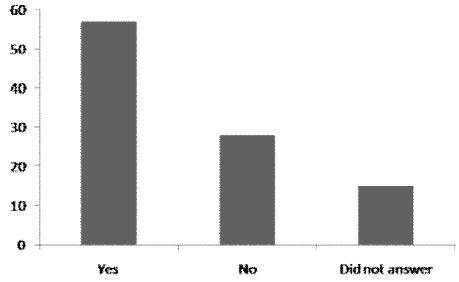
13) Do you have the habit to think about nature?



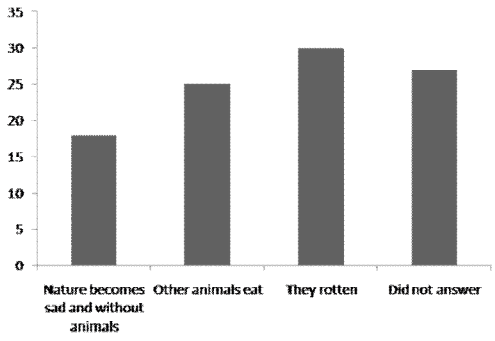
14) If you had a property by the river would you like to maintain the gallery forest ? (Local residents only)



15) Do you think it is possible that an animal or plant could disappear forever from earth? (Students only)



16) What happens when an animal dies in the bush? (Students only)



Camera trap photos from Cavernas do Peruaçu National Park

Giant anteater - *Myrmecophaga tridactyla*

Collared anteater - *Tamandua tetradactyla*

Nine-banded armadillo - *Dasypus novemcinctus*

Crab-eating fox - *Cerdocyon thous*

South American coati - *Nasua nasua*

Crab-eating racoon - *Procyon cancrivorus*

Striped hog-nosed skunk - *Conepatus semistriatus*

Tayra - *Eira barbara*

Neotropical otter - *Lontra longicaudis*

Ocelot - *Leopardus pardalis*

Jaguarundi - *Puma yagouaroundi*

Puma - *Puma concolor*

Collared peccary - *Pecari tajacu*

Gray brocket deer - *Mazama gouazoubira*

Rock cavy - *Kerodon rupestris*

Capybara - *Hydrochoerus hydrochaeris*

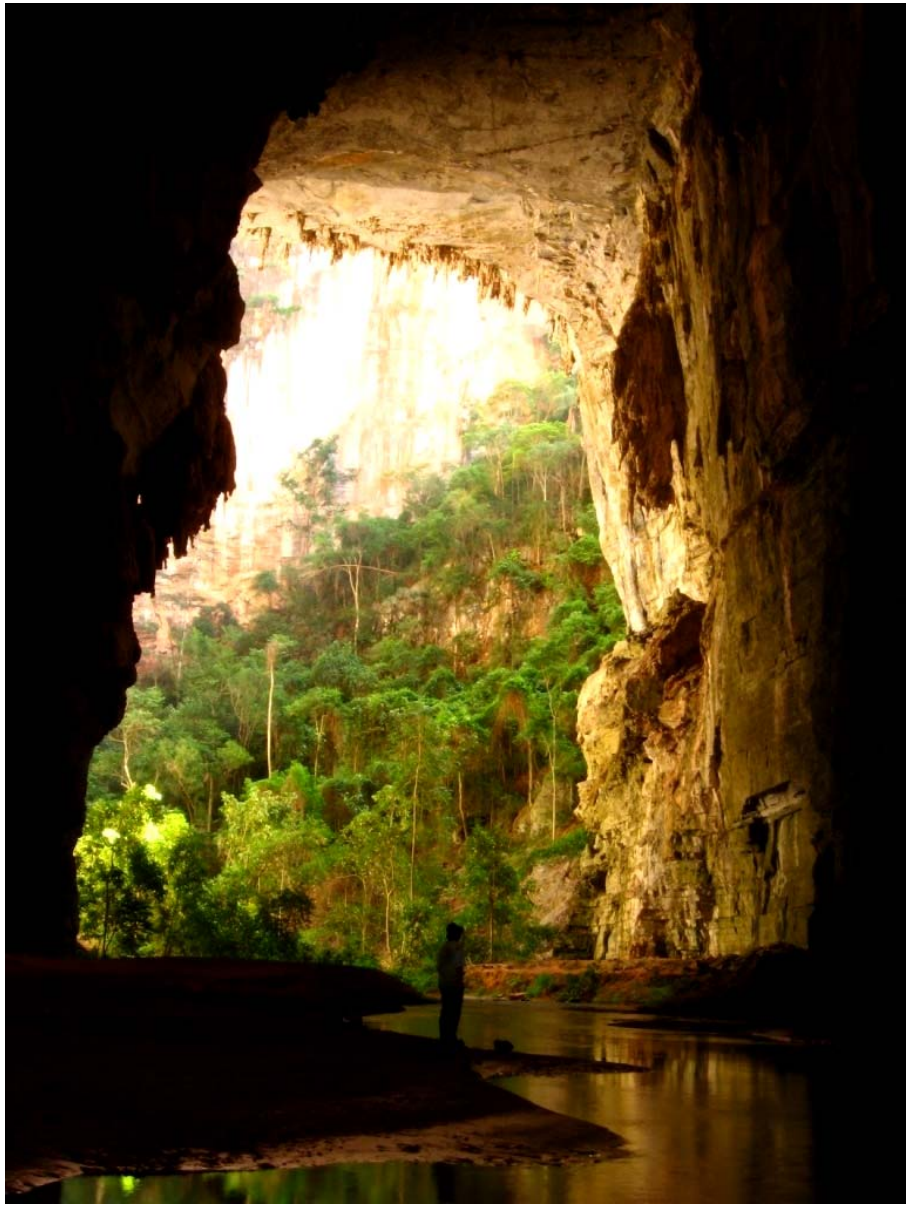
Spotted paca – *Cuniculus paca*

King vulture – *Sarcoramphus papa*

Authorized tourists visiting Cavernas do Peruaçu National Park

CLP staff visiting the project

Study area – photographs of Cavernas doPeruaçu National Park



Janelão cave – this 4 km long cave is the largest cave in the region and one of the main attractions in Cavernas do Peruaçu National Park

Peruaçu River and adjacent gallery forest – typical scenario in the river valley

Rock paintings – several panels can be found in the Peruaçu Valley, some of them as old as 7,000 YBP

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Address list and web links

- EstimateS software - http://viceroy.eeb.uconn.edu/estimates
- Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) - http://www.icmbio.gov.br/
- IUCN Red List - http://www.iucnredlist.org/
- Monitor software - http://www.esf.edu/efb/gibbs/monitor/

Distribution list

Copies of this report will be sent to:

- Cavernas do Peruaçu National Park office in Fabião I, Januária, Minas Gerais;
- National Research and Conservation Center of Carnivore Mammals (CENAP/ICMBio) office in Atibaia, São Paulo;
- Instituto Biotrópicos office in Diamantina, Minas Gerais.