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The Urban Monkeys Program: A Survey of *Alouatta clamitans* in the South of Porto Alegre and Its Influence on Land Use Policy Between 1997 and 2007

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Abstract: Endemic to the Atlantic Forest, the southern brown howler monkey, *Alouatta clamitans*, can still be found in forest fragments in the metropolitan area of Porto Alegre, the capital of the state of Rio Grande do Sul, in the south of Brazil. The Urban Monkeys Program (UMP) has been monitoring their numbers since 1994. Here we report on the results of the initial surveys carried out from 1994 to 1996 and discuss the variables that are determining the loss or survival of the howler monkey groups. We also examine how our results have influenced the politics of land use over the last ten years (1997–2007). Porto Alegre has an area of 47,630 ha. About 30% is a rural/urban matrix and the remainder is entirely urban. There are 44 hills in the municipality and all have been affected by human occupation and activities. We overlaid a grid on a map 1/50,000, with quadrates of 1 km² divided into four quadrates of 500 m² each. We surveyed all the quadrates that contained forest. The presence of howler monkeys was recorded by direct observation, the presence of feces, and by their vocalizations. Complementary information was obtained by talking to the local people. We used a field protocol to record the absence or presence of howlers, habitat quality and the extent and type of human disturbance or use. We surveyed 5,125 ha and found howler monkeys in 2,921 ha (57%). The physiognomy, altitude and connectivity with forest in other quadrates were the three predictors of the presence of howler monkeys. Reasons for this include the fact that human use for such as agriculture, cattle breeding, housing estates, and roads is more concentrated in the lowlands than in the more hilly areas. Our findings suggest that the brown howler monkeys of Porto Alegre live as a meta-population. We participated in forums to discuss land use and management decisions. UMP influenced the creation of 895 ha of municipal protected areas over the 10 years. UMP initiated a civil enquiry concerning problems of the electrocution of howler monkeys using power lines. Two years after, as a result, the Rio Grande do Sul State Electricity Company insulated the cables in the areas where they presented a hazard. In 2002, a bill of amendment was passed (municipal law no 482/99), which provided for tax exemption for landowners who conserve natural areas or use their land for agriculture. Our recommendations for the future include: 1) maintenance of the current rural matrix in the south of Porto Alegre; 2) the creation of the “Morro São Pedro Natural Park”; 3) the establishment of a federal strategy for primate conservation in urban areas in Brazil; and 4) the inclusion of a criterion concerning human population density in the areas of occurrence for the threatened categories of the IUCN Red List.

Key words: Brown howler monkey, *Alouatta clamitans*, survey, conservation, advocacy, land use

Introduction

The southern brown howler monkey, *Alouatta clamitans* Cabrera, 1940, is endemic to the Atlantic Forest. Formerly considered a subspecies, it was recently separated from *Alouatta guariba* (Humboldt, 1812) on the basis of cranio-metrical parameters and pelage (Gregorin 2006). The species occurs in eastern Brazil, from the Serra do Espinhaço, Minas Gerais, south to the basin of the Rio Camaquã, Rio Grande do Sul (Printes *et al.* 2001; Gregorin 2006), occurring also in Misiones, northeastern Argentina (di Bitteti *et al.* 1994).

There are three primates in the state of Rio Grande do Sul: *Alouatta clamitans* Cabrera, 1940; the black howler monkey, *Alouatta caraya* (Humboldt, 1812); and the black-horned capuchin *Cebus nigritus* (Goldfuss, 1806). The brown howler monkey occurs in forest fragments in the municipality (including some suburban areas) of Porto Alegre, the state capital (Fundação Zoobotânica do RS 1976). The *Programa Macacos Urbanos* (Urban Monkeys Program – UMP) based at the Federal University of Rio Grande do Sul has been monitoring their numbers since 1994 (Buss 1996). Populations were found in the south of the municipality, where, however, the rural zone is undergoing rapid urbanization (Romanowski *et al.* 1998).

One of the IUCN Red List criteria for the classification of threatened species is “Severely fragmented” (Criterion B)” (IUCN 2001). This IUCN defines as follows: “The phrase ‘severely fragmented’ refers to the situation in which increased extinction risk to the taxon results from the fact that most of its individuals are found in small and relatively isolated subpopulations (in certain circumstances this may be inferred from habitat information). These small subpopulations may go extinct, with a reduced probability of recolonization.” Severe fragmentation precisely describes the situation of the brown howler monkeys in the municipality of Porto Alegre. Group sizes are generally larger than is considered typical for the species, reproductive rates are high, and there is considerable variation in group composition. Fragmentation makes dispersal difficult and dangerous, and promotes inbreeding depression (Jardim 2005).

The city of Porto Alegre and its metropolitan area has 3,718,778 inhabitants, 3.2% (53,447 people) living in slums (Maricato and Tanaka 2006). Urbanization began in the north, near the docks, and gradually moved south, with the city gradually taking over the oldest green areas, including islands, hills and river basins. Some of these areas, most especially the hilly regions, have howler monkey populations or isolated groups. The UMP’s aim in monitoring the howler monkey populations has been to look for extirpation patterns in order to carry out measures to protect them (Printes *et al.* 2000). An understanding of their occurrence and status in the municipality has allowed us to establish a conservation strategy for the species. The loss of rural areas to the spread of large and small cities is occurring worldwide (Folke *et al.* 1997), but effective mitigation is possible at a local scale.

Here we report on the results of the initial surveys carried out from 1994 to 1996 and discuss the variables that are determining the loss or survival of the howler monkey populations and groups. We also show how our results have influenced the politics of land use over the last ten years (1997–2007), and the extent to which a scientific approach is effective in influencing planning and land use policy in expanding cities.

Methods

Porto Alegre

Excluding its metropolitan region, Porto Alegre (30°01'S, 51°13'; 0 to 317 m above sea level) has an area of 47,630 ha (Fig. 1). In 2007, the urban population in the town was 1,420,667 inhabitants (IBGE, 2007). The city was founded in 1772, on the banks of the Rio Guaíba. Today about 30% of Porto Alegre is a rural/urban matrix and the remainder is entirely urban. The climate is subtropical humid (Cfa). The mean temperature in the hottest month is a little over 22°C and there is no marked dry season. Mean annual rainfall is 1,324 mm.

The forests of the region have their origin in two migration routes followed by angiosperms 5,000 years ago: one from the Paraná and Uruguay basins and the other from the coastal rain forests (Porto, 1998). Rambo (1954) estimated that 87% the plant species of Porto Alegre flora originated from the western plateau of Rio Grande do Sul, the open vegetation of Chaco, central and southern Andes, and the rain forest.

Brack *et al.* (1998) have catalogued 268 species, 171 trees, in 64 families in the flora of Porto Alegre. Myrtaceae, with 27 species, was found to be the most important family for the trees, and Asteraceae, with 17, was the principal family for shrubs. According to Brack *et al.* (1998), one-third of the species of the Rio Grande do Sul flora occurs in Porto Alegre. After ten years of collection and studies, they were able to define eleven distinct floral communities in Porto Alegre.

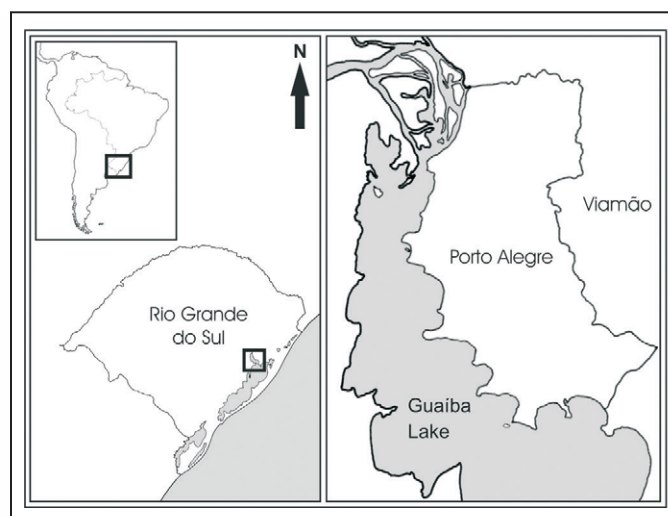


Figure 1. Porto Alegre, Rio Grande do Sul, Brazil.

The hilly areas, especially in the south, are covered by forest. The trees reach about 15 m in height. Grasslands cover the higher elevations due to the shallow soils. Sandy soil forest (*restinga*) (upper Palaeolithic dunes) characterizes the lower, flat areas of the Guaíba basin. The climate is wet in the winter, and the floral communities are distinct from those of forests at higher elevations (Brack *et al.* 1998; Fialho 2000). These ecosystems are threatened by cattle ranching, agriculture, and urbanization. The brown howler monkeys live in both the hills and restingas.

Although a federal law (11.428/06) protects the Atlantic Rain Forest remaining in Brazil, we have witnessed its rapid destruction and occupation over the last 15 years in Porto Alegre. The plains near the rivers and, likewise, the hilly regions are gradually being taken over by housing estates. There are 44 hills in the municipality and all have been affected by human occupation and activities: deforestation, fires, water pollution, motocross trails, alien invasive species, and cattle breeding (Velez *et al.* 1998). The housing estates in the forest fragments increase the mortality of the howler monkeys through death and mutilation caused by power lines (Printes 1999; Lokschin *et al.* 2007), road kill, dogs, and increased parasitosis (Valladares-Padua *et al.* 1995; Pickett *et al.* 2001; Cabral *et al.* 2007).

Surveys

The first surveys focussed on the southern part of Porto Alegre, which has the most forest in the municipality (see Fig. 2, stage 1). We overlaid a grid on a map 1/50,000, with quadrates of 1 km² divided into four quadrates of 500 m² each. This grid was then transposed onto a map scale 1/5,000 for use in the field. We surveyed all the quadrates that contained forest. Each survey involved at least three people, who spent up to 2 hours in search of howler monkey groups. For our localization we used a compass and a field map. The presence of howler monkeys was recorded by direct observation, the presence of feces, and by their vocalizations. Complementary information was obtained by talking to the local people. We used a field protocol to record the absence or presence of howlers, habitat quality and the extent and type of human disturbance or use. Parameters recorded were: a) percentage of the area with forest, assessed using maps, aerial photographs and field observations; b) distribution of the forest in the quadrate (continuous or fragmented), assessed using the maps and aerial photographs; c) connectivity of the forest with other quadrates, using a scale of 0 to 4 (0 = isolated quadrate and 4 = connection with all four surrounding quadrates); d) hydrography (presence of rivers, streams, and lakes); e) altitude; f) topography (flat, slope, or hill top); g) habitation (presence of houses and how many); and h) access to the quadrate, the presence of a narrow or wide trail, a road or highway, and estimating the amount of road traffic.

Analysis

Multiple logistic regression was performed using SPSS software. The parameters *a* to *h* were tested as predictors for

absence/presence as a dependent variable in the analysis. We used a maximum likelihood for estimation criterion. Statistical significance was set at 0.05 (Zar 2009).

Advocacy

We have participated in forums since the beginning of the Urban Monkeys Program in 1994 to discuss the land use and management decisions. The forums included those focussing on the resolution of conflicts concerning forest conservation versus industrial or urban development, especially the expansion of residential areas. For example, we have taken part in the so-called Participatory Budget, an official instance for discussion of priorities for public spending (from 1991–2003). Other examples include our participation in the Municipal Planning Forum, a working group composed of local municipal experts and citizens allowing for discussion of plans and local laws concerning land use and occupation, and the municipalities Environmental Council. In extreme cases, we have also been involved in judicial processes to guarantee the preservation of certain forests and their monkeys, combined with organized protests and media campaigns (Figs. 3 and 4). In some cases we were able to draw on legal mandates to talk directly with landowners, and propose alternatives that would

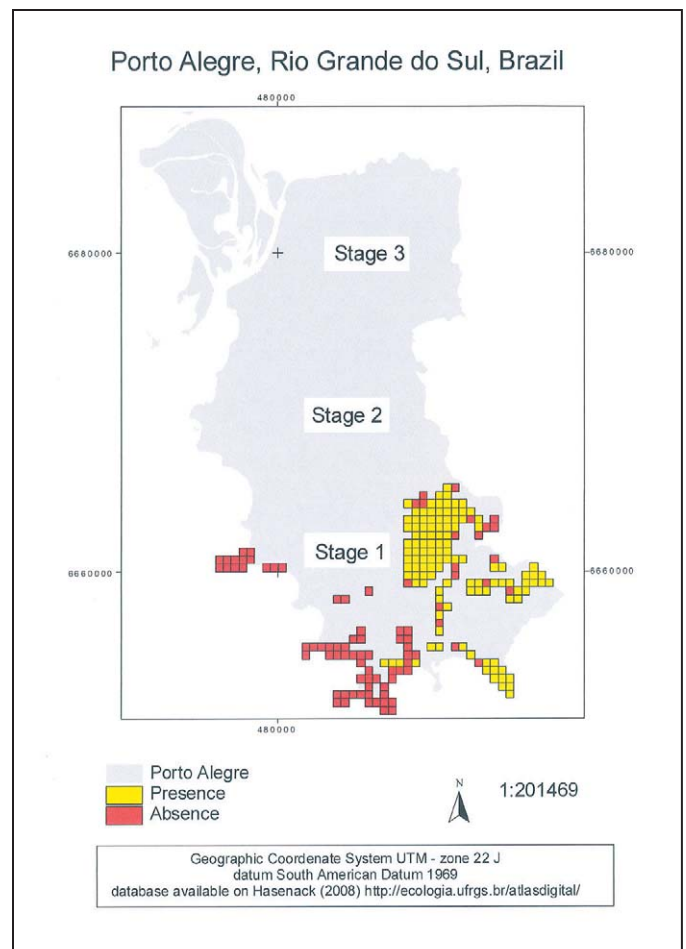


Figure 2. The three stages of survey and the distribution map of *Aouatta clamitans* in south of Porto Alegre, Rio Grande do Sul, Brazil.

be favorable for both the landowners and for the conservation of the forests and their resident howler monkeys.

To assess our influence concerning land use policy over the last ten years, we used: 1) the area (ha) that was converted into private or public reserves in Porto Alegre from 1997 to 2007; 2) the results of the judicial actions in terms of improvement to the well-being and safety of the howler populations; 3) the laws and decrees that were created by the municipality to protect wildlife, resulting at least in part from activities and contributions of the UMP.

Results and Discussion

Lessons from the past: the survey results

We surveyed 205 quadrates (5,125 ha) and found howler monkeys in 57% of them (2,921 ha) (Fig. 2). We saw howler monkeys in 28 quadrates, and in the remainder we identified their presence from finding their feces. The logistic regression analysis showed that topography (coefficient= -1.37 ; SE= 0.49 ; $p=0.005$), altitude (coefficient= 1.25 ; SE= 0.29 ; $p<0.001$) and, to a lesser extent, connectivity with forest in

other quadrates (coefficient= 0.57 ; SE= 0.27 ; $p<0.05$) were the three predictors of the presence of howler monkeys. Reasons for this probably include the fact that human use for such as farming, cattle breeding, houses and roads is more concentrated in the low-lying (flat) areas than in the more hilly areas, and also that tree species diversity is higher and the vegetation structure is more complex on slopes of the hills than in the lowlands (Fialho, 2000).

Brown howler monkeys were found in only one quadrate that was completely isolated. All others had forests that were connected to those in at least one neighboring quadrate. Howler monkeys were found to occur in 83% of the category 4 quadrates (continuity with all four neighboring quadrates). As such there is a high probability of howlers being found in quadrates which have forest that extends into three or four other quadrates. Forest connectivity is, therefore, an important parameter for the maintenance of howler monkeys in Porto Alegre, corroborating the hypothesis that isolation is decisive in determining local extinctions. Although the forest cover percentage in each quadrate was not an important predictor, it should be noted that howlers were not found in 86% of the quadrates with less than 10% (2.5 ha) of forest.

The results clearly indicate that the presence of howler monkeys is influenced by features of the landscape. The lack of association between the howler's presence and the number of houses in the quadrate is possibly due to the fact there were few houses in the majority of them. The howlers are quite able to live in areas of, say, 25 ha when there are just one or two houses. Land use in the area is more agricultural than urban, and is compatible as such with the survival of the howlers to the extent that forest patches are left standing and with some connectivity between them (Estrada 2007). One can predict that a negative correlation would appear with an increase in the density of houses. There is no significant association between the presence of howlers and the type of access to the quadrate. Traffic speed is possibly more important than actual form of access (a highway or a road). The volume of traffic and speed can make dispersal more hazardous (road kill), effectively increasing the isolation of the forest patches (Jardim, 2005). As with the numbers of houses, traffic volume and speed of course increases with increased urbanization (more and improved roads and highway).

Together these quantitative variables are important to evaluate the biogeographic context of the distribution of the howler monkeys in Porto Alegre (Fig. 5). The population of the Morro São Pedro (*morro*=hill) is the largest and probably the most important. It is connected to the Lami and Boa Vista populations through the forests along the Rio Lami, which also form a corridor between the flat lowlands and the Morro da Extrema, east of the Morro São Pedro. The impacts of urbanization are very evident, with the absence of howler monkeys surrounding the Morro São Pedro. For example, we accompanied the gradual displacement of howler groups up the north face of the hill following the beginning of the construction of the Favela do Castelo (*favela*=slum) in 1999. Prior to this, urbanization has isolated the howler monkey



Figure 3. “The right to live together”, an environmental education event in the Morro São Pedro, 1999.



Figure 4. The Urban Monkey Program's sticker.

population along the isthmus of Ponta Grossa and, according to those we interviewed, the monkeys disappeared about 40 years ago. The absence of forest corridors prevents recolonization. Today we are witnessing the gradual demise of a group in a lowland area of *restinga* forest in the Lami district that has been isolated since 1997. The animals suffer heavy parasite loads, because the water in the forest fragment is polluted by sewage and domestic waste from the nearby houses (Cabral *et al.* 2007). Dogs are another problem, chasing the monkeys and killing them when they go to the ground.

Our findings suggest that the brown howler monkeys of Porto Alegre now live as a metapopulation. We have no understanding of the occurrence or rates of dispersal, but it is clear that the permanence of the various subpopulations depends on the availability and suitability of corridors between fragments and a sufficient genetic flux (Chepko-Sade and Halpin 1987). The decrease in the number of occupied forest fragments and increasing isolation makes dispersal ever more difficult (Primack and Rodrigues 2001). Jardim (2005) studied 10 howler groups of this metapopulation and found that group size was larger than is typical for this species elsewhere, with high reproductive rates and correspondingly variable group composition, all indicating increased population densities, low dispersal and intense group dynamics. However, the long-term survival of these populations is uncertain due to the increasing pressures of urban occupation and the consequent fragmentation of their habitat. Further studies on population

densities and population dynamics, sex ratio, and effectiveness of corridors are needed to propose measures for the preservation of this metapopulation.

Lessons for the future

Lacking sufficient public initiatives to administer and control urban growth, the hills of Porto Alegre are fast being destroyed by the loss of the natural vegetation and the consequent erosion (Brazil 2004). The legislation is ineffective, and there is an estimated demand for more than 100,000 domiciles in Porto Alegre and its metropolitan region (Maricato and Tanaka 2006). Furthermore, land speculation in some regions of Porto Alegre, such as the islands and the older district, has for many years resulted in social exclusion, violence and environmental degradation. Urban planning and the accompanying legislation has no impact on the unregulated urban growth on the periphery, nor even sometimes for development and construction in the formal economy. The last census in Brazil (in 2000) revealed that 55 million people (32% of the population) live in just 11 big cities in Brazil (that includes Porto Alegre) and 82% of the people have inadequate housing (IBGE 2007). Our results are showing that the existence of the howler monkey metapopulation in Porto Alegre is merely a result of chance and Porto Alegre's own particular history. The hilly countryside has allowed for the permanence of forest on the slopes to date, but it would seem not forever, unless urban planning specifically and forcefully incorporates

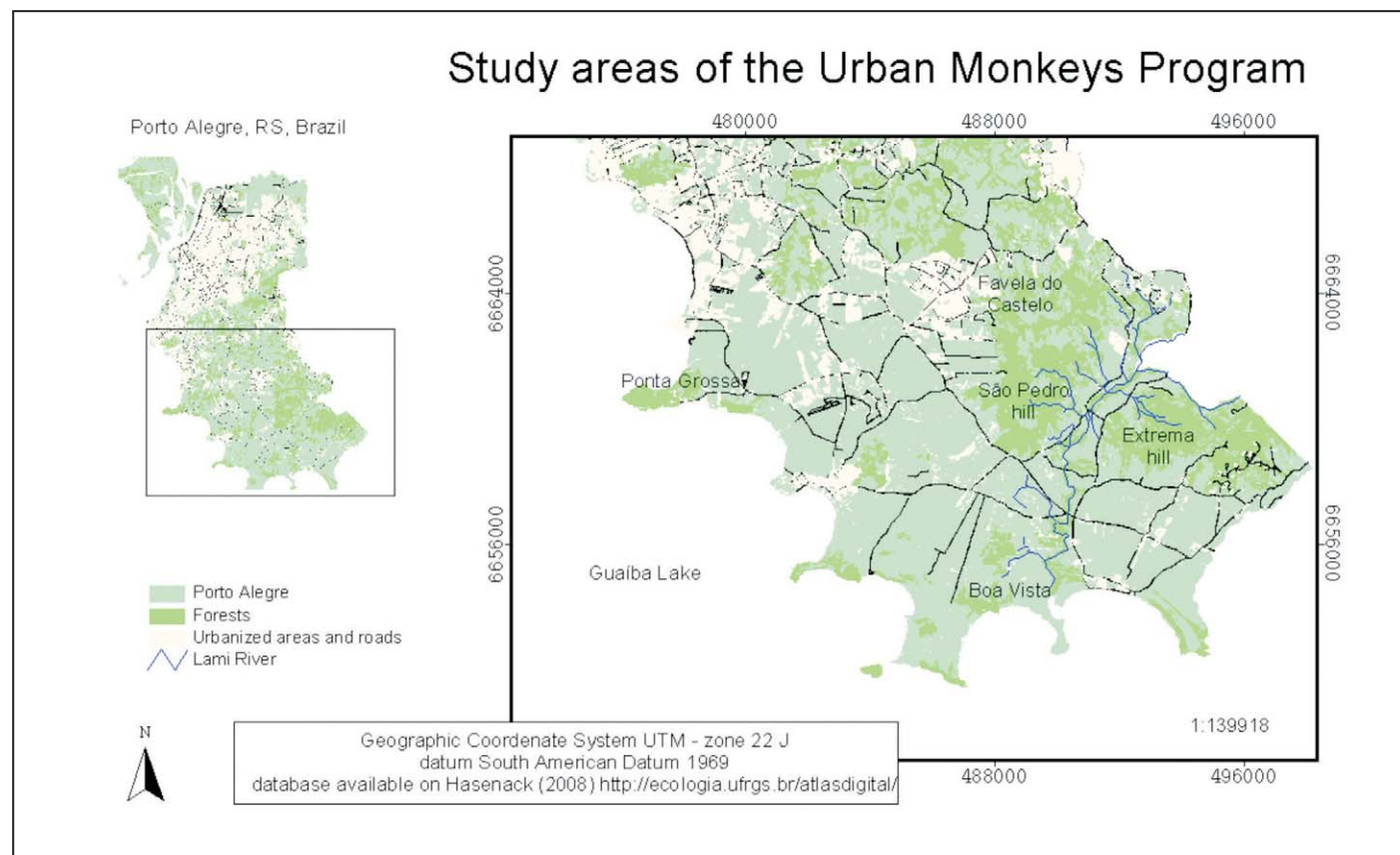


Figure 5. Study areas of the UMP.

the value of the remaining forests, for leisure, their services in terms of erosion prevention and water regulation, and the wildlife they contain.

Near urban centers, the occupation of natural areas occurs through the gradual expansion of slums, as is happening along the northern slopes of the Morro São Pedro and in the Lami *restinga*. In the rural areas, on the other hand, the occupation is agricultural, for example to the south of the Morro São Pedro and the Morro da Extrema, and in the Lami wetlands. While both rural and urbanized areas if properly planned can allow for the preservation of some forest fragments (and even corridors), the urbanized areas present further hazards for the howler monkeys such as dogs, water pollution, food scarcity, and increased chances of electrocution from power lines (Printes 1999; Lokschin *et al.* 2007).

Role of the UMP

How has the UMP fared in influencing land use patterns and urban planning in favor of the conservation of forests and the howler monkeys? We can evaluate its success using three parameters.



Figure 6. The southern brown howler monkey, *Alouatta clamitans*. Female and offspring at Lami, Porto Alegre, Rio Grande do Sul, Brazil. Photograph by Adriano Becker.

1. The area of private or public reserves created in Porto Alegre between 1997 and 2007

In all, UMP was influential in the creation of 895 ha of protected areas over the 10 years (Table 1). This would appear to be a small area, but in the urban context the number is very meaningful, and these valuable hectares are protecting some of the most important forest patches for howler monkeys. Other areas are in the process of receiving protected status. Other institutions and people of course were involved and contributed markedly to the creation of these protected areas, but the UMP's vital contribution has been the maps of the distribution and numbers of howler monkeys, in essence serving as flagship species for the forests. The map was crucial, for example, in the case of the expansion of the Lami Biological Reserve, and has provided solid arguments for the definition of the boundaries of the future Morro São Pedro Natural Park.

2. Legislative measures for the conservation of the howler monkey

The first judicial action was in 1996, when the local government decided to create a landfill for urban waste at the Morro da Extrema. The UMP had identified the area as an important corridor for the howlers. We formally denounced the proposal to the federal justice as illegal on the basis of the Forest Code (*Codigo Florestal*, No. 4771, 15 September 1965), arguing that the area had numerous streams (the Forest Code, has special provisions for the protection of forest along water courses) and was also important for the conservation of the howler monkey. Although the complaint was formally registered and the UMP had the full support of the local communities, the municipal government and the judiciary reached a compromise agreement, and the rubbish tip was established in 1997 (Reichert and Anjos 1997). Between 1998 and 2003, the municipal employees reported seeing the howler's crossing over the tip. Our failure was in part due to the inexistence at the time of the Environmental Crimes Law, decreed only in 1998 (*Lei de Crimes Ambientais*, No. 9605, 12 February 1998). This law incorporates the precautionary principle and dispenses proof in an environmental risk assessment.

The most important action of the UMP in the judiciary was the civil enquiry number 21/2003, concerning the electrocution of howler monkeys and other animals that climb onto the power lines. Documentation on the mutilation and

Table 1. Land (ha) converted to protected areas in Porto Alegre from 1997 to 2007.

Name	Area (ha)	Status	Domain	Influence of the UMP
Lami Biological Reserve	79 + 102	Created	Public (Municipal)	Process of expansion (102 ha) and development of the management plan (1999–2002)
Morro do Osso Natural Park	27 (with provision for another 87 ha)	Created	Public (Municipal)	Support for and participation in its creation (1996–2002)
Morro São Pedro Natural Park	Approx. 500	Creation in abeyance (political issues)	Public (Municipal)	Support for and participation in its creation (1999–2002)
Econsiência Private Reserve (RPPN)	Approx. 100	In the process of being created	Private	Support for and participation in its creation (2000–2007)
Total	895			

Table 2. Municipal legislation in Porto Alegre influenced by the UMP (1997–2007).

Municipal Laws and Decrees	Objective
Municipal Law 434/99	Municipal planning for urban and sustainable development
Municipal Law 482/2002 Decree 14265/2003	Exemption of taxes for agricultural land and natural areas
Municipal Law 8971/2002 Decree 14196/2003	Obligation to insulate electric cables

death of howler monkeys was very important in this case. UMP has been collecting information on incidents of this sort since 1999, using photographs, veterinary reports and interviews with inhabitants near the power lines (Printes 1999). After two years in the judiciary, the final decision was in favor of the howlers. The Rio Grande do Sul state electricity company (CEEE - *Companhia Estadual de Energia Elétrica - Rio Grande do Sul*) consequently insulated the cables in the areas where they presented a hazard (Lokschin *et al.* 2007). The UMP was appointed by the judiciary to make an inventory of priority areas. The decision was based on the Environmental Crimes' Law and was the first of its kind in Brazil. Since 2005, about US\$50,000 has been invested in the insulation of cables where wildlife is at risk. The number of cases of electrocution has decreased substantially as a result, and the UMP continues to monitor any further incidents for the CEEE to take the appropriate measures.

3. Municipal laws and decrees for the protection of wildlife

The UMP has been influential in the creation of municipal legislation concerning three major issues (Printes *et al.* 2000) (Table 2). The municipal planning for urban and sustainable development eliminated the legal concept of “rural area” within the metropolitan region in 1999 (Municipal Law 434/99) (Porto Alegre 2004). This act had very direct and major consequences in terms of soaring taxation, relaxed conservation laws applicable to the land concerned and, as a corollary, increased risks of unregulated urbanization and habitat destruction. We started a movement together with the farmers to create legal ways to stimulate the agricultural activities and the conservation of the natural areas. In 2002, an amendment bill for the municipal law number 482/99 guaranteed tributary exemption to landowners who conserved natural areas or demonstrated the use of their land for agriculture. Until 2006, 14 owners received benefits due to their protection natural vegetation on their land, and another 400 due to farming activities (Teles 2006).

Considerations

The co-existence of non-human primates and people in a rural matrix landscape has been well documented in a number of countries (Chiarello and Galetti 1994; Estrada and Coates-Estrada 1996; Estrada *et al.* 2006; Crockett 1998; Siex and Struhsaker 1999). In the absence of hunting, the howlers are perfectly able to live in fragments, in disturbed areas and very

close to human communities (Crockett 1998). We believe that if habitat loss is halted and corridors are maintained (and created), groups of howlers survive.

We propose the following:

- Preservation of the current rural features (green areas and corridors) in the southern part of the metropolitan area of Porto Alegre;
- The creation of the “Morro São Pedro Natural Park” important for the *Alouatta clamitans* metapopulation;
- The establishment of a federal strategy for primate conservation in urban areas in Brazil to counteract and moderate urban growth;
- Include human population density in the areas of primate occurrence as a new criterion for the IUCN Red List, as suggested by Harcourt and Parks (2003).

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