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Primates of Brownsberg Natuurpark, Suriname, with Particular Attention to the Pitheciins

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Introduction

Brownsberg Natuurpark (5°01'N, 55°34'W) is Suriname's only wildlife park that is open and accessible to both Suriname citizens and researchers. The park lies 130 km south of the capital, Paramaribo, and consists of a lateritic plateau, which at 530 m forms the top of the Brownsberg range. The plateau lies 473 m above the surrounding lowlands and is relatively humid with low cloud cover, particularly on the eastern perimeter. The Brownsberg range has at least one additional lateritic plateau at some 100-150 m above sea level, which is much drier than the upper one. In between the two plateaus are slopes with exceptionally high forest, but also occasional broad ridges or narrow semi-plateau areas with lateritic soil (e.g., at 200-350 m elevation) and medium to low forest. The areas with thick laterite crusts (perhaps 10% of the park), especially where the forest is low, are dominated by the Myrtaceae in all storeys (B. P. E. De Dijn, unpubl. data). Forests range from seasonally dry to seasonally flooded, consisting of both secondary and primary forest, steep forested slopes, and creek-side forest in the valleys – a total area of *c.* 8,000 ha (Reichart, 1997). The eastern edge of the plateau is bounded by Lake Afobaka, also referred to as the Brokopondo Reservoir of the Suriname River, and the northern edge of the park is approximately 3.0 km from the village of Brownsweg.

The origin of the village and the lake corresponds to the damming of the Suriname River in 1964 for construction of one of the first hydroelectric plants in South America. Half the territory of the Saramaccan people was flooded as a result of the construction of the dam. Approximately 4,500 people from three autonomous villages were relocated to Brownsweg, although De Dijn now estimates the population to be about 3,500 residents. The Brownsberg is valuable for its floristic and faunal diversity (as yet undiscovered for most taxonomic groups), and also for the educational opportunity it provides to the citizens of Suriname, most especially in the highly populous Brownsweg.

The Brownsberg has long been a destination for tourists, particularly from Holland, but the proximity of the park to Paramaribo also attracts day-trippers and over-night tourism from Surinamers. This has resulted in a recent increase in the number of dwellings in the park to accommodate a few dozen permanent staff, tourists, and researchers on the top of the berg, besides considerable forest clearing on the eastern slope of the plateau for picturesque "outlooks" over the forest and lake below. The berg itself rises 473 m above the relatively flat surrounding terrain (50 m above sea level) (Reichart, 1997). The flora is extremely diverse, supporting not only low-elevation species, but also a flora indicative of cloud forest on the top of the berg and intermediate climatic conditions on the slopes. Huber (1995) characterized Guayana Shield elevations of 500 m or more as cool and wet (submesothermic [mean annual temperature 18-24 °C], ombrophilous [rainfall >2000 mm]), with fewer than two dry months a year. An informal census by P.-M. Forget (pers. comm.), consisting of a single transect from the lake in the east, up to and across the plateau and down the northern side of the berg, suggested that the Brownsberg is more floristically diverse in flowering plant species than either Nouragues in French Guiana (see Bongers *et al.*, 2001) or the Central Suriname Nature Reserve (previously Raleighvallen-Voltzberg). All three sites are on the Guiana Shield, where 6.6% of plant genera and 40% of plant species are endemic (Berry *et al.*, 1995, p.165). Fitzgerald (2003) conducted a year-long wildlife survey on the Brownsberg from November 2000 to May 2002. Her census included primates, though not as a focus, but the work she initiated has been incorporated into a long-term monitoring program projected to extend until 2006.

The plateau and surrounding area of the Brownsberg have long been known to miners for their gold and bauxite reserves. In 1908, weekly trains transported gold from the Brownsberg area to Paramaribo, and gold has been mined in the area since 1718 (Reichart, 1997). In 1916, the Surinam Bauxite Company (SURALCO, a subsidiary of ALCOA-US) purchased the mountain and continues to hold mineral rights to the Brownsberg. Suriname's Foundation for Nature Conservation (STINASU) received a

75-year lease to the plateau and middle portion of the mountain in 1970. In 2001, the park was expanded to 12,200 ha from its original 8,400 ha by the addition of pristine high forest in the southern portion of the Brownsberg range. At the same time, 1,000 ha in the northwestern part of the park was relinquished to local inhabitants (Fitzgerald *et al.*, 2002).

Currently, gold mining provides a much-diminished return compared to the value-to-effort return of the early 20th century, but mining practices involving heavy equipment, water-powered extraction and the perfusion of stream beds with mercury are causing more damage than previous methods. Fitzgerald *et al.* (2002, p.2) characterized Brownsweg as "a large village with a busy small-scale gold mining industry." Our recent observations suggest that the level of production and speed of processing has destroyed hundreds of meters of pristine streambeds draining the Brownsberg since March 2003. Gold mining is also more actively pursued today than bauxite mining, but the threat of destruction on the plateau itself is not without devastating consequences. SURALCO has recently brought crews with survey equipment to the plateau in order to reassess the mineral content of the berg. We estimated that 4.8 ha of forest along the main plateau road was destroyed by SURALCO for the construction of test pits in May 2003. Both forms of mining put the forests and their wildlife at risk, and the bauxite mining and reclamation of the plateau threatens the very existence of the park as an ecotourism resource uniquely accessible to all Surinamers.

The purpose of this census was to gather data specific to primate populations, conduct a feasibility study to prepare for a long-term study of pitheciin primates, and to contribute to the database being created by STINASU to ensure long-term protection of the site.

Methods

The census was conducted for 28 consecutive days, from 21 May to 17 June 2003, during the early rainy season. Two research teams, of two to three people each, censused all trails and roads on the plateau of the Brownsberg every other day (Table 1). The censused area included slopes leading east to Lake Afobaka and north toward the village of Brownsweg. We began transect walks at 06:15 hrs and

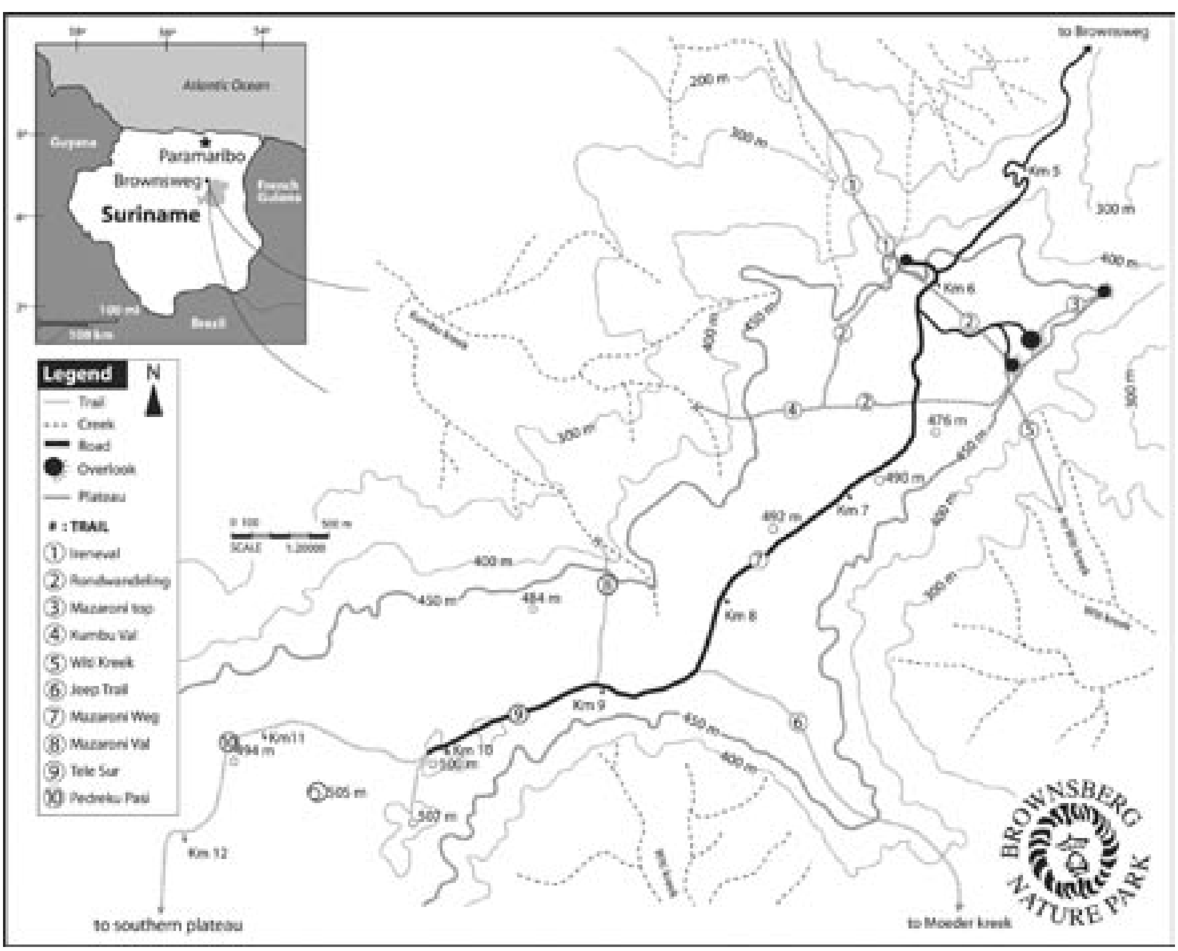

Figure 1. The Mazaroni plateau, encompassed within the 450 m topographical line, of Brownsberg Natuurpark, Suriname. Positions of the main road (dark line) and approximate position of trails (dotted lines) both on the plateau and descending the slopes of the mountain are indicated.

Table 1. Characteristics and length of trails that were used as transects for the census, and the total distance walked on each trail. The length of transect was not the entire length of the trail for AKP, Witi Kreek, and Jeep Trail. The elevation change is taken from the top of the plateau at 473 m. Elevation changes are estimates.

Trail Name	Trail characteristics	Length of trail (km)	Total distance walked (km)	Elevation change from the plateau[1]
AKP	Plateau & slope	3.6	62.2	- 250 m
Jeep Trail	Plateau & slope	3.1	58.6	- 300 m
Mazaroni Val	Plateau & slope	1.0	16.9	- 150 m
Irene Val	Plateau & slope	2.0	10.3	- 300 m
Kumbu Val	Plateau & slope	1.5	6.0	- 150 m
Witi Kreek	Slope & creek side	3.5	63.4	- 450 m
Mazaroni Weg	Plateau	3.0	70.7	0
Rondwandeling	Plateau	2.3	37.4	0
Tele Sur	Plateau	1.3	21.9	0
Mazaroni Top	Plateau	0.7	8.4	+ 10 m

([1]From Appendix C: Fitzgerald *et al.*, 2002.)

ended at approximately 14:30 hrs. Walking speed was approximately 1.3 km/hr. We collected the following data each time a primate group or individual was detected: time of day and weather, location (trail mark), observation of primate species (height, distance, and direction from the trail), group size and age/sex composition data, and activity at the time of the sighting. Species encountered informally, i.e., not part of transect walks, were not treated in the analysis.

Data were recorded in both directions of our travel route ("transect" and "return transect") since all but one of the trails (Rondwandeling) were linear. Visibility on either side of the trail varied, ranging from approximately 5 m to 25 m. We discarded any data that could have represented repeated sampling of a species or group and, for the analysis below, also eliminated all data collected on primate vocalizations. None of the primates were habituated to observers, but there were several cases in which we were able to accumulate sufficient data to calculate group size and composition with confidence. Nevertheless, the summary statistics that we report are considered to be minimum estimates.

Positional data on trail locations were collected prior to the onset of our study by K. Fitzgerald, S. Mitro, and B. P. E. De Dijn, using a Garmin GPS 12 XL. Satellite readings were taken every 100 m. We measured the road to Brownsweg (AKP) that was also used as a census transect using a Garmin eTrex Venture, again taking readings every 100 m. GPS data were entered into ArcView 3.2. Maps do not reflect elevational differences.

Individual encounter rates (ER) for each species (except *Saimiri* and *Ateles*, for which data were insufficient) were calculated by dividing the total number of individuals encountered by 26.2 km (total survey distance). Group encounter rates were calculated in the same manner, and both individual and group ER were expressed as groups encountered per 10 km. We censused a total linear distance of 364.2 km (see Table 1), an average of 12.26 ± 1.27 km/day. Thus each trail was censused approximately every two days. We estimated Primate Biomass Encounter Rate (PBER) per 10 km using body weight data from Ford and Davis (1992) multiplied by individual ER.

We also compared primate sightings on plateau vs. slope trails to assess variations in local abundance using non-parametric statistics (α-values were set at 0.05). Relative trail abundance is reported as the number of times a species was encountered divided by the number of times the trail was walked. Species abundance was calculated as the relative frequency of encountering a particular species on any trail.

Results

All eight primate species found in Suriname were seen at the Brownsberg. *Alouatta seniculus* was very abundant at the site, with an estimated 20 groups encountered, the highest biomass (PBER), and the second highest individual encounter rate (ER) (Table 2). Howlers were encountered on all trails save one, but were seen on that trail during informal observations. Group sizes were relatively small, ranging from 2 to 7 individuals, but the groups were well distributed both on the plateau and slopes of the Brownsberg (Table 3).

Chiropotes satanas had the highest estimated individual ER due to their large group sizes (average = 32.7 individuals, n = 3 groups) and relatively frequent encounters. We observed three groups that were encountered mainly on trails that transected the forested slopes of the berg, although they were also seen on the plateau during informal observations. They had the second highest PBER (see Table 2).

The tamarins (*Saguinus midas*) had the third highest encounter rates. We estimated that we encountered 16 groups of *S. midas* with an average group size of 5.7 individuals (see Table 2). Like the howlers, the tamarins were common and seen on almost all trails during the survey.

White-faced sakis (*Pithecia pithecia*) were relatively common, having the third highest group ER (n = 10).

Estimated group sizes ranged from 2 to 6 individuals (average = 3.7 individuals), although small groups with 2 to 3 individuals may very well have been underestimated in our counts. No groups were fully habituated and some were very skittish. Nevertheless, of those seen repeatedly, only one had more than one adult male (easily recognized by the males' white faces).

Cebus olivaceus were encountered quite frequently, but group sizes were difficult to estimate. An average group size of 12 is an underestimate, since a group of > 32 was encountered during informal (non-census) observations. *C. olivaceus* individuals were well-dispersed when encountered (unlike *Chiropotes* that were also found in large, but more cohesive groups) and accurate group counts were not possible. Nevertheless, capuchins appeared to be rare and very wide-ranging at the Brownsberg. We were more confident with the count of a single group of *Cebus apella* which was seen on multiple occasions, both while collecting transect data and during informal observations. We encountered *C. apella* most often on the plateau (Table 3), but suspected that they too are wide-ranging in an area that includes at least the eastern slope of the berg.

Ateles paniscus were more often heard than seen. Subgroup size ranged from 2 to 4 (see Table 2). When encountered, they first displayed by breaking off branches and hurling them down on observers, and then fled. We have little confidence in our population measures for *Ateles*. A single squirrel monkey group (*Saimiri sciureus*) was seen once; their preference for stream-side terrain at the base of the berg may make them rare, or at least only seasonal visitors, on the plateau.

We compared the trails that ran exclusively on the plateau with those that began on the plateau and then descended along the slopes of the berg (see Table 3). We found a non-significant trend for higher encounter rates on the slopes as opposed to the flat plateau on the top of the berg (Wilcoxon signed ranks test $Z = 1.83$, $p = 0.07$).

Table 2. Group size (minimum and range of group sizes) and number of groups observed during the census. Individual and group encounter rates (ER) were calculated from the group size data (see Methods). Primate biomass encounter rate (PBER) was calculated by multiplying body mass data (taken from Ford and Davis, 1992) by total number of individuals encountered / 10 km linear distance censused (after Wallace *et al*., 2000).

Species	Average observed group size (range)	Observed no. of groups	Individual ER/10 km	Group ER/10 km	PBER kg/10 km
Saguinus midas	5.69 (3-8)	16	34.73	6.1	1.85
Pithecia pithecia	3.70 (2-6)	10	14.12	6.1	2.29
Saimiri sciureus	–	–	–	–	–
Cebus apella	14	1	5.30	0.4	1.45
Cebus olivaceus	12.0 (9-14)	3	13.70	1.1	3.68
Chiropotes satanas	32.67 (22-44)	3	37.40	1.1	10.66
Alouatta seniculus	4.65 (2-7)	20	35.50	7.6	22.72
*Ateles paniscus**	2 (2-4)	–	–	–	–
Total PBER					**42.65**

– Insufficient data, * Subgroup size.

Table 3. Relative primate encounter rate (ER) per trail, which equals the total number of primate encounters per trail per number of census walks (n). The column totals are the total number of sightings per species. With the exception of Rondwandeling, all the trails were linear and n represents the number of round-trips. Shaded rows are trails that traversed both plateau and slope; unshaded rows are trails that are found only on the plateau. Total encounters are the sum of plateau and slope and plateau only.

Trail (n walks)	*S. midas*	*S. sciureus*	*P. pithecia*	*C. apella*	*C. olivaceus*	*C. satanas*	*A. seniculus*	*A. paniscus*	Relative ER/trail
AKP (10)	7		2		2	5	5	4	0.417
Jeep (9)	3		3	1	2	3	5		0.315
Mazaroni Val (9)					1	3	1		0.185
Irene Val (4)	2					1	1		0.333
Kumbu Val (4)	1		1				1		0.250
Witi Kreek (9)	5	1	5		2	1	5	3	0.349
Mazaroni Weg (17)	10		4	1			3	1	0.224
Rondwandeling (18)	9		10	4	1		9		0.367
Tele Sur (9)	1		1			3	2		0.194
Mazaroni Top (7)			1	1	1				0.143
Total enounters/spp.	**18/20**	**1/0**	**11/16**	**1/6**	**7/2**	**13/3**	**18/14**	**7/1**	

Discussion

Average group size for *A. seniculus* at the Brownsberg was small compared with a number of group size estimates from other *seniculus* populations (range 4.25 to 10.5). However, our estimated group size was similar to that found by Mittermeier (1977) at the Central Suriname Nature Reserve (where there was no hunting), and also similar to the sizes observed by Bennett *et al.* (2001) on the Río Tapiche in Peru (where hunting was reported as severe). We have no evidence that *Alouatta* is being hunted within the area that was censused at the Brownsberg, although there are reports of hunting primates inside the reserve near the margin of Lake Afobaka. If the larger group size reported from the llanos of Venezuela is excluded, there is relatively little variation in red howler group sizes (mean 5.23 ± 0.21, n = 6 studies) (Fig. 2).

With regard to pitheciins, we documented the largest reported groups of *Chiropotes satanas,* ranging from 22 to 44 individuals, larger than maximum estimates by Mittermeier (1977: 27 individuals) in Suriname or Muckenhirn *et al.* (1975: 20 individuals) in Guyana. Lehman *et al.* (2001) recently examined variation in group size and number of adult males and females in *Pithecia pithecia* groups. The largest body of data on *Pithecia* group size comes from 21 groups censused in Guyana, in which one group of 12 was seen (Lehman *et al.*, 2001). If that outlier is removed, the average from the remaining 20 groups is 4.4 ± 1.82 individuals (range 2-9). Groups ranging from 6 to 9 have been documented from island habitats (Setz and Gaspar, 1997; Norconk, 1996), but the body of evidence from Guyana and from our census (average 4.65 ± 1.66) suggests that small group size is typical for white-faced sakis (see Fig. 2). Lehman *et al.* (2001) found significant differences between the sizes of groups in Venezuela and Suriname, and between groups in Guyana and Suriname. The Venezuela-Suriname comparison should be excluded based on the lack of dispersal ability on the island habitat in Venezuela, and the Guyana and Suriname data now seem quite comparable.

The more frequent encounter rates of *Alouatta* at the Brownsberg probably reflect both the relatively small home ranges used by howlers and a ban on hunting primates in the immediate vicinity of the plateau. *Alouatta* sightings are much reduced at sites where hunting is relatively severe (e.g., the *terra firma* forest in Amazonia censused by Peres, 1997; and the Río Tapiche sites suveyed by Bennett *et al.*, 2001) and more common where hunting is prohibited (e.g., Nouragues, in Simmen *et al.*, 2001). Hunting at the Brownsberg does occur in active mining areas, and may be the cause of the relatively rare encounters of *Ateles paniscus* during our census, besides their threatening/evasive behavior when encountered. Encounter rates of *Ateles* in un-hunted sites such as Nouragues, French Guiana, were much higher than our Brownsberg estimates (Simmen *et al.*, 2001). Alternatively, our low encounter rates may have been due to a seasonal shortage of fruit in the census area.

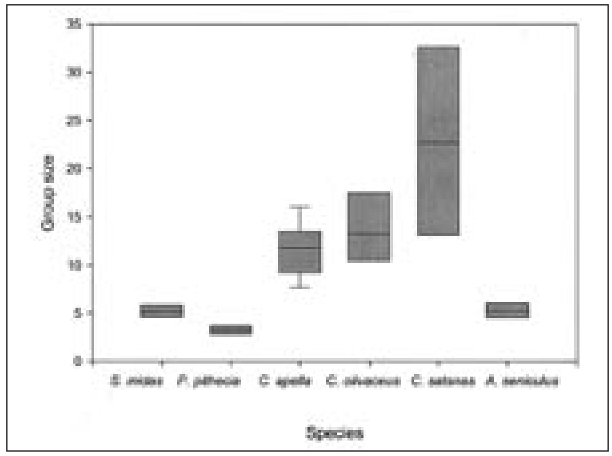

Figure 2. Comparison of group size estimates for the eight species of primates found at the Brownsberg. Data are from: Defler (1982, 2003), Janson (1985 in Sussman, 2000), Kessler (1998), Mittermeier (1977), Muckenhirn (1975), Simmen *et al.* (2001), Terborgh (1983), and this census.

Low species encounter rates for *Saimiri sciureus* may also have been an artifact of the season, but the habitats preferred by *Saimiri* only occurred on one trail, the streamside Witi Kreek trail. The heterogeneous habitats of the Brownsberg may limit the distribution of a habitat specialist such as *Saimiri.* For example, Peres (1997) reported high sighting rates of *Saimiri* in three *várzea* forests in Amazonia, and their absence or relative rarity in 12 *terra firma* forests. *Saimiri* had the highest sighting rates of the eight species at 16 sites in Guyana surveyed by Lehman (2000).

Saguinus midas and *Pithecia pithecia* had the second highest encounter rates at the Brownsberg. While *Saguinus* appears to be well-dispersed on both slopes and plateau, *Pithecia* was encountered more frequently on plateau trails (see Table 3).

The Brownsberg primate population may be summarized as follows:

1) *Alouatta seniculus* and *Saguinus midas* were well-dispersed in relatively small home ranges both on the plateau and on the slopes of the berg.

2) The two pitheciins were encountered frequently. The home ranges of *Pithecia* appear to be small (one was calculated as 10.3 ha, on the basis of repeated sightings and territorial behavior associated with intertroop encounters). *Chiropotes* occurred in larger groups than have been observed at any other site (including other Suriname sites) and are relatively wide-ranging, but more cohesive when traveling than *Cebus olivaceus. Pithecia* was observed more often on the plateau than the slopes, and *Chiropotes* was seen more often on the slopes. *Chiropotes* fed extensively on *Pouteria melanopoda* (Sapotaceae) during the census period. The distribution of that tree may have influenced its ranging patterns at the time of the census, but the rich diversity of saki resources may help to explain both the large group

sizes of *Chiropotes* and the high density of *Pithecia* groups. For example, Fitzgerald *et al.* (2002: Appendix G) reported 10 species of *Licania* (Chrysobalanaceae), four species of *Lecythis* and five of *Eschweilera* (Lecythidaceae), and 12 species of *Pouteria* (Sapotaceae).

3) The two capuchin species appear to be relatively rare at the site, and both species may have large home ranges. Only one *Cebus apella* group was seen and we estimated three *C. olivaceus* groups within the census area. The data were too few to assess habitat preferences for the capuchins, but they appeared to range widely.

4) *Saimiri* and *Ateles* also appear to be relatively rare. We saw *Saimiri* only once, but our census route covered only a small part of their potential range. *Ateles* were heard often, but rarely seen. Their behavior when they were encountered (almost exclusively in slope terrain) suggests that they are very sensitive to humans and furthermore, there were reliable reports of hunting by miners near Lake Afobaka. It is impossible to assess population size for either species on the basis of these census data.

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Primates in a Forest Fragment in Eastern Amazonia

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Introduction

Many new towns were established along the Belém-Brasília Highway following its construction in the 1960s. One was Paragominas, in the northeastern region of the state of Pará (Fig. 1). Large areas of forest in this region were cut for cattle pasture during the 1970s; and due to the depletion of timber resources in southern Brazil, in the 1980s Paragominas also became an important logging center, with the highest concentration of sawmills anywhere in Brazilian Amazonia. Today, timber is scarce in the region, and the sawmills have been moved to new frontiers, although Paragominas still remains an important commercial center for the industry.

The landscape around Paragominas today is a mosaic of agricultural land, pastures, logged and burned forest, and small patches of primary forest which cover about 6% of the original area (Nepstad *et al.*, 1999). The region of Paragominas has undergone some of the most intense deforestation and habitat degradation – and today supports the highest human population density – of anywhere in the Brazilian Amazon.

Although the remaining fragments suffer from hunting and selective logging, some still maintain primate populations (Lopes and Ferrari, 2000). In this study I evaluate the effects of this land use model on primates in a forest fragment isolated since the late 1970s and composed of three different habitats (unlogged - UN, logged - LG and secondary forest - SF), and compare my results with other studies in the same region.

Study Area

Data were collected at Fazenda Vitoria (FV) (02°55'S, 47°35'W), 6 km northwest from Paragominas town. Rainfall (1750 mm/yr) varies seasonally, with a pronounced dry season between July and November (< 50 mm/month) (EMBRAPA-CPATU). Hunting pressure is high, and hunters are frequently encountered, especially on weekends.

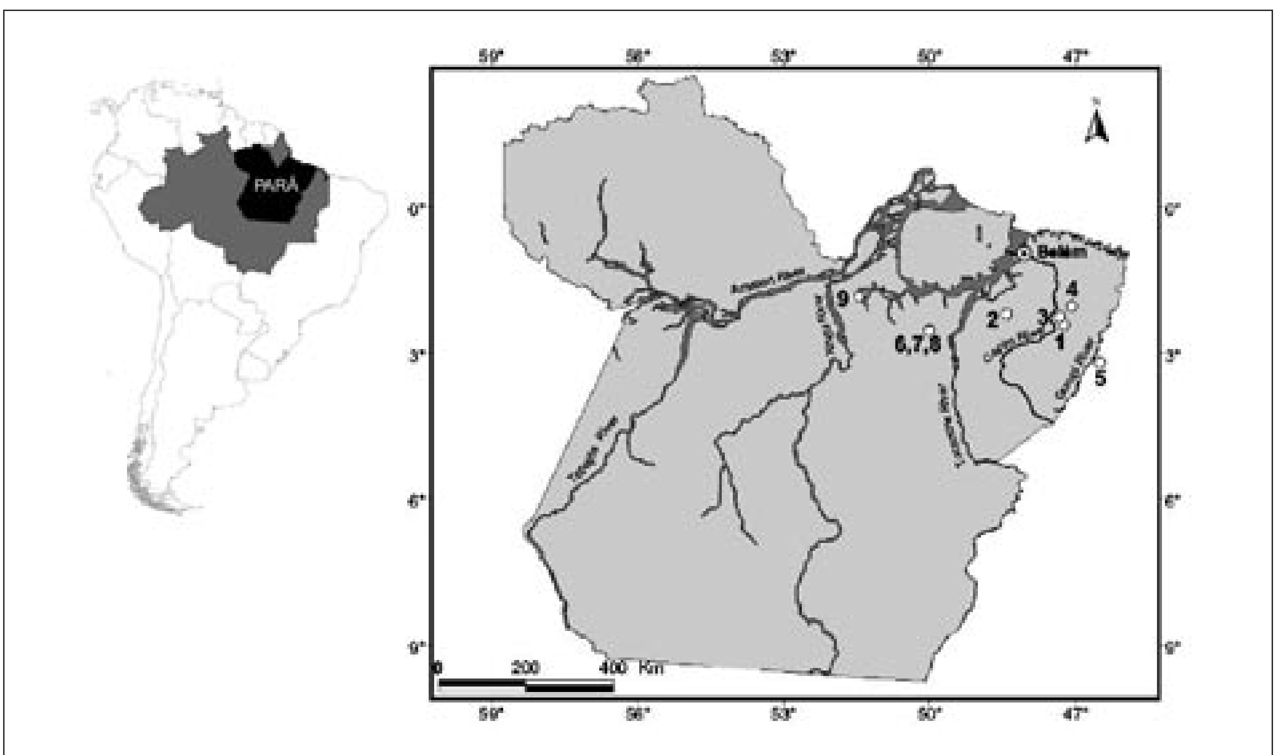

Figure 1. Location of the Fazenda Vitória (1) and the other sites in the state of Pará in eastern Brazilian Amazonia. See Table 1.