Habitat Characterization and Population Density of Brown Spider Monkeys (Ateles hybridus) in Magdalena Valley, Colombia

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Short Articles

Habitat Characterization and Population Density of Brown Spider Monkeys (*Ateles hybridus*) in Magdalena Valley, Colombia

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Introduction

The spider monkey *Ateles hybridus,* one of the most threatened primate species in the Neotropics is restricted to Colombia and Venezuela (Defler, 2004). There are two sub-species present in Colombia: *A. hybridus hybridus* and *A. hybridus brunneus* (Froehlich *et al.*, 1991 in Defler, 2004). The geographical range of the species includes the northwest region of the country, along the Magdalena River from the southern region of La Guajira to the northeast of the department of Boyacá (Defler, 2004). Populations of *Ateles hybridus* still exist in several Colombian departments (Magdalena, Cesár, Norte de Santander, Arauca, Santander, Bolívar, Antioquia and Caldas). Due to its limited distribution range, high hunting pressure, low birth rates and the accelerated transformation of its habitat, the species is now considered Critically Endangered (CR A3cd) and faces the highest risk of extinction in Colombia (Pinzón, 1998; IUCN, 2008; Defler and Rodriguez, 2003). Few conservation actions have focused on *A. hybridus* subspecies. In the 1970's, there was an initiative to create a protected area at the Serranía San Lucas, where *A. hybridus brunneus* occurs, but the plan has not been realized (Defler, 2004).

Studies and conservation programs for *Ateles hybridus* in Colombia are scarce (Defler, 2004). There are two published studies that include general ecological information on the populations in the state of Bolivar (Bernstein *et al.*, 1976; Green, 1978). Additionally, there are reports of the species from Venezuela (Mondolfi and Eisenberg, 1979 in Defler, 2004). However, there is much less information available for *A. hybridus* than for other spider monkey species (Defler, 2004). The main aims of the present study were to estimate the population density of brown spider monkeys (*Ateles hybridus hybridus*) at El Paujil Bird Reserve, Magdalena Valley (Colombia) and to compare the abundance of the monkeys across forests with different characteristics in the area. According to Stevenson (2001) the abundance of primate communities inside protected Neotropical forests is positively related to fruit production. For this reason we predicted higher population densities for forests with abundant fruit production. In addition, we examined the effect of different levels of logging and hunting pressure, which are known to impact the population density of large Neotropical primates (Peres and Palacios, 2007). Other projects within the study zone are being developed, focusing on the behavioral and ecological aspects of the species (A. Link pers. comm.), as well as conservation actions and educational campaigns.

Methods

The research was focused on the *A. hybridus hybridus* populations existing at El Paujil Bird Reserve (owned by Fundación ProAves) located at the Serranía de Las Quinchas in Santander and Boyacá departments (74° 11' W, 5° 56' N: 200 – 1700 m a.s.l.). The nearest weather station is located in the municipality of Otanche (74° 11′ W, 5° 40′ N: 1070 m a.s.l.), where the median temperature is 27.8°C. Precipitation is bimodal showing peaks in April-May and September-November; the total annual precipitation is 2,070 mm. Relative humidity ranges from 85% to 89% (Balcázar-Vargas *et al.*, 2000). Annual rainfall during 2007 was 3,285 mm (A. Link, pers. comm.)

Forest characterization

Four different forest types were studied: forest with a moderate level of selective logging (logged forest), forest on flood plains, young secondary forest (secondary forest), and forest with less logging pressure (undisturbed forest). Three of these forest types were present inside the reserve: logged forest, forest on flood plains, and secondary forest. Undisturbed forest was not found inside the reserve, but was studied on the property of Mr. Norberto Vargas, 8 km away from the reserve. The logged forest had been exploited for wood in the past, contrary to the undisturbed forest, which had been logged for fewer species and to a lesser extent. The flood plains were not very extensive, existing only at the bank of the Ermitaño River (< 50 m wide), and flooding occurred only for a few days during the rainy seasons; for this reason we did not establish vegetation plots in this forest type. To determine forest composition, we completed five 1-ha vegetation plots, taking into account the proportional area of each forest type found. In every hectare we marked and identified all trees and lianas with DBH (Diameter at Breast Height) greater or equal to 5 cm, following the methodology used in Stevenson *et al.* (2004). The identification of each plant was made with the aid of binoculars. In the cases where identification was not possible, we collected botanical samples for later identification. The vouchers were placed at the Universidad de Los Andes Herbarium (ANDES) and the National Herbarium (COL). For each 1-ha plot we calculated species richness, number of species per stem and the Fisher's diversity index.

Resource availability

Following the methodology proposed by Stevenson (2004), we carried out biweekly phenological transects to estimate fruit production of endozoochorous species. Transects were placed according to the proportion of each forest type inside the reserve. The distances covered for each forest type were: 8.9 km for logged forests, 1 km for secondary

forests and 0.8 km for flood plains. We estimated the crop as the total number of fruits produced by each tree present along the transects. To decrease the variance resulting from visual estimates made by different observers, we quantified fruit crop as the mean value of log-scale categories (i.e. 1-10, 10-100, 100-1000, and so on: Janson and Chapman, 1999). To obtain the production in terms of biomass for each individual, we estimated the average weight of each species, drying and weighing a minimum of 5 fruits. The total production was estimated as the total production of all individuals in an area determined from the length and effective width of the transects, which depends on the size of the trees (Stevenson, 2004). The undisturbed forest was not included because is located far from El Paujil Bird Reserve. However, in order to make comparisons within forests, we calculated the basal area of the endozoochorous species for all plots, using only individuals with DBH greater than 10 cm. In general, the basal area of fruiting trees is positively correlated with fruit production (Chapman *et al*., 1994; Stevenson *et al*., 1998).

Population density of Ateles hybridus and other primates
We used linear transects to estimate the population density of all diurnal primates in each forest type. We collected information once a month, recording the species, number of individuals, and perpendicular distance to the transect. The length of the transects was 6.0 km for the undisturbed forest, 9.9 km for the logged forest, 2.1 km for the flood plains and 1.1 km for the secondary forest. Data were analyzed for each species using the King estimator (Leopold 1933):

$$d = n / 2La$$

Where n is the number of individuals observed on each transect, L is the length of the transect, and a is the average perpendicular distance of the individuals to the trail. To determine differences in *A. hybridus* density between forests we performed a Kruskal-Wallis non-parametric test using Statistix 8.0.

Results

Forest type characterization
The diversity indexes calculated for each vegetation plot are shown in Table 1. We observed that the diversity indexes calculated for undisturbed forest were very similar to indexes calculated for the logged forest, while the diversity indexes for the secondary forest were notably lower than for the other forests.

Resource availability
We found relatively low production for the flood plains (38 kg/ha ± 2.3SD) and secondary forest (286 kg/ha ± 12.3 SD), while the logged forests showed higher production (501 kg/ha ± 9.4SD). The production in the flood plains was relatively constant through the sampling period, showing variation between the biweekly periods every month (Fig. 1a). Fruit production in the secondary forest showed a peak in April caused by the fructification of a single individual of *Inga alba*, a non-characteristic species of this forest type (Fig. 1b). For the logged forest, production showed a fructification peak during April-June, which matches with the first rainy season at the study site (Fig. 1c). We found significant differences of resource availability among forest types according to the disturbance level. The comparison based on the basal area of endozoochorous species (Table 1) suggests that fruit productivity should be higher in the undisturbed forest than in the logged forest, because it holds a higher basal area of endozoochorous species.

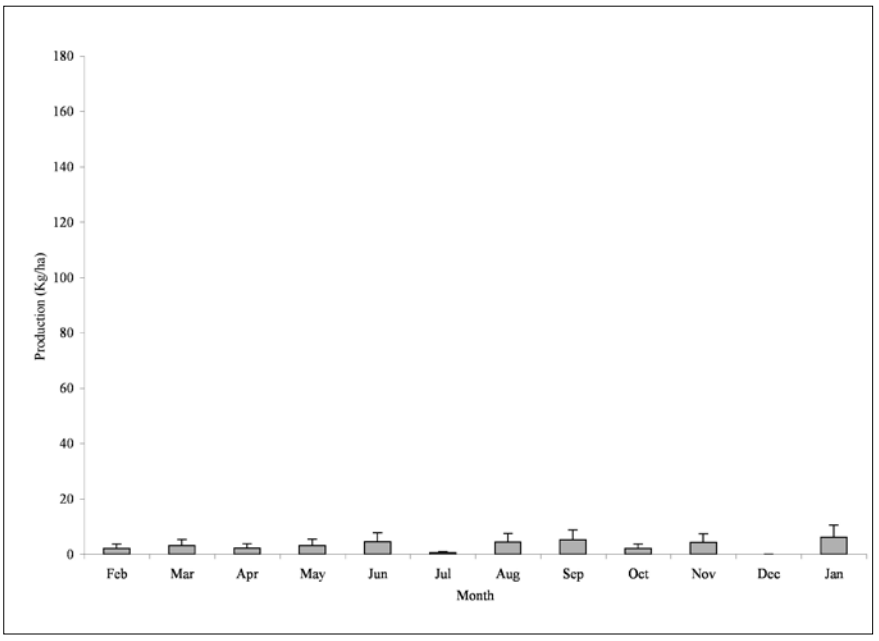
Population density of Ateles hybridus and other primates
We did not observe *Ateles hybridus* in secondary forest or in flood plains during the study (Table 2). In contrast, we found a high density of spider monkeys in the undisturbed and logged forests. Density was similar between these two types of forests (n= 24, F= 0.08, p= 0.77). A similar situation was found for *Alouatta seniculus*; the highest density of howlers were in the logged forest, and they were also present in the undisturbed forest, but not in the other forests. On the other hand, the highest density of *Cebus albifrons* was in the secondary forest, where there no other primate species were observed.

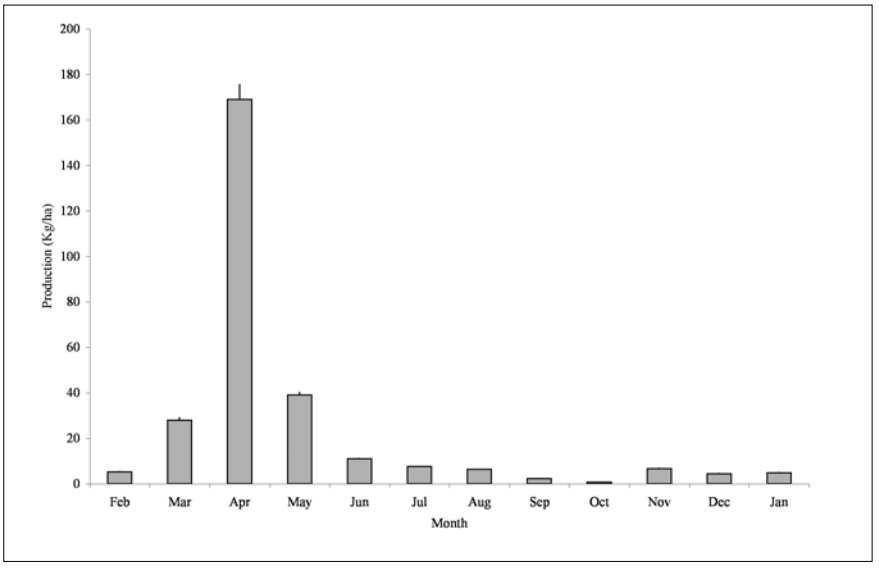
Discussion

We found differences among forest types in diversity, fruit production and basal area of endozoochorous species, which are associated with structural and floristic composition (Aldana *et al.* in prep.). According to our predictions, the forest types with high fruit production showed the highest population densities of *Ateles hybridus*. How-

Table 1. Diversity indices and basal area of endozoochorous plant species from each 1-ha vegetation plot in 3 different forest types at the study area (values in parenthesis correspond to plants > or = 10 cm DBH).

Forest type	No. Species	No. Individuals	Spp/Stem	Fisher´s Alpha	Basal Area Endozoochorous (m^2)
Secondary	45 (20)	471 (83)	0.096 (0.241)	12.3 (8.4)	1.1
Logged	225 (148)	1070 (499)	0.210 (0.297)	86.8 (71.3)	21.0
	194 (141)	1000 (544)	0.194 (0.259)	71.8 (61.8)	19.7
Undisturbed	243 (169)	1048 (527)	0.232 (0.321)	99.2 (86.1)	30.7
	213 (155)	924 (446)	0.231 (0.348)	86.9 (84.3)	36.3





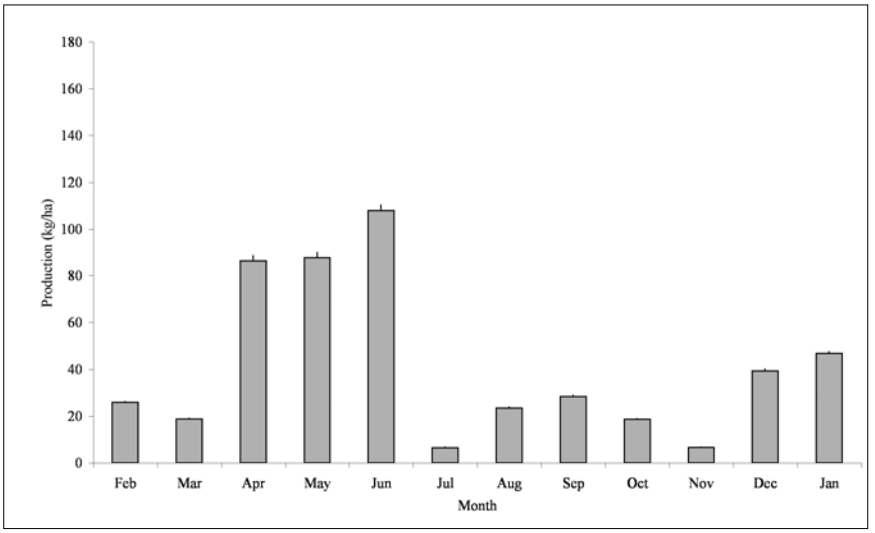


Figure 1. Monthly production (kg/ha) of endozoochorous fruits within different forest types found at El Paujíl Bird Reserve, for the period of time sampled: February 2006 – January 2007. a) Production in the secondary forest. b) Production in the flood plains. c) Production in the logged forest.

Table 2. Density of *A. hybridus* and other diurnal primate species in different forest types at El Paujíl Bird Reserve and nearby forests. n/a = non/applicable in the cases where the observations were zero for all months and the standard deviation could not be calculated.

Forest type	Species	Ind/km^2	Stand. Dev.
Undisturbed	***Ateles hybridus***	**29**	25
	Alouatta seniculus	3	9
	Cebus albifrons	34	65
Logged	***Ateles hybridus***	**38**	43
	Alouatta seniculus	10	11
	Cebus albifrons	83	114
Secondary	***Ateles hybridus***	**0**	n/a
	Alouatta seniculus	0	n/a
	Cebus albifrons	136	278
Flood plains	***Ateles hybridus***	**0**	n/a
	Alouatta seniculus	0	n/a
	Cebus albifrons	7	23

ever, there was little difference between density estimates in the logged and undisturbed forest. This unexpected result may be caused by several factors. It is possible that natural resources exploitation, in particular hunting pressure, could have had a high impact. The logged forest is located inside El Paujil reserve and currently provides protection to the primates and their habitat. In contrast, the undisturbed forest is outside the reserve, where human activities are not controlled and, besides the difficulty to access the area, there is no particular protection for the primates. Occasionally, during our fieldwork, we detected hunting sites in the undisturbed forest; hunting may reduce the population density, as well as the probability of detection and the foraging preference in the zone. Another possible explanation is that the logged forest is fragmented, with reduced forest area available, so the high density in the reserve may be explained by the effect of population concentration. Although it is difficult for these primates to move between fragments, there are some observations of individuals crossing between two fragments using the highest trees above roads (A. Link, pers. comm.). Furthermore, the group found on this fragment has approximately 24 individuals with 4 females carrying infants (A. Link, pers. com.); this indicates that the population contains a high proportion of young individuals, characteristic of growing populations, and suggests that the conditions in which these primates are found are adequate to sustain the population over the short term. In a preliminary evaluation of the *Ateles hybridus* diet at El Paujil, Diaz-Cubillos (2007) found that the group uses the fragment of logged forest, preferring areas with high canopy and high plant diversity. This explains why we did not find these primates inside the secondary forest or the flood plains, since these areas have lower canopy and are not very productive or diverse.

Conclusions and recommendations

Even though the undisturbed forest offers a higher quantity and diversity of endozoochorous plant species, the *Ateles hybridus* groups of the study area at the Serranía de Las Quinchas have similarly high population densities in undisturbed forests and logged forests, because the later are protected from hunting activities. In areas with past total deforestation, such as the secondary forests, we did not find *A. hybridus* groups. This suggests that, in contrast to selective logging, clear-cutting forests has long term negative consequences for this species. This study indicates that logged forest fragments in El Paujil Bird Reserve are still in adequate condition to carry healthy populations of primate species such as *A. hybridus, A. seniculus,* and *C. albifrons*. Accordingly, the results of this study suggest that a population of *A. hybridus* requires relative mature forest with high canopy levels. We recommend the expansion of the protected areas where the species can still be found in order to decrease fragmentation, increase connectivity within fragments, and assure a minimum area where the *A. hybridus* populations could have enough space to sustain healthy populations. We also recommend continued improvement and implementation of educational activities with children, and the development of activities with adults to raise awareness at all levels in the local communities. Aims should include the reduction of hunting activities outside of protected areas to guarantee the conservation of the species in the region.

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Primatas da rppn Gargaú, Paraíba, Brasil

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Introdução

A comunidade de primatas da Floresta Atlântica, um *hotspot* para a conservação biológica (Myers *et al*., 2000), é composta por pelo menos 21 táxons e, em certas regiões, até seis espécies podem conviver de forma simpátrica. Contudo, este bioma já perdeu mais de 93% de sua cobertura florestal original (Fundação SOS Mata Atlântica e INPE, 2002). Na área compreendida pela Zona da Mata dos estados de Alagoas, Pernambuco, Paraíba e Rio Grande do Norte, a biorregião Pernambucana (Galindo-Leal e Câmara, 2005) ou Centro de Endemismo Pernambuco (Silva e Casteleti, 2005), os remanescentes florestais não chegam a 5% de sua extensão original, pulverizados em uma matriz de canaviais (Coimbra-Filho e Câmara, 1996; Silva e Casteleti, 2005).

Nesta paisagem altamente fragmentada do Centro de Endemismo Pernambuco são encontradas três espécies de primatas, o sagui-de-tufos-brancos *Callithrix jacchus* (Linnaeus, 1758), o guariba-de-mãos-ruivas *Alouatta belzebul* (Linnaeus, 1766) e o macaco-prego-galego *Cebus flavius* (Schreber, 1774). *Callithrix jacchus* é uma espécie relativamente comum, ocorrendo também na região da Caatinga. Apesar de *A. belzebul* apresentar uma população disjunta na Amazônia oriental em razoável estado de conservação, a situação de suas populações remanescentes na Floresta Atlântica nordestina é crítica (Oliveira e Oliveira, 1993). *Cebus flavius* foi redescoberto em 2006 como táxon válido (Oliveira e Langguth, 2006). Segundo estes autores, a espécie ocorreria na Floresta Atlântica nordestina ao norte do rio São Francisco. Estudos em andamento apontam que as populações atuais de *C. flavius* na natureza não ultrapassam duas dezenas (Ferreira *et al*., 2007), o que sugere uma situação de altíssima vulnerabilidade. A espécie já é listada como Criticamente Ameaçada pela IUCN (2008).

O processo de fragmentação florestal pode afetar a viabilidade de populações selvagens de diversos modos, tais como o incremento da endogamia e a consequente susceptibilidade a doenças (Frankham *et al*., 2002). Por sua vez, os primatas podem responder à fragmentação alterando seu padrão de atividades, sua dieta e sua área de uso entre outros (Marsh, 2003). Populações remanescentes de primatas mais generalistas, como algumas espécies de *Alouatta*, *Cebus* e *Callithrix* (Crockett, 1998; Chiarello, 2003), são capazes de suportar o efeito de borda e se deslocar e/ou se alimentar de recursos do entorno dos fragmentos (pastagens e plantios, por exemplo). Assim, estas populações têm maiores probabilidades de sobreviver ao processo de fragmentação e isolamento e podem dispersar e colonizar outros fragmentos. Esta flexibilidade adaptativa, no entanto, não representa uma garantia de