Distribution and Abundance of White-Fronted Spider Monkeys, *Ateles belzebuth* (Atelidae), and Threats to Their Survival in Peruvian Amazonia

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Key Words

Ateles belzebuth · Population density · Group size · Geographic distribution · Sympatry · *Ateles chamek* · Conservation

Abstract

The white-fronted spider monkey, *Ateles belzebuth*, is listed as 'Endangered' according to the IUCN classification. In Peru it is found in the departments of Loreto, San Martín, Amazonas and Cajamarca, but detailed data on its geographic distribution, population densities and conservation status are scarce. In order to obtain such information, we conducted transect censuses on the Río Aushiri and Río San Antonio (right bank of Río Napo), and between the Río Curaray and the Río Arabela and Río Nashiño, respectively, and made additional explorations on the northern and southern banks of the Río Marañón. We obtained 48 sightings along 761 km of census transect. Group size and population densities were lower in an area with high hunting pressure compared to areas with medium or low hunting pressure. Besides hunting, increasing deforestation is a major threat to the survival of *A. belzebuth* in Peruvian Amazonia.

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Introduction

The white-fronted spider monkey, *Ateles belzebuth*¹, is 1 of 6 ateline taxa that occur in Peru [Aquino and Encarnación, 1994; Groves, 2001]. Because they are large, they are hunted extensively [Bodmer et al., 1997, 1999; Aquino et al., 2000a; Peres,

¹ We follow the taxonomy of Groves [2001] who recognizes 7 species of the genus *Ateles* but are aware that separation of *A. belzebuth* and *A. chamek* may not be definitive.

Table 1. Survey areas and sites for *A. belzebuth* in north-eastern Peru

Area	Site	UTM coordinates (E/N)	Degree of human disturbance	Predominant habitat types
Río Napo	Río San Antonio (1)	500000/9840000	high	low hill, high terrace, 'aguajal de altura'
	Río San Antonio (2)	510000/9825000	high	low hill, high terrace, 'aguajal de altura'
	Río Aushiri (3)	515000/9812500	high	high and medium terrace including aguajales
Curaray-Arabela	Río Curaray (4)	453529/9812500	low	high and medium terrace including aguajales
	Río Curaray (5)	451363/9816908	low	low hill, high and medium terrace including aguajales
	Río Arabela (6)	446572/9808350	low	low hill
	Río Arabela (7)	457483/9789796	low	low hill, high terrace
	Río Arabela (8)	459670/9785672	low	low hill, high terrace
Curaray-Nashiño	Río Curaray (9)	452622/9829407	moderate	low terrace including aguajales
	Nashiño (10)	457272/9834910	moderate	low hill, high terrace

Figures in parentheses following site names refer to the locations indicated in figure 1.

2000]. This has made *A. belzebuth* rare and it is now considered 'Endangered' (A2cd, decreasing population trend) [IUCN, 2012]. Detailed ecological and behavioural studies have been performed on this species, mainly in Colombia and Ecuador [Di Fiore et al., 2009; Blake et al., 2010; Stevenson and Link, 2010; for older references, see Campbell, 2008], but knowledge of *A. belzebuth* from Peruvian Amazonia is scanty and superficial. Even its geographic range in Peru is not well established, with errors or lack of precision found in distribution maps provided by Kellogg and Goldman [1944], Hill [1962], Aquino and Encarnación [1994], Collins and Dubach [2000] and Boubli et al. [2008]. These authors considered the areas between the rivers Napo and Putumayo and between the rivers Marañón, Huallaga and Aipena to be part of the distribution. Abundance data are only available for the Río Samiria and the Río Pucacuro [Aquino et al., 2000a, b; Aquino and Bodmer, 2006]. In the present study, therefore, we aim to: (1) define the geographic distribution, (2) obtain abundance and demographic data, and (3) identify threats to the survival of *A. belzebuth* in Peru. To these ends, expeditions and surveys were carried out between 2004 and 2009 in different areas of northern Peruvian Amazonia.

Methods

Study Sites

Transect censuses were carried out in January 2005 on the rivers Aushiri and San Antonio (right bank tributaries of the Río Napo), and in October-November 2007 and January-February 2008 on the Ríos Arabela, Curaray and Curaray-Nashiño. Detailed information on the geographic location, habitat types and a semiquantitative estimate of the degree of human disturbance at the 10 different survey sites are presented in table 1 and figure 1. High human disturbance in the Río Napo area is obvious from the many trails and camps used by hunters and loggers. The number of cartridges along trails and bony remains of animals, particularly primate and rodent skulls, and the intolerance of primates to approaches by humans are indica-

Fig. 1. Geographic location of the 10 *A. belzebuth* survey areas.

tors of a strong hunting pressure in this area. In the Curaray-Nashiño and Curaray-Arabela areas, human disturbance is mainly due to logging. In both areas, camps were found close to the river banks, and 7- to 8-metre-wide trails for timber extraction extended up to 300 m into the forest interior. Hunting trails were few and never longer than 3 km in the Curaray-Nashiño area and very rare in the Curaray-Arabela area: consequently, primates were much more tolerant to the approaches of humans. Additional expeditions to verify the geographic distribution of *A. belzebuth* were made in several other areas between 2004 and 2009 (for details, see table 2).

Survey Methods

In each of the 10 study sites 4 linear transects were opened, 3.0–4.0 km long in the Río Napo area, and 2.5–3.0 km long in the Curaray-Arabela and Curaray-Nashiño area. Two teams of experienced observers (a researcher and a field assistant) simultaneously walked different transects between 06.15 and 12.00 h (forward), and 14.00 and 17.00 h (return), respectively, at a speed of 1.0 km/h. Each transect was walked 2 or 3 times. Each time primates were encountered, species identity, perpendicular distance to the transect of the first individual detected, number of individuals detected, height and activity, and the presence of carried infants were noted. Complete counts of group size were obtained whenever possible. Given the fission-fusion organization of spider monkeys [Symington, 1990], these counts were generally foraging parties and probably not entire groups ('communities'). In total 761 km of transect were walked (table 3).

Table 2. Additional survey areas where presence/absence of *Ateles* (based on direct observations and interviews with locals) and human activities that may threaten the existence of the species were recorded

Period	Site	Departamento	Altitude m a.s.l.	UTMS coordinates	Type of evidence	<i>Ateles</i> species present
Aug–Sep 2004	Río Chipurana, locality San Antonio	San Martín	n.a.	n.a.	I	A.b.
	Río Mayo, locality Chazuta	San Martín	n.a.	n.a.	I	A.b.
	Río Abiseo, locality Nuevo San Juan	San Martín	n.a.	n.a.	O	A.b. (2)
Jul–Aug 2005	Río Tocache, locality Metal	San Martín	1,321	307317/9069170	I	A.b.
	Río Aspuzana, locality Nuevo San Martín	San Martín	616	376317/9047424	I	A.c.
	Tingo de Uchiza	San Martín	958	329144/9060432	I	A.c.
	Chontayacu, locality Cocalito	Huánuco	1,267	321439/9047700	I	A.c.
Oct–Nov 2005	Huamanpata	Amazonas	2,147	225623/9303347	I	A.c.
	San Martín	Amazonas	1,617	214506/9289808	I	A.c.
	Ocol	Amazonas	2,250	216777/9307395	I	A.c.
	Limabamba	Amazonas	1,668	225362/9280123	I	A.c.
	Choctamal	Amazonas	2,643	171450/9290049	I	A.b.
	Rodríguez de Mendoza	Amazonas	n.a.	n.a.	I	A.c.
	Pedro Ruiz Gallo	Amazonas	n.a.	n.a.	I	A.b.
	Chachapoyas	Amazonas	n.a.	n.a.	I	A.b.
	Yambrasbamba	Amazonas	1,894	176009/9365256	I	A.b.
May–Jun 2006	Río Pastaza, locality Andoas	Loreto	n.a.	342710/9678351	I	A.b.
	Río Pastaza, locality Alianza Cristiana	Loreto	n.a.	336303/9617424	I	A.b.
	Río Chuinda, locality Puerto Requena	Loreto	n.a.	302563/9532417	O	A.b. (2)
	Río Morona, locality Nueva Alegría	Loreto	n.a.	208567/9627904	O	A.b. (1)
	Río Morona, up to the Ecuadorian border	Loreto	n.a.	n.a.	I	A.b.
Jul–Aug 2006	Río Algodón	Loreto	n.a.	818792/9705328	I	–
Oct–Nov 2009	Río Parapapura, locality Balsa Puerto	Loreto	205	327379/9355102	I	–
	Río Aipena, locality San Antonio de Rumiayacu	Loreto	119	364985/9423516	I	–
	Río Marañón, locality Borja	Loreto	152	217313/9505358	I	–

Numbers of groups observed are indicated in parentheses. n.a. = Not available; O = observation; I = interview; A.b. = *Ateles belzebuth*; A.c. = *Ateles chamek*; – = no presence.

Table 3. Population densities and group sizes of *Ateles belzebuth* in the survey areas where transect censuses were conducted

Area and hunting pressure	Total length of transect walks, km	Number of groups observed	Sighting rate (sightings/10 km transect walk)	Population density		Mean group size $\pm$ SD	Range	n
				groups/km ²	individuals/km ²			
Río Napo (high)	132	3	0.23	0.45	1.5	3.3 $\pm$ 1.5	2–5	3
Curaray-Nashiño (moderate)	230	17	0.74	1.7	15.5	9.1 $\pm$ 4.8	5–19	7
Curaray-Arabela (low)	399	28	0.70	1.5	16.5	10.8 $\pm$ 5.9	5–18	6

n = The sample size for mean group size calculation differs from the number of groups observed since complete group counts were not always possible.

Data Analyses

Due to the low number of encounters with *A. belzebuth*, we could not apply the software Distance [Laake et al., 1994]. Instead, we used the formula $D = N/2dL$ [Burnham et al., 1980] to calculate group density D , where N is the number of groups encountered along transects, L the length (km) and d the mean perpendicular distance to the transect of the first animal sighted ($= 26$ m). The number of individuals per square kilometre was then calculated by multiplying D with the mean group size. We also calculated encounter rates as the number of sightings per 10 km of transect walked. In order to examine the effect of human disturbance on group size, we compared the mean group size between the different areas with a one-way ANOVA in Statistica 9.0.

Results

Geographic Distribution

Direct (sightings) and indirect evidence (interviews)² for the presence of *A. belzebuth* during expeditions and surveys in combination with information during expeditions to the Ríos Yanayacu de Tutapishco, Tamboryacu and Santa María, all left bank tributaries of the Río Napo, between 1982 and 1987 [Aquino and Encarnación, 1986; Aquino et al., 1992, 2005a, b], surveys in the Río Samiria and Río Pucacuru areas [Aquino et al., 2000a, 2000b; Aquino and Bodmer, 2006] and information for the Laguna de los Cóndores and the Río Chilchos in the Departamento San Martín [Barrios et al., 2003] formed the basis for defining the geographic distribution of *A. belzebuth* in Peru as follows (fig. 2):

Northern Peru, in the Departamentos Loreto, San Martín, Amazonas and probably Cajamarca.

Departamento Loreto. Northern limit formed by the Río Napo, eastern limit by the Río Amazonas. South of the Río Marañón in a narrow enclave between the Río Huallaga and the Quebrada Caucho Grande to the west and the Río Samiria to the east; in this enclave, *A. belzebuth* occurs sympatrically with *A. chamek* [Aquino and Bodmer, 2006]. We also observed *A. belzebuth* in the forest interior along the Río Morona (locality Nueva Alegría; 1 group) and Río Chuinda (locality Puerto Requena; 2 groups) (table 2). For other localities, its presence or absence is based on interviews of locals.

Departamento San Martín. Between Cordillera Escalera in the north to the left bank of Río Mishollo in the south, and foothills of the eastern cordillera of the Andes in the west to the Río Huallaga in the east. In the area north of the Río Tocache, *A. belzebuth* probably occurs in sympatry with *A. chamek*.

Departamento Amazonas. From the border with Ecuador and the Departamento Cajamarca in the north to the right bank of Río Utcubamba (at the height of Choctamal) and the headwaters of the Ríos Jelache and Salas in the south. In the extreme south-east of this range, *A. belzebuth* occurs in sympatry with *A. chamek*; this is based on interviews with people in the montane forest areas who described two species of *Ateles*: north one with black fur and a creamy-yellow forehead, the other completely black. At Huamanpata, south of the Río Salas, people only reported a completely black spider monkey, i.e. *A. chamek*. South of Huamanpata, on the Río

² We asked local people to describe in detail primate species they know from their area.

Fig. 2. Geographic distribution of *A. belzebuth* in Peruvian Amazonia.

Chilchos, a tributary of the Río Jelache on the border between the Departamentos San Martín and Amazonas, *A. belzebuth* has been observed by Barrios et al. [2003] at 1,620 m above sea level, but also pictures were taken at the same site of spider monkeys with fur coloration similar to hybrids between *A. belzebuth* and *A. chamek* at the Río Samiria [Aquino and Bodmer, 2006]. These data support the supposed sympatry between these two species in parts of the range.

Departamento Cajamarca. Probably both banks of the Río Chinchipe and its major tributaries.

We did not observe *A. belzebuth* in the area between the Cordilleras Cahuapanas and Escalera and the Río Marañón (microbasins of the Ríos Paranapura, Aipena, Potro, Aichiyacu and Cahuapanas). Older people (>50 years) emphasized that the only larger primate species that exist in this area are *Lagothrix poeppigii* and *Alouatta seniculus*.

Conservation Status and Threats to Survival

Both in the areas of detailed population surveys and in the other areas that were explored to verify the geographic distribution, the following human activities were identified that do or potentially can threaten the survival of *A. belzebuth*: hunting, deforestation for pasture, agriculture and timber extraction. Major populations of

this species remain principally in those areas that are either remote (headwaters of rivers) or difficult to access (*aguajales*). In Loreto, this conforms to a narrow strip along the border with Ecuador with the headwaters of the Ríos Nashiño and Curaray (affluents of the Río Napo), Tangarana, Baratillo, Corrientes and Macusari (tributaries of the Río Tigre), Chapuli, Chuinda y Sicuanga between the Ríos Pastaza and Morona, and the Cordillera Campanquiz between the Ríos Morona and Santiago. In the Departamento San Martín, *A. belzebuth* is relatively abundant in the Parque Nacional del Río Abiseo, and in the Departamento Amazonas; major concentrations occur south of the Marañón between the upper course and headwaters of the Ríos Imaza and Nievas, and north of the Marañón between the Ríos Santiago and Chinchipe close to the Ecuadorian border. Finally, the *aguajales* on the left bank of the Río Samiria in the Reserva Nacional Pacaya-Samiria harbour populations of *A. belzebuth*.

Sighting Rates, Population Densities and Party Size

In total 48 groups of *A. belzebuth* were encountered during the transect surveys. Sighting rates were low in the Río Napo area, and 3–4 times higher in the Curaray-Nashiño and Curaray-Arabela areas, respectively (table 3). Similarly, population density was low in the Río Napo area, and higher in the other two areas (table 3).

Party size did not differ significantly between areas ($F_{2, 13} = 2.36$, n.s.). Nevertheless, mean and maximum party sizes were lowest in the area with the highest degree of human disturbance (Río Napo; table 3). The discrepancy between the Río Napo area and the other two areas might even be stronger, since larger parties of *A. belzebuth* are usually more dispersed, making reliable counts more difficult. In the area of moderate human disturbance, the two smallest parties (5 and 6 individuals, respectively) were encountered along small streams, i.e. areas where exposure to humans is potentially higher.

Discussion

The geographic distribution of *A. belzebuth* outlined here contrasts with previous distribution maps by Kellogg and Goldman [1944], Hill [1962], Aquino and Encarnación [1994] and Collins and Dubach [2000]: (1) the species is absent from areas north of the Ríos Napo and Amazonas; (2) the species is also lacking from the area defined by the Ríos Marañón and Huallaga in the north and east, respectively, and the Cordilleras de Cahuapanas and Escalera in the west and south. For this second area, the lack of sightings during expeditions is corroborated by information from local hunters who maintained that the species occurs only on the western and southern slope of the two Cordilleras, in the Departamentos Amazonas and San Martín, respectively. We currently lack an explanation for this ‘lacuna’ in the distribution of *A. belzebuth*. Such ‘lacunae’ have also been reported for *Ateles marginatus* and *Lagothrix cana* from Brazilian Amazonia [Iwanaga and Ferrari, 2002; Ravetta and Ferrari, 2009] and may be more common than appreciated so far in the geographic distribution of many New World primates [Palminteri, 2010; Palminteri et al., 2011]. While local absence can often be explained by extinction due to excessive hunting [Peres, 1990; Nuñez-Iturri and Howe, 2007], local and regional lack of a species may also relate to fine-grained and often unrecognized habitat factors [Ravetta and Ferrari, 2009; Palminteri, 2010].

Habitats occupied by *A. belzebuth* in Peru are varied and comprise both inundated forests and dense *aguajales*, high-ground forest, and premontane forest up to around 1,800 m above sea level. However, throughout its range, populations are threatened – to different degrees – by human activities like hunting (both subsistence and commercial), deforestation, logging, mining and petroleum exploitation. The latter threat may become increasingly strong. In many areas that have been licensed for oil exploitation, activities will start or will increase with the opening of heliports, installation of housing areas, opening of transects for seismic explorations, and the seismic explorations themselves. Seismic transects will also increase access to hunters and illegal loggers.

Deforestation is a major threat in the Departamentos San Martín and Amazonas, where land is increasingly cleared for cattle ranging and agriculture, but also for the extraction of commercially valuable timber. Where forest remains, it is highly fragmented, and even if populations of *A. belzebuth* could survive in such fragments (which is doubtful), in the long term the lack of gene flow would result in population extinction.

The effect of hunting and habitat disturbance on populations of *A. belzebuth* is obvious from our results on population density. Group densities were about 50% and individual densities 70–80% lower in the area with the highest degree of hunting and disturbance (Río Napo). Densities of *A. belzebuth* in the Curaray-Arabela and Curaray-Nashiño areas are higher than those on the Río Pucacuru (0.16 groups/km², 0.8 individuals/km² [Aquino et al., 2000b]) and those of *A. belzebuth* and *A. chamek* on the Río Samiria (*A. belzebuth*: 0.2 groups/km², 1.0 individual/km², *A. chamek*: 0.06 groups/km², 0.5 individuals/km² [Aquino and Bodmer, 2006]), both areas with a moderate to strong hunting impact. In a more strictly protected area, the Parque Nacional del Manu, population densities of *A. chamek* are considerably higher than those reported here (28–31 individuals/km² [White 1986; Symington, 1988a]). The effect of hunting on population densities is in line with findings for other atelines throughout Amazonia [Peres, 1990, 2000; Souza-Mazurrek et al., 2000; Nuñez-Iturri and Howe, 2007]. However, population densities of spider monkeys may also be influenced by habitat quality [Symington, 1988a]. The effect of hunting was also obvious from responses to the presence of observers: spider monkeys in the Curaray-Arabela and Curaray-Nashiño areas tolerated and even approached observers, dropping and throwing branches towards them.

Larger parties in the areas with low or moderate human influence (Curaray-Arabela and Curaray-Nashiño) seem to suggest that hunting may also affect party size. However, this effect is probably less clear than this observation might indicate. Party sizes at the Curaray-Arabela and Curaray-Nashiño are larger than those of *A. belzebuth* and *A. chamek* in the Reserva Nacional Pacaya-Samiria (5.1 and 7.3, respectively; strong hunting pressure in the past [Aquino and Bodmer, 2006]), higher than those reported for *A. chamek* in the Parque Nacional del Manu (3.2 [White, 1986]; 3.65–4.05 [Symington, 1990]; almost no hunting pressure), but similar to those of *A. chamek* in the Sierra de Contamana (13 [Aquino et al., 2005a]; almost no hunting). However, since party size may vary seasonally as a function of resource availability [van Roosmalen, 1985; Symington, 1988b; Chapman, 1990], differences in party size may emerge if surveys in different areas are made in different seasons and may not always indicate real differences.

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References

- Aquino R, Bodmer RE (2006). Distribución y abundancia de *Ateles belzebuth* E. Geoffroy y *Ateles chamek* Humboldt (Cebidae: Primates) en la Reserva Nacional Pacaya Samiria, Perú. *Revista Peruana de Biología* 13: 103–106.
- Aquino R, Encarnación F (1986). Characteristics and use of sleeping sites in *Aotus* (Cebidae: Primates) in the Amazon lowland of Peru. *American Journal of Primatology* 11: 319–331.
- Aquino R, Encarnación F (1994). Primates of Peru/Los Primates del Perú. *Primate Report* 40: 1–130.
- Aquino R, Álvarez J, Mulanovich A (2005a). Diversidad y estado de conservación de primates en las Sierras de Contamana, Amazonía peruana. *Revista Peruana de Biología* 12: 427–434.
- Aquino R, Bodmer RE, Gil G (2000a). Impacto de la caza en poblaciones de primates en la cuenca del río Samiria, Reserva Nacional Pacaya Samiria. In *La Primatología en el Perú* (Espinoza J, San Martín F, Montoya E, eds.), vol 2, pp 81–90. Lima, Master Graf Editores.
- Aquino R, Bodmer RE, Pezo E (2000b). Evaluación de primates en la cuenca del río Pucacuro. In *La Primatología en el Perú* (Espinoza J, San Martín F, Montoya E, eds.), vol 2, pp 92–100. Lima, Master Graf Editores.
- Aquino R, Ique C, Gálvez H (2005b). Reconocimiento preliminar de la densidad y estructura poblacional de *Saguinus tripartitus* Milne-Eduards en la Amazonía Peruana. *Revista Peruana de Biología* 12: 435–440.
- Aquino R, Puertas P, Encarnación F (1992). Las poblaciones de *Aotus vociferans* y *Aotus nancymae* en la Amazonia Peruana. *Alma Mater* 3: 77–82.
- Barrios J, Mendoza C, Venegas P (2003). Inventario biológico preliminar de la cordillera nororiental, zonas de las lagunas de Los Cóndores y Río Chilchos. Final Report to Fundación Holandesa Stichting DNP.
- Blake JG, Guerra J, Mosquera D, Torres R, Loiselle BA, Romo D (2010). Use of mineral licks by white-bellied spider monkeys (*Ateles belzebuth*) and red howler monkeys (*Alouatta seniculus*) in eastern Ecuador. *International Journal of Primatology* 31: 471–483.
- Bodmer RE, Allen C, Penn J, Aquino R, Reyes C (1999). *Evaluación del uso sostenible de la fauna silvestre en la Reserva Nacional Pacaya Samiria*. Documento de Trabajo América Verde No. 4b. The Nature Conservancy. 36 pp.
- Bodmer RE, Aquino R, Puertas P (1997). Alternativas de manejo para la Reserva Nacional Pacaya Samiria: Un análisis sobre el uso sostenible de la caza. In *Manejo de Fauna Silvestre en la Amazonia* (Fang T, Bodmer R, Aquino R, Valqui M, eds.), pp 65–74. La Paz, OVAFIM.
- Boubli JP, Di Fiore A, Stevenson P, Link A, Marsh L, Morales AL (2008). *Ateles belzebuth*. In IUCN Red List of Threatened Species. Version 2012.1. www.iucnredlist.org (accessed September 27, 2012).
- Burnham KP, Anderson DL, Laake JL (1980). Estimation of density from line transects sampling of biological populations. *Wildlife Monographs* 72: 1–202.
- Campbell CJ (2008). Introduction. In: *Spider Monkeys: Behavior, Ecology and Evolution of the Genus Ateles* (Campbell CJ, ed.), pp 1–15. Cambridge, Cambridge University Press.
- Chapman CA (1990). Association patterns of spider monkeys: the influence of ecology and sex on social organization. *Behavioral Ecology and Sociobiology* 26: 409–414.

- Collins AC, Dubach JM (2000). Phylogenetic relationships of spider monkeys (*Ateles*) based on mitochondrial DNA variation. *International Journal of Primatology* 21: 381–420.
- de Souza-Mazurek RR, Pedrinho T, Feliciano X, Hilário W, Gerônimo S, Marcelo E (2000). Subsistence hunting among the Waimiri Atroari Indians in central Amazonia, Brazil. *Biodiversity and Conservation* 9: 579–596.
- Di Fiore A, Link A, Schmitt CA, Spehar SN (2009). Dispersal patterns in sympatric woolly and spider monkeys: integrating molecular and observational data. *Behaviour* 146: 437–470.
- Froehlich JW, Supriatna J, Froehlich PH (1991). Morphometric analyses of *Ateles*: systematic and biogeographic implications. *American Journal of Primatology* 25: 1–22.
- Groves C (2001). *Primate Taxonomy*. Washington, Smithsonian Institution Press.
- Hill WCO (1962). *Primates: Comparative Anatomy and Taxonomy*, vol V: Cebidae, Part A. Edinburgh, Edinburgh University Press.
- IUCN: IUCN Red List of Threatened Species. Version 2012.1. www.iucnredlist.org (accessed September 19, 2012).
- Iwanaga S, Ferrari SF (2002). Geographic distribution and abundance of woolly (*Lagothrix cana*) and spider (*Ateles chamek*) monkeys in southwestern Brazilian Amazonia. *American Journal of Primatology* 56: 57–64.
- Kellogg R, Goldman EA (1944). Review of the spider monkeys. *Proceedings of the United States National Museum* 96: 1–45.
- Laake JF, Buckland ST, Anderson DR, Burnham KP (1994). *Distance Sampling: Abundance Estimation of Biological Populations – Distance User's Guide*. Fort Collins, Colorado Cooperative, Fish and Wildlife Research Unit, Colorado State University.
- Núñez-Iturri G, Howe HF (2007). Bushmeat and the fate of trees with seeds dispersed by large primates in a lowland rain forest in western Amazonia. *Biotropica* 39: 348–354.
- Palminteri S (2010). *Determinants of Primate Distribution and Abundance in Southwestern Amazonia, with a Focus on Bald-Faced Saki Monkeys (Pithecia irrorata)*. PhD thesis, University of East Anglia, Norwich.
- Palminteri S, Powell G, Endo W, Kirkby C, Yu D, Peres CA (2011). Usefulness of species range polygons for predicting local primate occurrences in southeastern Peru. *American Journal of Primatology* 73: 53–61.
- Peres CA (1990). Effects of hunting on western Amazonian primate communities. *Biological Conservation* 54: 47–59.
- Peres CA (2000). Effects of subsistence hunting on vertebrate community structure in Amazonian forests. *Conservation Biology* 14: 240–253.
- Ravetta AL, Ferrari SF (2009). Geographic distribution and population characteristics of the endangered white-fronted spider monkey (*Ateles marginatus*) on the lower Tapajós River in central Brazilian Amazonia. *Primates* 50: 261–268.
- Stevenson PR, Link A (2010). Fruit preferences of *Ateles belzebuth* in Tinigua Park, northwestern Amazonia. *International Journal of Primatology* 31: 393–407.
- Symington MM (1988a). Environmental determinants of population densities in *Ateles*. *Primate Conservation* 9: 74–79.
- Symington MM (1988b). Food competition and foraging party size in the black spider monkey (*Ateles paniscus chamek*). *Behaviour* 105: 117–134.
- Symington MM (1990). Fusion-fission social organization in *Ateles* and *Pan*. *International Journal of Primatology* 11: 47–61.
- van Roosmalen MGM (1985). Habitat preferences, diet, feeding strategy and social organization of the black spider monkey (*Ateles p. paniscus* Linnaeus 1758) in Surinam. *Acta Amazônica* 15(suppl): 1–238.
- White F (1986). Census and preliminary observations on the ecology of black-faced black spider monkey (*Ateles paniscus chamek*) in Manu National Park. *American Journal of Primatology* 11: 125–132.