

16 **Conservation of *Saimiri sciureus albigena*, a Colombian endemic subspecies of squirrel monkey**

Conservación de Saimiri sciureus albigena, una Subespecie de Mono Ardilla Endémica de Colombia

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ABSTRACT

Three subspecies of squirrel monkeys (*Saimiri sciureus albigena*, *S. s. cassiquiarensis* y *S. s. macrodon*) are known for Colombia and one of those (*S.s. albigena*) was classified in 2008 as near threatened by the IUCN. We assessed the conservation status of *Saimiri sciureus albigena* based on different types of data including habitat availability, ecological and population information from some areas of the distribution and reports of its presence in other parts of the distribution. The main threats of this endemic subspecies of squirrel monkey are the reduction and fragmentation of its distribution area in almost half (100.000 km² to 60.000 km² approximately) due to an increase of palm oil plantations in the Colombian Llanos and its use as pet. Although density values are variable (7,69 – 167.62 ind/ km²), their census numbers are low (191 in 532.78 km²). Isolation and fragment size are some of the variables affecting the long term permanence of the group in its highly disturbed area of distribution. This analysis of available information and new genetic data could modify its taxonomy and they suggest that this subspecies could be classified as vulnerable under IUCN criteria A2 (a, b) and B1 (a, b (ii, iii and iv). The use of fence rows of different heights and coverages, education programs, and joint work with livestock farmers and palm oil plantations could reduce the isolation, disturbance and local extinction of this Colombian endemic subspecies.

Key words: *Saimiri sciureus albigena*, Colombian Llanos, habitat availability, density estimate values, effective numbers

RESUMEN

Tres subespecies de monos ardilla (*Saimiri sciureus albigena*, *S. s. cassiquiarensis* y *S. s. macrodon*) son conocidos para Colombia y una de estas (*S.s. albigena*) fue clasificada en el 2008 como casi amenazada por la UICN. Evaluamos el estado de conservación de *S. s. albigena* basados en diferentes tipos de datos incluyendo disponibilidad de hábitat, información ecológica y poblacional de algunas áreas de su distribución y reportes de su presencia en otras partes de su distribución. Las principales amenazas de esta subespecie endémica de mono ardilla son la reducción y fragmentación de su área de distribución en casi la mitad (100.000 km² a 60.000 km² aproximadamente) debido al incremento de los cultivos de palma de aceite africana en los

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Llanos Colombianos y su uso como mascota. Aunque los valores de densidad son variables (7.69 – 167.62 ind/ km²), sus números censuales estimados son bajos (191 individuos reproductivos en 532,78 km²). El aislamiento y tamaño del fragmento son algunas de las variables que afectan la permanencia a largo plazo de los grupos en su altamente perturbada área de distribución. Este análisis y los datos genéticos modificando su taxonomía, sugieren que esta subespecie deba ser clasificada como vulnerable bajo los criterios de la IUCN A2(a, b) y B1(a, b (ii, iii and iv). El uso de las cercas vivas de diferentes alturas y coberturas, programas de educación y trabajo conjunto con ganaderos y plantaciones de palma de aceite Africana pueden reducir el aislamiento, perturbación y extinción local de esta subespecie endémica Colombiana.

Palabras claves: *Saimiri sciureus albigena*, Llanos Colombianos, disponibilidad de hábitat, valores de densidad estimados, números censuales estimados

INTRODUCTION

Fragmentation and habitat loss are the main threats for primates in Colombia (Defler, 2010). Fragmentation produces different effects on primate populations, depending on fragment shape, size and isolation between them (Hobbes y Yates, 2003). Colombian primates living in areas of colonization, agriculture and increased livestock are more threatened. In the last five years fragmentation has increased due to illegal crops and incentives for palm oil plantation (Instituto von Humboldt, 2011, Fedepalma, 2011).

Three subspecies of the common squirrel monkeys (*Saimiri sciureus albigena*, *S. s. cassiquiarensis* and *S. s. macrodon*) are reported for Colombia. The Ecuadorian squirrel monkey (*S. s. macrodon*) occurs in the basins of the Putumayo and Caquetá rivers, and south of the Río Apaporis (Fig. 1). Humboldt's squirrel monkey (*S. s. cassiquiarensis*) occurs to the north of the Apaporis, including the basins of the Vaupés, Guainía and Inírida rivers, and northward as far as the southern (right) margin of the Vichada River and west to the Andes between the upper Apaporis and Guayabero rivers. The Llanos Orientales, eastern Andean piedmont and upper Magdalena River are the most northern areas for the Colombian squirrel monkey (*S. s. albigena*, Fig. 1) (Defler, 2010). The highest altitude recorded for this squirrel monkey is 1,500 m in Huila (Hernández-Camacho y Cooper, 1976). The eastern limits in Arauca and Casanare are poorly defined (Defler, 2010) (Fig. 2) but increasing grasslands, decreasing rainfall, and the scarcity of gallery forests are the limiting factors. *Saimiri s. albigena* occupies gallery forest with low canopy and sclerophyllous and hillside forest, palm forest (associations of *Mauritia flexuosa*) and, extending to the south, seasonally flooded and *terra firma* rain forests of the Amazon basin (Hernández-Camacho y Cooper, 1976).

Saimiri. s. cassiquiarensis and *S. s. macrodon* were categorized as ‘Least Concern’ (LC) in the 2008 IUCN Red List of Threatened Species (Boubli et al., 2011). *Saimiri s. albigena*, on the other hand, was considered as “Near Threatened” (NT) because a sizeable part of its range has been deforested and population loss was estimated to be at least 20% in the past 25 years (based on a generation length of 8 years), due to continuing habitat

loss and exploitation for pets (IUCN 2008). However, a recent revision of the conservation status of Colombian endemic subspecies of squirrel monkey (*Saimiri sciureus albigena*) suggested reclassifying this taxon as vulnerable (VU) due to a reduction of their distribution and decline of population size (Carretero-Pinzón *et al.*, 2009). Here, a detailed revision of *S. s. albigena* distribution is reported and more data on densities, census numbers and ecological data is given to support changes in their proposed conservation status (Carretero-Pinzón *et al.*, 2009).

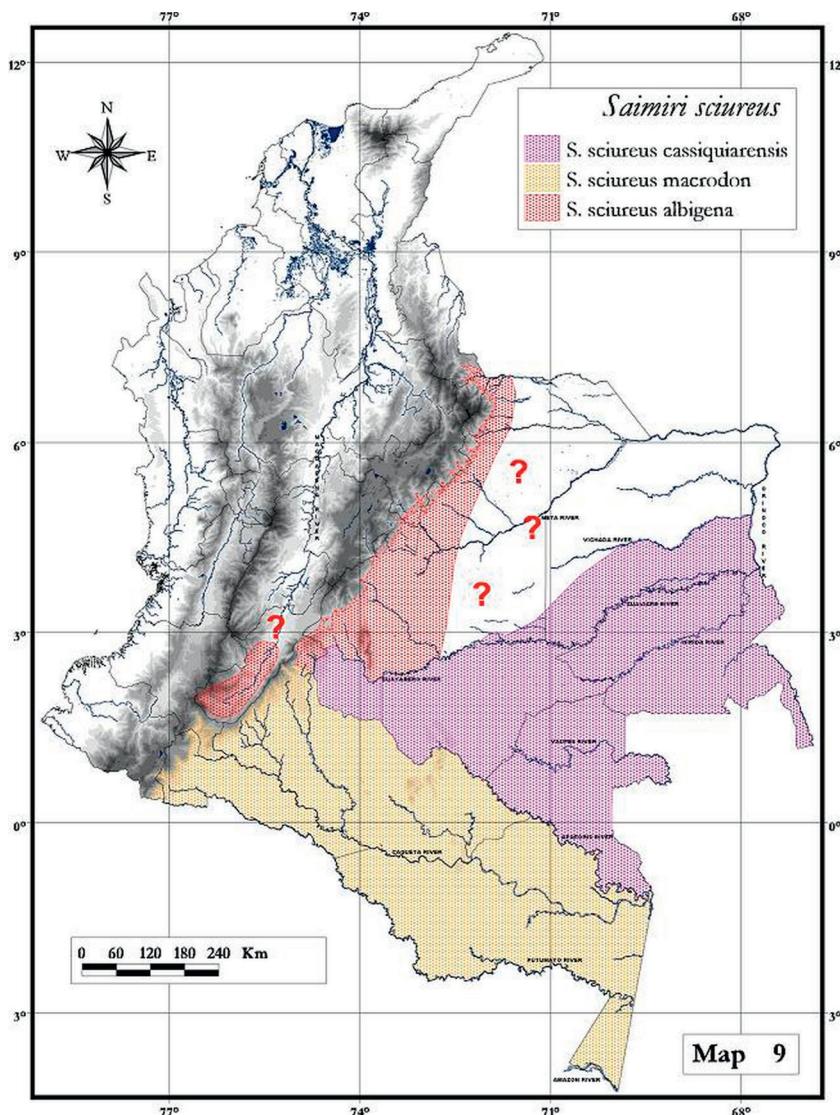


Figure 1. *Saimiri sciureus's* subspecies distribution in Colombia (Taken from Carretero-Pinzón *et al.*, 2009).

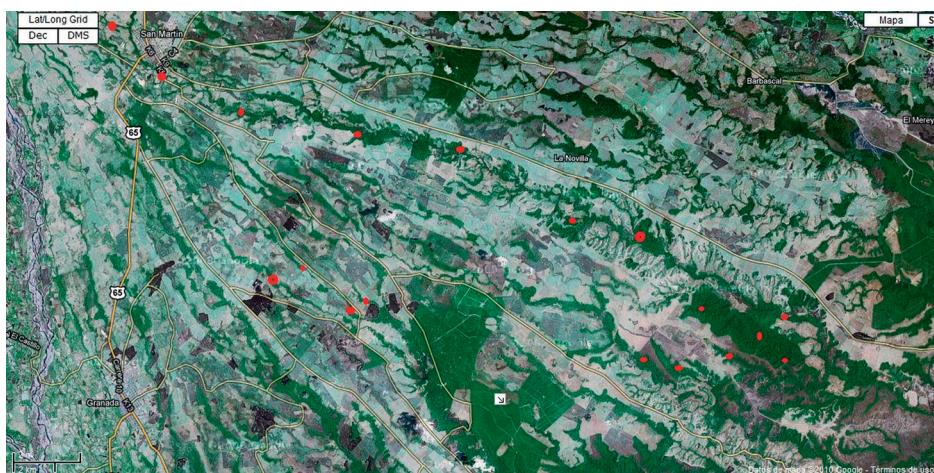


Figure 2. *Saimiri sciureus albigena*'s groups found near of San Martín town, Meta department, Colombian Llanos.

METHODS

Distribution and habitat loss

We reviewed and recalculated the distribution of *Saimiri sciureus albigena* using satellite images. We confirm the actual distribution on the basis of confirmed observations, and its likely presence because of vegetation cover. In areas covering the current distribution of the subspecies, reports of other researchers and local people were recorded. We calculated area values based on Google Earth tools and data from Vazquez y Serrano (2010) and Lasso and collaborators (2010).

Ecology, effective numbers and densities estimates

We collected ecological data from 2005 to 2007 from one group living in gallery forest fragments (Carretero-Pinzón, 2008) and recorded population data from 2004 in small fragments of different sizes and from a large fragment studied in 2008 near San Martín de los Llanos, Meta in the Colombian Llanos Orientales (Carretero-Pinzón, 2010; Enciso, 2006). We used population data to estimate density values and census numbers based on direct counts in small fragments and on the line transect method in the largest fragment (1050 ha). We used ecological data to estimate home range in a fragmented and continuous area and we calculated the estimated density values for small fragments using the ecological density formula: the number of individuals divided by the available or sampled area (Soini, 1992). The estimated density value for the largest fragment (1050 ha) was calculated with the software Distance 6.0 (Thomas *et al.*, 2002), and we collected data for the density values between 6:00 -12:00 and from 14:00 – 18:00. Groups observed were followed at each fragment and observed during 15 minutes to determine group composition. The number of individuals in the group and their individual identification within the troop were

also analyzed and individuals were identified and differentiated between troops. Adult composition of each group was used to estimate census numbers (reproductive individuals) in the population, only for the survey area of 532,78 km², solitary individuals were not used to calculate census numbers.

RESULTS AND DISCUSSION

Distribution and habitat loss

Table 1 shows a revision of natural parks and conservation areas protected by Colombian laws. Within those, a calculated area of 49.730,29 km² is likely to have populations of *Saimiri sciureus albigena*, but only 49.102,11 km² has the species' presence confirmed. This is less than the area previously calculated (Carretero-Pinzón et al., 2009). However not all these areas are forests, some of these are a mixture of forest fragments and agriculture and livestock lands. For example, areas in the Integrated Management District (DMI acronym in Spanish) Ariari – Guayabero, DMI Macarena Norte and DMI Macarena Sur are zones with people living inside of Macarena National Park with a high proportion of agriculture, livestock, illegal crops and social unrest (Vasquez & Serrano, 2009). Such threats make management difficult because of multiple pressures on *S. s. albigena* populations. Other areas have some small zones where it is still possible to find the species. For example, Hernandez-Camacho y Cooper (1976) reported a northern enclave of this subspecies in some areas of Huila department, although a recent survey in a remnant forest and interviews of local people did not find *Saimiri* populations and the species seems to be extirpated locally from vast areas near the towns of Gigante and Garzon since at least the 1980's (Carretero-Pinzón, unpublished data). The last year at PNN Cueva de los Guacharos, the research group of Dr. Stevenson found a small population of this subspecies that can have some future in this part of its distribution (P. Stevenson com pers.). Data from Casanare and Arauca piedmont are scarce and only some reports from people working on environmental impact surveys for oil companies have a few reports of the presence of this subspecies in their survey areas and in some areas of palm oil plantations (J.L.B. pers. com.; A.G.C. pers. com.).

Table 2 shows some private natural reserves that probably have *Saimiri* populations (385,403 km²) and where its presence has been confirmed (71,092 km²). These forests are highly important as conservation tools in zones with human pressure on this subspecies and on other species of endemic primates of the region such as *Aotus brumbacki* and *Callicebus ornatus*. Outside the areas previously mentioned, it is possible to find *Saimiri* populations living in small fragments linked by fence rows, such as around the San Martín area, however visual verification it needed.

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Table 1. Natural parks and conservation areas protected by Colombian laws, and fragmented forest likely to have *S. s. albigena*.

Department	Nearest town	GPS Point	Estimated area (km ²)	Height	Protection status	S.s. albigena presence
Huila	Gabine te	1°53'06.40"N 75°55'42.51"W	0.148	1780 m		?
Huila	San Antonio de Aranzonia - Vargalarga	2°53'31.52"N 75°01.30.17"W	4.15			?
Huila	Tarqui	2°58'26.47"N 75°00.38.08"W	114.94	1927 m		?
Huila	Bruselas	2°47'32.59"N 75°06.45.34"W	0.432525	974 m		?
Huila	Palestina	1°48'21.78"N 76°04.00.91"W	0.6751	1902 m		?
Huila	Palestina	1°48'41.60"N 76°03.21.23"W	0.203975	1753 m		?
Huila	Guasalito	1°54'31.94"N 76°02.15.62"W	0.246875	1721 m		?
Huila	Guasalito	1°53'54.69"N 75°47.09.55"W	0.039976	1288 m		?
Huila	Altamira	2°03'10.87"N 75°47.20.31"W	0.038227	1058 m		?
Mara	La Uribe - La Macarena	2°22'47.52"N 74°04.36.27"W	1033 m			?
Mara - Caquetá	La Uribe - San Vicente del Caguán - La Macarena - Mesetas - Puerto Concordia - San Juan de Arama - Puerto Rico	2°45'11.776"N 74°41.15.97"W	2234.5	500 m	PNN Tinigua*	Yes
Mara	Granada - Fuente de Oro - San Juan de Arama - Puerto Ibarra - Mesetas - Puerto Rico - La Macarena - San José del Guaviare - Mesetas - San Juan de Arama - Vista Hermosa - Puerto Rico - La Macarena	2°34'47.88"N 73°39.54.45"W	6230.52	100 - 1500 m	PNN Serranía de la Macarena*	Yes
Meta - Guaviaré	2°03'41.86"N 73°57.35.05"W	23558.57	200 - 3500 m	DML Ariari - Guayabero*	Yes	
Meta	Hermosa - Puerto Rico - La Macarena	3°22'08.05"N 74°07'32.73"W	3491.54	200 - 2000 m	DML Macarena Norte*	Yes
Meta	La Macarena	2°03'41.86"N 73°57.35.05"W	393.05	200 m	DML Macarena Sur*	Yes
Meta	Villavicencio	4°09'03.12"N 73°40'41.37"W	14.52	470 - 1350 m	RFP Honda Stream - Parrado and Bugue spouts*	Yes
Meta	Villavicencio	4°11'23.36"N 73°37'09.24"W	7.31	450 - 850 m	RFP Vanguardia Hill - Vanguardia spout and stream*	?
Meta	Castilla la Nueva - San Carlos del Guárico - Acacias - Villavicencio - Resrepo - Cumaryl - Meilina - Paratubieno - Cabuyaro - Barranca de Uria - Uraza - Santa María - San Luis de Gáeseno - Puerto López - Pore - Paz de Ríoporo - Tamara Hato Corozal				Conservation Nominated Area Alto Rio Mata**	Yes
Casanare	Aguas Atul	3°41'N 72°45'W - 4°57'N 73°53'W	10125	160 - 1400 m	RFP Zamacote Hill*	?
Casanare		5°56'43.72"N 72°02.25.09"W	95.67	600 - 1300 m	REH Las Gramas stream*	?
Casanare		6°03'43.06"N 72°02.28.11"W	24.98	360 - 800 m	ZUP La Cascada, San Juan and Minquirá streams*	Yes
Casanare		5°25'08.02"N 72°31.16.45"W	34.63	700 - 1800 m	Conservation Nominated	
Casanare	Maní	4°30'N 71°50'W 5°09'N 72°43'W	4.50	120 - 650 m	Area Cusiana*	?
Arauca	Saravena	6°48'12.20"N 71°55.00.05"W	41.52	400 - 1500 m	RFP Satoca River*	?
Arauca	Tame	6°28'54.03"N 71°51.58.54"W	1.36	700 m	RF La Escalera spout*	?
TOTAL AREA:						49790.29

*Data from Vásquez & Serrano (2010); PNN = Parque Nacional Natural (National Natural Park); DML = Distrito Integral de Manejo (Integrated Management District); RFP = Reserva Forestal; Protectora Protegida Forestal Reserve; REH = Reserva ecológica e hidráulica (Ecological and hydrological Reserve); RF = Reserva forestal (Forestal reserve); ZUPIS = Zona de utilidad pública e interés social (Public utility and social interest area).

**Data from Lasso et al (2010).

Table 2. Areas of private natural reserves with and without *S. s. albigena* present (data from Nodo Orinoquía webpage (<http://nodorinoquia.com/>)).

Department	Name	Town	Area (km ²)	<i>S.s. albigena</i> Presence
Meta	Caño Quenane	Villavicencio	0.29	?
	La casa de la abuela	San Martín	0.01	Yes
	Las Unamas	San Martín	37.832	Yes
	Rancho Camana	Restrepo	0.025	?
	Rey Zamuro	San Martín	15.525	Yes
	Kaliawirinae	Cumaral	0.04	?
	La Reseda	Puerto López	0.8095	?
	Aguas Calientes	Paratebueno	43.449	?
	El Paraíso	Restrepo	0.0379	?
	Nakua	Villavicencio	0.0439	?
	La Esperanza	Villavicencio	0.3785	?
	Mata Redonda	San Martín	15.525	Yes
	Floresta	Cumaral	0.195	?
	El Jardín del Comino	Villavicencio	0.3	?
	Altamira	Acacias	0.35	Yes
	El Socay	Acacias	0.13	Yes
	Manaco6	San Martín	0.9	?
	El Caduceo	San Martín	1.73	Yes
	El Toruno	Puerto Gaitán	132.15	?
Casanare	La Esperanza 1 y 2	Paz de Ariporo	16	?
	La Gloria	Paz de Ariporo	25.63	?
	Campoalegre	San Luis de Palenque	48	?
	Agua Verde	Hato Corozal	39.45	?
	Amanecer en el Paln	Tilodiran	1.21	?
	Matafresca	Orocue	13.614	?
	La Palmita	Trinidad	6.525	?
	San José	Paz de Ariporo	7.576	?
	La Culebra	Puerto Rondón	6.85	?
	El Torreño	Puerto Rondón	9.931	?
Total			385.4	

Ecological data, effective numbers and density estimates

Table 3 shows density estimate values, abundance, and estimated census numbers of different sized fragments. Densities commonly reported for squirrel monkeys are 50 – 80 ind/ km² (Klein and Klein, 1976; Terborgh, 1983; Soini, 1986). Lower densities of 4 ind/ km² been reported at the Apaporis river for *Saimiri sciureus cassiquiensis* (Defler, 2010); Tinigua National Park (an average of 12.7 ind/ km², Stevenson, 2007) and a previous report for the same fragments near San Martín town (1 – 6 ind/ km²; Carretero-Pinzón, 2005). Densities

reported here can be overestimated for small fragments because each fragment has only one group, in addition in the case of the fragment of 46.5 ha, the group disappeared in 2005. The density reported for the smallest fragment is based on only one individual observed alone and the density for a fragment of 21 ha is based on one group that used fragments of different sizes connected by fence rows (Carretero-Pinzón, 2008; Carretero-Pinzón, in press). The density estimated for the largest fragment (1050 ha) is similar to that found in continuous forest (50 – 80 ind/km²: Klein y Klein, 1976; Terborgh, 1983; Soini, 1986) and higher than that found for Tinigua National Park (12.7 ind/ km²: Stevenson 2007).

Table 3. Density, abundance and effective numbers of *Saimiri sciureus albigena* at fragments of different sizes near of San Martín town.

Fragment area (Ha)	Density (ind/ km2)	Abundance	Estimates census number
21	164.29**	42	13
46.5	5.43**	15	8
13	5.13**	1	1
16	0**	0	0
370	105.47**	390	169
1050	30.33	319	103*

*Based on female and male proportion of 7 groups observed on this fragment
**Based on direct counts

The estimated total census number of this population is 191 reproductive individuals, which is lower than that estimated for viable population (200 – 500 breeding individuals) (Brito y Grelle 2006). An increase of fragmentation and isolation in this area could lead to local extinction unless connectivity and education programs can be implemented in this region (Carretero-Pinzón *et al.*, in press). This area is around 532,78 km² with a mixture of forest fragments of different sizes, pastures, palm oil plantations and fence rows with at least 18 groups of *Saimiri sciureus albigena* divided in two populations (4 and 14 groups in each population), that seems to be isolated by pastures, forest fragments without other nearby *Saimiri* groups and by a big sizeable oil plantation that the *Saimiri* do not seem to use (Fig. 2; Carretero-Pinzón, unpublished data). Areas with small fragments connected by fence rows seem to support *Saimiri* groups (three groups); however this population could faces extinction in the near future unless it can be connected to the largest fragment. Although abundance is high (767 individuals) an elevated proportion is composed of immature individuals (around 55 %, Carretero-Pinzón, unpublished data) and apparently a high mortality rate of immature individual has maintained the group size stable throughout the years (average of 32 individuals, Carretero-Pinzón, 2004 – 2010 unpublished data).

Fragmentation affects the home range of *Saimiri* groups which in continuous forest is around 240 ha (Carretero-Pinzón, 2000) and in fragmented areas is less than half. The reduced home ranges are composed of a matrix of forest fragments, pastures and fence

rows of different heights (Carretero-Pinzón, 2008). Reduction of home ranges can affect survivorship of *Saimiri*'s groups that are isolated in small fragments due to less resource availability and greater space requirements (Carretero-Pinzón, 2008). Reduction can also force *Saimiri* to use fence rows, wire fences and in some cases pastures to disperse or to use fruit resources isolated in a pasture matrix, increasing their predator risk from small felids, raptors and domestic dogs present in the study area (Carretero-Pinzón et al., 2010).

In conclusion, a high reduction of *Saimiri sciureus albigena* habitat in its distributional area, small census numbers, and a higher predation risk due to the increased use of fence rows, wire fences and pastures are leading this Colombian endemic subspecies to a critical situation, confirming its conservation status as Vulnerable by IUCN criteria as proposed by Carretero-Pinzón et al., (2009).

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