

RESEARCH ARTICLE

Demographic Survey of Black Howler Monkey (*Alouatta pigra*) in the Lachuá Eco-Region in Alta Verapaz, GuatemalaMARLENY ROSALES-MEDA^{1*}, ALEJANDRO ESTRADA², AND JORGE E. LÓPEZ¹¹Programa de Investigación y Monitoreo de la Eco-región Lachuá -PIMEL-, Escuela de Biología, Facultad de Ciencias Químicas y Farmacia, Ciudad Universitaria, Guatemala²Laboratorio de Primatología, Estación de Biología Tropical Los Tuxtlas, Instituto de Biología, Universidad Nacional Autónoma de México, San Andrés Tuxtla, Veracruz

Guatemala harbors three species of primates (*Alouatta palliata*, *Alouatta pigra* and *Ateles geoffroyi*), but the distribution and state of conservation of populations of these species are poorly documented. In the case of *A. pigra*, populations have been studied recently and documented in several sites in Mexico and Belize, and only in one site in Guatemala (Tikal National Park). In this study, we report first-time population data for *A. pigra* existing in the Lachuá Eco-region in northwestern Guatemala. Surveys were conducted between September 2002 and April 2003 in the northern portion (32 km²) of the Lachuá National Park (LLNP; 145 km²) and in a fragmented landscape north of the protected area. In this latter area we surveyed a large forest fragment (17.14 km²), “Nueve Cerros”, and 26 small forest fragments that ranged in size from 0.01 to 3.9 km². Surveys resulted in a total count of 414 howler monkeys of which 403 belonged to 80 mixed-sex groups, four were solitary males, two were solitary females and five were found in two male groups. Standardized sampling effort among sites indicated 16.7 monkeys/100 survey hours at LLNP, 35.8 individuals/100 survey hours at “Nueve Cerros” and 71.0 ± 62.2 individuals/100 survey hours in the forest fragments. Mean group size varied from 4.07 individuals at LLNP to 5.19 individuals in the forest fragments. Conservation problems for the black howler population surveyed are discussed, along with possible conservation scenarios. *Am. J. Primatol.* 70:231–237, 2008. © 2007 Wiley-Liss, Inc.

Key words: black howler monkey; *Alouatta pigra*; demography; forest fragments; Laguna Lachuá National Park; Guatemala

INTRODUCTION

Guatemala harbors three species of primates [*Alouatta palliata*, *Alouatta pigra* and *Ateles geoffroyi*; Rylands et al., 2006]. Of these, the black howler monkey, *A. pigra*, is endemic to the area of Mesoamerica shared by Belize, northern Guatemala and southeast Mexico [Rylands et al., 2006]. Habitat loss caused by human activity has caused important reductions in the natural distribution of this primate [Estrada et al., 2006], which coupled to lack of information on the location of remnant populations and demographic parameters make it difficult to construct conservation scenarios. Although populations of *A. pigra* have recently been the subject of various surveys and studies in Mexico and Belize [Alexander et al., 2006; Estrada et al., 2002a,b; Horwich et al., 2001; Serio Silva et al., 2006; Van Belle & Estrada, 2006], population surveys in Guatemala are practically nonexistent and detailed information on demographic parameters only have been documented for one site, Tikal National Park [Coelho et al., 1976; Estrada et al., 2004; Schlichte, 1978]. In this study, we report demographic data for

a population of *A. pigra* existing in a 202 km² area in the Lachuá Eco-region (elevation 170–300 m), Alta Verapaz, in northwestern Guatemala. The area surveyed includes a segment of the protected area of Laguna Lachuá National Park (LLNP), a non-protected area (“Nueve Cerros” Mountain Range) and 26 small forest fragments in a human modified landscape.

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METHODS

Study Sites

The study was carried out in the Lachuá Eco-region in northwestern Guatemala ($15^{\circ}46'54'$, $15^{\circ}49'16'$, $15^{\circ}57'19'$ and $15^{\circ}59'11'$ N; $90^{\circ}29'56'$, $90^{\circ}34'38'$, $90^{\circ}45'14'$ and $90^{\circ}45'26'$ W). The research reported here complied with protocols approved by the Guatemalan Ministry of Environment and Natural Resources and adhered to the legal requirements of the country of Guatemala.

The LLNP site is a 145 km^2 protected area of tropical rain forest located in the northwestern area of the department of Alta Verapáz, Guatemala (Fig. 1). Average annual precipitation and temperature are $2,252\text{ mm}$ ($\pm 328\text{ mm}$) and 26.3°C ($\pm 0.6^{\circ}\text{C}$), respectively [INSIVUMEH, 2003]. Precipitation is seasonal, with a dry season between February and May ($84.5 \pm 39.4\text{ mm}$) and a rainy season between June and November [$273.2 \pm 35.5\text{ mm}$; INSIVUMEH, 2003]. Around LLNP the landscapes are occupied by 49 human settlements and the majority of the people are indigenous Maya-Q'eqchi', who base their economy on production of corn, beans, vegetables and fruit production for personal consumption, and cardamom (*Elettaria cardamomum*) and coffee (*Coffea arabica*) for commercial purposes. Cattle ranching and pineapple growing are increasing new industries in the area. Both, LLNP and the forest fragments are located in the lowlands of the mountain range "Sierra de Chamá", which is the most important forest area ($3,565\text{ km}^2$) in east-central Guatemala [Pineda et al., 2006].

Demographic surveys of black howler monkeys were conducted in a 32 km^2 northern section of LLNP, in the mountain range "Nueve Cerros", a patch of forest about 18 km^2 in size and in 26 forest fragments ranging in size from 0.01 to 3.9 km^2 (mean $0.66 \pm 1.09\text{ km}^2$; total area accumulated was 17.14 km^2 ; Fig. 1 and 2). We classified the vegetation cover and estimated the area of existing patches using a Landsat satellite image (March 30, 2001, bands: 5, 4 and 3) supported with field observations during field sampling. Arc View GIS 3.2 (Environmental Systems Research Institute Inc. EUA 1999–2000), the Patch Analyst[©] v. 2.1 [Rempel, 1999] extension for the Arc View GIS 3.2, and ERDAS 8.4 (ERDAS Inc. EUA 1999) software packages were used for the analysis.

Primate Surveys

Between September 2002 and April 2003 (encompassing part of the wet and dry seasons), we spent 12–20 days/month surveying the primate populations at the study sites. An attempt was made to complete a similar number of survey hours for each type of site. Hence, survey hours (taken here as a measure of sampling effort) were 366 hr for LLNP, 358 for Nueve Cerros and 343 for the forest fragments. In the case of the 26 forest fragments, an effort was made to sample these in proportion to their area, with more surveys hours spent in larger than in smaller fragments. Although variable difficulties in survey work were found as a result of topographic conditions, a strong correlation found

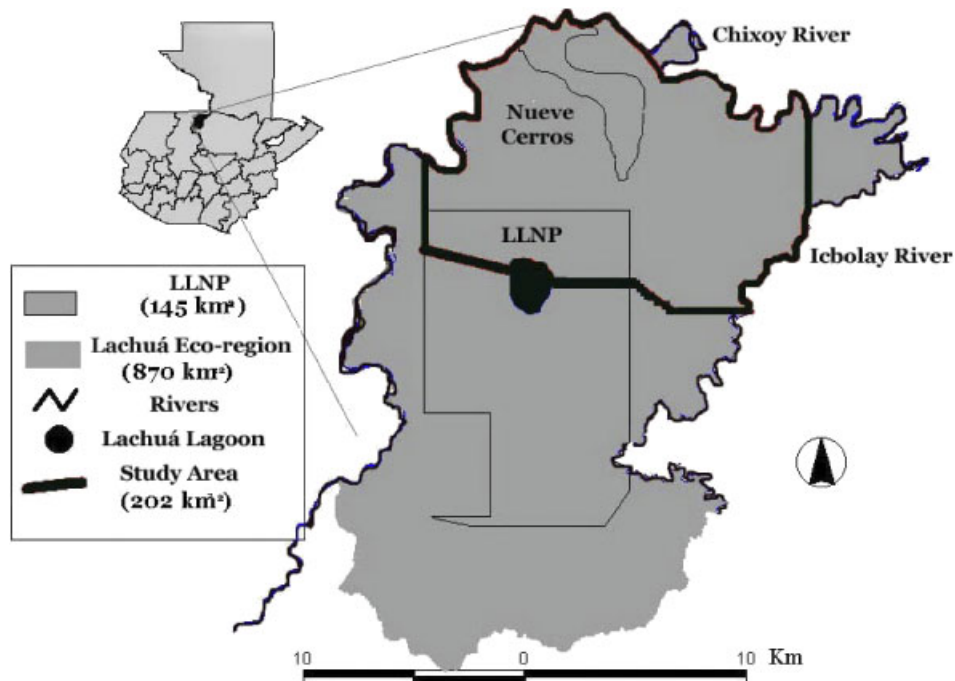


Fig. 1. Study area (202 km^2 , encompassed by the black perimeter) and Lachuá Eco-region (gray area) in Cobán, Alta Verapáz, Guatemala.

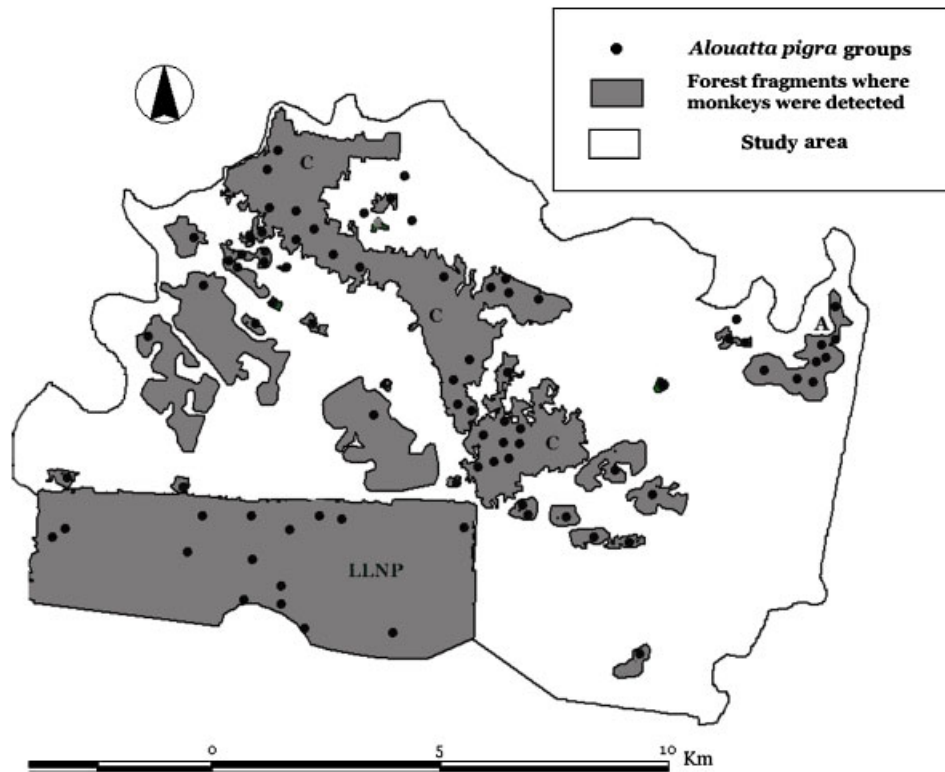


Fig. 2. Approximate distribution of *Alouatta pigra* groups (black points) in the study sites of Lachuá Eco-región (study area about 202 km²). Laguna Lachuá National Park (LLNP), Mountain Range “Nueve Cerros” (C) and the 26 forest fragments are indicated in gray. Black dots show the approximate location of the black howler monkey groups detected.

between these two variables ($r = 0.95$, $P < 0.0001$) indicated a high level of approximation in this approach.

At each site and at dawn we recorded the direction of early morning long distance howls to triangulate the position of the monkeys, and used existing trails and/or walked through the forest with the aim of locating existing groups and solitary individuals. Once visual contact was established, the geographical position of a group or that of solitary individuals was recorded with a GPS. The located monkeys were followed for as long as possible and individuals were repeatedly counted until a consensus was reached among observers regarding number of individuals in each age-sex class. Individuals were identified by sex (conspicuous white scrotum in males of all ages) and age group. Age was classified as adult (independent and totally developed), juvenile (individual that moves independent of the mother, half size, very active) and infant (clinging to the mother's dorsal or ventral hair, totally dependent and separates from mother for only short periods of time) [NRC, 1981].

An abundance index was estimated by dividing the total number of sightings of individuals and/or groups per site by the total number of survey hours. We then expressed the resulting figure as number of individuals and groups detected per 100 survey hours

and also used the resulting figure to compare howler monkey general abundance among the three types of sites. In the case of the forest fragments as a group, resulting figures are means and standard deviations.

RESULTS

A total of 1,067 survey hours were completed in the search for howler monkeys. This resulted in the recorded presence of 414 black howlers, of which 403 belonged to 80 mixed-sex groups, four were solitary males, two solitary females and five conformed two groups of three and two males each. In only 1% of the individual records it was not possible to identify the sex of juvenile individuals (Table I).

Laguna Lachuá National Park

At LLNP we counted 61 individuals of which, 57 were members of 14 groups, one was a solitary male and three composed of a single male sex group (Table I, Fig. 2). The abundance index indicated 16.7 individuals/100 survey hours and 4.0 groups/100 survey hours. Mean group size in LLNP was 4.07 ± 1.33 individuals (range 3–6). Mean age and sex composition of the groups was 1.29 (± 0.47) adult males, 1.43 (± 0.65) adult females, 0.29 (± 0.47) juvenile males, 0.43 (± 0.51) juvenile females and 0.57 (± 0.76) infants. The average Adult male:Adult

TABLE I. Detected Groups of Black Howler Monkeys in the Protected Forest of Laguna Lachúa National Park (Sampled Area = 32 km²), in the Non-protected Area “Nueve Cerros” (Area 18 km²), and in 26 Forest Fragments (Accumulated Area 17.4 km²; Mean Size 0.66±1.09 km²) in the Area of Influence of Laguna Lachúa National Park, Alta Verapaz, Guatemala

	Adults						Juveniles			Total individuals	Number of groups
	Males		Females		Not sexed	Infants	Males	Females			
LLNP											
Total	18	20	4	6	1	8	57	14			
Mean	1.29	1.43	0.29	0.43	0.07	0.57	4.07				
SD	±0.47	±0.65	±0.47	±0.51	±0.27	±0.76	±1.33				
Solitary individuals	1						1				
Individuals in same sex group	3						3				
Total individuals							61				
Nueve Cerros											
Total	48	38	7	6	4	20	123	23			
Mean	2.09	1.65	0.30	0.26	0.17	0.87	5.35				
SD	±0.67	±0.83	±0.47	±0.45	±0.39	±0.87	±1.70				
Solitary individuals	1	1		1			3				
Individuals in same sex group	2	0		0			2				
Total individuals							128				
Forest fragments N = 26											
Total	70	84	13	22	-	34	223	43			
Mean	1.63	1.98	0.30	0.51	-	0.79	5.19				
SD	±0.85	±1.01	±0.56	±0.59	-	±0.94	±1.97				
Solitary individuals	2						2				
Total individuals							225				

LLNP, Laguna Lachúa National Park.

female ratio was 1:1.25 (± 0.73). Mean adult female to immature ratios was 1:0.98 ± 0.66 .

Mountain Range “Nueve Cerros”

At “Nueve Cerros” we counted 128 individuals, of which 123 were components of 23 groups, one was a solitary male, two were solitary females and two were members of a single male sex group (Table I, Fig. 2). The abundance index indicated 35.8 individuals/100 survey hours and 6.4 groups/100 survey hours. Mean group size in “Nueve Cerros” was 5.35 (± 1.70) individuals (range 3–8). Mean age and sex composition of the groups was 2.09 (± 0.67) adult males, 1.65 (± 0.83) adult females, 0.30 (± 0.47) juvenile males, 0.26 (± 0.45) juvenile females and 0.87 (± 0.87) infants. The average AM:AF ratio was 1:0.91 (± 0.66). Mean adult female to immature ratios was 1:0.85 ± 0.76 .

Forest Fragments

At the 26 forest fragments we counted 225 individuals of which 223 were in 43 groups, and two were solitary males (Table I, Fig. 2). The abundance index indicated 71.0 ± 62.2 ind/100 survey hours and 13.7 ± 10.4 groups/100 survey hours. Mean group size was 5.19 (± 1.97) individuals (range 2–11 individuals). Mean age and sex composition of the groups was 1.63 (± 0.85) adult males, 1.98 (± 1.01) adult females, 0.30 (± 0.56) juvenile males, 0.51 (± 0.59) juvenile females and 0.79 (± 0.94) infants. The average AM:AF ratio was 1:1.50 (± 0.99). Mean adult female to immature ratios was 1:0.89 ± 0.68 .

Comparisons Among Sites

The abundance index showed, for both number of individuals and number of groups, increasing values from LLNP to “Nueve Cerros” to forest fragments, suggesting larger populations of black howlers at the latter two sites than in the protected reserve. No differences existed in mean group size among the three sites (Friedman’s test $\chi^2 = 3.67$, df 2, $P = 0.15$), and this was also the case for the adult female to immature ratio (Friedman’s test $\chi^2 = 1.85$, df 2, $P = 0.39$). However, significant differences existed in the number of adult males in the groups among the three sites (LLNP mean = 1.29 ± 0.47 ; “Nueve Cerros” mean = 2.09 ± 0.55 ; Fragments means = 2.69 ± 0.69) (Friedman’s test $\chi^2 = 6.46$, df 3, $P = 0.03$).

DISCUSSION

Our study showed the presence of an important population of *A. pigra* in the Lachuá Eco-region, located in the lowlands of northwestern Guatemala. In addition, we show that this population has been fragmented as a result of habitat loss and fragmentation caused by human activity. In the past, the

population in the study area was probably part of a much larger population of black howlers existing there and extending into Mexico, as suggested by recent surveys north of the study area [Estrada et al., 2004].

Currently, a segment of the population detected (15%) was found in the natural protected area (LLNP), 31% in the “Nueve Cerros” mountain range and 54% in the 26 forest fragments surveyed outside the protected area. Oddly, the size of these sites does not match the differences in the size of their monkey populations, with LLNP the larger site (145 km²) harboring the smallest number of monkeys and the forest fragments (17 km²) containing the largest number of monkeys. This condition is likely the result of monkeys escaping surrounding forest destruction and being “forced” to inhabit smaller fragments with higher monkey densities outside the protected area.

Mean group size in the sites investigated varied from 4.07 individuals at LLNP to 5.35 individuals in “Nueve Cerros”, to 5.19 individuals in the forest fragments. All of these estimates are lower than the overall mean of 6.57 ± 1.20 individuals reported for populations of *A. pigra* in eight extensive and protected forests in Mexico and Guatemala [Van Belle & Estrada, 2006]. The mean group size values were more similar to those reported for *A. pigra* in a fragmented landscape in Palenque, México [5.35 ± 3.08 individuals; Estrada et al., 2002b] and in another fragmented landscape in Belize Community Baboon Sanctuary (5.66 ± 0.62 individuals) [Ostro et al., 2001].

Groups with one adult male contributed to 33% of the total population surveyed, but a site by site examination showed that while at LLNP 71% of the groups were one male groups, at “Nueve Cerros” and the forest fragments only 17 and 28% were one male groups. Although this general pattern is consistent with the reported predominance of multi-male–multifemale groups in *A. pigra* [Van Belle & Estrada, 2006], the contrasting data for LLNP may be the result of a trend where in areas with low densities of howlers there are low numbers of males and females that could potentially conform multi-male–multifemale groups. Our observations of presence of solitary males and females seem to confirm bisexual dispersal for this species, a feature also reported for other populations of *A. pigra* in Guatemala [Baumgarten, 2000] and Belize [Brockett et al., 2000; Horwich et al., 2001].

Two possible explanations for the low relative abundance and smaller group size in the LLNP reserve are: (a) previous habitat perturbation in this segment of the reserve when it was used to cultivate cardamom before it became a national park, and/or (b) there are not enough food resources to sustain larger numbers of black howler monkeys in this area.

The larger relative abundance of howlers in the “Nueve Cerros” site and in the forest fragments may be the result of a noticeable abundance of trees of *Brosimum* spp. (Moraceae), *Ficus* spp. (Moraceae) and *Dialium* spp. (Fabaceae) trees, which have been reported to be important to black howlers as sources of leaves and fruit [Behie & Pavelka, 2005; Rivera & Calme, 2006; Silver et al., 1998].

Tropical forest conservation problems cannot be understated in the case of Guatemala owing to high rates of deforestation (−1.71%/year for the period 1990–2000) [Estrada et al., 2006]. For example, for the study area in Lachuá 30% of forest cover was lost for the period 1998–2001 [Rosales-Meda, 2003]. As is the case for other Central American countries, high levels of poverty are also a typical feature of the human population in Guatemala. Such conditions place important demands on the land for food production and for other goods and services, and these demands are enhanced by poorly developed socioeconomic programs and by other social and economic pressures leading governments to expand colonization programs. These processes translate into important losses of native vegetation, impacting the persistence of primate populations.

Currently, there are 192 natural protected areas in Guatemala encompassing about 37% of the territory [108,906 km²; Pineda et al., 2006]. The persistence of the black howler population in LLNP is safeguarded because it is a protected site. However, in the landscapes outside the protected area, where the majority of the recorded population exists, the populations may be at risk. Deforestation and forest fragmentation is a continuing process in the landscapes surrounding LLNP. In some cases, the forest fragments have been preserved by local farmers because they protect sources of water, they can farm cardamom and coffee or they can selectively extract timber. However, changes in local and global market demands could change the landscape dramatically by deemphasizing forest-shaded crops (e.g. cardamom and coffee) over emphasis on beef production or on crops that do not require shade (e.g. pineapple is becoming an important crop in Lachuá). From conservation view point, management and a monitoring program of the population of black howlers found in the area shared by the LLNP, “Nueve Cerros” and the surrounding forest fragments is essential to assure the long-term well-being of this primate specie in this region. A possible scenario could be to increase connectivity among the landscape units examined via corridors of vegetation (e.g. live fences, riparian strips and others) as community-based projects. Such management could be coupled to the development of projects such ecotourism, with the howlers playing a key role.

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