

Primates in Montane Forests of the Región Amazonas, Peru: New Records and the Current Situation of *Lagothrix flavicauda* and Other Primates

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Abstract: Most of the primate studies in the montane forests of Peruvian Amazonia have been carried out in its northeastern portion, and most have focused on the yellow-tailed woolly monkey, *Lagothrix flavicauda*. Information gaps remain for much of the forests in this region and the primate species that are found there. Here we report on a survey of *L. flavicauda* (Critically Endangered) and the White-bellied Spider Monkey *Ateles belzebuth* (Endangered) and other primates, particularly to assess the status of their populations and identify the anthropogenic threats they face, in the Peruvian Yungas in the northeast of the Región Amazonas. We collected data to estimate abundance in terms of the number of groups detected and their size and location. A preliminary analysis was also carried out to assess anthropic activities that pose threats to the survival of the populations there. The study was conducted from June to August and October 2018. We carried out surveys along line transects and pre-existing trails in three fragments of primary forest in the villages of Flor de la Viña, Cambiopitec and Vista Alegre. In 334 km of surveying, we observed 13 groups of four species. *Lagothrix flavicauda* was the most frequently sighted (seven groups) and *A. belzebuth* the least sighted (one group). The other two species seen were the large-headed capuchin *Sapajus apella macrocephalus* and the Andean white-fronted capuchin *Cebus yuracus*. Most of the *L. flavicauda* groups were seen in forests near the village of Flor de la Viña. The single group of *A. belzebuth* was seen in Vista Alegre. With the exception of Cambiopitec, primates were sighted in extensive forest fragments. The average group size of *L. flavicauda* was 7.8 individuals (± 4.2 ; range 4 to 15). For the other species, the numbers of sightings were insufficient to estimate average size. Accordingly, *L. flavicauda* showed the highest relative abundance 2.42 indiv./10 km and *Sapajus a. macrocephalus* was the least abundant 0.84 indiv./10 km in Flor de la Viña. Deforestation for agriculture and livestock farming and hunting were the main threats to the survival of these primates. In general, primate richness, the number and size of groups, and the relative abundance that we recorded were similar to those obtained at other sites with similar human activities in the region. The presence of *L. flavicauda* and *A. belzebuth*, considered to be the most vulnerable to habitat disturbance, contributed to the local community's awareness of the importance of forest conservation, mainly in Flor de la Viña. The information obtained on the status of *L. flavicauda* and other primates will reinforce conservation actions at these sites, particularly Vista Alegre, where there is a Regional Conservation Area. It may also foster other sustainable activities involving the participation of local communities, such as ecotourism and agroforestry.

Key words: Primates, montane forest, new records, abundance, threats.

Introduction

The montane forests of the Peruvian Amazon, also known as the Yungas (Brack 1986) or Yungas Peruanas (Dinerstein *et al.* 1995), are located between 1,000 m and 3,600 m above sea level on the eastern flanks of the Andes (Tovar *et al.* 2010). The Yungas Peruanas is rich in biodiversity, 60% of the mammalian fauna is endemic (Pacheco *et al.* 2009) and forms part of the Tropical Andes Biodiversity Hotspot that has the greatest diversity of flora and fauna in the world (Myers *et al.* 2000). These Amazonian montane forests have suffered widespread habitat loss and fragmentation resulting from agriculture, livestock farming, road construction, commercial logging by local communities, and the expansion of urban areas (Davidson *et al.* 2012; Shanee and Shanee 2014; Estrada *et al.* 2017; Kalamandeen *et al.* 2018; Ríos *et al.* 2018; Bax *et al.* 2019; Aquino *et al.* 2020). This habitat loss and fragmentation is particularly evident in unprotected areas and outside indigenous lands (Llactayo *et al.* 2013; Schleicher *et al.* 2017). Increased knowledge of the occurrence of primate species and which of these threats could be driving population declines is necessary to guide timely and effective conservation measures.

Four threatened atelin primates occur in the Yungas Peruanas: Tschudi's woolly monkey, *Lagothrix lagothricha tschudii* Pucheran, 1857 (Data Deficient on the IUCN List of Threatened Species); the yellow-tailed woolly monkey, *Lagothrix flavicauda* (Humboldt, 1812) (Critically Endangered); the white-bellied spider monkey, *Ateles belzebuth* É. Geoffroy Saint-Hilaire, 1806 (Endangered); and the black-faced black spider monkey, *Ateles chamek* (Humboldt, 1812) (Endangered) (Aquino and Encarnación 1994; Shanee *et al.* 2013a, 2013b; Shanee and Shanee 2018a; Peru, MINAGRI 2014; Aquino *et al.* 2015a, 2017b, 2020; IUCN 2020). *Lagothrix flavicauda* was included on the list of the 25 most threatened primate species in 2000 and from 2006 to 2012 (Mittermeier *et al.* 2012). These monkeys are strongly affected by habitat disturbance and fragmentation (Cowlshaw and Dunbar 2000; Rimbach *et al.* 2013). Their presence and abundance are related to the quality and conservation status of the forest (Symington 1988; Aquino *et al.* 2016b) and because of that they can serve as flagship species for conservation efforts in the region (Dietz *et al.* 1994; Harcourt 2000; Shanee *et al.* 2018b).

There is plenty of evidence that human activities have negatively impacted primate populations in the Yungas (Shanee *et al.* 2013b; Aquino *et al.* 2020). *Lagothrix flavicauda* and *A. belzebuth* are now rare in various sectors of the eastern flanks of the Andes, occurring in relatively small groups in remnant forests, and even local extinctions have been reported (Shanee 2011; Shanee and Shanee 2014; Aquino *et al.* 2017a, 2018a, 2018b). *Ateles belzebuth* occurs in low densities in the lower elevation forests, where the main threat is hunting (subsistence and commercial), and it may be locally extinct in the basins of the northern Río

Amazonas tributaries, thus rendering this species one of the most threatened in Peru (Aquino *et al.* 2013, 2016b).

The remaining primary forests of the Yungas Peruanas are reduced to fragments, mostly in the very rugged terrain from Cajamarca to Junín where economic development activities are not feasible, except for logging, which, however, particularly affects the wide-ranging, canopy-dwelling, and highly frugivorous atelins (Shanee *et al.* 2013a; Aquino *et al.* 2014a, 2017b, 2020; McHugh 2020). There are still forest patches in the Región Amazonas that remain in good condition, particularly north of the Río Marañón and to the southeast near the border with the Región San Martín but with, however, little information on the diversity, abundance and current status of the primates there (Barrio *et al.* 2003; Shanee *et al.* 2013a; Aquino *et al.* 2017b, 2018b, 2020; Shanee and Shanee 2018a). The available information for diurnal primates comes from field work carried out in national protected areas (Leo Luna 1980, 1987, 1989; Butchart *et al.* 1995; DeLuycker 2007) and private and communal protected areas (Barrio *et al.* 2003; Cornejo 2007; Shanee *et al.* 2007b; Shanee and Shanee 2011a, 2011b; Sánchez Larrañaga and Shanee 2012; Shanee *et al.* 2013a; Shanee 2014a, 2014b; Aquino *et al.* 2018b; Fack *et al.* 2018a, 2018b, 2020a, 2020b; Almeyda Zambrano *et al.* 2019; Reátegui Guzmán *et al.* 2020), but there are still large areas in the Región Amazonas with little information on their primate communities, notably in the central western forests of Flor de la Viña and Cambiopitec and the southern forests around Vista Alegre that we report on here. We estimate their relative abundance, numbers and group size, and the extent to which the forests are conserved. We also identify and assess the anthropogenic threats that could affect the survival of the atelins and other primates of the region.

Methods

Study area

The study was carried out in forests near the villages of Flor de la Viña (78°19'38.69"W, 5°26'50.72"S), Cambiopitec (78°20'16.35"W, 5°35'54.08"S) and Vista Alegre (77°18'12.64"W, 6°12'53.93"S) in the northeast of the Región Amazonas (Fig. 1). The area is part of the Yungas Peruanas Ecoregion (Dinerstein *et al.* 1995) that is characterized by dense forest with a vertical structure organized in multiple strata on extremely rugged terrain, with almost permanent high atmospheric humidity, rains of various intensities and temperatures between 7°C and 19°C. These conditions facilitate the presence of bromeliads, orchids, ferns, and other epiphytic plants (Tovar *et al.* 2010). Our survey sites were selected using the following criteria: the existence of primary and/or essentially primary remnant forest; accessibility; and the availability of local field guides. At each of these sites, the censuses were conducted in patches of forest more than 5 km from the villages.

The forests patches at Flor de la Viña and Vista Alegre were relatively large because deforestation for agricultural

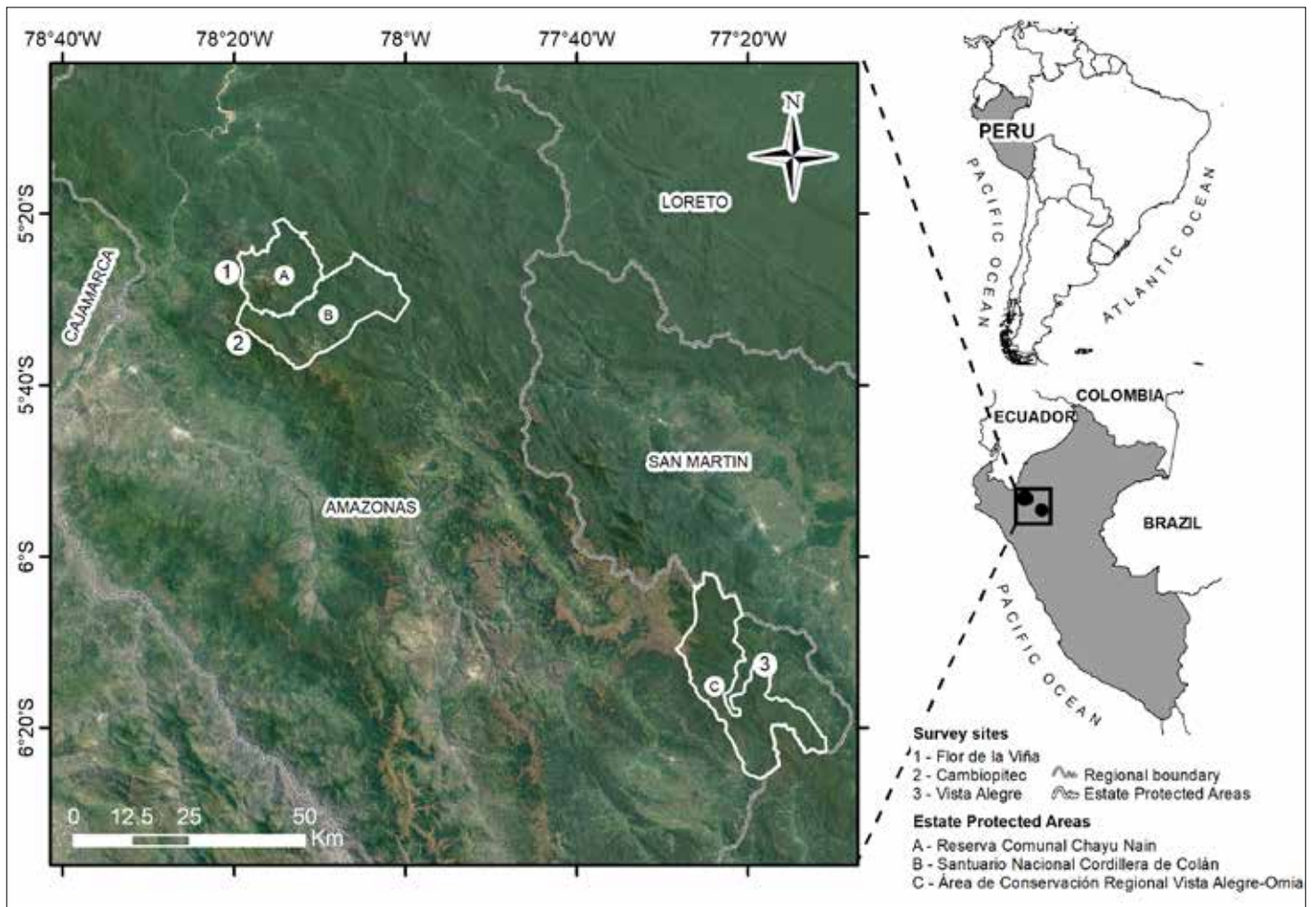


Figure 1. Survey sites in the Región Amazonas for the inventory and evaluation of *Lagothrix flavicauda* and other primates.

and livestock farming has been moderate to low. They were, however, still subject to clearing for pasture, mostly by immigrants from the Sierra de Cajamarca. The primary forest patches were on steep mountain slopes unsuitable for agriculture and livestock farming.

At Cambiopitec, there was a higher rate of deforestation for pasture, and the forest patches showed evidence of past and current high human disturbance. Large species such as the spectacled bear (*Tremarctos ornatus*) and puma (*Puma concolor*) were, however, still present. The inhabitants of Cambiopitec were aware of the importance of their forests, and they were taking measures to protect them, including banning the felling of trees in the vicinity of the nearby Santuario Nacional Cordillera de Colán.

Survey methods and abundance estimates

The survey was carried out from 15 June to 15 August 2018 in forests surrounding the villages of Flor de la Viña and Cambiopitec, located in the buffer zone of the Reserva Comunal Chayu Nain (RCCN) and Santuario Nacional Cordillera de Colán, respectively, and from 12 to 25 October of that same year in forests in the Área de Conservación Regional Vista Alegre-Omia. For the censuses, we used some trails used by the villagers, others we cut. Three or

four trails were opened at each survey site. The trails were 2–3 km long, depending on the topography. During the censuses we recorded all diurnal primates present in the study area; the nocturnal *Aotus miconax* was excluded. Censuses were made by two teams, each consisting of a researcher and a field assistant from 07:00 to 16:00 (local time) at an average speed of 0.6 km/h. Each would walk the trail in both directions (round trip) and would stop for three to five minutes every time they heard calls, heard or saw moving branches caused by the movement of the monkeys, or the fall of discarded fruits. Each transect and trail was walked 2–3 times over non-consecutive days (intervals of two to three days).

When a group of primates was seen we recorded the time, species, geographical coordinates (Garmin GPSmap 76CSx), elevation (m above sea level), vertical stratum of the forest of the first individual sighted, and activity (feeding, resting and locomotion). We then recorded group size, and the age and sex composition to the extent possible, and the location on the trail. Dependent infants were recorded but not included in the group counts.

Because the number of records for each of the species was less than ten, we estimated the abundance by counting the number of groups sighted per 10 km (groups/10 km).

The relative abundance of individuals/10 km was calculated by multiplying the number of groups by the average size of the group (possible only for *L. flavicauda*) or by the largest number of individuals observed in the cases of species in which no complete group count was achieved (Aquino *et al.* 2015b). In Cambiopitec, we were unable to calculate the abundance for *L. flavicauda* and *Sapajus apella macrocephalus* because only one record was obtained for each. Abundance in the study area was estimated for all species except for *A. belzebuth* for which we had just the one sighting (Table 3).

Interviews and threat analyses

A threat-ranking analysis was carried out with information obtained from interviews with local people and from our field observations. We used this information to make a list of the possible direct and indirect threats to the habitat and to the primates, especially *L. flavicauda* and *A. belzebuth*. The interviews were done in a dialogue format with the intention of mitigating any discomfort or mistrust of interviewees toward the researchers (outsiders) that could bias their answers or stories about the populations of primates and wildlife in general and their habitats. In the two villages closest to the survey sites, we interviewed at least two people, each about 40 years old that were hunters and had resided in the area for more than 20 years (Aquino *et al.* 2019). The main purpose was to confirm or rule out the existence of *L. flavicauda* in the forests surrounding the villages. To facilitate identification, we showed photographs of *L. flavicauda* from other expeditions, and of other primates *A. belzebuth*, *Alouatta seniculus*, *S. a. macrocephalus*, *Cebus yuracus* and *A. miconax* illustrated in Aquino *et al.* (2015a) and Emmons and Feer (1999).

We used the threat analysis method developed as part of the planning methodology of Open Standards for Conservation from the Conservation Measures Partnership and operationalized using Miradi (Conservation Measures Partnership 2020). The planning software has a module for threat analysis that has been used successfully for ranking threats for conservation planning with other species of primates (Ruiz-Miranda *et al.* 2019).

An action or event is considered a direct threat when its occurrence or changes in its intensity or frequency have caused changes in the conservation targets. Indirect or mediating factors are those actions that facilitate or contribute to the frequency, intensity, or probability of occurrence of a direct threat. The evaluation of the threats consisted of assigning a level among four options (low, medium, high, very high) to each of the three dimensions (or component factors) of the threat as follows:

1. Severity. How severe will the population or habitat reduction be in the next 10 years? Very high (VH): Eliminate the target or reduce its population by 71–100%. High (H): seriously degrade the target or reduce the population by 31–70%. Medium (M): Moderate degradation of the target or reduce the population by 11–30%. Low (L): Slight

degradation or reduction of the population by 1–10%.

2. Scope. What percentage of the area or populations will be affected in the next 10 years? VH: Pervasive effect affecting 71–100% of the area of occurrence of the target. H: Widespread or affecting 31–77% of the area. M: Restricted effects or affecting 11–30% of the area. L: Narrow scope or affecting 1–10% of the area.
3. Irreversibility or permanence of the effect. What is the degree of difficulty to reverse the damage back to the prior level? Vh: Cannot be reversed or reversal would take >100 years. H: Could be reversed but not affordable and would take 21–100 years to do so. M: Can be reversed with a reasonable commitment of resources with a time scope of 6–20 years. L: Easily reversed with low costs in a time frame of 0–5 years.

The levels were assigned by consensus of the field team and other authors based on the direct observations and information obtained from the interviews of local people. The Miradi algorithm consolidated the scores of the three dimensions into one score for each threat for each conservation target being considered. In this study, we considered two conservation targets: *Lagothrix* populations and the habitat (primary or well conserved secondary forests). The threat identification ranking applies to other species as well, but the interviews and field work had *Lagothrix* as the target species.

Results

Species and groups observed

We walked 334 km (519 hours) of transect surveys. Of these, 127 km and 201 hours in Flor de la Viña, 72 km and 113 hours in Cambiopitec, and 135 km and 205 hours were in Vista Alegre. We sighted 13 groups of four species (Table 1). Six of the 13 groups were seen in Flor de la Viña, the rest between Cambiopitec and Vista Alegre. *Lagothrix flavicauda* (Fig. 2) was the species with the highest number of sightings (seven groups), followed by *S. a. macrocephalus* (Fig. 3) with three groups. The only group of *A. belzebuth* sighted was in Vista Alegre. The interviewees from Flor de la Viña reported that *A. belzebuth* was still present in the forests surrounding that community and could be observed occasionally in the vicinity of their agricultural plots and pastures in the buffer zone of the Reserva Comunal Chayu Nain in subgroups of up to six individuals. The interviewees assured us that, apart from *L. flavicauda* and *A. belzebuth*, no other large primates such as the red howler, *A. seniculus*, have been seen in the site's forests. The interviewees told us that they had never heard howler's vocalizing there (Table 1). They acknowledged the presence of *A. miconax*, which we observed outside the census.

A full count was not possible for most of the groups sighted because the monkeys were too dispersed or because

they fled in the presence of observers, a behavior typical of primates that are hunted or persecuted in areas disturbed by the presence of humans.

Group size

Lagothrix flavicauda was the species with the most with full group counts (Table 2). The average size was 7.8 individuals. The single counted group of *A. belzebuth* had 12 individuals, not counting dependent infants. We observed infants being carried by lactating females in both *L. flavicauda* and *A. belzebuth* (Table 1). The incomplete group size counts for *S. a. macrocephalus* and *C. yuracus* ranged from 6–8, but their numbers were probably closer to 12 because we heard vocalizations and saw branch movements nearby. We observed one dependent infant *S. a. macrocephalus* (Table 1).

Relative abundance

The highest abundance was recorded in forests around Flor de la Viña and Vista Alegre (Table 3). *Lagothrix flavicauda* was the most abundant, and the lowest abundance was that of *S. a. macrocephalus* in Flor de la Viña. The relative abundance for *A. belzebuth* was not calculated because we obtained just one record. The most abundant species were *L. flavicauda* and *S. a. macrocephalus* in Flor de la Viña, and *C. yuracus* in Vista Alegre with 1.2 indiv./10 km. At the study area level, the highest abundance was once again for *L. flavicauda* with 0.21 groups/10 km and 1.64 indiv./10 km, while the lowest was *C. yuracus* with just 0.06 groups/10 km and 0.48 indiv./10 km (Table 3).

Table 1. Primate species reported by local people and groups sighted at each study site.

Survey sites	Species*	Interviewees	# of records	Group size	Dependent infants	Geographic coordinates	Altitude (m.a.s.l.)	
Flor de la Viña	<i>Ateles belzebuth</i>	X	n.a.					
	<i>Lagothrix flavicauda</i>	X	1	5	1	5°26'34"S 78°20'14"W	1,719	
			2	>2 ⁰		5°26'37"S 78°20'5"W	1,779	
			3	8	1	5°26'34"S 78°19'27"W	1,985	
			4	4		5°26'42"S 78°19'20"W	1,938	
	<i>Alouatta seniculus</i>	-						
	<i>Sapajus a. macrocephalus</i>	X	1	>6 ⁰	1	5°26'37"S 78°20'6"W	1,763	
2			>2 ⁰		5°26'49"S 78°19'45"W	1,800		
<i>Cebus yuracus</i>	X		n.a.					
Cambiopitec	<i>Ateles belzebuth</i>	X	n.a.					
	<i>Lagothrix flavicauda</i>	X	1	5		5°35'20"S 78°21'8"W	2,084	
	<i>Alouatta seniculus</i>	-						
	<i>Sapajus a. macrocephalus</i>	X	1	>6 ⁰		5°36'50"S 78°21'43"W	1,618	
	<i>Cebus yuracus</i>	X						
Vista Alegre	<i>Ateles belzebuth</i>	X	1	12	2	6°12'11"S 77°17'53"W	1,827	
	<i>Lagothrix flavicauda</i>	X	1	15		6°12'30"S 77°18'6"W	2,153	
			2	10		6°13'0"S 77°18'9"W	2,069	
	<i>Alouatta seniculus</i>	-						
	<i>Cebus yuracus</i>	X	1	>8 ⁰			6°12'25"S 77°18'2"W	2,057
			2	>2 ⁰			6°11'42"S 77°18'1"W	1,587

*Order decreasing body mass; ⁰Group without complete count; n.a.: not available.



Figure 2. Adult female *Lagothrix flavicauda* observed in the village of Flor de la Viña, Región Amazonas. Photograph by Luis López.



Figure 3. Adult *Sapajus a. macrocephalus* in the montane forest of Flor de la Viña. Photograph by Luis López.

Table 2. Group size and range of variation observed in the study area.

Species*	Group size		Number of groups	
	Mean \pm SD	Range	Total	With complete counts
<i>Ateles belzebuth</i>		12	1	1
<i>Lagothrix flavicauda</i>	7.8 \pm 4.2	4–15	7	6
<i>Sapajus a. macrocephalus</i>		>6	3	
<i>Cebus yuracus</i>		>8	2	

*Order decreasing body mass

Table 3. Rate of sightings for primates at sampling sites and the study area in the Región Amazonas. n.a.: not available

Survey sites	Species		
	<i>L. flavicauda</i>	<i>S. a. macrocephalus</i>	<i>C. yuracus</i>
Flor de la Viña			
Total length of transect walks km	127	127	127
# of records	4	2	n.a.
Groups/10 km	0.31	0.16	n.a.
Indiv./10 km	2.42	0.96	n.a.
Cambiopitec			
Total length of transect walks km	72	72	72
# of records	1	1	n.a.
Groups/10 km	n.a.	n.a.	n.a.
Indiv./10 km	n.a.	n.a.	n.a.
Vista Alegre			
Total length of transect walks km	135	-	135
# of records	2	-	2
Groups/10 km	0.15	-	0.15
Indiv./10 km	1.17	-	1.2
Study area			
Total length of transect walks km	334	199	334
# of records	7	3	2
Groups/10 km	0.21	0.15	0.06
Indiv./10 km	1.64	0.69	0.48

n.a.: not available

Threats and conservation of the forest

The landscape of the study area was composed of forest fragments in a matrix of cattle pasture, agriculture and agroforestry, and secondary vegetation. The fragments varied in size and extent of anthropogenic disturbance. Deforestation was more intense in Cambiopitec, particularly due to livestock farming. There the primary forest fragment remnants were found only where the topography was most rugged, particularly on the cliffs and mountain peaks, where the “romerillo” (*Podocarpus glomeratus*, Podocarpaceae) still exists, unfortunately being illegally extracted for its high-quality wood. These forests are also under pressure from the extraction of plants for medicinal use such as the “quina” (*Cinchona* sp., Rubiaceae) and “sangre de grado” (*Croton*

draconoides, Euphorbiaceae), the latter sometimes cut down to extract the sap in greater quantity. Some, forest fragments were being cut to create new grassland for cattle (Fig. 4), or, less often, for agriculture. We also observed deforestation for cultivating beans (*Phaseolus vulgaris*, Fabaceae) and rocoto peppers (*Capsicum pubescens*, Solanaceae). Hunting was also in evidence with the collection of spent shotgun cartridges. Information obtained from interviewees indicated that the species most hunted were deer, peccary and the larger primates.

Unlike Cambiopitec, the forests surrounding Flor de la Viña and Vista Alegre had a profile of only moderate disturbance. At both sites, deforestation was for agriculture, mainly coffee plantations (Fig. 5), the extraction of forest



Figure 4. Habitat loss from deforestation for cattle ranching in the village of Cambiopitec, Región Amazonas.

Table 4. Summary table of the threat analysis for the two main conservation targets.

Threats/Targets	<i>Lagothrix</i> populations	Habitat Conservation	Summary Threat Rating
Poaching/Hunting	High	Medium	Medium
Cattle Ranching	High	High	High
Coffee plantations	Medium	Medium	Medium
Timber Extraction		Low	Low
Forest plant Harvest		Low	Low
Summary Target Ratings	High	Medium	Overall Threat Rating= High

species, and, to a lesser degree, for cattle ranching. We noticed that the forest fragments were more extensive in Vista Alegre than in Flor de la Viña. In Vista Alegre, however, deforestation could increase in the coming years due to illegal logging. We observed planks of “cedro” (*Cedrela* sp.) for commercialization in Nueva Cajamarca, the nearest city to Vista Alegre. Hunting was also present in the three sites. In the case of Flor de la Viña, hunting is practiced mainly by Awajún indigenous people, because part of their protein diet comes from wild meat mainly large primates. One of the interviewees commented that he observed a resident of the Awajún community carrying a dead *L. flavicauda* on his back. Interviewees also mentioned that there is the

potential for people from other remote non-indigenous communities to enter the area to hunt animals such as paca and deer, and probably the large primates. The interviewees said that hunting is sporadic.

As a starting point to guide conservation efforts, we constructed a conceptual framework of the threats (Fig. 6) showing how the three main direct threats (poaching/hunting, deforestation, and forest degradation) affect either the primate populations or the habitat at a regional level. The model also indicates the indirect threats or contributing factors (ranching, coffee plantations, timber extraction and wild plant harvesting) that influence each threat. The threat analysis was done on the levels of threat posed by the component

factors (Table 4). Even though the overall analysis rates the threat level as High, only two threats pose immediate concern (High Values): cattle ranching and poaching/hunting. The other threats have low to medium values.

Discussion

Of the four diurnal primates recorded in our study, only *L. flavicauda* occurred in all three sites, the other three were present in one or two sites. Regarding *A. belzebuth*, the only sighting was of one group in one site (Vista Alegre) suggesting that this species could have been extirpated in the other sites and possibly numerous other forest patches in Amazonas, San Martín and Huánuco, just as it may be in several sectors of the interfluvium Marañón-Huallaga (Aquino *et al.* 2018a, 2020) and the basin of the Río Amazonas (Aquino *et al.* 2012, 2016b). Assigning this species as having a “Critically Endangered” status would better reflect its current situation in Peru (Aquino *et al.* 2020), and we hope it will be taken into account by the Ministerio del Ambiente (MINAM)/Servicio Nacional Forestal y de Fauna Silvestre (SERFOR). Besides Vista Alegre, the absence of *S. a. macrocephalus* has also been documented for other study areas

in the Región Amazonas (Mittermeier *et al.* 1975; Shanee *et al.* 2013a; Aquino *et al.* 2018b). As far as we know, this species has been observed in the Cordillera Colán at altitudes between 1550 and 2350 m above sea level (Butchart *et al.* 1995). The forests around Vista Alegre may merely not be part of its geographical distribution (Aquino *et al.* 2018b).

The number of species of primates registered in the study area was similar to those reported for other areas of the montane forest of Peru (Table 5). In our study, the site with the least number of species, Cambiopitec, was also the location with more deforestation and hunting, human impacts that have influenced primate diversity in the montane forests (Aquino *et al.* 2016a, 2018a, 2020; Estrada *et al.* 2017). Another factor that could explain the low number of primate species is the low diversity of trees, depending on the type of habitat (Shanee *et al.* 2013b).

Group size can vary according to the extent of hunting and the availability of food sources (Symington, 1988; Endo *et al.* 2010). In study sites such as this one and in most other studies cited, extreme values for group size could be used as indicators of population status in an area (Shanee and Shanee 2015; Aquino *et al.* 2015c). Larger primates are strongly sensitive to habitat alteration and fragmentation (Cowlshaw



Figure 5. Coffee plantation in the sector Vista Alegre.

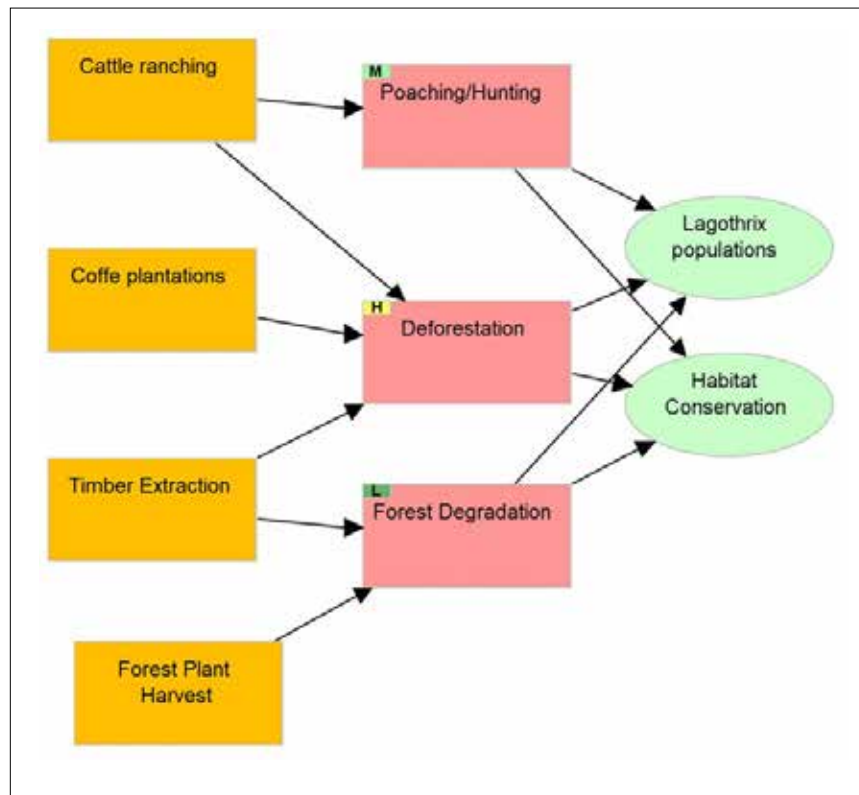


Figure 6. Conceptual framework using the Open Standards for the Practice of Conservation Methodology. The green ellipses represent the conservation targets. By habitat, we mean primary forest or well-conserved secondary forest. The red rectangles represent the direct threats to those conservation targets. The yellow rectangles represent the indirect threats or contributing factors to the direct threat. M, H and L in the red rectangles mean Medium, High and Low, respectively. The image was created in Miradi Software Version 4.5.0.

and Dunbar 2000) and even small-scale disturbances can affect their group sizes (Kolowski and Alonso 2012). In the Región Huánuco, for example, groups of *L. flavicauda* near roads (2–3 km) were smaller and individuals more fearful than groups more distant from roads (Aquino *et al.* 2015c). We recorded the largest groups of *L. flavicauda* (10–15 individuals) in Vista Alegre, the site with the least disturbed and largest forests; and the smallest full group counts were seen in Flor de la Viña and Cambiopitec, this last with the highest disturbance. These group sizes are similar to the ones observed in several other field surveys of montane forests that were either high altitude (Leo Luna 1980; Butchart *et al.* 1995; McHugh *et al.* 2020) or disturbed forests (Shanee and Shanee 2015; Aquino 2017a, 2018a), even though it is possible that they were subgroups. Larger group sizes (19–30) have been recorded, however, in other montane sites of low or moderate disturbance (DeLuycker 2007, Aquino *et al.* 2015c, Fack *et al.* 2020b). For *A. belzebuth*, the size of the one sub-group sighted was smaller than those reported from several low to medium disruption Peruvian montane sites (Aquino *et al.* 2018a, 2018b) and the Amazonian lowlands (Aquino *et al.* 2013, 2016b). Group size was higher, however, than has been reported in the Colombian Andes (Barrera *et al.* 2019) and severely disturbed forests along the upper Río Napo (2–5) (Aquino *et al.* 2013).

Regarding the smaller species, *S. a. macrocephalus* and *C. yuracus*, we were unable to obtain a full count for any of the groups. As with *A. belzebuth*, the groups always fled in our presence (Shanee *et al.* 2007b). Judging from the movement of branches and vocalizations perceived around the groups, we suspect that those of *S. a. macrocephalus* groups were large. These species may regard humans as dangerous because they are sometimes hunted for being pestilential in feeding on maize and other crops (Shanee *et al.* 2013a; Aquino *et al.* 2015c). Groups of up to 22 individuals have been recorded in an area with no hunting in the Área de Conservación Privada Los Chilchos (ACP Los Chilchos) (Aquino *et al.* 2018b). Future studies may find larger groups than those seen in Flor de la Viña and Vista Alegre because hunting at these sites is sporadic and largely aimed at other, larger mammals. The group size recorded here was within the range of those reported for other medium to high disturbance areas (Berton *et al.* 2008; Aquino *et al.* 2014a, 2017a).

Abundance varied among sampling sites coincident with the degree of anthropogenic habitat disturbance. Vista Alegre was the site with the lowest abundance recorded for *Lagothrix flavicauda*. The estimated abundance for *L. flavicauda* in the study area was higher than that reported for forests with high-disturbance levels (Aquino *et al.* 2016a, 2018a) and similar or slightly less to those estimated for

Table 5. Compilation of information on sites with the highest number of directly recorded primate species, forest protection, degree of human disturbance, and distance covered in transects based on other studies carried out in montane forests.

Región*	Sector	Distance (km)	Protected Area	Human disturbance	Number of species (**)	Source
Amazonas	Flor de la Viña	334	No	Moderate	5 (a,c,g,h,i)	This study
	Cambiopitec	127	No	High		
	Vista Alegre	72	Yes	Moderate		
	Área de Conservación Privada Los Chilchos	282	Yes	Low/High	5 (a,c,e,h,i)	Aquino <i>et al.</i> 2018b
	Laguna de los Cóndores and Los Chilchos	-	Yes	Low	5 (b,c,e,h,i)	Barrio <i>et al.</i> 2003
	Yambrasbamba	-	Yes	Low	4 (a,c,h,i)	Shanee <i>et al.</i> 2013a
Cajamarca	Huamantanga and Torohuaca	238	No	Very high	3 (e,h,j)	Aquino <i>et al.</i> 2014a
Huánuco	Río Chontayacu microbasin	129	No	Very high	7 (b,c,d,e,g,h,i)	Aquino <i>et al.</i> 2017a
	Río Monzón microbasin	160	No			
	Río Huallaga-Pozuzo microbasin	213	No	High		
	Río Chontayacu microbasin	267	No	Moderate	6 (b,c,e,g,h,j)	Aquino <i>et al.</i> 2015c
	Río Chinchao microbasin	131	No	Very high		
	Río Huallaga microbasin	220	No	High		
	Río Santa Martha microbasin (Alto Azul)	76	No	High	6 (c,e,g,h,i,k)	Aquino <i>et al.</i> 2016a
San Martín	Río Mishollo microbasin	138	No	High	5 (c,e,g,h,i)	Aquino <i>et al.</i> 2017a
	Río Tocache microbasin	182	No			
	Río Crisnejas microbasin	106	No			
Ucayali	Río Previsto microbasin	155	No	High	6 (b,d,e,h,j,k)	Aquino <i>et al.</i> 2019
	Río Lobo microbasin	168	No	Moderate		
Cusco	Kcosñipata	-	Yes	Low	3 (d,g,j)	Medina <i>et al.</i> 2003
Junín	Río Pampa Hermosa microbasin	180	Yes	Moderate	5 (b,c,f,g,h)	McHugh <i>et al.</i> 2020

*order from north to south

** Species observed: a: *Ateles belzebuth*; b: *Ateles chamek*; c: *Lagothrix flavicauda*; d: *Lagothrix l. tschudii*; e: *Alouatta seniculus*; f: *Cacajao calvus*; g: *Sapajus a. macrocephalus*; h: *Cebus yuracus*; i: *Aotus miconax*; j: *Aotus* sp.; k: *Leontocebus leucogenys*.

forest of low-and medium disturbance (Aquino *et al.* 2015c, 2016a, 2017a, 2018b).

In this study, it was not possible to determine the abundance for *A. belzebuth* since we only saw one group. In this regard, Shanee (2009) argued that its population density varies with altitude (lower at higher altitudes) as well as with human pressure. Aquino *et al.* (2015c), however, observed higher densities in areas where these animals were not hunted and also proposed that higher densities could be the result of smaller forest patches.

The presence of *L. flavicauda* in the three study sites, and the scarcity of *A. belzebuth* could also be related to competition for habitat and food resources. Competition was suggested by Aquino *et al.* (2014b) from observations of *A. belzebuth* and *Lagothrix poeppigii* in the little-disturbed forests of the Curaray basin, and by Defler (2004) where there was sympatry between *A. belzebuth* and *L. lagothricha*

in Colombia. In other locations with little human pressure (Parque Nacional del Manu), however, *A. chamek* was present in higher densities than sympatric *Lagothrix* (Endo *et al.* 2010). The factors that affect abundance of these larger primates are difficult to tease apart from the available literature. Variables such as sampling effort, degree of human disturbance, and altitude are confounded in these studies. *Ateles belzebuth* is mainly a lowland species and is probably better adapted to this environment, whereas *L. flavicauda* is a highland endemic, and so adapted. These variables and species competition have been suggested as factors that determine the abundance of *Lagothrix* and *Ateles* in the Amazon. More results from comparative ecological studies and biogeographical analyses are needed to estimate the relative importance of each.

In the case of *S. a. macrocephalus* and *C. yuracus*, the abundance estimates for both species were lower than

reported for other locations surveyed, such as Cajamarca (Aquino *et al.* 2014a), Chontayacu and Alto Huallaga in the Región Huánuco (Aquino *et al.* 2015c) and La Libertad and San Martín (Aquino *et al.* 2018a). In two sectors surveyed in the the regions of La Libertad and Huánuco, however, the abundance estimates for *S. a. macrocephalus* were the same as or lower than our estimates, and for *C. yuracus* they were higher (Aquino *et al.* 2017a). Again, the cited studies differ from ours in the extent of destruction of their habitats, and the distance covered during the surveys.

Conservation status: threats and opportunities

Identification and ranking of threats to the populations of *L. flavicauda* were assessed through an analysis constructed from the informed opinion and direct observation of participating researchers and complemented by information from interviews with local inhabitants. The threats to habitat apply to *A. belzebuth* and the other primates surveyed and to non-primate species as well. We documented five threats related to human economic or subsistence activities. Of those observed here, deforestation for agriculture and livestock, and subsistence hunting are the main threats to primates and other wildlife that inhabit montane forests. They are present throughout the Peruvian Amazon, and particularly the regions of La Libertad, San Martín, Huánuco, and Pasco (Shanee 2011; Shanee *et al.* 2007a, 2013b; Aquino *et al.* 2015c, 2017b, 2019).

The threat ranking considers both the range of its influence and the potential severity of its effects. The overall threat rating reflects the presence of ongoing threats with substantial potential effects on primate populations and their habitats. Hunting, even if mostly for subsistence, was considered a high-level threat because its effect could be severe considering the dynamics of primate populations in the area. It is possible that hunting is an important factor that would result in *L. flavicauda* moving to higher elevations. This species has been recorded at 2,153 m in Vista Alegre (in this study) and up to approximately 2,800 m in other sites (Shanee 2011; Aquino *et al.* 2020). Hunting could lead to local extinction of the larger primates in the areas closest to human habitation and activities (Aquino *et al.* 2018a, 2020). Cattle ranching was considered a high-level threat to primate populations because it is difficult to reverse total deforestation. Ranching could also be a contributing factor to hunting by placing people in proximity to the large primates (either individuals tending to the cattle or by facilitating access to forests). Clearing for agriculture was mostly for coffee, beans and rocoto peppers; we did not record any agroforestry or shaded-coffee plantations. Wild plant harvesting is another threat but today its incidence is low. Its impacts could intensify, however, if it becomes a good source of revenue in the region as the human population grows.

The conservation opportunities and threats differ among the three sites. There are still relatively large fragments of essentially primary forest in Flor de la Viña and Vista Alegre, and they still maintain primates, albeit at lower abundances

than reported for other areas of montane forest of north-eastern and central eastern Peruvian Amazonia (Shanee and Shanee 2015; Aquino *et al.* 2017b, 2018a, 2018b, 2019). The state of conservation of these fragments seems to reflect the attitude of its human population: a commitment to avoid deforestation and hunting for their current benefits and for their future generations. Subsistence hunting is another threat to primates in Flor de la Viña and Vista Alegre. In the case of Flor de la Viña, hunting is sporadic, practiced mainly by the Awajún indigenous people who live in areas far from the study sites and who have a predilection for large primates (DeLuycker 2007; Shanee and Shanee 2014).

Despite the disturbance to the forest, the larger fauna is still diverse and relatively abundant in Flor de la Viña and Vista Alegre, especially the non-hunted species such as the spectacled bear (*Tremarctos ornatus*), puma (*Puma concolor*), jaguar (*Panthera onca*), bicolored spined porcupine (*Coendou bicolor*), river otter (*Lontra longicaudis*), coati (*Nasua nasua*) and tayra (*Eira barbara*), all of which were registered by direct and/or indirect observation (footprints) during the surveys. The people of both communities told us that they are aware of the importance of conserving forests, so they have taken measures accordingly, including the prohibition of logging and hunting in the forests adjacent to the hamlet and the buffer zone of the Reserva Comunal Chayu Nain and river headwaters, creeks and on steep slopes near Vista Alegre. These forests should be considered for legal protection and ecotourism, especially those in Flor de la Viña. There, the increased number of indirect records of *T. ornatus*, *P. concolor* and *L. longicaudis*, suggest that this site is in good condition regarding its biodiversity. Vista Alegre also presents good opportunities for ecotourism, with large tracts of well-conserved forest, and where three of the four primate species were registered. It is likely that there are more groups of *L. flavicauda* and *A. belzebuth* than we recorded. It is worthwhile to consider that this area was declared as an Área de Conservación Regional Vista Alegre-Omia (Peru, MINAM 2018), one of the first two areas of regional conservation in the Región Amazonas.

In Peru, there are 14 categories of legally recognized protected areas (Shanee *et al.* 2020). They are managed by state, regional and local governments, and there are, besides, non-governmental protected areas (Shanee *et al.* 2020). In the Región Amazonas, there are eight protected areas administered by the state, and it has a large number of private and communal protected areas, occupying fifth place, after the Madre de Dios and San Martín regions located in first and second place, respectively (Shanee *et al.* 2020; Peru, SER-NANP 2022). These conservation measures are encouraged by the facilitating agents that are non-governmental institutions actively promoting and/or supporting their creation (Shanee *et al.* 2020).

We hope that our study will further emphasize the importance of these sites for the survival of populations of *L. flavicauda* and *A. belzebuth*, and other large mammals threatened in this part of the Región Amazonas. Regarding

A. belzebuth, the critical state of its populations both in the lower Amazon and in montane forests (Aquino *et al.* 2018a, 2018b), warrants that it should be urgently recategorized as Critically Endangered.

There are a number of opportunities for long-term conservation; the threats are present but there are still no large-scale enterprises. We are, therefore, still in time to raise awareness among the inhabitants who live in this part of the Peruvian Amazon and elsewhere, about the importance of the forest for the wildlife, water and other vital resources for local communities, as well as for humanity. Some areas in the region have been denominated protected areas, but that designation does not have the necessary efficacy to curtail ongoing threats and their potential expansion without the concomitant presence of agents (government or third sector) supporting the positive attitudes of the local people and promoting conservation measures that lead to sustainable economic activity, such as ecotourism and agroforestry.

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