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Authors: Shanee, Sam, Shanee, Noga, and Allgas-Marchena, Néstor

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Primate Surveys in the Marañón-Huallaga Landscape, Northern Peru with Notes on Conservation

Sam Shanee[1], Noga Shanee[1] and Néstor Allgas-Marchena[2,3]

[1]Neotropical Primate Conservation, Manchester, UK
[2]Neotropical Primate Conservation Peru, La Esperanza, Yambrasbamba, Peru
[3]Facultad de Ciencias Biológicas, Universidad Nacional Mayor de San Marcos, Lima, Peru

Abstract: With about 50 species and subspecies, the diversity of primates in Peru is amongst the highest in the world. Primate field surveys, however, are still scarce for many areas. Peru's northern forests lie at the heart of the Tropical Andes and are home to four of the country's endemic primates: *Aotus miconax*, *Callicebus oenanthe*, *Oreonax flavicauda*, and *Saguinus leucogenys*. We present here an overview of results from more than five years of primate surveys in northern Peru. Surveys were carried out in the valleys and intervening highlands between the ríos Marañón and Huallaga in the departments of Amazonas, La Libertad, Huánuco and San Martín. Data were gathered between March 2007 and October 2012 from 36 locations at 26 sites. Surveys were carried out as part of biological inventories in proposed conservation areas. In all, 14 species were recorded from 11 genera. The presence or absence of a species was largely determined by altitude. The four endemic species were present in the majority of survey sites. The most common species encountered were *Oreonax flavicauda*, *Ateles belzebuth*, *Cebus yuracus*, and *Aotus miconax*. The highest species diversities were found at lower altitudes further from human development, although some species previously registered in these regions were not encountered. All areas visited suffered from at least some anthropogenic disturbance, with the majority showing high levels of habitat disturbance, deforestation and hunting.

Keywords: Río Marañón, Río Huallaga, altitude, cloud forest, deforestation, conservation

Resumen: Con aproximadamente 50 especies y subespecies, Perú posee una de las mayores diversidades de primates entre todos los países del mundo, pero los estudios de campo son escasos en muchas áreas. Los bosques del Norte del Perú se encuentran en el corazón de los Andes Tropicales y son el hogar de cuatro especies de primates endémicos. Presentamos una visión general de los resultados de más de cinco años de trabajo de campo con primates en el Norte del Perú. Los trabajos fueron realizados en los valles y partes altas entre los ríos Marañón y Huallaga, en los Departamentos de Amazonas, La Libertad, Huánuco y San Martín. Los datos fueron reunidos entre marzo del 2007 y octubre del 2012 en 36 localidades de 26 sitios. Los trabajos de campo fueron realizados como parte de inventarios biológicos llevados a cabo durante la creación de propuestas para áreas de conservación. Un total de 14 especies fueron registradas para 11 géneros. Altura fue el factor más importante para la presencia de especies. Las cuatro especies endémicas del Perú fueron encontradas en la mayoría de los lugares de trabajo. Las especies comúnmente más encontradas fueron; *Oreonax flavicauda*, *Ateles belzebuth*, *Cebus yuracus* y *Aotus miconax*. La más alta diversidad de especies fue registrada en los lugares de menor altitud en bosques alejados de impacto antropogénico. Algunas de las especies que fueron previamente registradas en estas regiones no fueron encontradas. Todas las áreas visitadas durante el estudio presentan algún tipo de disturbio antropogénico, en la mayoría se puede observar destrucción de hábitat, deforestación y cacería.

Palabras Clave: Río Marañón, Río Huallaga, altitud, bosque montano, deforestación, conservación

Introduction

Peru is one of the most biodiverse countries in the world in terms of mammals, birds, amphibians and plants (Pacheco *et al.* 2009; Rodríguez and Young 2000; Schulenberg *et al.* 2010). Aquino and Encarnación (1994) carried out the only recent comprehensive revision of the primates of Peru, listing 32 species. Following taxonomic revisions since then, 44 species and 50 species and subspecies are now recognized by the IUCN/SSC Primate Specialist Group; as such, the sixth highest primate diversity of any country, following only Brazil, Madagascar, Indonesia, the Democratic Republic of the Congo (DRC), and Colombia (Mittermeier 2013). Despite this, field studies of primates in Peru are still lacking for many areas and species, and the distributional limits of most species are as yet poorly understood.

Peru's northern regions of Amazonas, La Libertad, Huánuco and San Martín present a great variety of ecosystems in a relatively small area (Peru, ONREN 1976; Brack Egg 1986). This ecological complexity comes from altitudinal gradients, local and general rain shadow effects in inter-Andean valleys, and the influence of the dry coastal climate, which penetrates further inland here than anywhere else in Peru (Rodríguez and Young 2000). This complexity is reflected in the diversity of species present; able to colonize new areas by the reduced size of rivers near their headwaters and, in lowland areas, to migrate along the valleys of the ríos Marañón and Huallaga and their tributaries.

Of Peru's 44 recognized primate species, six are endemic to Peru (Matauschek *et al.* 2011; Mittermeier 2013). Of these, four—the yellow-tailed woolly monkey (*Oreonax flavicauda*), the Andean night monkey (*Aotus miconax*), the Andean titi monkey (*Callicebus oenanthe*), and the saddle-back tamarin (*Saguinus leucogenys*)—are endemic to the north of the country. They are all found on the eastern slopes of the Andes in the regions of Amazonas, La Libertad, Huánuco and San Martín (Leo Luna 1987; Buckingham and Shanee 2009; Schjellerup *et al.* 2009) an area at the heart of the 'Tropical Andes Biodiversity Hotspot' (Myers *et al.* 2000; Myers 2003). *Saguinus leucogenys* has a larger distribution, found as far south as the region of Pasco (Aquino and Encarnación 1994).

Due to their inaccessibility and steep terrain, the forested areas between the ríos Marañón and Huallaga remained relatively undisturbed until recent decades (Leo Luna 1987; Buckingham and Shanee 2009; Schjellerup *et al.* 2009). A surge in immigration and development projects since the 1970's, however, has opened many new frontiers in deforestation (Dourojeanni *et al.* 2009). Sustained deforestation rates are particularly high because the low productivity of montane soils and slow adaptation of migrants to new agricultural conditions has led to a reliance on unsustainable farming methods (Bebbington 1990; Loker 1996; MINAG 2010; N. Shanee 2012a).

We conducted rapid biological inventories at sites throughout Amazonas and San Martín and neighboring areas of La Libertad and Huánuco. Our surveys were part of a broader community conservation initiative in this landscape (http://www.neoprimate.org/index.php/en/projects-npc). We visited areas during surveys for the creation of private, communal or government protected areas, or in areas where baseline data were needed for community conservation work to evaluate possibilities and the need for conservation.

Methods

Study area

We conducted surveys of primates between March 2007 and October 2012. All sites were in areas on the eastern side of the Río Marañón valley, the western side of the Río Huallaga valley and the intervening highlands in the regions of Amazonas, La Liberted, Huánuco and San Martín, between 05°31'S and 09°44'S and 78°39'W and 76°15'W (Fig. 1). We surveyed forested areas between 300 m and 2900 m above sea level. Habitat types we surveyed included montane and pre-montane cloud forests, lowland *terra firma* forests, shade coffee plantations, and the dry forests of the Marañón and Huallaga valleys (Table 1). Daytime temperatures for these

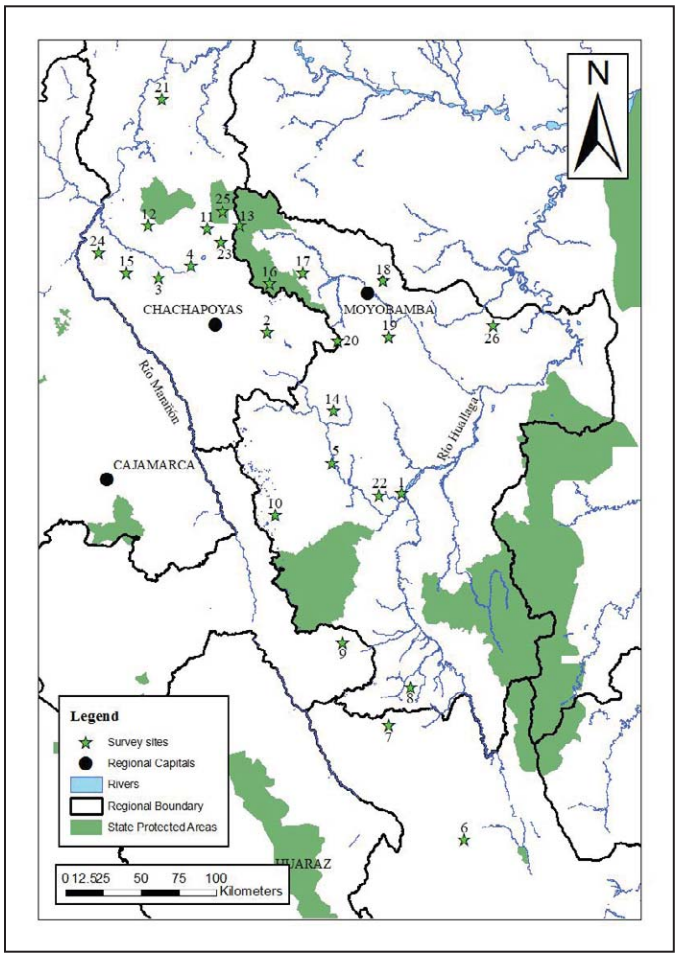

Figure 1. The study area showing survey sites, state protected areas, major rivers and political boundaries. 1 - Pucunucho; 2 - Ocol; 3 - Berlin; 4 - Shipasbamba; 5 - Simacache; 6 - Monzon; 7 - Ajenco; 8 - Shunte; 9 - Poroto; 10 - Alto Huayabamba; 11 - Yambrasbamba; 12 - Copallín; 13 - Venceremos; 14 - Paujil; 15 - Delta; 16 - Bosque Protección Alto Mayo; 17 - Colca; 18 - Nuevo Paraiso; 19 - Gira-Sisa; 20 - Paitoja; 21 - Halcabamba; 22 - Pachiza; 23 - Corosha; 24 - Campo redondo; 25 - Río Nieva; 26 - Cordillera Escalera.

areas vary from 8°C to 36°C. Average monthly rainfall ranges from approximately 15 mm to 1500 mm.

Field Surveys

We expected to encounter 18 species of primate previously recorded in the area. We used methods developed for rapid biological inventories that have been used successfully in Peru in previous studies (for example, S. Shanee 2011b; Vriesendrop *et al.* 2004). Sites varied in size from isolated forests of about 400 ha to areas of contiguous forest, as well as areas of forest mosaics with patches of <10 ha. Data were gathered using a combination of field surveys and

Table 1. Survey site locations and habitat types.

Survey site	Department	Coordinates	Altitude (m)	Habitat type	Level of anthropogenic disturbance	Conservation status
Pucunucho	San Martín	07°13'46"S 76°45'22"W	300–400	Huallaga semi-arid forest	Advanced secondary re-growth	Private Conservation Area (23.5 ha), in process
Ocol	Amazonas	06°16'04"S 77°33'27"W	2200–2300	Montane palm forest	Highly fragmented	Private Conservation Area (16 ha), awarded
Berlin	Amazonas	05°55'08"S 78°24'45"W	2000–2200	Montane cloud forest	Highly fragmented	Private Conservation Area (59 ha), in process
Shipasbamba	Amazonas	05°54'35"S 77°58'50"W	2000–2300	Montane cloud forest	Moderate disturbance and hunting	Not protected
Simacache	San Martín	07°2'39"S 77°11'59"W	200–500	Primary rainforest	Moderate hunting	Conservation Concession (51,269), in process
Monzon*	Huánuco	09°15'29"S 76°23'36"W	700–1500	Pre-montane cloud forest	Low disturbance and moderate hunting	Not protected
Ajenco*	Huánuco	08°39'06"S 76°47'28"W	1800–2100	Montane cloud forest	Low disturbance and moderate hunting	Not protected
Shunte*	San Martín	08°24'40"S 76°43'07"W	1200–1700	Montane cloud forest	Low disturbance and moderate hunting	Regional Conservation Area, in process
Poroto*	La Libertad	08°07'02"S 77°08'8"W	1700–1900	Montane cloud forest	Moderate disturbance and hunting	Not protected
Alto Huyllabamba*	San Martín	07°19'14"S 77°27'39"W	2200–2600	Montane cloud forest	Low disturbance and moderate hunting	Conservation Concession (143,928 ha), awarded
Yambrasbamba*	Amazonas	05°39'56"S 77°54'36"W	1700–2100	Montane cloud forest	Highly fragmented and Little hunting	Private Conservation Area (2,776 ha), in process
Copallin	Amazonas	05°38'30"S 78°15'03"W	1700–2500	Montane cloud forests	Low disturbance and little hunting	Private Conservation Area (11,549 ha), awarded
Venceremos	San Martín	05°40'18"S 77°45'52"W	1800–2000	Montane cloud forest	Low disturbance and moderate hunting	Alto Mayo Protected Forest (182,000 ha).
Paujil*	San Martín	06°42'28"S 77°13'29"W	1600–1800	Pre-montane cloud forest	Moderate disturbance and heavy hunting	Conservation Concession (7,418 ha), in process
Delta	Amazonas	05°47'57"S 78°34'16"W	600–800	Maranon dry forest	Fragmented and moderate hunting	Conservation Concession (423 ha), Awarded
Bosque Protección Alto Mayo	San Martín	05°57'43"S 77°35'38"W	2500–2800	Montane cloud forest	Low disturbance no hunting	Alto Mayo Protected Forest (182,000 ha)
Colca	San Martín	05°53'40"S 77°23'15"W	1700–1900	Pre-montane cloud forest	Moderate disturbance and hunting	Not protected
Nuevo Paraiso	San Martín	05°57'44"S 76°57'16"W	1200–1500	Lowland rainforest	Highly fragmented and heavy hunting	Not protected
Gira–Sisa*	San Martin	06°17'34"S 76°54'24"W	100–1700	Pre-montane cloud forest	Moderate disturbance and hunting	Conservation Concession (*c.*3,000 ha), in process.
Paitoja	San Martín	06°21'42"S 77°04'52"W	1600–1900	Pre-montane cloud forest	Moderate disturbance and hunting	Not protected
Nuevo Halcabamba	Amazonas	04°52'59"S 78°12'24"W	200–300	Lowland rainforest	Moderate disturbance and heavy hunting	Not protected
Pachiza*	San Martín	07°14'20"S 76°53'25"W	500–1200	Lowland seasonal moist forest	Low disturbance and little hunting	Two Conservation Concessions (5,768 ha), in process
Corosha	Amazonas	05°47'43"S 77°47'12"W	2100–2500	Montane cloud forest	Minimal disturbance no hunting	Private Conservation Area (2,282 ha), awarded
Campo Redondo	Amazonas	06°13'00"S 78°19'47"W	1200–1500	Shade coffee plantations	100% altered environment	Not protected
Rio Nieva	Amazonas	05°34'31"S 77°50'54"W	1500–1900	Montane cloud forest	Moderate disturbance and hunting	Reserved Zone (36,348 ha)
Cordillera Escalera*	San Martín	06°27'45"S 76°17'23"W	900–1500	Pre-montane cloud forest	Low disturbance and little hunting	Regional Conservation Area (149,870 ha)

* Sites where surveys were carried out in more than one location; for these sites coordinates represent an area between survey locations.

key-informant interviews. We surveyed areas using existing trail systems and, when necessary, purpose-cut trails. We walked trails accompanied by local residents as guides. The cutting of new trails was kept to a minimum to limit forest disturbance. Inventory trips took between three and seven days. The location of all sites was recorded with a handheld GPS, as were points of visual, audio or incidental detection (for example, food residues showing clear bite marks). We never inferred a species' presence from bite marks without additional secondary evidence. We also collected additional data on threats to habitat in each area.

We collected secondary data on species occurrence from local informants. Species identification was made during individual and group interviews. We used photographs and drawings of the various primate species that may have been present in each area to help identification. Positive identifications were cross referenced between several informants and we asked further details of behavior, diet, and locomotion to ensure correct identification. We also collected additional information on hunting practices, forest resource use and anthropological disturbance such as deforestation, logging, burning and contamination to better assess threats and for planning of conservation initiatives.

Results

We surveyed 36 locations, totalling 213 days of field surveys. Due to their proximity, the results of 10 of them were combined, giving 26 localities in all. The habitat types visited and the presence of primate species was recorded at all sites. Fourteen species were recorded from 10 genera in eight habitat types (Table 1); 12 species were recorded by direct observation, an additional two through interviews (Table 2).

Table 2. Species records.

Survey site	Species encountered	Recorded from secondary evidence
Pucunucho	*Saguinus leucogenys*; *Callicebus oenanthe*	-
Ocol	*Aotus miconax*	*Cebus yuracus*; *Ateles* sp.; *Oreonax flavicauda*
Berlin	*Cebus yuracus*; *Aotus miconax*; *Oreonax flavicauda*	-
Shipasbamba	*Oreonax flavicauda*; *Aotus miconax*	*Cebus yuracus*; *Ateles belzebuth*
Simacache	*Cebuella pygmaea*; *Saguinus leucogenys*; *Cebus yuracus*; *Aotus nigriceps*; *Callicebus cupreus**; *Callicebus oenanthe*; *Alouatta seniculus*	*Saimiri macrodon*; *Sapajus macrocephalus*; *Aotus* sp.; *Pithecia* sp.
Monzon	*Cebus yuracus*	*Callicebus discolor*
Ajenco	-	*Cebus yuracus*; *Oreonax flavicauda*
Shunte	*Cebus yuracus*	*Callicebus discolor*; *Aotus* sp.; *Oreonax flavicauda*
Poroto	-	*Aotus* sp.; *Oreonax flavicauda*;
Alto Huayabamba	*Oreonax flavicauda*	*Cebus yuracus*; *Ateles* sp.; *Aotus* sp.
Yambrasbamba	*Cebus yuracus*; *Aotus miconax*; *Ateles belzebuth*; *Oreonax flavicauda*	*Alouatta seniculus*
Copallín	*Ateles belzebuth*; *Oreonax flavicauda*	*Cebus yuracus*; *Aotus miconax*
Venceremos	*Cebus yuracus*; *Oreonax flavicauda*	
Paujil	*Cebus yuracus*; *Aotus miconax*; *Alouatta seniculus*; *Ateles belzebuth*	*Saguinus leucogenys*; *Saimiri macrodon*
Delta	*Aotus* sp.	*Cebus yuracus*
Bosque Protección Alto Mayo	-	*Aotus* sp.; *Oreonax flavicauda*
Colca	-	*Oreonax flavicauda*
Nuevo Paraiso	*Saimiri macrodon*	*Saguinus leucogenys*; *Sapajus macrocephalus; Cacajao calvus***; *Ateles* sp.
Gira-Sisa	*Callicebus oenanthe*; *Aotus nigriceps*	*Saguinus leucogenys*; *Saimiri macrodon*; *Cebus yuracus*; *Alouatta seniculus*
Paitoja	*Oreonax flavicauda*	*Cebus yuracus*; *Aotus* sp.
Halcabamba	-	*Saguinus leucogenys*; *Saimiri macrodon*
Pachiza	*Saguinus leucogenys*; *Callicebus oenanthe*; *Aotus nigriceps*; *Alouatta seniculus*	*Saimiri macrodon*; *Cebus yuracus*; *Ateles* sp.
Corosha	*Aotus miconax*; *Oreonax flavicauda*	*Cebus yuracus*
Campo redondo	*Aotus miconax*	*Cebus yuracus*; *Ateles belzebuth*; *Oreonax flavicauda*
Río Nieva	*Aotus miconax*	*Cebus yuracus*; *Alouatta seniculus*; *Ateles belzebuth*; *Oreonax flavicauda*
Cordillera Escalera	*Saguinus leucogenys*; *Aotus* sp.	*Cebus yuracus*; *Ateles* sp.; *Oreonax flavicauda*

* Registered on south bank of the Río Huallaga. **Record from local informant

The most commonly seen in montane and pre-montane forests were *Oreonax flavicauda* and *Aotus miconax*. Both species were found in the majority of sites above 1500 m. *Oreonax flavicauda* was not found in *Podocarpus*-dominated or white-sand forests in central Amazonas, whereas *Aotus miconax* was found at all montane sites including *Podocarpus*-dominated and white-sand forests, and *Alzatea verticillata*-dominated forests in the Utcubamba valley south of Bagua Grande in Amazonas. No large species were found in the dry or semi-arid forests of the Utcubamba and Marañón valleys in Amazonas or central Huallaga Valley in San Martín. The most diverse primate assemblage was found at Simacache, an area of lowland *terra firma* forest in San Martín (Tables 1 and 2), where seven species were seen, with an additional four recorded from interviews. The least diverse (a single species) was in the Área de Conservación Privada Ocol, Amazonas; a large fragment of montane palm forest (Tables 1 and 2).

Important records of range extensions were obtained for *Cebuella pygmaea*, which was found in Simacache, about 100 km west of its previously recorded range, and crossing the Río Huallaga. Similarly, *Cacajao calvus* was recorded from interviews far from its recorded distribution, only the second record of this species this far west, in San Martín (Tello-Alvarado *et al.* 2012). Neither of these species was recorded in intervening areas. We also recorded the presence of *Aotus miconax* in Campo Redondo, Amazonas, at an elevation of 1300 m, below its expected altitudinal range. *Ateles belzebuth* and *Cebus yuracus* were commonly found at high elevations in montane cloud forest. *Ateles belzebuth* was widely distributed at sites in central Amazonas from the ACP Copallín east to Yambrasbamba and south along the border between Amazonas and San Martín. This species was reported for both high and low elevation sites but seems to be locally more common at high elevations. *Cebus yuracus* was found at the same high elevation sites as *A. belzebuth* but was also found much further to the south in Monzon, Huánuco. Of the 14 species encountered, six are categorized as threatened, either by the IUCN or under Peruvian law.

Many local informants reported that primate populations are receding farther and farther from human settlements, requiring several hours walking in order to find them. They blamed this on hunting and deforestation. Many primates have survived in fragments; we found groups of *O. flavicauda, A. miconax*, *C. oenanthe* and *S. leucogenys* surviving and reproducing in small patches, <3 ha, where small-scale logging for firewood was still practiced.

No areas we surveyed were free from current anthropogenic disturbance. At least low-level hunting was encountered at all sites except Venceremos, in the Alto Mayo Protected Forest (Table 1). Habitat disturbance was omnipresent except at Simacache (Table 1). The hunting of primates in areas we surveyed was usually for subsistence with just occasional commercial sale as bushmeat, in the local and national pet trade, or as tourist attractions. In some areas we found increasing instances of hunting as a control measure against crop raiding, particularly for *Cebus yuracus*, *Sapajus macrocephalus* and *O. flavicauda* in corn fields and fruit plantations.

In the highlands, deforestation is mainly for cattle ranching and small-scale agriculture. Hillsides are burnt to clear the area for farming or in the belief that smoke from fires promotes rainfall. Mining concessions were also abundant in the highlands. Mining is a potential threat to primates through deforestation and pollution, but the majority of concessions were still in exploratory stages, and the full extent of their impact is hard to assess. In lowland and dry-forest areas, conversion for monocultures such as oil palm, rice, cacao and exotic timber trees were the main causes of deforestation.

The majority of human populations in the areas surveyed were migrants. In many cases, movements were fuelled by land trafficking, with new settlements established up to 15-hours walk from the nearest access route. Migrants were generally impoverished and relied entirely on natural resources for subsistence. Pioneer settlers often solicited regional authorities to construct roads to connect them to the main highways. These small roads attract more migrants to the area, resulting in further loss and fragmentation of primate habitat.

The number of protected areas in the region increased considerably over the five years of the study period. Of the sites we surveyed, 14 (15 including the Alto Mayo Protected Forest – BPAM) are now afforded some level of protection (Table 1). New protected areas include one state protected area, the Río Neiva Reserved Zone, six Private Conservation Areas (ACP), and five Conservation Concessions (CC), officially awarded or in process, and one new Regional Conservation Area (ACR). Together these areas cover 553,331 ha. Nine areas are still unprotected, with only one, Campo Redondo, the site of a possible new conservation project. A further area, Gira-Sisa, is considered here as a conservation concession although officially the area is designated as a reserved zone by the regional government of San Martín. It has received no on-the-ground protection and has been invaded by farmers and loggers. Informal landscape-level conservation initiatives were also found to be common, resulting from direct promotion and conservation education efforts of NGOs and grassroots organizations. These were most commonly in the form of rural villagers controlling deforestation and the provision of protection for endangered species through local institutions.

Discussion

Peru has the sixth highest primate diversity of any country, and, correspondingly, regions with extraordinarily rich primate communities, such as Manu National Park with 13 species (Terborgh *et al.* 1984) and the Pacaya Samiria National Reserve with 12 (Neville *et al.* 1976). Overall, we recorded 14 species during our surveys in north-eastern Peru, and in one site, Simacache, we found evidence of 11. The rich primate communities we encountered are probably allied to the diversity of vegetation types in the areas between the ríos Marañón and Huallaga: *terra firma* rain forest in the lowland areas of San Martín and northern Amazonas, pre-montane

and montane cloud forests of the intervening highlands, and the unique Huallaga, Marañón and Utcubamba dry forests. Altitudes range from 200 m to over 4000 m (above the snow line). Primates were also recorded in secondary forest and timber and shade-coffee plantations.

We failed to see three species expected for the region. *Lagothrix poeppigii* is undoubtedly heavily hunted in most areas we visited (see Peres 1990; Bodmer *et al.* 1997). *Aotus nancymaae* and *Saimiri boliviensis peruviensis* have been reported for San Martín, but it appears that both are limited to the east of the Río Huallaga and south of the Río Marañón as indicated by Hershkovitz (1983, 1984) and Aquino and Encarnación (1994). In the Comunidad Campesina de Leymebamba on the border of Amazonas and San Martín, *A. belzebuth* and *A. chamek* have been reported to be sympatric, even occurring in mixed species groups (Barrio and Dignum 2003), but this may have been due to the misidentification of the darker pelage of some *A. belzebuth* populations that are confused with the black *A. chamek* (H. Dignum pers. comm.).

Human population growth in the area is among the highest in Peru (Peru, INEI 2007). The majority of migrants arrive from Cajamarca, where mining concessions occupy almost 50% of the region (calculated from Peru, MEM 2011). This has resulted in increasing land prices, social instability, and a lack of drinking water and fertile land (Bury 2007; N. Shanee 2012a). Likewise, the proliferation of large-scale monocultures in the lowlands forces migration into new areas, generally into steeper areas (S. Shanee 2011). Migrants are usually poor, and use unsuitable farming methods (Bebbington 1990; N. Shanee 2011a). Illicit coca (*Erythroxylum coca*) cultivation is also a cause of deforestation in the central and southern portions of the survey areas. Deforestation from illicit crops is augmented by the effects of the control measures (herbicides and burning) used against the production of cocaine. In some areas of San Martín and Huánuco this has become the major cause of deforestation (Young 1996; Fjeldså *et al.* 2005).

Hunting in northern Peru varies greatly between sites. Indigenous groups, which generally occupy lowland areas, hunt heavily for subsistence, while migrants generally hunt opportunistically (N. Shanee 2012b). Live animal and bushmeat trades exist mainly in the lowland areas of Amazonas and San Martín. The smaller species are often sent to the coast, but the larger, more endangered monkeys are generally kept in Amazonas and San Martín to be sold as bushmeat or as pets and tourist attractions (Pautrat 2002; Altherr 2007; N. Shanee 2012b). In many of the areas surveyed, especially the lowlands, the larger primates were relatively scarce; a common phenomenon in the Amazon (Bodmer *et al.* 1997; Chapman and Onderdonk 1998; Robinson and Bennett 2000; Peres 2001; Jerozolimski and Peres 2003). *Ateles belzebuth,* a predominantly lowland species (S. Shanee 2009), was more commonly found at high elevation sites during our surveys probably because of greater levels of habitat disturbance and hunting in the lowlands.

Peru is one of the countries facing serious challenges from climate change, with rural areas being the most vulnerable (Brooks and Adger 2003; UNFCCC 2007). Tropical montane cloud forests are considered amongst the most vulnerable to climate change of all tropical forests systems (Markham 1998; Still *et al*. 1999; Bubb *et al.* 2004). Changes in climate described by the local residents in the areas that we visited could be among the biggest threats to the primates of the Marañón-Huallaga basins. Predictions of climate change effects, some of which have already been observed by local residents that could further endanger Andean primates include: a significant up-slope shift in species and ecosystems; reduced cloud immersion by vegetation; recurring droughts and extreme rains; intensification of wildfires; and the alteration of plant phenologies, affecting reproduction of animal and plant species and consequently food availability (Bawa and Dayanandan 1998; Corlett and Lafrankie 1998; Chapman and Peres 2001; McCarty 2001; Bubb *et al.* 2004; Lenoir *et al.* 2008; Fisher 2011). The increasing effects of climate change and land degradation also increase pressure on farmers, leading to more land clearance, thus creating a positive feedback loop (Laurance and Williamson 2001; Young and Lipton 2006; N. Shanee 2012a).

Protected areas when small, few and isolated, may often contribute little to species conservation and must be complemented by strategies for management at the landscape level (Harris 1984; Newmark 1987; Margules and Pressey 2000; Ancrenaz *et al*. 2007). Private Conservation Areas (ACP) and Conservation Concessions (CC) are generally relatively small (Table 1), and therefore offer limited protection for primates, especially the larger species. Informal landscape-level conservation can, however, serve well in complementing the systems of formal protected areas by offering partial protection or having a role as buffer zones, and should be promoted throughout the north of Peru through local authorities, NGO projects and grassroots organizations.

Understanding species' distributions is a basic requirement for conservation planning. Good distribution maps are lacking for many of Peru's primate species, particularly in the eastern Andes. Existing maps of primate distributions often assume that major rivers and other geographical barriers delimit species distributions. Rivers in northern Peru mark the limits to the ranges of a number of species, for example *Callicebus oenanthe* and *C. cupreus*, but rivers are narrower in their upper reaches, reducing their effectiveness as barriers to dispersal (Ayres and Clutton-Brock 1992). In more mountainous areas, distributional limits are less defined by clear geographic features, and in many cases more complex environmental changes reflecting differences in elevation, soils, climate and floristic communities evidently form less tangible barriers, more difficult to discern. Field studies are needed to 1) define species' ranges more precisely in the eastern Peruvian Andes and 2) understand the physical, biological or ecological barriers involved. This will not only provide for more informed conservation planning for these species but will also contribute to the broader understanding of primate biogeography in general and in relation to anthropogenic environments.

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Authors' addresses:
Sam Shanee, **Noga Shanee**, Neotropical Primate Conservation, 23 Portland Road, Manchester PL32, UK, and **Néstor Allgas-Marchena**, Neotropical Primate Conservation Peru, 1187 Carretera Fernando Belaunde Terry, La Esperanza, Yambrasbamba, Peru, and Facultad de Ciencias Biológicas, Universidad Nacional Mayor de San Marcos, Av. Universitaria/ Av. Germán Amézaga s/n, Edificio Jorge Basadre, Ciudad Universitaria, Lima, Peru. *E-mail of corresponding author*: <sam@neoprimate.org>.

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