Working together towards one goal: results of the first primate census in western Ecuador

Laura Cervera[1,2,3], Stella de la Torre[4,1,2], Galo Zapata-Ríos[5,2], Felipe Alfonso-Cortés[6,1], Sara Álvarez-Solas[7,1,2,3], Olivia Crowe[4], Rubén Cueva[5], Amalia de la Torre[4,8], Irene Dutch-Latorre[4,9], María Fernanda-Solórzano[10,1,2], Nathalia Fuentes[6,1], Daniela Larriva[4], David Maila[11], David Mantilla[6], Ana Mariscal[11], Carmen Mariscal[11], Edison Molina[5], Mauricio Morales[10], Citlalli Morelos-Juárez[12,1], Viviana Narváez-Ruano[5,2], Adrián Naveda-Rodríguez[5], Jaime Palacios[5], Lucas Ramis[7], Esteban Rivera[6], Alejandro Rubio[4], Jaime Salas-Zambrano[13], Diana Sulca[10], Andrea Tapia[12], Marcela Toapanta[11], Erika Troya[4], Sylvana Urbina[6,1], Victor Utreras[10,2]., Daniel A. Velarde-Garcés[4] and Oscar A. Veloz[13]

Affiliations:

1 Grupo de Estudio de Primates del Ecuador, Quito, Ecuador
2 Asociación Ecuatoriana de Mastozoología, Quito, Ecuador
3 Asociación Española de Primatología, Girona, España
4 Universidad San Francisco de Quito, Quito, Ecuador
5 Wildlife Conservation Society - Ecuador Program, Quito, Ecuador
6 Proyecto Washu, Fundación Naturaleza y Arte, Quito, Ecuador
7 Universidad Regional Amazónica Ikiam, Tena, Ecuador
8 Instituto de Neuroetologia, Universidad Veracruzana, Mexico
9 Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Spain
10 Proyecto Paisajes - Vida Silvestre, Dirección Nacional de Biodiversidad, Ministerio del Ambiente del Ecuador, Quito, Ecuador
11 Bosque Protector Cambugán y Paso Alto, Fundación Cambugán
12 Reserva de los Monos Araña Tesoro Escondido – Fundación de Conservación Jocotoco
13 Universidad de Guayaquil, Guayaquil, Ecuador
14 Universidad Técnica Particular de Loja, Loja, Ecuador

Abstract

Effective conservation strategies need to be created based on accurate and updated data on the distribution and conservation status of the species under study. Not surprisingly,

the most diverse countries which are currently facing the greater threats, tend to be the ones with the greater lack of information. This is the case of Ecuador, where deforestation rates have been extremely severe, especially in the coastal region, where only 10% of its original forest cover is estimated to remain. Given the fact that primates rely on habitat connectivity for their survival, it is crucial to understand the impact of these threats on their populations. To obtain data on the current distribution of the four primate species known to inhabit western Ecuador, several organizations worked together to conduct the first primate census in coastal Ecuador from October 2016 to March 2017. Teams of 2-5 people walked existing trails and recorded both visual and auditory detections. Additionally, we conducted semi-structured interviews to members of local communities to complement field data. We surveyed a total of 83 locations, accumulating more than 300 km along trails, and recorded 310 independent detections. The four species known to occur in the region were detected (*Alouatta palliata*, *Ateles fusciceps*, *Cebus aequatorialis* and *Cebus capucinus*). Two additional species, *Aotus* sp. and *Saimiri* sp., were mentioned during the interviews. This project is a clear example of what can be achieved when different organizations unify their efforts towards one goal, provides the basis for future research, and suggests specific conservation actions that could improve the conservation of the primates in the area.

Introduction

Strategic conservation actions should be designed and implemented upon the basis of updated and precise data on the distribution and conservation status of wildlife species. To increase its effectiveness, efforts should focus on critically endangered species located in areas with both high biodiversity and high disturbance levels (Jack and Campos, 2012; Agostini *et al*., 2015). Western Ecuador is located in the Chocó-Darien-Western Ecuador hotspot which contains high rates of species richness and endemism (Myers *et al*., 2000),

yet accurate information on the conservation status of even well-known species is scarce (de la Torre, 2012). Deforestation has greatly affected Ecuador for decades, reaching the highest deforestation rate of South America during the period 2000-2010 (Mosandl *et al.*, 2008; Gonzalez-Jaramillo, 2016). Forest loss and fragmentation has been especially severe in the coastal region since the mid-twentieth century, where an estimated 72% of the original forest cover has been converted to other uses, and with no signs towards a decrease in deforestation rates if no actions are taken (Ecuador 2012; Sierra 2013; Gonzalez-Jaramillo, 2016). Deforestation has been caused by the conversion of forest into agricultural lands in ancient and current times (Mosandl *et al*., 2008). This conversion has been mainly promoted by the presence of fertile soils, water availability, flat and wide terrains, together with a land reform act that promoted colonization of "nonproductive" lands during the 80s (Dodson and Gentry, 1991; Sierra, 2001; Viteri-Diaz, 2007; Mosandl *et al*., 2008).

The awareness and effort applied to improve the conservation of western Ecuador habitats has increased over the last decades, yet natural disasters such as the earthquake that took place in April 2016, directly damaged the forest by landslides, and also indirectly increased the pressure on natural resources through the need of raw materials to reconstruct infrastructure, threatening more the fragile natural balance of the area. This degradation pattern has been previously shown in other countries were similar natural disasters have taken place (Viña *et al.*, 2011). In addition, mining has shown to be a threat for wildlife as it has both short and long-term effects on forest cover as it pollutes the water sources and removes the soil, affecting plant and animal populations and slowing tree regeneration (Peterson and Heemskerk 2001; Estrada *et al.* 2017; ARCOM 2017). Furthermore, mining is associated with bushmeat hunting, thus endangering even more

the survival of large mammals such as primates (Peterson and Heemskerk 2001; Estrada *et al.* 2017).

Besides the direct loss of hectares, deforestation also has an indirect effect on the fauna of the region as it modifies the structure and function of the ecosystem (Gouveia *et al*., 2015; Rocha-Santos *et al*., 2016). Primates rely on habitat connectivity for locomotion, feeding, and dispersal (Benchimol and Peres, 2014; da Silva, 2015), being highly affected by habitat loss and fragmentation, which can eventually lead to isolation and local extinction (Hilario *et al*., 2017). Hunting by members of local communities for both subsistence and profit by selling its meat, has also had a direct effect on the primate populations inhabiting Ecuador, especially for the ones with higher body mass, such as *Ateles fusciceps*, greatly diminishing their populations and threatening the species with extinction (Tirira, 2011).

The most recent assessment of the conservation status of primates, reported that 36% of all Neotropical primate species are threatened with extinction due to the impact of human activities (Estrada *et al*., 2017). Despite this threat, the Neotropics are the least studied region when comparing published articles (from 1965 to 2016) on individual primate species. Only about 16% of the studies carried out in the last 51 years focus on Neotropical monkeys, in contrast to 36% focusing on African primates, and 48% on Asian primates (Estrada *et al*., 2017). This data highlights the need to generate accurate information of Neotropical primate species to better understand their current situation.

There are currently 21 primate taxa (22 if we take into account *Pithecia aequatorialis*) inhabiting Ecuador (Tirira, 2017), four of which can be found west of the Andes (*Cebus aequatorialis*, *Cebus capucinus*, *Allouata palliata* and *Ateles fusciceps*) (de la Torre, 2012), considered to be four of the six most threatened primate species in Ecuador (Cervera *et al.*, 2017). Although there is a lack of information regarding the ecology and

conservation status of the primates inhabiting coastal Ecuador, the fact that two taxa listed as Critically Endangered by IUCN (*Cebus aequatorialis* and *Ateles fusciceps*) can only be found in this region indicates the impact of anthropogenic activities and the importance of preserving the remaining forests in the region. In fact, *Ateles fusciceps* is now considered to be amongst the 25 most endangered primate species worldwide (Schwitzer *et al.* 2017). Until now, most primatological studies in western Ecuador have been species specific, following different methodologies, difficulting a reliable comparison of the results and the assessment of the real status of the species is a difficult task (Peck *et al*., 2011; Arcos *et al*., 2013; Mata *et al*., 2015; Cervera and Griffith 2016; Hurtado *et al*., 2016; Morelos-Juarez 2016).

In an effort to overcome these difficulties, public and private organizations including the Ministry of Environment of Ecuador, got together to conduct the first primate census in western Ecuador using a standardized methodology to obtain updated information on the distribution and demography of the primate species in the region. This effort resulted in a baseline for population monitoring, inputs for designing conservation actions and the identification of potential areas for protection.

Methods

The primate surveys were conducted in protected and non-protected areas along western Ecuador (Figure 1). Western Ecuador has an area of approximately 80 000 km^2, and is limited by the Pacific Ocean to the west and the Andean mountain range to the east. Field work was conducted from October 2016 to March 2017 by a group of researchers, students and local guides who were previously trained on survey techniques, directly or with the use of a video we created beforehand (https://vimeo.com/163574453). To ensure the correct identification of the different species, we provided pictures highlighting the distinctive morphological characteristics of each species as well as differences between

sexes and age classes for demography description purposes. Additionally, we included pictures of other species that have been reported as present in the coastal region by local people, but that have not been officially recorded yet, such as the squirrel monkey (*Saimiri* sp.) and night monkey (*Aotus* sp.).

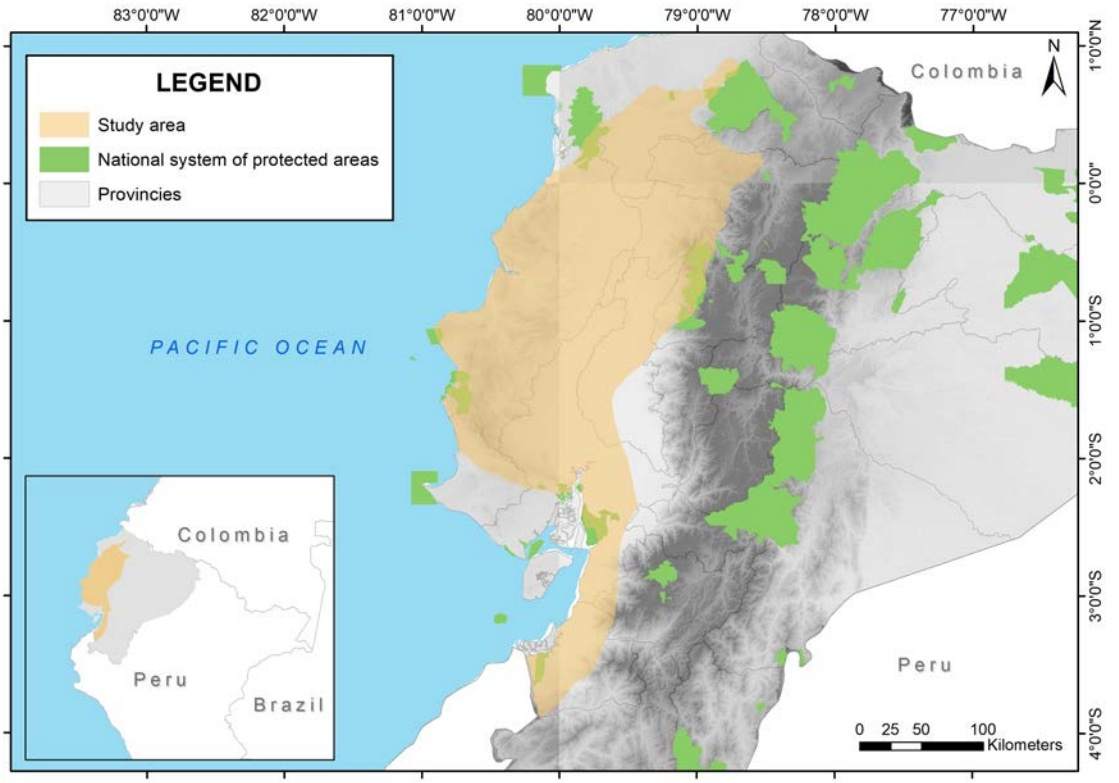

Figure 1. Study area covered during this study (October 2016 – March 2017) in western Ecuador.

Considering the ecological differences of the four species under study, the variety of conditions in each area, and the resources required to cover such an extended region, we decided to apply a methodology that would generate reliable data at a minimum cost. Teams of 2-5 observers walked existing trails to minimize the impact of our presence on the habitat. Considering the time primates are most active in the forest, surveys were carried out during the morning (06:30-11:00) and the afternoon (15:30-17:30) (Agostini *et al*., 2012). Trails walked in the morning session were avoided in the afternoon session. We recorded the track of every trail with a GPS, and every time we visually detected a

group, we recorded the time, GPS coordinates, species, the number of individuals, and group composition (Peres, 1999; Nekaris and Jayewardene, 2004; Campbell *et al*., 2016). We also recorded primate vocalization data of the groups that could not be visually detected. Researchers walked the trails at an average speed of 1km/hr. Given that we were not aiming to estimate population density, but rather to gather the maximum amount of presence/absence data, the choice of survey localities was assisted by accounts of previous reports of the species in published and unpublished reports, and also taking into account reports of local people in specific areas (e.g.: Gavilanez-Endara, 2006; Baird, 2007; Cueva, 2008; Estévez-Noboa, 2009; Cueva and Pozo, 2010; Peck *et al*., 2011; Jack and Campos, 2012; Tapia-Arboleda, 2014; Cervera *et al*., 2015; Cervera and Griffith, 2016). Furthermore, all terrestrial areas of the national system of protected areas within western Ecuador were included in the surveys.

In addition to the data registered in the field, we conducted semi-structured interviews to members of the local communities close to the survey points. To assess respondents' ability to distinguish between the different species, we asked them to morphologically describe the species they mentioned. Information on how many species did they know to occur in the area as well as the frequency in which they saw them was also gathered. In order to assess the perception of the different local communities towards the conservation of primates, we asked them which was the main use of the species in the area (being ecotourism, food, pet, non-eatable and no use the options given).

Results

In total, we visited 83 localities in 13 provinces (53 inside protected areas – public and private – and 22 non-protected areas). When unifying all visited localities, the resulting area was larger than 60 000 km^2 and we accumulated 312 km of survey effort in 1305

working hours. We registered a total of 310 independent encounters (including visual detections and vocalizations), 154 (49%) of which were detected inside protected areas and 156 (51%) outside. The four primate species previously known to occur in the coastal region were confirmed, and reports of two additional species (squirrel monkey and night monkey) were mentioned in interviews. *Alouatta palliata* was the most frequently detected and widely distributed species with 209 records (73 visual and 136 auditory), followed by *Ateles fusciceps fusciceps* with 34 encounters (25 visual and 9 auditory). We registered *Cebus aequatorialis* 13 times (10 visual and 3 auditory). *Cebus capucinus* was the least frequent species with only 5 records (4 visual and 1 auditory).

Mean group size and group composition varied among species, with *Cebus capucinus* forming the biggest groups, and the brown-headed spider monkey forming the smallest ones (Table 1).

	A. palliata		*A. fusciceps*		*C. aequatorialis*		*C. capucinus*	
	S±Std	*n*	S±Std	*n*	S±Std	*n*	S±Std	*n*
Group size	6±4.8	72	4.6±4.2	25	9.4±5.7	11	10.5±4.5	4
Males	2.1±2.2	52	2.2±1.6	14	3.3±2.3	7	3.3±3.2	3
Females	3.2±2.7	62	2.5±2.2	21	2.3±1.7	9	3.7±2.1	3
Juveniles	2±1.5	27	1.5±0.7	10	3.3±2	8	1.5±0.7	2
Infants	1.5±1	28	1±0	8	1±0	5	2	1
Male:Female	1.5		1.1		0.7		1.1	
Female:imm	1.1		1		1.9		0.9	

Table 1. Average (S) group size and group composition with standard deviation (Std.) and sample size (n) in the four primate species found during the census in western Ecuador.

We conducted 227 interviews to members of local communities around survey points. Ninety percent of respondents confirmed at least one primate species was present in the area, and 83% of them confirmed seeing monkeys in the last six months. Most localities (76%) presented between two or three species of primates. When inquiring the members of the local communities about the main use of primates in their area, most did not identify any specific use. Nevertheless, this answer was more frequent in non-protected areas

compared to protected areas (Figure 2). Respondents showed a higher tendency to consider ecotourism as a use primates provided the community in protected areas (32.6%) compared to unprotected ones (14.1%). Although in a lower percentage, primates were considered as food and pets both inside and outside of protected areas (Figure 2).

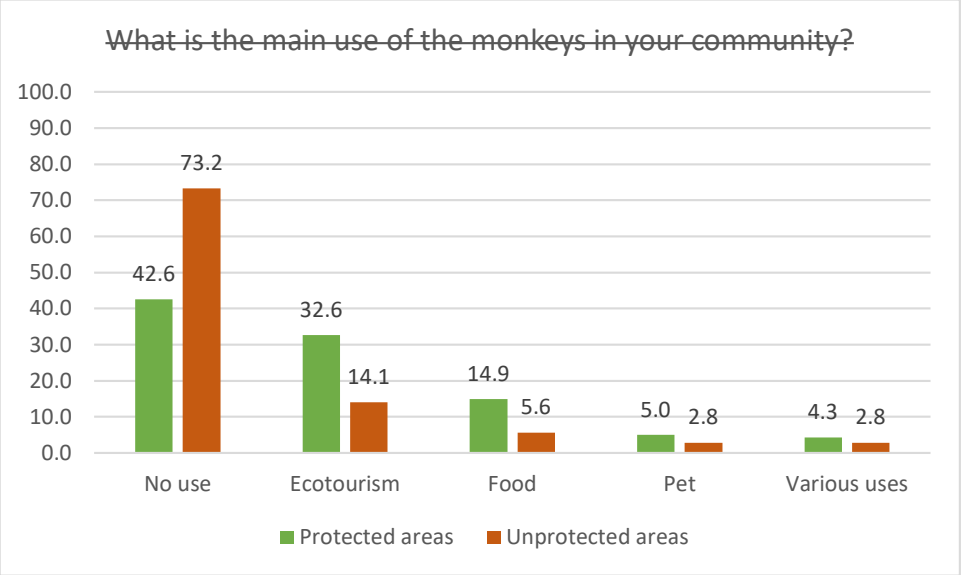

Figure 2. Results of the question regarding the use of primates in local communities.

Discussion

Considering the current situation of the primates of western Ecuador, the results of this study represent the first effort to obtain updated information using a standardized methodology in such a large area. This study allows for a reliable comparison of the results among four of the six most threatened primate species of Ecuador. The two species of the genus *Cebus* presented the biggest group size, with *C. aequatorialis* forming slightly smaller groups than the average reported by Jack and Campos (2012), which can be explained by the difference in the number of encounters (11 in this study *vs.* 115 in Jack and Campos, 2012). In the case of *A. palliata*, group size is also in the lower range reported by other studies in western Ecuador (Cervera *et al.*, 2015). *Ateles fusciecps*

fusciceps formed the smallest groups, aligning with the results obtained in the Flavio Alfaro region (Cervera and Griffith, 2016).

Given the short amount of time spent in each locality, the probability of encountering all the species present in any given area was low, yet we were able to cover a large number of sites providing useful data, allowing us to confirm and expand the known distribution of the species. The mantled howler monkey was detected in almost all visited localities, presenting the widest distribution of all four species (Figure 3A). We were also able to record the brown-headed spider monkeys in the recently described population in Flavio Alfaro (Cervera and Griffith, 2016) and reported this species in sites in Esmeraldas province, in the north of the country (Figure 3B). We recorded the white-fronted capuchin monkey north of the Guayllabamba river, which represents an extension of the range previously reported for this species (Tirira, 2017) (Figure 3C). Although the linear distance between this sighting and the northernmost point of its previously known distribution is small, the importance resides in the fact of recording the species north of what was thought a geographical barrier. This finding creates the need to conduct further research to stablish the new geographical border and explore the potential sympatry between *Cebus capucinus* and *Cebus aequatroialis*. *Cebus capucinus* presented the most restricted distribution in the north of the province of Esmeraldas (Figure 3D) with very few detections, highlighting the need to conduct further studies on this species to assess its conservation status and define which conservation actions need to be prioritized.

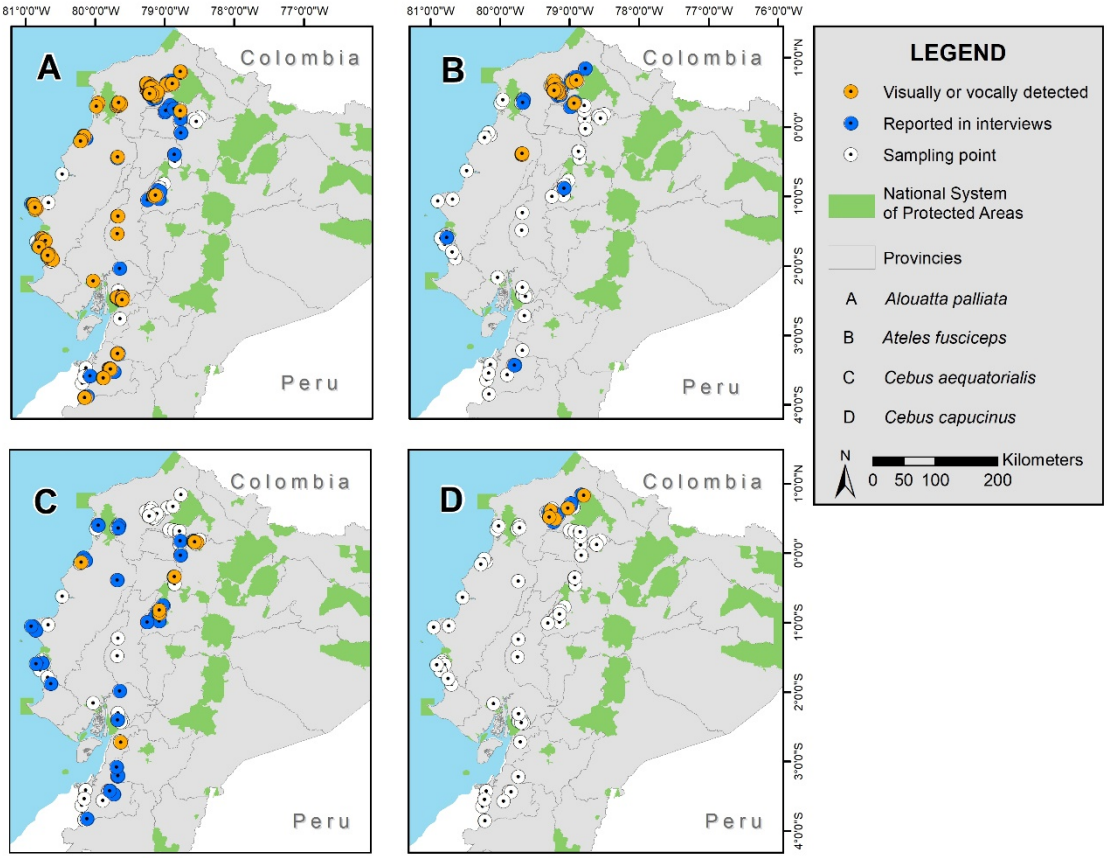

Figure 3. Location of surveys during the census (in white) with confirmed visual or auditory presence (in orange) and species reported in interviews (in blue) for the four officially reported species (A-D).

When analyzing the reported distributions of the species (Figure 3A-D), it is evident that there are areas in the north of the country, province of Esmeraldas, where three of the four species are present in areas outside the national system of protected areas. Equally important, in the province of Manabí, the Flavio Alfaro region also registered the presence of three primate species, two of which are critically endangered: the brown-headed spider monkey and the Ecuadorian white fronted capuchin. Both areas should be surveyed more exhaustively in future censuses, and eventually have a legal protection status promoting a proper landscape management in order to ensure the survival of both species.

Despite current threats in the coastal region (including deforestation, mining and expansion of the agricultural frontier), only 15% of its terrestrial area is officially protected under the national system of protected areas, compared with a 26% of the

Amazon region. The results generated in this study should be used to identify key areas that demand an official protected status to ensure the survival of the most vulnerable species, such as the critically endangered brown-headed spider monkey and the white-fronted capuchin monkey. The severe habitat loss and fragmentation western Ecuador has suffered makes preserving the remaining patches of old-growth forest, and establishing functional corridors between those remnants, a priority to ensure the natural dispersion and survival of primate populations. Additionally, monitoring primate populations should be part of the activities conducted in all protected areas in Ecuador to evaluate potential negative changes in population trends (Plumptree and Cox, 2006). An example of the applicability of the results of this study is the vulnerability analysis we conducted to identify which factors are having the greater impact on the persistence of *Alouatta palliata* (Dutch et al., 2018).

Local knowledge has proven to be a key tool complementing field data (Starr *et al*., 2011), and also provides new information on otherwise unknown locations of primate populations. In our study, the results obtained from the interviews were crucial to confirm the presence of all species in areas where researchers could not detect them due to time constraints. Independent respondents in more than one location reported on the presence of the squirrel monkey and night monkey, yet these reports should be taken with caution, as arboreal species such as the olingo (*Bassaricyon gabbii*) and kinkajou (*Potos flavius*) have been previously mistaken with night monkeys in the past. Nevertheless, we firmly believe local knowledge is of great importance, and will provide the basis for future surveys where species reported in the interviews were not detected in the surveys. We intend to carry out these surveys each year using the results of the previous year to identify the locations where more effort is required. In the mid-to-long term, we expect resulting

data will allow us to assess the conservation status and resilience of the different species to anthropogenic disturbance.

This first primate census is an example of what can be achieved when the Ministry of Environment of Ecuador, universities and NGO's work together towards one goal: obtaining information on the primate species of western Ecuador. The use of a standardized methodology was a key factor to optimize economical, logistical and human efforts to cover a large area. We believe this approach should be considered when developing new surveys in other regions in the country and elsewhere, to facilitate the comparison of results and the design of effective conservation actions.

Only if conservation action plans are based on updated distribution data, will we be able to identify current key areas where conservation actions need to be implemented. Our proposal of protecting new areas in the north of the province of Esmeraldas and in the province of Manabí is the direct application of the information generated in this census. Considering the fast rate of habitat destruction that the four primate species are facing, it is crucial to take immediate action to ensure the conservation of the species inhabiting western Ecuador. Programs focusing on controlling illegal activities inside protected areas need to be implemented to decrease selective logging and hunting. Additionally, involving members of the local communities in primate participatory monitoring and increasing environmental education, could have a direct effect on people's perceptions, and potentially improving primate conservation.

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