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Working Together Towards One Goal: Results of the First Primate Census in Western Ecuador

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Abstract: Effective conservation strategies need to be created based on accurate and updated data on the distribution and conservation status of the species of concern. Not surprisingly, the most diverse countries which are currently facing the greater threats, tend to be those with the greatest lack of information. This is the case for Ecuador, where deforestation rates have been extremely severe, especially in the coastal region, where less than 10% of its original forest cover remains. Given the fact that primates rely on habitat connectivity for their survival, it is crucial to understand the impact of threats to their populations. To obtain data on the current distribution of the four primates 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. We also conducted semi-structured interviews to members of local communities to complement field data. We surveyed 83 locations, and recorded 260 independent detections, along more than 300 km of trails, The four species known to occur in the region were detected: the Ecuadorian mantled howler *Alouatta palliata aequatorialis*; the Brown-headed Spider Monkey *Ateles fusciceps*; the Ecuadorian White-fronted Capuchin *Cebus aequatorialis*, and the Colombian White-faced Capuchin *Cebus capucinus capucinus*. Two other 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 a single goal that provides the basis for future research, and suggests specific conservation measures to improve the conservation status of the primates.

Key words: Collaborative work, conservation, endangered, hotspot, survey, threats

Introduction

Strategic conservation actions should be designed and implemented on the basis of updated and precise data on the distribution and conservation status of wildlife species. To increase their effectiveness, efforts should focus on critically endangered species in areas with both high biodiversity and high disturbance (Jack and Campos 2012; Agostini *et al.* 2015). Western Ecuador is part of the Chocó-Darien-Western Ecuador Hotspot, a region that is species rich with numerous endemics (Myers *et al.* 2000; Mittermeier and Rylands 2017) but amongst the most threatened tropical forests on Earth (WWF 2015). Information on the conservation status of even well-known species is scarce (de la Torre 2012). Deforestation for agriculture is the principal threat (Mosandl *et al.* 2008) due to the fertile soils, availability of water, and suitable topography. A land reform act promoted the colonization of "non-productive" lands during the 1980s (Dodson and Gentry 1991; Sierra 2001; Viteri-Diaz 2007; Mosandl *et al.* 2008). Deforestation has greatly affected Ecuador for decades, and from 2000-2010 the country suffered the highest deforestation rate in South America (Mosandl *et al.* 2008; Gonzalez-Jaramillo 2016). Forest loss and fragmentation have been especially severe in the coastal region since the mid-twentieth century, where an estimated 72% of the original forest cover has been converted for other uses, and there are no indications that deforestation will be curbed in the near future (Ecuador 2012; Sierra 2013; Gonzalez-Jaramillo 2016).

Awareness of the problem and efforts to conserve the forests of western Ecuador have, however, increased over the last decades. Natural disasters such as the earthquake of April 2016 caused widespread damage to the forests because of landslides, and besides increased the pressure on natural resources through the need for raw materials to rebuild infrastructure, threatening even more the fragile natural balance of the area. This pattern of forest loss and degradation has been previously shown in other countries where similar natural disasters have taken place (Viña *et al.* 2011). Mining is also a threat for wildlife as it has both short- and long-term effects on forest cover by polluting water sources and removing the soil, affecting plant and animal populations and slowing tree regeneration (Peterson and Heemskerk 2001; Estrada *et al.* 2017; ARCOM 2017). Mining is associated with bushmeat hunting, endangering further the survival of large mammals such as primates (Peterson and Heemskerk 2001; Estrada *et al.* 2017).

Besides direct loss, deforestation has an indirect effect on the fauna as it modifies the structure and functions of the ecosystems (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), and are severely affected by habitat loss and fragmentation to the extent that they lead to isolation and local extinctions (Hilário *et al.* 2017). Hunting for both subsistence and profit directly impacts primate populations in Ecuador, especially of the larger species, such as the Ecuadorian brown-headed spider monkey *Ateles fusciceps* (see Tirira 2011).

The most recent assessment of the conservation status of the Neotropical primates, reported that 36% of the species are threatened due to human activities (Estrada *et al.* 2017). Despite this, the Neotropics is the region least studied 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 have focused on Neotropical primates, in contrast to 36% focusing on African primates, and 48% on Asian primates (Estrada *et al.* 2017). These numbers highlight the need for accurate information on Neotropical primate species and subspecies to better understand their current situation.

There are currently 21 primate species and subspecies in Ecuador (22 if we take into account the equatorial saki *Pithecia aequatorialis*) (Tirira 2017). Four of them occur west of the Andes (Ecuadorian White-fronted Capuchin *Cebus aequatorialis*, Colombian White-faced Capuchin *Cebus capucinus capucinus*, Ecuadorian Mantled Howler *Alouatta palliata aequatorialis*, and the Brown-headed Spider Monkey *Ateles fusciceps*) (de la Torre 2012), and are among the six most threatened in Ecuador (Cervera *et al.* 2017). Two that are endemic to the region, *Cebus aequatorialis* and *Ateles fusciceps*, are Critically Endangered, and *A. fusciceps* is one of the 25 most endangered primate species worldwide (Schwitzer *et al.* 2017), emphasizing the importance of preserving the remaining forests there. Although there have been some studies pertinent to our understanding of the threats and population status of these primates, differing methodologies make it difficult to make comparisons, over time or between populations (for example, 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, and provided inputs for designing conservation actions, including the identification of potential areas for protection.

Methods

The primate surveys were conducted in protected and unprotected areas along western Ecuador (Fig. 1). Western Ecuador has an area of approximately 80,000 km^2, and is limited by the Pacific Ocean to the west and the Andes to the east. Field work was conducted from October 2016 to March 2017 by a group of researchers, students and local guides who had been previously trained in survey techniques, directly or with the use of a video that we created (<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

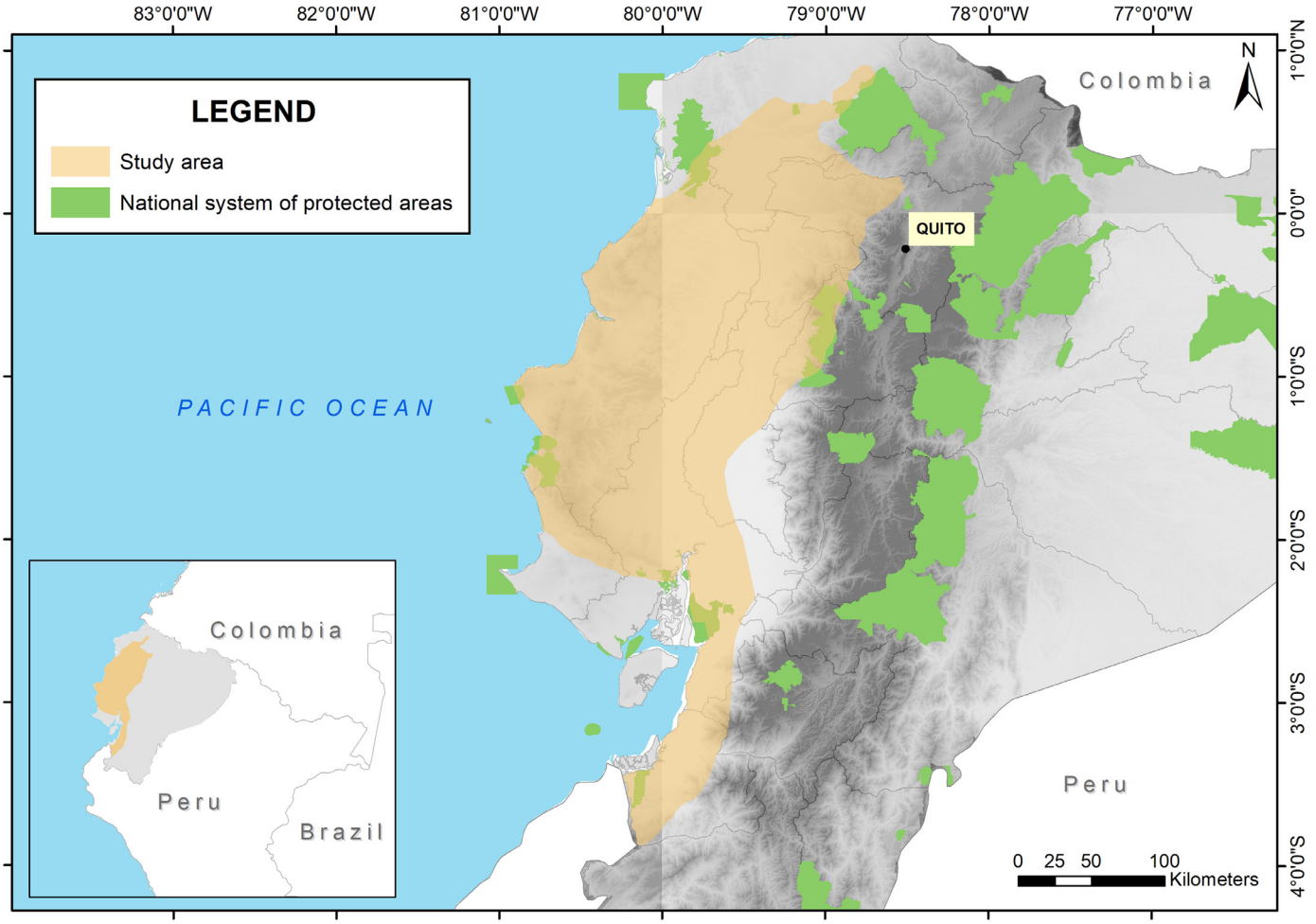

Figure 1. Area covered during this study (October 2016 – March 2017) in western Ecuador.

as differences between sexes and age classes for demography description purposes. We included pictures of other species that have been reported as present in the coastal region by local people, but to date not been officially recorded there—the squirrel monkey (*Saimiri* sp.) and night monkey (*Aotus* sp.).

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. Surveys were carried out in the morning (06:30–11:00) and afternoon (15:30–17:30) (Agostini *et al.* 2012). Trails walked in the morning session were avoided in the afternoon session. We mapped each trail with a GPS, and every time we saw 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 registered calls of groups that we were unable to see. Researchers walked the trails at an average speed of 1 km/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 we also took into account reports of local people in specific areas (for example, 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). We surveyed all terrestrial protected areas of the national system.

In addition to the data registered in the field, we conducted semi-structured interviews with members of the local communities close to the survey points. To assess the respondents' ability to distinguish between the different species, we asked them to describe the species they mentioned. Information on how many species they knew to occur in the area as well as the frequency with which they saw them was also obtained. In order to assess the local communities' perceptions about conserving wildlife and primates, we asked them which were the main uses of the species in the area (ecotourism, as food, or as pets, or "no use").

Results

We visited 83 localities in 13 provinces (55 localities in public and private protected areas and 28 in unprotected areas). When combining all localities visited, the resulting area covered was estimated to be 60,000 km^2, with 312 km

Table 1. Average (Mean) group size and group composition with standard deviation (SD) and sample size (n) in the four primate species found during the census in western Ecuador from October 2016 to March 2017.

	A. palliata		***A. fusciceps***		***C. aequatorialis***		***C. capucinus***	
	Mean±SD	n	Mean±SD	n	Mean±SD	n	Mean±SD	N
Group size	6±4.8	72	4.6±4.2	25	9.4±5.7	10	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:Immature	1.1		1		1.9		0.9	

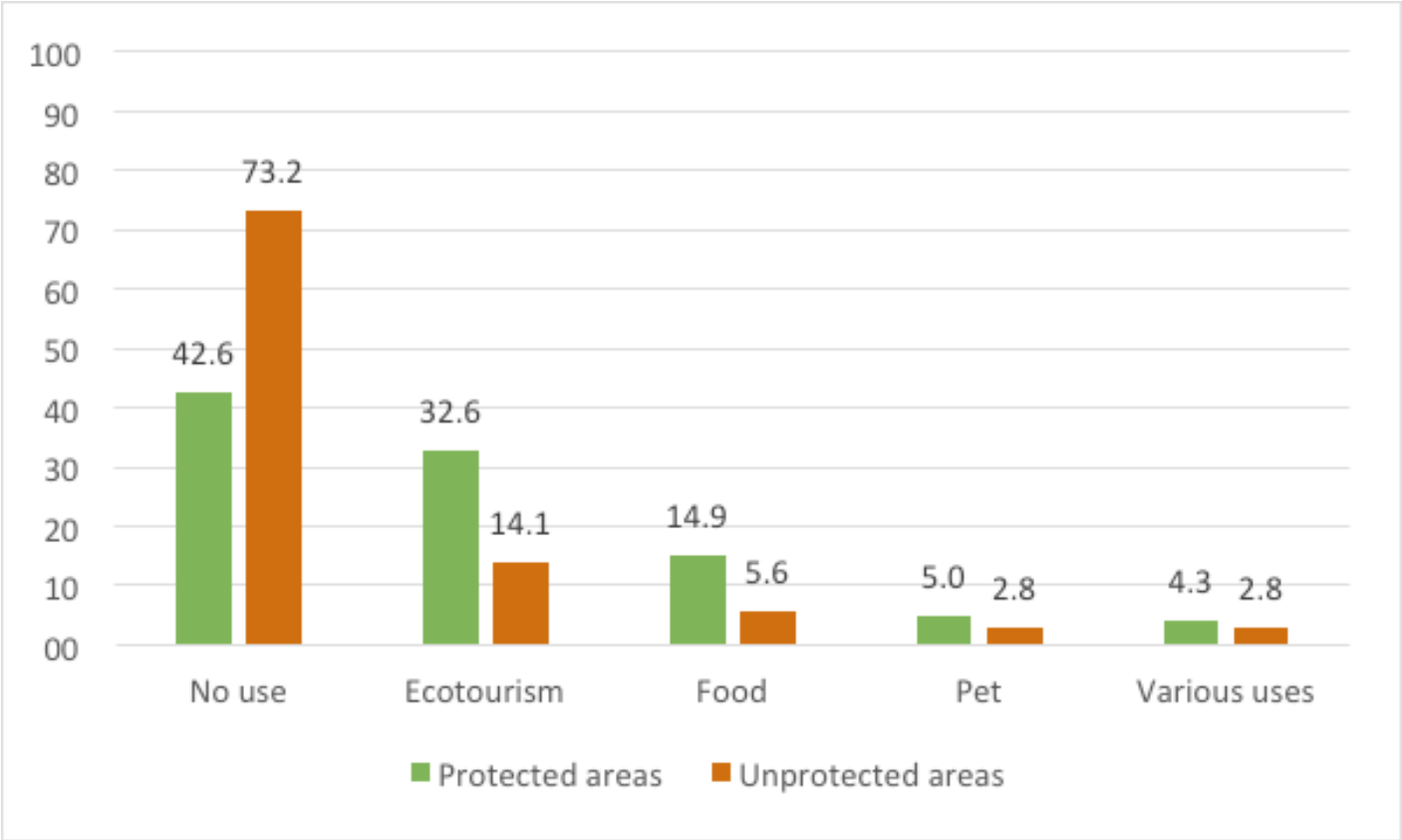

Figure 2. Results of the question regarding the use of primates in local communities according to the interviews conducted in western Ecuador from October 2016 to March 2017 (n = 227).western Ecuador from October 2016 to March 2017.

of survey effort in 1,305 survey hours. We registered a total of 260 independent encounters (including visual detections and vocalizations), 127 (49%) of which were inside protected areas and 133 (51%) outside. The four primates 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 most widely distributed species with 208 records (72 visual and 136 auditory), followed by *A. fusciceps* with 34 encounters (25 visual and nine auditory). We registered *C. aequatorialis* 13 times (10 visual and three auditory), and *C. capucinus* was the least frequently recorded with only five records (four visual and one auditory).

Mean group size and group composition varied among species: the largest mean group size was recorded for *C. capucinus*, and the smallest mean group size was recorded for *A. fusciceps* (Table 1). The results presented in the following table should be taken with caution, due to the wide variation in the data. The number of males recorded in *A. palliata* groups, for example, ranged from 1 to 11, and thus the standard deviation was greater than the average.

We conducted 227 interviews of members of local communities around the locations we surveyed. Ninety percent of the respondents confirmed that at least one primate species was present in the area, and 83% of them reported seeing monkeys within the last six months. Two or three species

of primates were reported for 76% of the localities. When enquiring about the main use of primates in their area, most did not identify anything specific. This answer of "no-use" was more frequent, however, in unprotected areas compared to protected areas (Fig. 2). Respondents were more likely to report ecotourism as the main use of primates in protected areas (32.6%) compared to unprotected ones (14.1%). To a lesser extent, primates were considered as food and or as pets both inside and outside of protected areas (Fig. 2).

Discussion

The results of this study are the first effort to obtain updated information on the current distribution and demographics of primates in western Ecuador, applying a standardized methodology over a large area. This study allows for a reliable comparison of the results for four of the six most threatened primates of Ecuador. The two species of the genus *Cebus* had the largest group sizes, 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 in other studies in western Ecuador (for example, Cervera *et al.* 2015). *Ateles fusciceps* had the smallest mean group size. Group sizes reported for this species may reflect its fission-fusion social system (Aureli *et al.* 2008). Solitary individuals were recorded for this species and *A. palliata*.

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, allowing us to confirm and expand the known distribution of the species. *Alouatta palliata* was detected in almost all localities visited, presenting the widest distribution of all four species (Fig. 3A). We were also able to record *A. fusciceps* 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 (Fig. 3B). We recorded *C. aequatorialis* north of the Río Guayllabamba, which extends the range previously reported for this species (Tirira 2017) (Fig. 3C). Although the linear distance

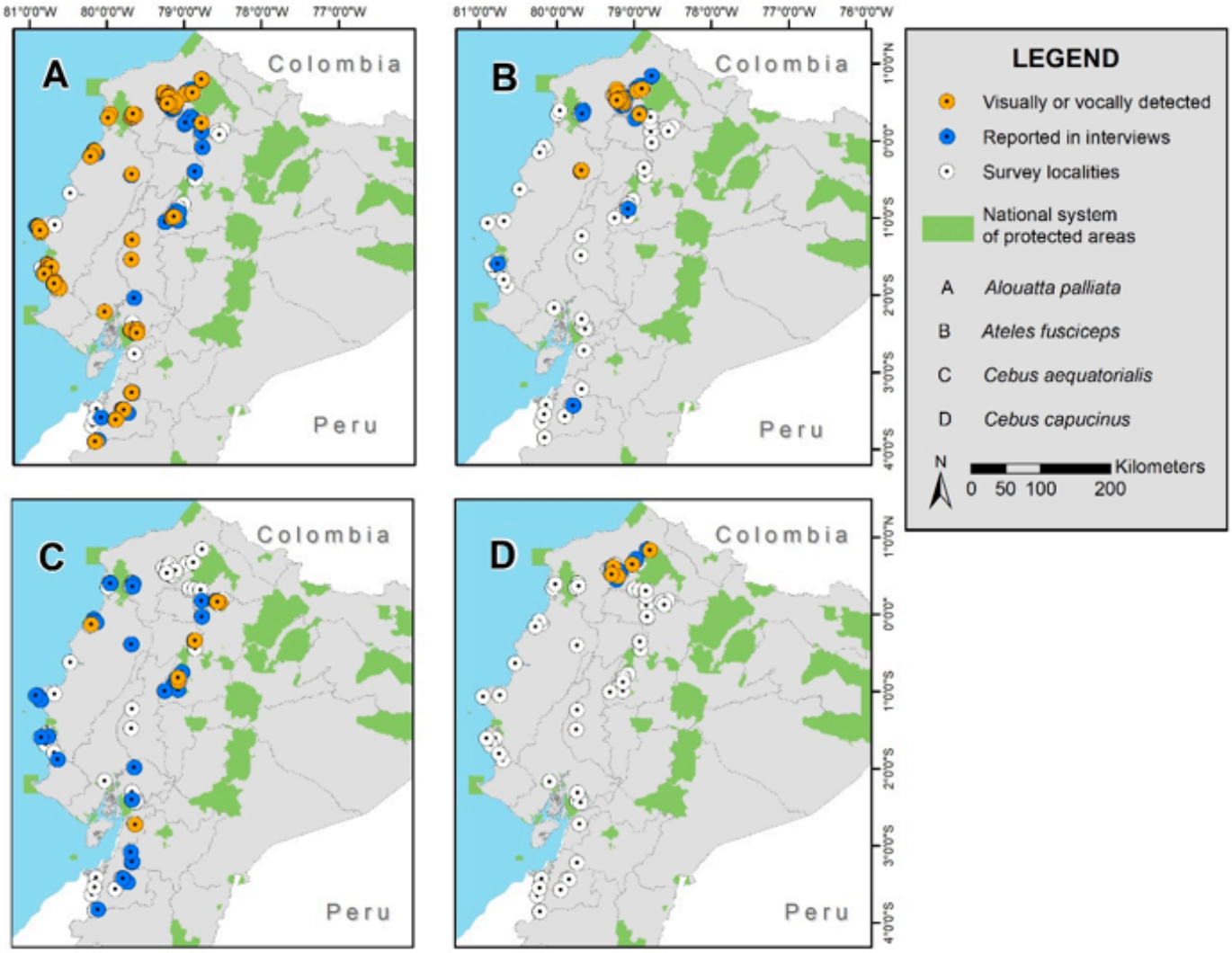

Figure 3. Location of surveys during the census (in white) with confirmed visual or auditory presence (in orange) and species reported in interviews (in blue) for the four officially reported species (A-D). (October 2016 to March 2017, N = 83 surveys, 227 interviews).

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 to be a geographical barrier for this species. This finding points to the need to conduct further research to establish the new geographical boundary of its distribution and to explore the potential sympatry between this species and *C. capucinus*. *Cebus capucinus* had the most restricted distribution, in the north of the province of Esmeraldas (Fig. 3D), with very few detections, highlighting the need to conduct further studies on this species to assess its conservation status and define the conservation actions needed.

Analyzing the reported distributions of the species (Fig. 3 A-D), it is evident that there are areas in the north of the country, in the province of Esmeraldas, where three of the four species are present. These areas are currently not included in 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: *A. fusciceps* and *C. aequatorialis*. Both areas should be surveyed more exhaustively in future censuses. Protected areas should be created for 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 area is officially protected under the national system of protected areas, compared with 26% in 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 *A. fusciceps* and *C. aequatorialis*. The widespread habitat loss and fragmentation that western Ecuador has suffered makes preserving the remaining patches of old-growth forest, and establishing functional corridors between those remnants, a major priority to ensure the natural dispersal and the viability of the primate populations there. Monitoring primate populations should be part of the activities conducted in all protected areas in Ecuador to evaluate potential population declines (Plumptre 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 most impact on *A. palliata* (Duch-Latoree *et al.* 2018).

Local knowledge has proven to be a key tool complementing field data (Starr *et al.* 2011) and 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 the presence of squirrel monkeys and night monkeys, although reports of the latter should be taken with caution, as arboreal species such as the olingo (*Bassaricyon gabbii*) and kinkajou (*Potos flavius*) can easily be mistaken with night monkeys. Conservation efforts should focus on conservation education programs to increase knowledge and awareness of the plight of Endangered primates, and eventually to ensure the veracity and validity of local knowledge (Feilen *et al.* 2018). Nevertheless, we firmly believe that local knowledge (particularly of hunters and ex-hunters) is of great importance and can 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 economic, 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 measures are needed. 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 rapid habitat destruction that the four primate species are facing, it is crucial to take immediate actions to ensure their survival in 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 the people's perceptions, and potentially improve primate conservation.

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