COMPARING TRADITIONAL ECOLOGICAL KNOWLEDGE AND SCIENTIFIC CENSUS DATA ON PRIMATE POPULATIONS IN THE SUCUSARI COMMUNITY, PERUVIAN AMAZON

by

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DEDICATION

This is dedicated to my loving mother, for her unconditional support and for being my greatest source of inspiration, also to my father and my siblings for always being there for me even at a distance. And I would like to dedicate this to my cousin Natalia for her support throughout my program. Last but not the least, this work is dedicated to each individual of the community of Sucusari, especially to all those whom I had the opportunity to work closely, Sebastián, Victorino, Samuel, Celia, Victoria, Manuela, Jairo, Marina, and many more. Their generosity, charisma, commitment and eagerness to contribute are some of the main reasons why I truly believe that conservation work is not just a matter of saving species, but it is also about the people who inhabit the most beautiful places on Earth.

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ABSTRACT

COMPARING TRADITIONAL ECOLOGICAL KNOWLEDGE AND SCIENTIFIC CENSUS DATA ON PRIMATE POPULATIONS IN THE SUCUSARI COMMUNITY, PERUVIAN AMAZON

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Similar to other ecosystems around the world, the Amazon rainforest is threatened by a wide variety of anthropogenic activities. The urgent need for conservation often requires arduous, long, and expensive fieldwork. Primates are one of the species most affected by human activities within tropical rainforests mainly due to habitat degradation and hunting pressure. Indigenous people possess valuable knowledge obtained through experience with the environment and passed down through generations, known as traditional ecological knowledge (TEK). The aim of this study was to compare the TEK of the community of Sucusari in the Peruvian Amazon to scientific primate census data, ultimately determining if TEK can be used to help enhance or even replace high cost conservation surveys of primates. Primate diversity, group size, and habitat use of all primate species found during field surveys were compared with data obtained through 50 semi-structured interviews. Transects were performed on a parallel trail system (22 trails that are approximately 4 km each) located within the Sucusari River basin. The results

suggest that the reliability of TEK compared to scientific data improves with larger-sized and culturally important primates. In conclusion, TEK is an important tool to enhance high-cost and time-intensive scientific sampling methods**,** especially for large-bodied primate populations and those significant to local cultural traditions. It should be used cautiously and target local community experts.

INTRODUCTION

The Amazon rainforest is one of the most biodiverse areas in the world (Mittermeier *et al.* 1998), and it is being threatened from a range of anthropogenic activities (Laurance and Williamson, 2001; Fearnside, 2002; Peres and Lake, 2003; Nepstad *et al.* 2006; Finer *et al.* 2008; Swenson *et al.* 2011). Mammals are one of the focal groups in biodiversity monitoring programs mainly due to their vulnerability to human-threats, their importance as a food source for many local and indigenous communities (Cormier, 2006), and their role in forest dynamics (Stoner *et al.* 2007).

Low abundances or densities of several mammal species and financial constraints limit monitoring techniques to collect data on this taxon. Several studies suggest high sampling effort and a combination of monitoring techniques to maximize the efficiency of monitoring programs (Witmer, 2005; Munari *et al.* 2011). Consequently, obtaining high quality data requires time, high costs and well-trained researchers.

Among terrestrial mammals, primates are difficult to study due to their mobility, agility, and the fact that they are mostly arboreal species. Additionally, primates are one of the taxonomic groups that is most affected by human activities within the tropical rainforest mainly due to habitat degradation and hunting pressures (Mittermeier, 1987; Peres, 1990; Cowlishaw and Dunbar, 2000; Chapman and Peres, 2001; Pinto *et al.* 2009). Given their fundamental role in tropical rainforests as seed dispersers, primate conservation is critical to rainforest regeneration (Bourliere, 1985; Stevenson, 2000; Andresen, 2002; Wehncke *et al.* 2003). Furthermore, the study of the social organization, group size, abundance and habitat preference of this taxonomic group are essential parameters in ecology and conservation. However, the estimation of these parameters requires fieldwork over long periods, and extensive funding in order to get a clear understanding of what it is happening with primates in their habitat and within their populations (Nash, 1983; Pinto *et al*. 2013).

Nevertheless, indigenous communities can play an essential role in this process, especially when working in threatened and poorly, or non-surveyed, biologically diverse tropical habitats. Indigenous people can provide relevant information regarding their local fauna and flora for biodiversity conservation and management (Gilchrist *et al.* 2005; Fraser *et al.* 2006; Anadón *et al.* 2009; Gilmore *et al*. 2013; Cámara-Leret *et al.* 2014). They rely heavily on their natural resources to survive, and have acquired unique knowledge through continuous observations, practice and beliefs over their lifetimes, also known as Traditional Ecological Knowledge (TEK). TEK is defined as "a cumulative body of knowledge, practice, and beliefs about the environment, evolving by adaptive processes and handed down through generations by cultural transmission" (Berkes, 1999:8).

TEK provides the cultural and historical component needed in conservation, adding the human or sociocultural perspective to the knowledge regarding their environment and natural resources (Gadgil *et al.* 1993; Berkes *et al.* 2000; Halme and Bodmer, 2006). In primatological studies, rather than focusing solely on ecological and behavioral patterns, there is a need to integrate human and non-human primate interactions, known as "ethnoprimatology" (Fuentes and Hockings, 2010). Primates are embedded in complex social relationships, where human hunting, uses, beliefs and traditions would affect their behavior and ecology. Some ethnoprimatological studies in the Amazon have demonstrated the role of primates in the traditional lifestyle of indigenous people (Shepard, 2002; Cormier, 2002; Lizarralde, 2002, da Silva *et al*. 2005; Cormier, 2006; Papworth *et al.* 2013). Therefore, understanding human-nonhuman primate cultural conceptions is critical to primate conservation.

The integration of TEK and scientific ecological knowledge provides relevant information to accomplish effective conservation planning and sustainable management (Becker and Ghimire, 2003; Fraser *et al.* 2006). Very few studies demonstrate the utility of surveying local communities as a basic tool for obtaining biological information regarding different species; although, such surveys can provide less expensive means to gather data (Gilchrist *et al.* 2005; Anadón *et al.* 2009), especially in previously unexplored areas. The participation of indigenous people could help different stakeholders involved in conservation, not only scientists, but also managers, decision makers, and local communities, as demonstrated by Padmanaba *et al.* (2013). Nonetheless it is necessary to evaluate its effectiveness, given that TEK is not only cheaper but also faster and simpler than traditional field studies.

One possible shortfall of relying on the knowledge of locals is that TEK is not evenly distributed within a community. Due to different factors, environmental knowledge varies between groups or individuals (Chalmers and Fabricius, 2007), even more when people from the same community have different ethnicities, cultures and traditions. Therefore, these differences result in the development of ‘local experts’, defined as a group or individuals within a community who have greater knowledge about specific topics such as ecosystems (Donovan and Puri, 2004). It is necessary to bring traditional and scientific knowledge together in order to improve our understanding of biodiversity conservation and ecosystem management. Nonetheless, to make this a cost efficient, effective and reliable method the identification and selection of ‘local experts’ is fundamental when exploring TEK (Davis and Wagner, 2003).

OBJECTIVES

The primary objectives of this project were to: (1) document the TEK of the villagers of the community of Sucusari to describe the diversity, group size and habitat use of primate populations as perceived by local people, and (2) compare this knowledge to results calculated by a primate survey method using line transects. This project ultimately compared TEK and scientific knowledge to determine if TEK can provide reliable information that could potentially be used in place of expensive scientific surveys.

Complementary analysis provided a deeper understanding of the dynamics of TEK within the community of Sucusari, thereby identifying the 'expert' group or individuals, as well as the strengths and weaknesses of using TEK in primate population studies.

MAIJUNA INDIGENOUS PEOPLE

The Maijuna (also known as the Orejón) are a Western Tucanoan people who live in the northeastern Peruvian Amazon. Currently there are approximately 400 Maijuna individuals who live along the Yanayacu, Algodón and Sucusari rivers (Gilmore, 2010; Horn *et al.* 2012; Gilmore *et al.* 2013). These three river basins are part of the ancestral territory of the Maijuna (Gilmore *et al.* 2013).

There are four Maijuna communities situated along the rivers mentioned above: Puerto Huamán and Nueva Vida along the Yanayacu River, San Pablo de Totoya along the Algodón River, and Sucusari along the Sucusari River. Each of the four Maijuna communities is recognized as a native community (*Comunidad Nativa*) by the Peruvian government and has been granted title to land surrounding their community. However, in June of 2015 the National Government of Peru formally created the new Maijuna-Kichwa Regional Conservation Area (RCA). The Decree, No. 008-2015 of the Ministry of Environment, officially protects 391,039 hectares of Maijuna ancestral territory for the benefit of the local people and its extraordinary biological diversity.

Due to both its biological and cultural importance it is critical to protect and conserve Maijuna ancestral territory. Maijuna lands have been exposed to many illegal and unsustainable activities that have adversely affected a wide variety of species and ecosystems. Also, since the Maijuna stopped illegal logging in their titled and ancestral lands in 2008 they have increased their interest in developing sustainable activities to protect their natural resources (Horn *et al.* 2012).

A rapid biological inventory was performed in 2009 within the recently established RCA, providing important information on the flora and fauna within this area (Gilmore *et al.* 2010). Nevertheless, little information is known about the abundance, richness and distribution of different species within the Sucusari River basin, including primates. Therefore, the results of this project provided baseline information about primate populations within this area.

STUDY AREA

This study was conducted in the Maijuna indigenous community of Sucusari, situated along the Sucusari River, a tributary of the Napo River, in northeastern Peru (Figure 1). This village is located approximately 126 kilometers by river from Iquitos, the capital of the Department of Loreto (Horn *et al.* 2012). The Sucusari community has a legal territory covering an area of 4,771 hectares, which adjoins the recently established RCA Maijuna-Kichwa, and is the only village located within the Sucusari River basin. An ecotourism lodge called ExplorNapo Lodge, established in 1983, is situated between 4 and 4.5 kilometers downriver from the main community (Gilmore, 2010).

The community has one hundred sixty-six residents divided into thirty-two monofamilial or plurifamilial houses. Within the total number of inhabitants in the Sucusari community, 32.53% are entirely Maijuna and 26.51% are at least one-half Maijuna, 34.94% are mestizos[1], and the remaining 6.02% are Kichwa (M. Gilmore, personal communication). Their main subsistence activities include hunting, fishing, swidden-fallow agriculture, and the gathering of various forest products (Gilmore *et al.* 2010). To generate income, residents sell game meat, domestic animals, agricultural products, and a variety of non-timber forest products (Gilmore *et al.* 2010).

[1] *Mestizos* are individuals of mixed Amerindian and Iberian descent who live throughout the Peruvian Amazon region, and practice a mixture of traditional agriculture, hunting, fishing, and forest product extraction for their livelihoods (Coomes and Ban 2004: 421).

This region of Peru is tropical, warm and humid, with a mean annual temperature of 26°C and a mean annual precipitation of approximately 3100mm per year (Marengo, 1998). The Sucusari River basin is dominated by upland tropical wet forest, with seasonally flooded forest also present in the lower portion of the river basin.

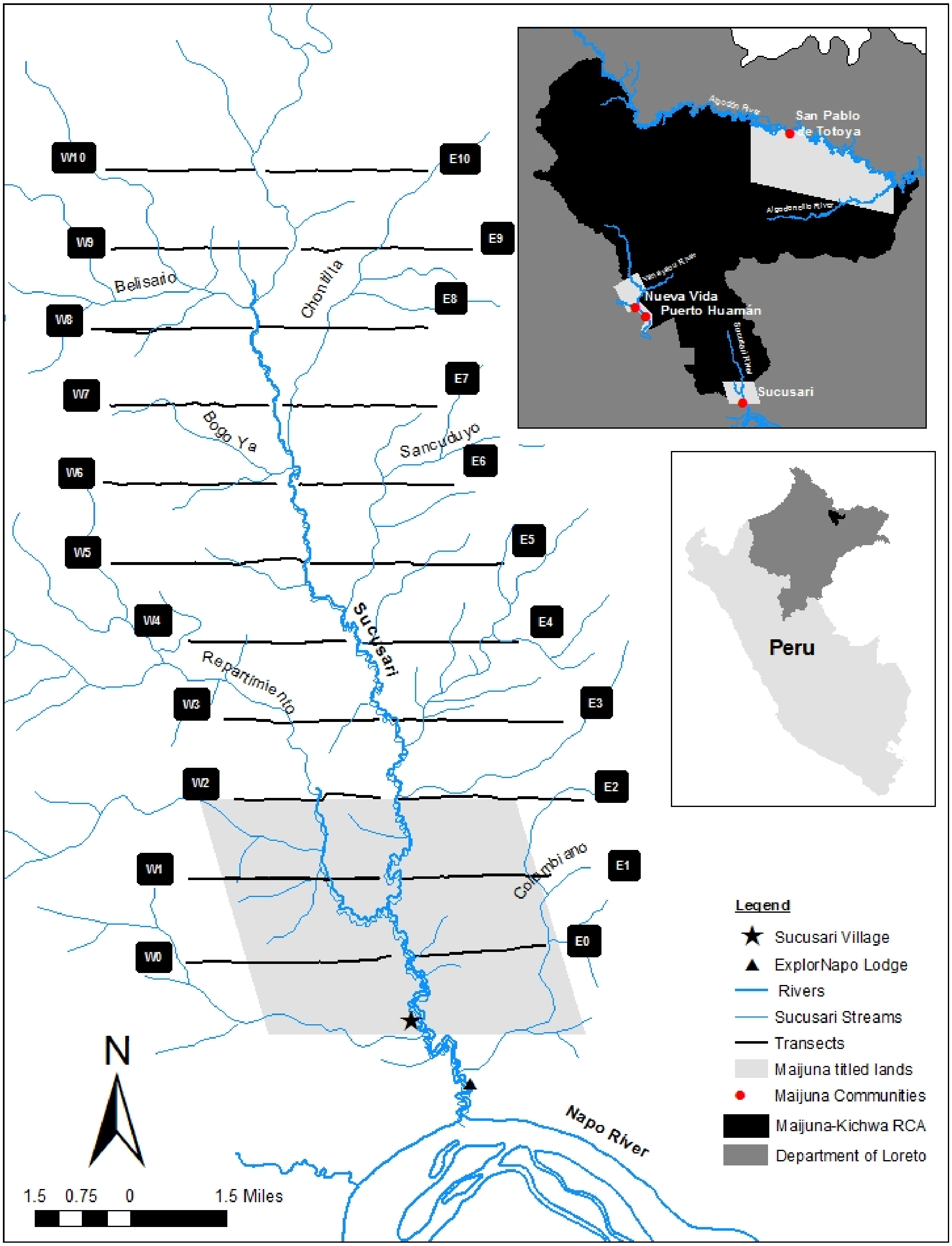

Figure 1. Map of the study area. Field surveys were conducted on a parallel trail system of 22 transects located along the Sucusari River, Peru. Semi-structured interviews were performed in the Maijuna indigenous community of Sucusari.

METHODS

Data collection

Interviews

Questionnaires (see Appendix I) were completed in August 2014, and involved a sample of 50 residents of the Sucusari community. Respondents were selected according to their availability, targeting household heads or other resident adults (>18 years old). The interviews were conducted in Spanish or in Maijuna, the latter with the help of a community leader that is fluent in both Spanish and Maijuna. Each interview took between 45 and 100 minutes to complete.

The sample included 30 (60%) males and 20 (40%) females, with a mean age of 43.58 (SD ±13.82) years. The differentiation of hunters and non-hunters was assessed in order to compare and contrast their knowledge about primates. It should be stressed that, for the purpose of this project, hunters were defined as any individual of the community that has hunted once or more during their lifetime. After a Spearman correlation analysis "hunters" and "gender" were highly correlated (r_s=0.918, p< 0.001), because males in the Maijuna community do all of the hunting. Gender thus served as a measure to differentiate hunters vs. non-hunters. See Table 1. for a complete demographic description of the interviewees.

Table 1. Demographics of the interviewees in the Maijuna community of Sucusari, Peru

N		50
Gender (Hunters)		
	Female (No)	20 (40%)
	Male (Yes)	30 (60%)
Ethnicity		
	Maijuna	26 (52%)
	Mestizo	23 (46%)
	Kiwcha	1 (2%)
Age		
	Mean (SD)	43.58 (13.82)
	Min-Max	21-72
Years of Education		
	Mean (SD)	5.36 (3.35)
	Min-Max	0-13
Years living in Sucusari		
	Mean (SD)	25.26 (22.49)
	Min-Max	0.5-69
Time spent on the river (days per year)		
	Mean (SD)	260.88 (144.85)
	Min-Max	0-365
Time spent in the forest (days per year)		
	Mean (SD)	54 (82.03)
	Min-Max	0-365

Respondents were interviewed using a semi-structured questionnaire. Questions were constructed to understand and document TEK related to primate population richness, group size, habitat preferences, and sociocultural information provided by the villagers in the community of Sucusari. It targeted information regarding the eleven primate species believed to be present in the area (Gilmore *et al.* 2010). No formal primate surveys have been done within the Sucusari River basin, thus the status of the primate species believed to be present in this study were determined from rapid biological inventories performed within Maijuna ancestral lands and surrounding areas.

These inventories were conducted in 2009 by the Field Museum of Chicago (Gilmore *et al.* 2010), along the Yanayacu and Algodón rivers, and around the ExplorNapo lodge located in the lower part of the Sucusari River. From these inventories 11 primate species were reported within Maijuna ancestral lands: *Cebuella pygmaea*, *Saguinus nigricollis, Callicebus discolor, Callicebus lucifer*, *Pithecia monachus*, *Saimiri sciureus, Cebus albifrons, Sapajus macrocephalus*, *Alouatta seniculus,* and *Lagothrix lagotricha* (Gilmore *et al.* 2010).

To verify local knowledge and supplement/compare it with the field survey findings, the questionnaire included photographs of twenty primates, nine of which were believed to not occur in the area serving as a control. The control species were: *Saguinus mystax*, *Saguinus tripartitus*, *Aotus nigriceps*, *Callicebus cupreus*, *Saimiri boliviensis*, *Cacajao calvus*, *Ateles belzebuth*, *Ateles chamek*, and *Lagothrix poeppigii*. The remaining eleven pictures were the species presumed to be present in the area, and were used to validate the supposition that people were aware of the species in their area, rather than guessing. Respondents were asked to identify the primate species shown in each photo as well as to determine its presence along the Sucusari River. A correct identification and location were based on the information gathered by the field surveys conducted in the present study. To compare field survey data and local knowledge, seven primate species with higher encounter rates (i.e., *Saguinus nigricollis, Saimiri sciureus*, *Callicebus lucifer*, *Pithecia monachus, Cebus albifrons*, *Alouatta seniculus,* and *Lagothrix lagotricha*) were used as well as the information of respondents who correctly identified the species and location from the photos.

Field surveys

Line transects were employed to survey primate communities, following the protocol and published techniques for tropical forest surveys of primates (Peres and Cunha, 2011; Buckland *et al.* 2001). Field surveys were performed from December 2013 to March 2014 and from May to July 2014. Transects were carried out on a parallel trail system (22 trails), with each trail ranging from 3.4 – 5.2 km in length (Figure 1) and walked at a speed of 1-2 km per hour. They were cut between November 2013 and January 2014, by four teams of two or three individuals; with one individual from each team responsible for guiding and the other(s) cutting the transect using a *machete*. Transects were randomly positioned, and covered a representative sample of the forest habitats present in the Sucusari River basin (See Figure 1 and Appendix III).

Different transects were walked in parallel by three teams, each consisting of a researcher and a local community member, between 0630 to 1100 hours and 1400 to 1800 hours. Any one transect was not surveyed on consecutive sampling days. For each primate species encountered, the following information was recorded: species, date, time, detection mode (e.g., visual or acoustic), perpendicular distance (PD) from the transect to the first individual seen, distance along the transect, habitat description (upland, floodplain, *Mauritia flexuosa* palm swamp), and group size.

Data analysis

Freelisting and cultural salience

Freelisting is a method that can be used to determine the cultural salience of named species, representing the cultural importance of a particular animal within the studied community (Bernard, 2006). Freelisting was used to determine the cultural salience of the primate species listed. Cultural salience calculations assume that: (i) items named by most individuals are more salient, and (ii) the first items in the list are more salient (Quinlan, 2005). Based on these assumptions Quinlan (2005) created the following formula to determine the cultural salience of each animal species listed by an individual:

Salience = $(1 + length_i - position_i)/length_i$, where: *length* is the total number of animals listed by individual *i*, and *position* is the location of a particular animal in the list of individual *i*. Animals not listed by an individual had a cultural salience of zero.

The cultural salience of each animal was calculated using the following equation:

Cultural salience = $\Sigma\ salience_i/n$, where: *n* (n=50) is the total number of respondents who participated in the study.

Identification and location of primates using photos

A backward stepwise logistic regression and a multiple linear regression (Field, 2009) were used to identify the predictor variables influencing the correct identification and location per species, and the overall correct identification and location of primates, respectively. The former requires a dichotomous categorical dependent variable (Yes, No) and the latter a numerical variable (score). The backward stepwise selection builds a regression model that starts by placing all the predictor variables in the model, and in each subsequent step the least significant variable is removed. No significant variables were removed from the model, and the model was re-estimated for the remaining predictors. Logistic and multiple linear regressions were performed using the first four-predictor variables shown in Table 1. The four-predictor variables were selected after running a Spearman rank correlation analysis to avoid multicollinearity among variables (cut off *rho* = 0.4). The variables used were: gender, age, ethnicity, and years of education. When more than 80% of the respondents properly identified the species or location, the logistic regression model could not be run, thus no relationship was found between the dependent and independent variables. In total, seven primate species were removed from the identification analysis and six primate species were removed from the location analysis. Field and questionnaire data were entered and organized using Microsoft Excel. Statistical tests were reported using Pearson chi-square (X^2), and performed using the program *SPSS v. 22.0*. The level of significance was set at $p<0.05$.

Field surveys

Encounter rates were used as a measure of relative abundance of primate species per habitat. This method was chosen to control for overall differences in sampling effort (Palminteri *et al.* 2011), and because for some species the number of encounters was not large enough to estimate their densities. For all species, the total distance walked (sampling effort) in each habitat was calculated as the sum of the distance walked on all individual trails per site. To facilitate the analysis of relative abundance per species, transects were grouped into six different sites (Repartimiento, Bogo Ya, Belisario, Colombiano, Sancuduyo and Chontilla) based on the major streams in the Sucusari River basin (See Figure 1 and Appendix III). Encounter rates were calculated using the number of groups (per species) encountered per 10 km walked, for each habitat type. Relative species abundance was calculated multiplying the encounter rate by the mean group size, taking into account only reliable group counts.

In order to overcome the difficulties inherent in any sampling scheme and identify reliable group counts, the "effective distance" was obtained for each of the seven species. Histograms, using the PD from transect to first individual sighted, were produced for each species, followed by the estimation of the fall-off distance (Whitesides *et al.* 1988). The latter was determined by identifying the first interval at which the number of detections of groups for a particular species dropped to half or less than of the immediately previous interval. The estimate of "effective distance" was calculated using the following formula:

Effective distance = $\mathbf{N_t/N_f * (FD)}$, where: N_t = species-specific total number of sightings of groups, N_f = species-specific number of sightings of groups at distances less than the fall-off distance, and FD = fall-off distance.

Comparison of primate group size between field surveys and TEK

Mean group size per species was compared between the field surveys and TEK. Mean (TEK_{mean}) and minimum (TEK_{min}) values, obtained through the interviews, were used to evaluate TEK group size. Given the inherent difficulties of obtaining complete group size counts using line transect techniques (Defler and Pintor, 1985; Jhons, 1985; Marshall *et al.* 2008), only reliable group size counts were used for the comparison between field surveys and TEK. It was hypothesized that mean group size values from field surveys would be similar to TEK_{mean} and would differ from TEK_{min} group size values. Differences between group sizes estimated from field surveys and TEK (mean and minimum) were examined using Mann-Whitney *U*-tests (Mean + SD) due to the non-normal distribution of the data. The level of significance was set at $p<0.05$.

Comparison of primate habitat use between field surveys and TEK

To document the habitat preference of primates, a description of the main characteristics, location, and length of each habitat type was performed along each transect (Figure 1). Three main habitat types were determined according to the classification system developed by Encarnación (1993). The percentage of upland forest, floodplain forest, and *Mauritia flexuosa* palm swamp were 68%, 29%, and 3%, respectively, along all transects performed in the Sucusari River.

i) Upland: non-flooding forests with well-drained terrain, and with a heterogeneous floral composition. The landscape is predominantly hilly, with slopes varying from approximately 15% to 70%.

ii) Floodplain: occasionally flooded forests with soils that have a drainage system that can be good or bad, and with a heterogeneous floral composition. This type of habitat includes areas flooded due to irregular rainfalls, which raises the water level of small streams that are part of the Sucusari River basin, and areas flooded annually due to the rise of water levels in the Napo River during the wet season.

iii) *Mauritia flexuosa* palm swamp (regionally called aguajales): forests with poorly-drained terrain, which accumulates water and/or dead and decaying plant material.

Mauritia flexuosa, aguaje, is one of the most dominant plant species along with huasai palms, *Euterpa oleracea*.

To determine habitat use, using field survey data, the expected number of groups encountered in each habitat type was calculated according to their distribution along all transects, corrected according to sampling effort. The observed and expected frequencies were compared using the chi-square test (Norusis, 1993). Expected numbers were calculated using the following formula:

Expected = $\mathbf{N_{total}}$ *** Sampling effort** $\mathbf{_{habitat}}$**/sampling effort**$\mathbf{_{all}}$, where: N_{total} is the total number of groups encountered per species.

Habitat use, using TEK, was assessed using the information of individuals who were able to correctly identify the primate species and its presence in the Sucusari River Basin. Thus, the number of respondents varied according to each species. Respondents were asked: (i) in what type of forest is "x" species found (upland, floodplain, and/or *Mauritia flexuosa* palm swamp)? (ii) Is "x" species seen in habitat "*y*" during the whole year or only during particular months? Habitat responses in which species were found during the whole year were considered as habitats most frequently used by the primate, and were included in the data analysis.

The habitats were grouped according to the responses provided by each respondent: upland (UP), floodplain (FL), *Mauritia flexuosa* palm swamp (PS), upland and floodplain (UP + FL), upland and *Mauritia flexuosa* palm swamp (UP + PS), floodplain and *Mauritia flexuosa* palm swamp (FL + PS), and upland, floodplain and *Mauritia flexuosa* palm swamp (All).

RESULTS

Monkey ("*mono*") definition

In order to elucidate how primates were defined or categorized within the community of Sucusari, respondents were asked to define the term "*mono*" in Spanish, which means "monkey" in English. There was no clear consensus of how primates were defined and categorized. Among all the responses given, definitions of monkey were divided into eight categories. The percentages of each category were: (1) live in trees (68%), (2) jump/climb in branches (52%), (3) eat fruits/food in trees (32%), (4) possess a long tail (32%), (5) possess a prehensile tail (12%), (6) can go down to ground to eat (10%), (7) distinct fur (4%), and (8) live in various places (2%). Most of these categories also applied to some of the non-primate species listed by respondents during the interviews, such as *Potos flavus.*

Assessing primate diversity: freelisting and cultural salience

During the interviews, respondents were asked to free list all of the monkey species that were found in the Sucusari River basin. Eleven primate species were listed by the interviewees (Table 2). The species mentioned by more than 80% of respondents were: *P. monachus* (96%), *S. sciureus* (94%), *A. seniculus* (92%), *L. lagotricha* (90%), and *S. nigricollis* (84%). The remaining species listed were: *C. albifrons* (72%), *A. vociferans* (50%), *C. pygmaea* (40%), and *S. macrocephalus* (10%). The titi monkeys represented a special case. Although 92% of the respondents mentioned titi monkeys during the freelisting, 61% referred to them with a single common name ("*tocón*"), and did not differentiate between the two species: *C. discolor* and *C. lucifer*.

Table 2. Primate species reported to occur in the Sucusari River basin by the respondents and the findings of the field surveys.

Species*	English common name	Spanish common name	Listed as present by respondents	Presence in Sucusari (field surveys)
Cebuella pygmaea	Pygmy marmoset	Leoncito	Present[a]	Not seen[e]
Saguinus nigricollis	Black mantle tamarin	Pichico	Present	Presence confirmed
Aotus vociferans	Spix's night monkey	Musmuqui	Present[a]	Presence confirmed[d]
Saimiri sciureus	Common squirrel monkey	Fraile	Present	Presence confirmed
Callicebus discolor	Red titi	Tocón colorado/bincha/cenizo	Present[b]	Presence confirmed[d]
Callicebus lucifer	Lucifer titi	Tocón negro	Present[b]	Presence confirmed
Pithecia monachus	Monk saki	Huapo negro	Present	Presence confirmed
Cebus albifrons	White-fronted capuchin	Mono/machín blanco	Present	Presence confirmed
Sapajus macrocephalus	Large-headed capuchin	Mono/machín negro	Present[a]	Potentially occurring species
Alouatta seniculus	Red howler	Mono Aullador rojo	Present	Presence confirmed
Lagothrix lagotricha	Common woolly	Mono Lanudo común	Present	Presence confirmed

[a] Not mentioned by >50% of the respondents

[b] 61% of respondents mentioned "tocón" without differentiating the two species

[c] One encounter during the census

[d] Two encounters during the census

[e] Encountered outside field surveys

* Species listed in order of increasing body mass

Note: Encounters of remaining species ranged from 10 to 180 encounters

During the freelisting, only 22% of the respondents listed only primate species, and 78% of them mentioned other non-primate mammal species (Table 3). Kinkajou (*Potos flavus*), a nocturnal mammal species with many features that resemble a primate, was mentioned by 82% of respondents. The following most common non-primate mammal species listed were squirrels (38%), porcupines (33%), coatis (31%), sloths (28%), tamanduas (21%), tayras (15%) and only one respondent included the common opossum in the list.

Both primate and non-primate mammal species mentioned during the freelisting were included to calculate the cultural salience of the animals listed. Cultural salience analysis showed that the most culturally salient primate species were *S. sciureus* (0.68), *P. monachus* (0.66), *Callicebus spp.* (0.6), *L. lagotricha* (0.55), *A. seniculus* (0.52), and *S. nigricollis* (0.52). The species with lower cultural salience were *C. albifrons* (0.4), *A. vociferans* (0.2), *C. pygmaea* (0.18) and *S. macrocephalus* (0.04) (Figure 2). Given that 61% referred to the titi monkey using a single common name ("*tocón*"), and did not differentiate between the two species (*C. discolor* and *C. lucifer*), the single common name was used for the analysis (*Callicebus spp.*). *P. flavus* had the highest cultural salience among the non-primate mammal species, even greater than some primate species.

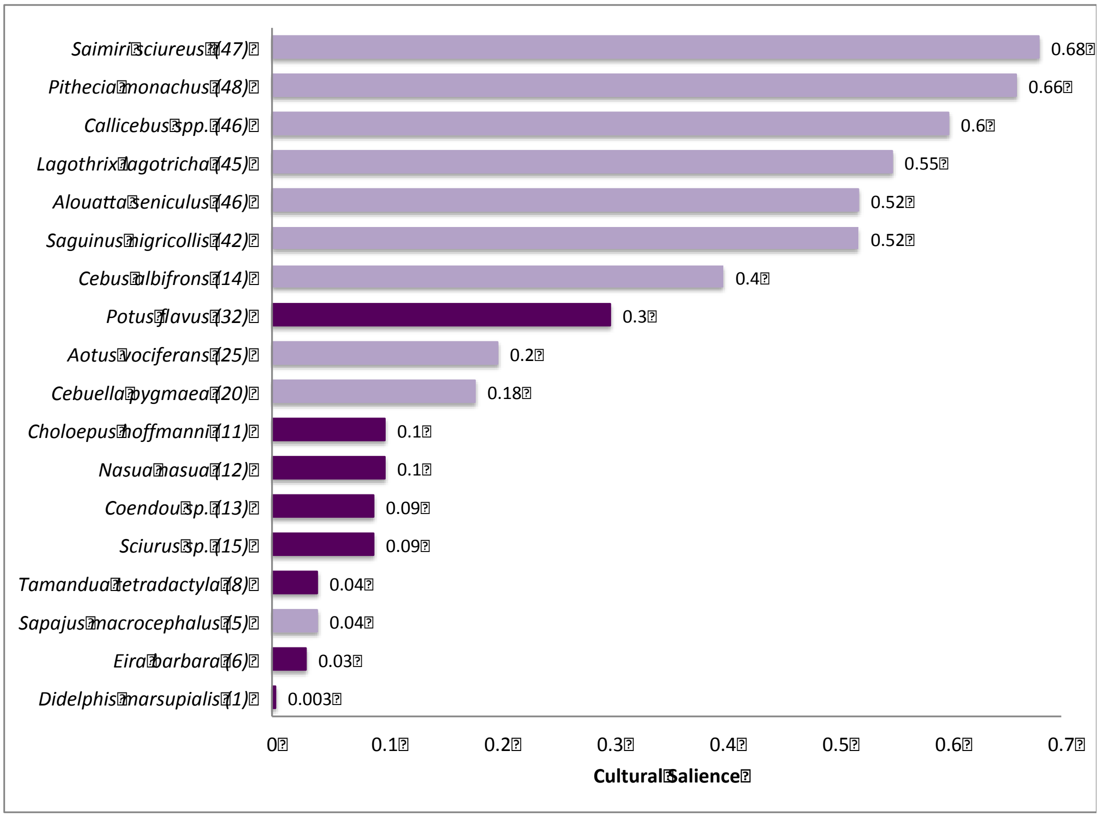

Figure 2. Cultural salience of all primate and non-primate mammal species listed during the freelisting of 50 individuals. Lighter and darker bars are primates and non-primate mammal species, respectively. Number of respondents who mentioned each species is shown in brackets after the species name. Note: Cultural Salience ranges between 0 and 1.

Table 3. Percentage of non-primate mammal species reported as monkeys during the freelisting.

Scientific name	English Common name	Spanish Common name	Number of respondents	(%)
Potos flavus	Kinkajou	Chosna	32	82
Sciurus spp.	Squirrels	Ardilla	15	38
Coendou spp.	Porcupine	Cashacushillo	13	33
Nasua nasua	Coati	Achuni	12	31
Choloepus hoffmanni	Sloth	Pelejo	11	28
Tamandua tetradactyla	Tamandua	Shiwi	8	21
Eira barbara	Tayra	Manco	6	15
Didelphis marsupialis	Common Opposum	Zorrito	1	3

During the field surveys, all the primate species listed by the respondents were detected except for *C. pygmaea*. Due to the non-detection of *C. pygmaea* and the low encounter rates of *S. macrocephalus*, *C. discolor* and *A. vociferans*, these species were excluded from TEK and field survey data comparisons. Therefore, associations between TEK and field survey data of the remaining seven species were analyzed.

Identification and location of primates using photos

Among the 11 primate species believed to be present in the Sucusari River basin, more than 80% of respondents were able to correctly identify six of the species and their presence along the Sucusari River during the photo exercise (Figure 3. A. and 3. B.). The species correctly identified by the majority of the respondents were: *L. lagotricha* (96%), *P. monachus* (96%), *C. discolor* (90%), *S. nigricollis* (90%), *S. sciureus* (88%), and *A. seniculus* (86%). It is important to highlight that these were also the top six primate species in terms of cultural salience (Figure 2).

In regards to the correct location of each primate species, respondents who correctly identified the primate species from a photo were most likely to correctly identify their location, except for *S. macrocephalus*, which was considered to be present in the Sucusari River basin by only 8% of the respondents (Figure 3.B). It is worth noting that the species that were commonly confused by the respondents were *C. albifrons* and *S. macrocephalus*.

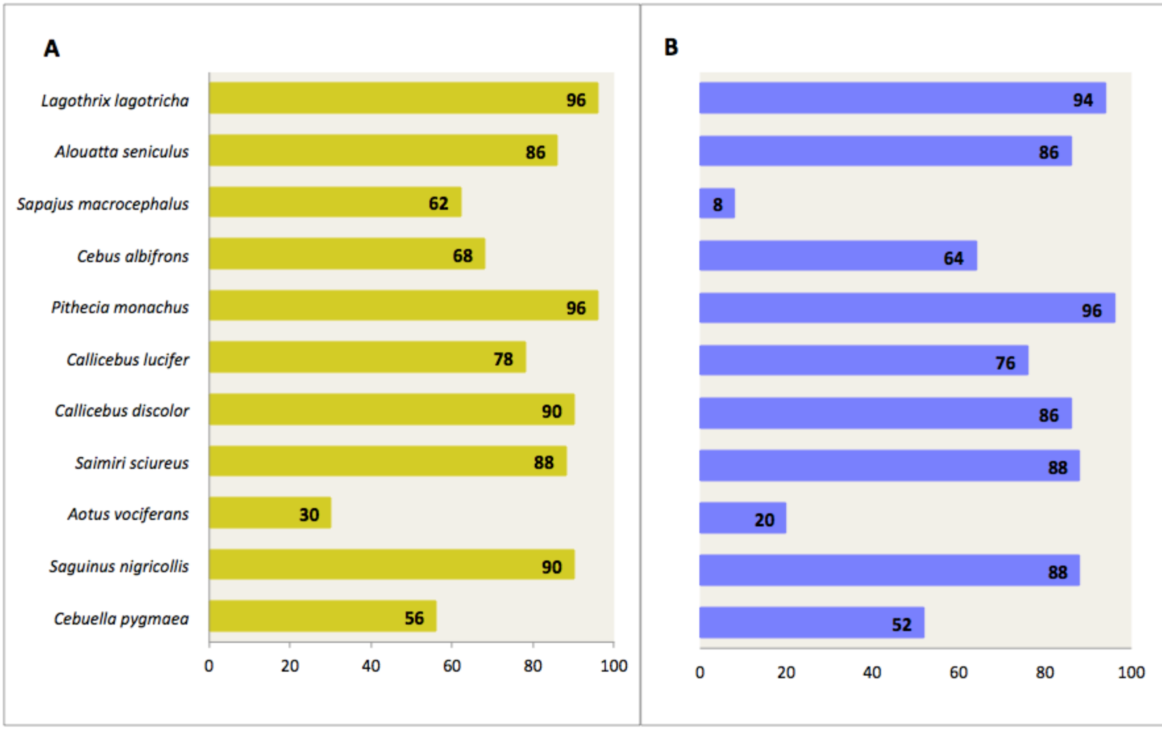

Figure 3. Percentage of respondents that successfully identified the primates (A) and their location in the Sucusari River basin (B) from a photo. Species listed in order of decreasing body mass**.**

Aiming at identifying the "expert" group or individuals based on the correct identification and location of the primate species, backward stepwise logistic and linear regressions were carried out. For those primate species that were identified by more than 80% of the respondents (*S. nigricollis, S. sciureus, C. discolor, P. monachus, A. seniculus,* and *L. lagotricha*) logistic regression models were unable to provide reliable estimates of responses. The logistic regression models for determining which variables contributed to properly identifying the species and location of the remaining primates believed to be present in the Sucusari River basin were based on the most parsimonious model (reduced model).

The reduced models revealed statistical significance ($p<0.05$) for *A. vociferans* ($X^2 = 7.667$, $p = 0.022$), *C. lucifer* ($X^2 = 24.759$, $p<0.001$), *C. albifrons* ($X^2 = 14.413$, $p = 0.002$), and *S. macrocephalus* ($X^2 = 10.484$, $p = 0.001$). As shown in Appendix II.A, the predictor variables that yielded a statistically significant contribution to the correct identification of the photos were **age** (OR=1.077, p=0.012) for *A. vociferans*; **gender** (OR= 76.432, p= 0.002) and **years of education** (OR=0.656, p=0.021) for *C. lucifer*; **ethnicity** for *C. albifrons* (OR=15.743, p=0.007); and **gender** (OR=7.429, p=0.002) for *S. macrocephalus.*

The reduced logistic regression models for determining which variables contributed to properly identify the location of the primates believed to be present in the Sucusari River basin revealed statistical significance for *C. pygmaea* ($X^2 = 6.609$, $p = 0.01$); *A. vociferans* ($X^2 = 5.18$, $p = 0.023$); *C. discolor* ($X^2 = 12.22$, $p = 0.002$); *C. lucifer* ($X^2 = 33.505$, $p<0.001$); and *C. albifrons* ($X^2 = 12.943$, $p = 0.005$). As shown in Appendix II.B the predictor variables that yielded a statistically significant contribution to the correct location were **gender** (OR=4.667, p=0.013) for *C. pygmaea*; **age** (OR=1.064, p=0.03) for *A. vociferans*; **gender** for *C. discolor* (OR= 17.177, p= 0.019) and *C. lucifer* **(**OR= 137.024, p<0.001**)**; and **ethnicity (**OR= 9.85, p= 0.008**)** for *C. albifrons*.

Multiple linear regressions were used to develop a model for predicting the variables influencing the correct identification and location per respondent and among all the primates believed to be present in the Sucusari River basin. The four-predictor models (age, ethnicity, gender and years of education) were able to account for 45% (F=19.017, $p<0.001$) and 43% (F=17.628, $p<0.001$) of the variance in the correct identification and location of primates respectively. Although this is not a very high percentage as roughly 55% is left unexplained. It is important to highlight that although almost all the respondents were able to recognize most of the primate species from the photos, the multiple linear regression models showed who could be the most reliable individuals in the community of Sucusari for gathering primate data. This is the case especially for those primate species that were not very familiar for some of the respondents. Based on the most parsimonious models **gender** ($p<0.001$) and **age** ($p=0.026$) yielded a statistically significant contribution to the correct identification (Appendix II.C) of the primate species present in the Sucusari River basin. **Gender** ($p=0.000$) and **ethnicity** ($p=0.022$) yielded a statistically significant contribution to the correct location of the primate species present in the Sucusari River basin (Appendix II.D).

Field surveys

The total distance walked along all transects was 1,005.11 km, with each transect walked an average of 13 times (Appendix III). Three hundred eighty-five encounters with groups from the seven primate species analyzed were recorded during the surveys. Number of encounters and relative abundance were highest for smaller species and lowest for the largest species. The species with highest encounters of groups were *S. nigricollis* and *C. lucifer*; and the lowest encounters were of *A. seniculus* and *L. lagotricha* (Table 4).

All primate species combined, the majority of group encounters were in upland forest (n=291), 74 groups were encountered in floodplain forest, and 20 groups in *Mauritia flexuosa* palm swamp. Five primate species were found in the three different types of habitat. The exceptions were *A. seniculus*, which was found in upland forest and *Mauritia flexuosa* palm swamp, and *L. lagotricha*, which was found solely in upland forest. Due to the small proportion of *Mauritia flexuosa* palm swamp habitat (3%) along the transects, compared to upland forest (68%) and floodplain forest (29%), there was a lower sampling effort in this habitat. This resulted in overinflated relative abundance values, especially for *S. nigricollis* and *C. lucifer*, and could also have underestimated the relative abundance of species with lower sample size, such as *A. seniculus*. All the species encountered in *Mauritia flexuosa* palm swamp were recorded during the fruiting season (Jun-Jul 2014), except for one encounter of *A. seniculus* in March 2014. Moreover, *A. seniculus* and *L. lagotricha* were restricted to four sites located in the middle and upper part of the basin: Bogo Ya, Belisario, Colombiano, Sancuduyo; and, Bogo Ya, Belisario, Sancuduyo and Chontilla, respectively, whereas the remaining species were found in all the study sites.

Table 4. Survey data of primate species: number of sites, number of groups encountered in total and per habitat type, group encounter rate, and relative abundance per species in each habitat type.

Species	N Sites	# of groups		Upland		Floodplain		*Mauritia flexuosa* palm swamp	
		Total	With reliable group count	Group Enc. rate/km	Relative abundance	Group Enc. rate/km	Relative abundance	Group Enc. rate/km	Relative abundance
Saguinus nigricollis	6	180	164	2.07	9.39	1.36	6.79	5.43	19.97
Saimiri sciureus	6	25	19	0.26	4.19	0.27	5.30	0.95	*
Callicebus lucifer	6	77	58	0.81	1.87	0.45	0.82	8.60	21.04
Pithecia monachus	6	62	57	0.81	2.73	0.40	1.02	1.42	3.24
Cebus albifrons	6	20	15	0.18	1.05	0.21	0.95	1.09	0.59
Alouatta seniculus	3	10	9	0.09	0.23	NP	NP	0.70	0.99
Lagothrix lagothrica	4	11	10	0.17	3.74	NP	NP	NP	NP
Total		385	332						

NP= Species not present in this habitat type
* No reliable group count
Species listed in order of increasing body mass

Comparison of group size between field surveys and TEK

The mean group size per species was compared between the field surveys and TEK data. Table 5 shows the mean group size and range per species among three different groups (field surveys, TEK_{mean}, TEK_{min}). Given that more than 80% of respondents listed (freelisting) and correctly identified (photo identification exercise) *L. lagotricha, A. seniculus, P. monachus, S. sciureus,* and *S. nigricollis* it was expected that TEK_{mean} would be similar to field survey group size for all species, except for *C. lucifer* (correctly identified by 78% of respondents) and *C. albifrons* (correctly identified by 68% of respondents). Based on the logistic regression analysis (See Appendix II.B), gender (Male) and ethnicity (Maijuna) yielded a statistically significant contribution to the correct location of *C. lucifer* and *C. albifrons,* respectively. Per this information, three main hypotheses were proposed: (1) Field survey data from all primate species will be similar to TEK_{mean}, except for *C. lucifer* and *C. albifrons*; (2) group size data reported by males will be similar to field survey data for *C. lucifer,* and (3) group size data reported by the Maijuna will be similar to field survey data for *C. albifrons*. Therefore, comparison of mean group size were performed between field surveys and TEK using four different groups: (1) using all the data, (2) only Males, (3) only Maijuna, and (4) Males & Maijuna data.

Table 5. Mean group size of primate species using field surveys and TEK.

	Field Survey		**TEK**			
	Group size		Mean group size		Minimum group size	
	Mean (SD)	Range	Mean (SD)	Range	Mean (SD)	Range
Cebuella pygmaea	ID	ID	3.96 (1.84)	1-10	2.85 (1.83)	1-9
Saguinus nigricollis	4.53 (2.05)	1-10	11.23 (11.80)	4-80	6.52 (4.44)	1-20
Aotus vociferans	ID	ID	4.7 (2.67)	1-9	3.3 (1.77)	1-6
Saimiri sciureus	20.72 (18.09)	1-60	34.09 (20.66)	5-90	20.36 (12.55)	2-50
Callicebus discolor	ID	ID	3.8 (1.51)	1-11	2.4 (0.83)	1-5
Callicebus lucifer	2.26 (1.32)	1-5	4.08 (1.87)	2-8	2.76 (1.48)	1-6
Pithecia monachus	3.22 (1.57)	1-7	4.87 (2.28)	2-14	3.11 (1.87)	1-8
Cebus albifrons	5.44 (2.61)	1-10	11.65 (8.73)	2-30	6.65 (5.36)	2-20
Alouatta seniculus	2.11 (1.54)	1-5	8.63 (12.02)	3-65	5.8 (8.38)	1-50
Lagothrix lagotricha	23.43 (14.16)	10-45	24.48 (25.69)	3-160	13.20 (9.9)	2-40

ID=Insufficient Data

Contrary to expectations, among all respondents, mean group size data showed more significant differences between TEK_{mean} and field survey data as compared to TEK_{min} and field survey data (Table 6). Differences in group size between field surveys and TEK_{mean}, using the data from all respondents, were significant for *S. nigricollis* (U=956, p<0.001), *S. sciureus* (U=266.5, p=0.012), *C. lucifer* (U=467.5, p<0.001), *P. monachus* (U=723.5, p<0.001), *C. albifrons* (U=152.5, p=0.032), and *A. seniculus*

(*U*=25, *p*<0.001). The exception was for *L. lagotricha* (*U*=139.5, *p*=0.636). Using only Males data, differences in group size were significant for all species, except for *L. lagotricha* (*U*=79.5, *p*=0.454). Comparing Maijuna group size and field survey data, differences in group size were significant for all species, except for *S. sciureus* (*U*=166, *p*=0.054), *C. albifrons* (*U*=116.5, *p*=0.115), and *L. lagotricha* (*U*=83.5, *p*=0.747). Finally, comparison between field survey and Males & Maijuna data yielded statistical significance for all species, except for *L. lagotricha* (U=48, *p*=0.624).

By contrast, differences in group size between field surveys and TEK_{min} were significant for *S. nigricollis* (*U*=2553.5, *p*=0.012; *U*=1238.5, *p*=0.019), *A. seniculus* (*U*=70, *p*=0.003; *U*=46.5, *p*=0.015) and *L. lagotricha* (*U*=80.5, *p*=0.037; *U*=46, *p*=0.048) using “All” and “Maijuna” data respectively; *A. seniculus* (*U*=58, *p*=0.009) using “Male” data; and *S. nigricollis* (*U*=801, *p*=0.048) and *A. seniculus* (*U*=35.5, *p*=0.037) using “Males & Maijuna” data (Table 6).

Table 6. Mean group size per species from Field Surveys and TEK_{mean} and TEK_{min} using “All”, “Males”, “Maijuna”, and “Males & Maijuna” data.

	Field Survey	All		Males		Maijuna		Males & Maijuna	
		TEK_{mean}	TEK_{min}	TEK_{mean}	TEK_{min}	TEK_{mean}	TEK_{min}	TEK_{mean}	TEK_{min}
S. nigricollis	4.53	11.23***	6.52*	11.41***	6.04	13.04***	6.91*	14.43***	6.87*
S. sciureus	20.72	34.09**	20.36	40.5*	23.86	30.32	17.48	36.47**	21.06
C. lucifer	2.26	4.08***	2.76	4.05***	2.76	4.04***	2.65	3.97***	2.56
P. monachus	3.22	4.87***	3.11	5.22***	3.07	4.7*	2.84	4.93**	2.8
C. albifrons	5.44	11.65*	6.65	14.77***	8.14	11.5	6.86	15**	8.64
A. seniculus	2.11	8.63***	5.8**	7.87***	4.67**	5.72***	3.87*	5.59***	3.56*
L. lagotricha	23.43	24.48	13.2*	31.23	16.36	21.92	13.31*	24.84	15.5

*p<0.05, **p<0.01, ***p<0.001

Differences between groups were analyzed using Mann-Whitney "U" test

Species are in order of increasing body mass

Comparison of habitat use between field surveys and TEK

According to field survey data, *S. nigricollis, P. monachus,* and *A. seniculus* species showed significant habitat specialization (p<0.05; Table 7). *S. nigricollis* and *P. monachus* used upland forests significantly more than expected, and the later used *Mauritia flexuosa* palm swamps two times more frequently than expected. *A. seniculus* preferred *Mauritia flexuosa* palm swamps five times more than expected. All 11 sightings of *L. lagotricha* occurred in upland forests, prohibiting a more detailed statistical analysis of its habitat preference. *S. sciureus, C. lucifer* and *C. albifrons* were found in all types of habitats and did not show significant habitat preference (Table 7).

Table 7. Observed and expected frequency of use of different habitat types per species along the Sucusari River.

Habitat	Percentage of sampling effort	*S. nigricollis*		*S. sciureus*		*C. lucifer*		*P. monachus*		*C. albifrons*		*A.seniculus*		*L. lagotricha*	
		Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.
Upland	68.35	142	123.03	17	17.09	56	52.63	49	42.38	11	13.67	5	6.83	11	-
Floodplain	28.31	35	50.96	7	7.08	16	21.80	9	17.55	7	5.66	0	2.83	0	-
Mauritia Flexuosa Palm Swamp	3.34	3	6.02	1	0.84	5	2.57	4	2.07	2	0.67	5	0.33	0	-
N observations		180		25		77		62		20		10		11	
X^2 (2 d.f)		**9.44, P=0.009**		0.319, P=0.984		4.06, P=0.132		**7, P=0.03**		3.48, P=0.176		**69.4, P<0.001**		Not Applicable	

Habitat use, using TEK, was assessed using the percentage of habitat use responses of individuals who were able to correctly identify the primate species and its presence in the Sucusari River basin. Thus, the number of responses varied according to each species. Out of the 50 interviewees the number of responses used per species was: *S.*

nigricollis (n=44), *S. sciureus* (n=44), *C. lucifer* (n=38), *P. monachus* (n=47), *C. albifrons* (n=31), *A. seniculus* (n=42) and *L. lagotricha* (n=47). According to TEK, the highest percentage of responses for *S. nigricollis* (50%), *S. sciureus* (59%), *C. lucifer* (50%), *P. monachus* (40%) and *C. albifrons* (74%) showed that "All" types of habitat were used similarly. Habitat use for *A. seniculus* was similarly distributed in *Mauritia flexuosa* palm swamp (29%) and "All" (26%) types of habitat. *L. lagotricha* could be considered habitat specialist, it was reported to be mostly located in upland forests (60%) (Figure 4).

The percentage of responses of only "Males" and "Maijuna" were selected, and the results showed the same pattern. *L. lagotricha* was reported to be mostly located in upland in both groups: Males=66%, Maijuna=69%. For the remaining species, "All" types of habitats were used similarly, except for *A. seniculus*. *A. seniculus* showed inconclusive results given similar responses between "All", "*Mauritia flexuosa* palm swamp", "Upland and *Mauritia flexuosa* palm swamp", and "Upland and Floodplain" (Data shown in Appendix IV).

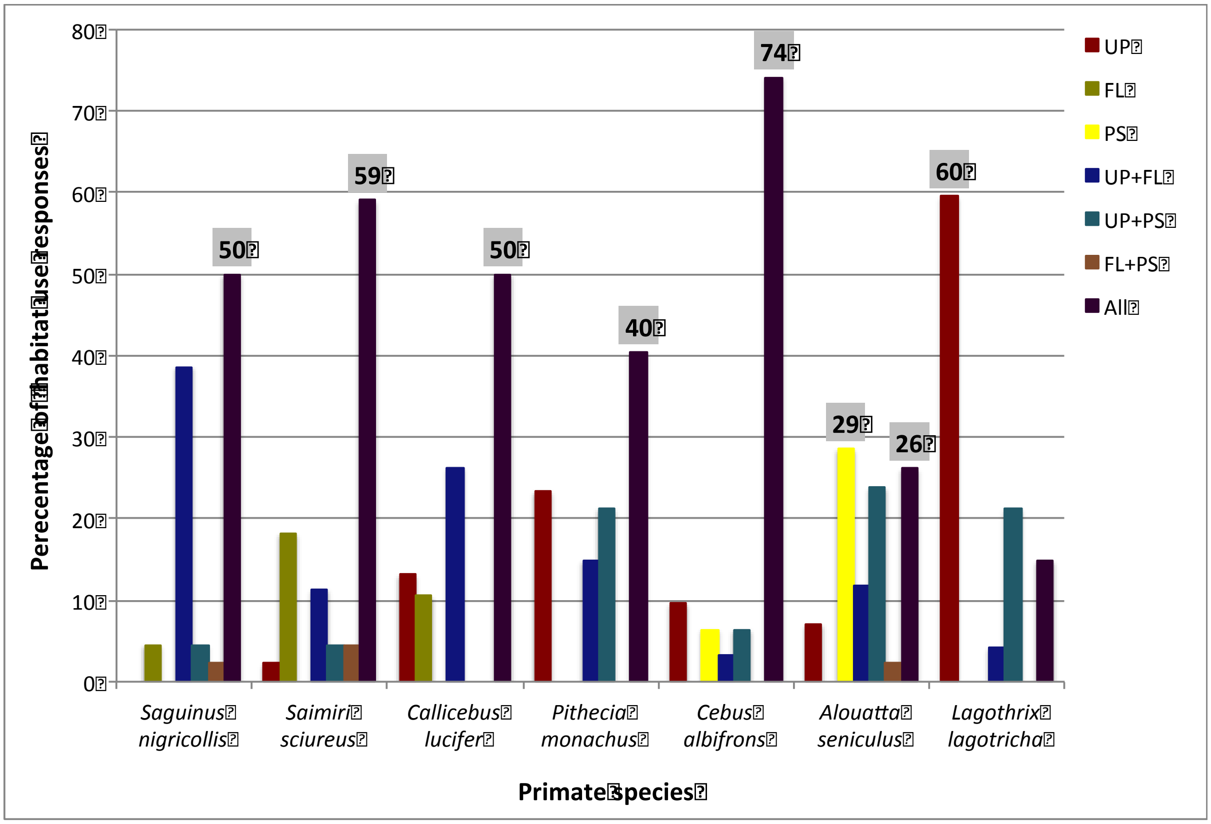

Figure 4. Percentage of habitat use responses per primate species using TEK. Habitat abbreviations are: (UP) Upland, (FL) Floodplain, (PS) *Mauritia flexuosa* palm swamp, (UP + FL) Upland & Floodplain, (UP + PS) Upland & *Mauritia flexuosa* palm swamp, (FL + PS) Floodplain & *Mauritia flexuosa* palm swamp, and (All) Upland, Floodplain and *Mauritia flexuosa* palm swamp. Species are in order of increasing body mass.

Uses, traditional beliefs and stories of primates

Participants were asked to list all the known uses for each primate species. Among all responses given primate species were used as a food source, pets, domestic tools (i.e., duster, house ornamentation, hyoid bone of the red howler was used as a cup) and in the development of handicrafts (Table 8). Although it was not part of the questionnaire, some respondents provided further information regarding primate food preferences. Three respondents reported that *L. lagotricha* was considered the preferred primate species to hunt, not only for its size but also for its flavor. Hunting woolly monkeys was preferable during the fruiting season of “leche huayo” (*Couma macrocarpa*), also called “leche caspi”, due to their increased body fat content during that period.

Although *A. seniculus* is one of the largest primates, and had been eaten by all the respondents, it was not described as “tasty” by any of the respondents. In the Maijuna culture, red howlers were not frequently eaten in the past due to food taboos or avoidance, as it was considered a sorcerer (see explanation below). *P. monachus* –a medium-sized monkey- was reported as a very tasty primate meat by one respondent. Though medium-sized and small monkey species were also eaten (except for *C. pygmaea*), these were not frequently hunted due to their size. Many respondents reported: “*it is not worth it to waste shotgun cartridges on small animals*.” Nonetheless, *S. nigricollis* and *A. vociferans* were hunted in times of game scarcity – a situation that did not occur in the area at the time of study.

During interviews, all primate species confirmed to be present in the study area had been raised as pets by at least one individual. Respondents indicated some preferences as well. *A. seniculus* (67%) and *C. albifrons* (78%) were some of the primate species with the lowest percentage of responses. The former was rarely kept as a pet because their loud calls disturbed household members; and the latter was considered mischievous and restless, which was the reason why it was difficult to keep as a pet. *S. nigricollis* was reported as a pet that helps to keep the house clean due to their insectivorous behavior. Among all the species, *L. lagotricha* was the most commonly reported pet species (98%), and the only observed pet in the village during surveys.

Moreover, the tails of *P. monachus, C. discolor*, and *C. lucifer* were reported to be used as house dusters, especially those from monk sakis (48%) because of their bushy appearance. Tiny bones and teeth of *S. sciureus, C. discolor, P. monachus, C. albifrons*, and *A. seniculus* were used in handicrafts. The hyoid bone, which is one of the most salient features of the red howler monkey, was used as a cup to drink beverages or in handicrafts and it was commonly referred as "*coto*" or "*huingo*." Furthermore, some respondents reported digestive and throat medicinal treatments using the tail and hyoid bone of *P. monachus* and *A. seniculus*, respectively.

The large majority of Maijuna traditional stories associated with primates described the origin, physical attributes, diet and calls of the primate species found along the Sucusari River. For the Maijuna, primates descended from humans and were created by *Maineno*, their traditional Creator. The transformations performed by *Maineno* helped the Maijuna to understand and explain the primate diversity found in the Sucusari River basin. The creation of various monkey species is detailed in the traditional Maijuna stories presented in Appendixes V. A., B, C, and D. Nonetheless, *C. pygmaea*, *A. vociferans,* and *S. macrocephalus* were not included in the monkey creation story by any of the respondents. In Kichwa mythology only *A. seniculus* and *C. discolor* have a story that symbolize physical attributes of both species (Appendix V. E.).

Traditional beliefs in the community of Sucusari were based on ancestral dietary taboos, exclusively among the Maijuna (Table 8). In the past, Maijuna ancestors believed that red howler monkeys were sorcerers, which is the reason why they are sometimes called "sorcerer monkey" or *mono brujo* in Spanish. According to their beliefs, this monkey harmed kids and adults, and its meat was avoided. Although this belief does not continue anymore, every time someone eats it, it should be done in silence as a sign of respect. For instance, if someone says: "*I don't like the meat*", or if it is thrown away, it is believed that a tumor may appear in the body or throat of that person, which could lead to death.

Lagothrix lagotricha is one of the primate species that is deeply intertwined in Maijuna indigenous culture. Prior to 1974, this primate was used in the ritual of the first yearly harvest of *pijuayo* palm (*Bactris gasipaes*) fruits within the community of Sucusari. This fruit is eaten cooked or as a fermented beverage known as "chicha de pijuayo." The ceremony included the consumption of woolly monkeys, and this served as part of a traditional courtship ritual for the Maijuna. If a woman accepted a piece of woolly monkey meat given by a Maijuna man, then she was also accepting the man, similarly if she declined it meant that she was not interested in the man and was uninterested in his proposal.

The monk saki was considered a poisonous animal only for dogs, due to the "poisonous fruits" they eat in the forest. After it is eaten, any leftovers are discarded carefully. In case dogs get poisoned, their ears are cut in order to eliminate the venom. The night monkey, *Aotus vociferans,* was described as a devil monkey that used to eat people, especially hunters in their hunting camps. This belief was related to the local name of "buri-buri." One Maijuna villager affirmed that buri-buri is the Kichwa name for night monkey. As stated by a Maijuna villager**,** “Buri-buri is a group of monkeys that used to attack people in their hunting camps, they killed like jaguars. During the logging period, one of the loggers told me that they [buri-buri] killed a man while a group [of buri-buri] was singing in the forest. He [the man] heard the monkeys near a mineral lick, and then the monkeys attacked him. The following day, the rest of the group went to the place were his friend was killed, but he wasn’t there. For this reason, they are considered the devil of the forest. Nowadays, buri-buri don’t get close to people, they just sing.”

In order to elucidate if the night monkey and buri-buri were the same species, respondents were asked: (1) What is a buri-buri? (2) Does the buri-buri live in Sucusari?, and (3) What are the differences between the night monkey and buri-buri?. Among all respondents, 58% had never heard of buri-buri. Only 16% of the respondents agreed that “buri-buri” and the night monkey referred to the same animal and 26% alleged that they were different species. Differences between the night monkey and buri-buri were mainly explained by their distinctive calls, but not due to different physical appearance. The lack of physical differences was due to their nocturnal behavior making the identification of morphological traits more difficult.

Table 8. Traditional Maijuna[2] and Kichwa names, body mass, uses, beliefs, and stories for the primate species confirmed to be present in the Sucusari River basin.

Species	Maijuna name	Kichwa name	Mass (kg)	Use	Beliefs/Traditions	Story
Cebuella pygmaea	***camishishi***	***chambirisho***	0.1-0.14	Pet	-	No
Saguinus nigricollis	***chichi***	-	0.4-0.5	Edible, pet	-	Yes[c]
Aotus vociferans	***itɨ***	-	0.7-1.2	Edible, pet, used to test malaria treatments in the past	Devil monkey[c,e]	Yes[c]
Saimiri sciureus	***bo chichi***	***varisa***	0.6-1.4	Edible, pet, bones used as needles to sew handicfrafts, teeth used in handicrafts	They are the father-in law of the white-fronted capuchin, reason why they travel together in the same troop	Yes[c]
Callicebus discolor	***ñame bao***	***sukali***	0.9-1.4	Edible, tail used as a duster, pet, bones used as needles to sew handicfrafts	-	Yes[c,d]
Callicebus lucifer	***bao***	***yana-sukali***	0.8-1.5	Edible, tail used as a duster, pet	-	Yes[c]
Pithecia monachus	***baotutu***	***parahuaco***	2.2-2.5	Edible[b], tail used as a duster, decoration and to treat digestive disorders, pet, bones used as needles to sew handicfrafts.	Poisonous for dogs	Yes[c]
Cebus albifrons	***bo taque***	-	1.2-3.6	Edible, pet, bones and fur used for handicrafts	-	Yes[c]
Alouatta seniculus	***jaiquɨ***	***imú***	3.6-11.1	Edible, bones used as needles to sew handicfrafts, hyoid bone is used to drink water, in handicrafs, or for soar throats, fur is used to cover drums, commercialization of meat*	Sorcerer monkey	Yes[c,d]
Lagothrix lagotricha	***naso***	***arawata***	3.6-10	Edible, pet, commercialization of meat*	Used in the ceremony of the initial cultivation of "*pijuayo*" [last ceremony was performed in 1974]	Yes[c]

[a] Low preference

[b] High preference

[c] Maijuna, [d] Kichwa, [e] Mestizo beliefs, traditions, and stories

[*] Mentioned by 2 respondents

Source: Mass data from Emmons (1990)

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[2] Transcription of Maijuna words was accomplished with the help of S. Ríos Ochoa, a bilingual and literate Maijuna individual, using a practical orthography previously established by Velie (1981). The practical orthography developed by Velie consists of 27 letters that are pronounced as if reading Spanish, with the following exceptions: In a position between two vowels, *d* is pronounced like the Spanish *r*; *ɨ* is pronounced like the Spanish *u* but without rounding or puckering the lips; and *a̲*, *e̲*, *i̲*, *o̲*, *u̲*, and *ɨ̲* are pronounced like *a*, *e*, *i*, *o*, *u*, and *ɨ* but nasalized. Also, the presence of an accent indicates an elevated tone of the voice; accents are only used when the tone is the only difference between two Maijuna words and the word's meaning is not clarified by its context. The 27 letters that make up the Maijuna alphabet are *a*, *a̲*, *b*, *c*, *ch*, *d*, *e*, *e̲*, *g*, *h*, *i*, *i̲*, *j*, *m*, *n*, *ñ*, *o*, *o̲*, *p*, *q*, *s*, *t*, *u*, *u̲*, *y*, *ɨ*, and *ɨ̲*.

DISCUSSION

Monkey ("*mono*") definition

Respondents free listed the eleven primate species believed to be present in the Sucusari River basin. Therein, kinkajous, together with other mammal species were also referred to as monkeys. Kinkajous were mentioned by a high number of respondents (82%) during the freelisting. The perception of monkeys as a group that includes other arboreal mammal species, such as the kinkajou, is consistent with other ethnobiological classification systems in other areas of the lowland Neotropics (Lizarralde, 2002; Urbani, 2006; Papworth *et al.* 2013). For instance, the Huaorani indigenous group in Ecuador, grouped species such as kinkajous and olingos as primates due to their arboreal lifestyles, nocturnal behavior like the night monkeys, and the presence of hands instead of paws (Papworth *et al.* 2013).

For the villagers in the community of Sucusari, behavioral and physical attributes were also important factors defining primates as a group. Although there was not a wide consensus on the definition of a monkey, they were defined particularly by their arboreal lifestyle and the fact they can climb within and jump between trees, which represent one of the key characteristics of New World monkeys (Rosenberger and Hartwig, 2001). These characteristics were substantial reasons to include other mammal species with these characteristics in the group of primates. The purpose of using TEK to assess primate diversity was not to impose Western scientific knowledge, but to inform conservation, accepting different cultural perceptions of the natural world.

Primate diversity and cultural salience

Ten out of the eleven primate species assumed to be present in the Sucusari River basin were encountered during the field surveys; *C. pygmaea* was the only exception. Our failure to detect this species could be due to their high degree of habitat specificity, restricted to river-edge forest (Soini, 1982; de la Torre *et al.* 2000; Aquino *et al.* 2014), its small size and/or its highly camouflaged nature (Palminteri *et al.* 2011). TEK derived from the interviews supported the habitat specificity of pygmy marmosets to river-edge and floodplain forests. Additionally, respondents provided information regarding where this species could be found based on their primary food source, such as the sap oozed from cashu caspi trees (*Anacardium giganteu*) (Izawa, 1976).

The presence of *Sapajus macrocephalus* along the Sucusari River was inconclusive given that there was no agreement among the respondents regarding its presence since only 10% mentioned it during the freelisting, plus it was frequently confused with *C. albifrons* during the photo identification exercise. Perhaps, the photo used for *S. macrocephalus* was not as high quality as required to differentiate the two species. Moreover, within that 10% of respondents that affirmed the presence of *S. macrocephalus* in the river basin, two were Maijuna and three were mestizos who were not born in Sucusari. Given that there was one visual encounter during the field surveys, this could be explained by: (1) an extremely fragmented distribution and low density in this area, (2) an error in identification, or (3) the occurrence of this monkey in Sucusari lands may in fact be due to the presence of the ExplorNapo Lodge. The lodge may have brought this species and released it into the area. However, it should be emphasized that the most active hunters in the community agreed that this species was not present along the Sucusari River. Due to the high level of uncertainty regarding this species further research is needed to determine its presence in the Sucusari River basin.

Primate species diversity assessments require the identification of primates at the species level. Two species of titi monkeys were reported during the field surveys, but were not discerned by most of the respondents (61%) during the freelisting. Fleck *et al.* (1999) referred to the latter as "*underdifferentiation*," and it occurs when a single folk-biological name is attributed to more than one biological species.

Indigenous and local communities classify animals using what is known as "*ethno*-or *folk- taxonomy*." Folk-taxonomy, important within the field of TEK, is a way to classify organisms and organize local knowledge (Atran, 1998; Souza and Begossi, 2007). This classification system may vary among individuals or groups of people due to the salience of each organism in their local habitat, and the similarities and differences that can be identified among recognized groups (Souza and Begossi, 2007). According to the folk-biological ranks established by Berlín (1992), the "generic-species" rank is the core of folk taxonomy, and it often relates to scientific genera or species. In the present study, the Spanish common names entailed the genus of primate species; but in some cases the respondents did not determine precisely to what species (i.e., *C. discolor* or *C. lucifer*) they were referring. Unlike the Spanish common names used by several participants, the Maijuna folk-taxonomy differentiated between primate species (i.e.,

ñame bao for *C. discolor*; and ***bao*** for *C. lucifer*). Unfortunately, given the rapid loss of Maijuna traditional knowledge and language (Gilmore *et al.* 2013; personal observation), just eighteen out of the twenty-six Maijuna individuals interviewed were able to provide the Maijuna names of primates.

For instance, "*pichico*" is the name applied to tamarins in the *Saguinus* genus of the Callithricidae family (Brownrigg, 1996). Tamarins are one of the most diverse primate genera, with about 35 recognized taxa that can be distinguished mainly by differences in pelage coloration (Matauschek *et al.* 2011). However with one single folk biological name, the identification of a particular species becomes challenging, even more so when tamarin species are sympatric with each other (i.e., *Saguinus fuscicollis* and *Saguinus nigricollis*; Bicca-Marques, 1999).

One way to guarantee that all the focal species are included and correctly identified as a unique animal type is for researchers to use high quality photographic methods during interviews, taking into consideration the inclusion of similar sympatric species. Visual differentiation improves the accuracy and reliability of information obtained from local people (Papworth *et al.* 2013) and in this study helped to reaffirm the presence of the two species of titi monkeys in the Sucusari River basin. Nonetheless, in some cases, visual differentiation was not enough to disentangle the folk taxonomy caused by *underdifferentiation*. Incorrect identification of primate pictures was mainly due to the non-identification of the animal, but also by the lack of visual differentiation between species of the same Genus or Family. For instance, respondents were confused when trying to differentiate photos between *S. sciureus* and *S. boliviensis* and *L.*

lagotricha and *L. poeppigi*. Consequently, if no field surveys were carried out there would have been no certainty regarding the specific primate species inhabiting the Sucusari River basin, especially for sympatric and similar species.

Six primate species were both correctly named and properly identified from a photo by the majority of the respondents (>80%): *L. lagotricha, A. seniculus, P. monachus, C. discolor, S. sciureus,* and *S. nigricollis*. These primates were also culturally salient species; except for *C. discolor*. In the case of titi monkeys (*C. lucifer* and *C. discolor*), the two species were grouped into one category (*Callicebus spp.*) for the cultural salience analysis. Although *Callicebus* was a genus with high cultural significance it was not possible to determine which of the two species, *C. discolor* or *C. lucifer*, was the one with highest cultural salience due to the occurrence of *underdifferentiation*. Nevertheless, based on the photo identification exercise it could be inferred that *C. discolor* had the higher cultural salience given its higher percentage of recognition (90%) in comparison with *C. lucifer* (78%).

The results suggested that these six primates were particularly important to the villagers in the community of Sucusari. A first group, comprised of *L. lagotricha*, *A. seniculus,* and *P. monachus*, the primate species with greater body mass, still play important roles within Maijuna cultural traditions, uses and stories (See Discussion: *Uses, Traditional beliefs and Stories of Primates*). A second group, *S. sciureus*, *Callicebus spp*. and *S. nigricollis*, were comprised of the small sized primates; *S. sciureus* can be found in large troops (~60 individuals, see Table 5), and were frequently seen along the riverbanks. Considering that most of the villagers, including men and women, spent large amounts of time on the river (See Table 1), the probabilities of seeing troops of *S. saimiri* were high. In the case of *Callicebus spp*., explanations are uncertain but it is suggested that if *C. discolor* was the species to which they were referring, then these monkeys were regularly seen along the riverbanks, and their songs were commonly heard near the village in the early mornings. *S. nigricollis* was the most abundant primates within the river basin, especially in upland and floodplain forests (See Table 4). These factors could explain why these three species had the highest cultural salience among all primates.

Dougherty (1978) pointed out that salience of biological organisms is shaped by the degree of interactions between people and these organisms. Therefore, salience of particular organisms could be reflected by its cultural importance and/or its abundance in the environment (i.e., species that occur more frequently would be more recognized and named). In this study, sociocultural importance (i.e., *L. lagotricha*, *A. seniculus* and *P. monachus*) and higher abundance (i.e., *S. saimiri*, *Callicebus spp*., and *S. nigricollis*) of certain primate species could be critical factors influencing the use of TEK to assess primate diversity.

Through the selection of important demographic characteristics of the group interviewed it was possible to identify local individuals who provided more reliable information. It should be stressed that the majority of the respondents were able to list and identify most of the primates in the Sucusari River basin. However, male Maijuna hunters were the individuals who provided the most accurate information based on the correct identification and location of the overall primate community in the Sucusari River basin through the identification of photos. As expected, the individuals within this group were able to recognize the majority of primate species due to the amount of time spent in the forest, and the long connection with their ancestral lands. It is important to highlight that the predictor variables used (gender, age, ethnicity, and years of education) only accounted for ~45% of the variation in the correct identification and location of the primate species. Therefore, there were other factors (e.g., main subsistence activities carried out by interviewees, monthly expenditures as an indicator for monetary earnings, quality and resolution of the photos) not included in the analysis that could have influenced the identification of primates.

The use of TEK as a tool to replace expensive field surveys to assess primate diversity was useful as well as cost and time effective. Nonetheless, underdifferentiation represents a big challenge for the scientific community, and for this reason the use of TEK is recommended as a complementary method to augment field survey data. Three important points should be considered when using TEK as a complementary approach: (1) it is critical to ensure that the interviewees and researchers are referring to the same taxonomic group, (2) high quality photographic methods should be utilized to identify with certainty the species located in the area of study, including similar sympatric species, and (3) local experts should be identified to obtain the most reliable and detailed information.

Comparison of group size between field surveys and TEK

For all primate species, TEK_{mean} group size was significantly larger than field survey data except for *L. lagotricha*. This pattern was similar using data from the different groups of participants (All, Males, Maijuna, and Males & Maijuna). However, using solely Maijuna data, TEK_{mean} group size was similar to field survey data not only for *L. lagotricha* but also for *S. sciureus* and *C. albifrons*. On the contrary, TEK_{min} group size was similar to field survey data for the majority of primate species.

Two possibilities could explain the above findings: (1) underestimation of group size using the line-transect technique or (2) overestimation of group size using TEK. Several assumptions and limitations of using the line-transect technique have been described (Buckland *et al.* 2001; Marshall *et al.* 2008). According to Marshall *et al.* (2008), the most challenging are taking exact distance measurements and lack of certainty of detection of objects on or near the transect given that in dense habitats, such as tropical rainforests, there is a high likelihood that individuals are skipped on the transect. Additionally, different factors (e.g., presence of fragmented groups, cryptic behavior, and changes in activity profile) can reduce the detectability of certain species, both in intact or disturbed forests (Defler and Pintor, 1985; Johns, 1985).

In the Sucusari River basin, researchers encountered some of these difficulties to a larger extent than others. The most frequent primate response to humans was to flee, reducing the chances of obtaining accurate group size counts. The intensive illegal logging experienced from 2000 to 2008 in the river basin and the fact that villagers continue to hunt primate populations could explain the cause of this behavior. Moreover, the occurrence of fragmented or increased dispersion of groups and their cryptic nature (e.g., *A. seniculus*, *P. monachus*) could be potential factors for greater similarities between field survey and TEK_{min} data.

Although no method used to estimate density of primate groups is free of bias, the most accurate estimations are attained from complete group counts (McNeilage *et al.* 2001; Davenport *et al.* 2007). Given the reduced detectability and visibility experienced during the line transects, results could have underestimated the real group size of primate species. However, the “effective-distance” method allowed the identification of reliable group size counts (Whitesides *et al.* 1988), thus discarding the former possibility.

L. lagotricha was the only species that showed no difference between field survey and TEK_{mean} group size, among all the different groups of participants (All, Males, Maijuna, and Males & Maijuna). Silveira *et al.* (2003) states that line transect techniques are dependent on favorable field conditions, well-trained researchers, and are biased towards large-bodied diurnal species. Woolly monkeys are one of the large-bodied primate species found within the river basin, which could have favored researchers and local people’s accuracy on data collection. Even excluding their larger size, woolly monkeys are embedded in an intricate socio-cultural system, highlighting a cultural importance for Amazonian indigenous people, including the Maijuna (See Discussion: *Use, Traditions and Stories of primates*). Therefore, group size data provided by TEK could possibly be overestimating values for smaller and less culturally important primate species within the Sucusari River basin.

Comparison of habitat use between field surveys and TEK

The assumption that primate species spend more time in preferred areas within their home range is explained by the availability of feeding resources or resting sites in such areas (Warner, 2002). Therefore, primate and habitat associations are critically important for ecological studies and conservation planning. Upland forests, due to a high variety of plant communities, are known for harboring high primate species richness compared to floodplain forests (Peres, 1997).

Considering primate communities within the Sucusari River basin, all of the upland forests combined harbored the seven species analyzed in the study. Among these species, *L. lagotricha* was solely encountered in this forest type and were mostly found in the study sites further away from the village, especially in the upper part of the basin. In the Western Brazilian Amazon, *L. lagotricha* appeared to avoid flooded forests (Peres, 1993; Haugaasen and Peres, 2009). Nonetheless, Rylands (1987) reported brief incursions into flooded habitats during seasons with high fruit abundance. Peres (1997) had classified it as an upland specialist primate species, corroborating this study's results and the information provided by TEK.

A higher relative abundance of *A. seniculus* in *Mauritia flexuosa* palm swamps (Table 4) and their occurrence in this habitat five times more than expected (Table 7), confirmed their preference for flooded forests, especially *Mauritia flexuosa* palm swamps, where high primate densities have been reported in other areas in northeastern Peru (Bodmer *et al.* 1997; Aquino *et al.* 2001). The low percentage of *Mauritia flexuosa* palm swamps (3%) in the present study led to a lower sampling effort compared to the other two habitats described, possibly explaining the lower encounter rates of this species. Mittermeier *et al.* (2013) described their preference for flooded forests, especially for those flooded annually by silt-rich white water, and for mineral licks. Although these results were not completely underpinned by TEK, given that similar responses were reported between *Mauritia flexuosa* palm swamps and "All" types of habitats, it had been the only species reported to solely inhabit *Mauritia flexuosa* palm swamps throughout the year.

C. albifrons has been reported to inhabit a variety of habitat types (Terborgh, 1983), and in tropical lowland rainforest in southeastern Peru, *C. albifrons* showed no habitat preference between upland and floodplain forests during the dry season (Warner, 2002). The results from field surveys and TEK revealed that all habitat types were used similarly by this species, hence supporting the above findings. *P. monachus* has been reported to occupy uplands, white-water seasonally inundated forests and *Mauritia flexuosa* palm swamp forests (Mittermeier *et al.* 2013). Along the Sucusari River, *P. monachus* used upland forests and *Mauritia flexuosa* palm swamps more frequently than expected. Despite the majority of TEK responses indicated the use of all types of habitats similarly by *P. monachus*, the subsequent high percentages of responses (upland=23%; upland and *Mauritia flexuosa* palm swamps=21%) corroborated the field survey findings.

In Peru, *C. lucifer* appears to prefer white-sand or sandy clay soil habitats, and swamps are not favored (Mittermeier *et al.* 2013). In the present study, no habitat preference was found either during field surveys or through TEK. Among the species found in floodplain forests, *S. sciureus* was the most abundant species in this habitat. Although no significant habitat preference was demonstrated in this study, neither during the field surveys nor interviews, some authors have considered it a primarily floodplain forest species due to their frugivorous and leaf-gleaning insectivore behavior (Peres, 1997; Haugaasen and Peres, 2005). Conversely, Terborgh (1983) and Warner (2002) highlighted the lack of preference for either upland or floodplain forests, thus occurring in varied habitats. Mittermeier *et al.* (2013) described *S. nigricollis* occupying mainly upland forests in Ecuador, although group home ranges included white-water flooded forest dominated by *Mauritia flexuosa* palms as well as black and white-water flooded forests. Field survey data showed significant habitat preference for upland forests, while TEK indicated the use of all types of habitat.

The qualitative nature of TEK to analyze habitat use is a factor that could have biased the present results, and therefore must be viewed with caution. Even so, primate species that showed similar habitat use between TEK and field survey data were *S. sciureus* (“All”), *C. lucifer* (“All”), *C. albifrons* (“All”), and *L. lagotricha* (“Upland”). *S. nigricollis*, *P. monachus* and *A. seniculus* showed significant differences in habitat use during the field survey but not through TEK.

Comparing field survey and TEK results, it is certainly reasonable to conclude that *L. lagotricha* used mainly upland forest within the Sucusari River basin. Even though the low number of sightings of *L. lagotricha* prohibited a robust statistical analysis, all encounters occurred in upland forests. This preference was corroborated by TEK, given that 60% of participants indicated exclusively upland forests as the main habitat type used. The lack of habitat preference for *S. sciureus*, *C. lucifer* and *C. albifrons* had been supported by the present study and TEK responses. However, TEK results for these latter species should be taken cautiously. Firstly, given the high use of riverside areas (260 days per year, See Table 1) by the interviewees, this could have introduced bias on habitat use responses. Similarly, field surveys did not include the first 100 meters of riverside habitats owing to reduced accessibility. Secondly, since TEK is perhaps overestimating group size data of smaller or culturally less important species, then habitat use results could also be explained by respondents' uncertainty for smaller or culturally less important species.

Uses, traditional beliefs and stories of primates

The study of the interconnection between humans and other primates is known as *ethnoprimatology*, where humans are considered an integral part of the primate ecosystem (Fuentes, 2012). The role of primates in several indigenous cultures in the Amazon has demonstrated how important they are within their livelihoods and lifestyles (Cormier, 2006).

Primates are an important food source for several Amazonian indigenous groups, and in some regions they are considered one of the most delicious mammals within their diet (Robinson and Bodmer, 1999; Ohl-Schacherer *et al.* 2007), which is one reason why hunting for bushmeat poses a critical threat to primate populations (Chapman and Peres, 2001). Primate meat is valuable because it provides an important protein source for local and indigenous people, especially primates of the subfamily Atelinae (i.e., genus *Alouatta*, *Ateles*, *Lagothrix*, and *Brachyteles*) due to their greater biomass (Chapman and Peres, 2001; Di Fiore *et al.* 2011). Primate consumption by indigenous people in the Amazon indicates a preference for larger primate species, whereas medium and small-sized monkeys are considered less desirable (Mittermeier, 1987; Shepard, 2002; Cormier, 2006; Papworth *et al.* 2013). Peres (1990) documented primate-hunting preferences of a single rubber tapper family in the western Brazilian Amazon, where within a period of 18 months, 200 woolly monkeys, 100 spider monkeys, and 80 howlers were killed. Likewise, Yost and Kelley (1983) reported 562 woolly monkeys and 146 howler monkeys being killed by indigenous Huaorani hunters, in Ecuador, within a period of 275 days. In Peru, *Lagothrix spp*. and *Ateles spp.* are the preferred hunted species for the Matsigenkas (Shepard, 2002).

The inhabitants of the Sucusari community were not an exception. Primates are hunted primarily for local consumption, but also for their commercial value (i.e., only *L. lagotricha* and *A. seniculus*). The commercialization of bushmeat in the nearest cities, such as Mazán and Iquitos, represented an important source of income for the community of Sucusari (Gilmore *et al.* 2013), but given that only two respondents mentioned the commercialization of primate meat during the interviews, this could indicate that primates are not frequently targeted for this activity. All of the primate species found in the river basin were targeted for hunting, except for *C. pygmaea*. Large and medium species such as *L. lagotricha* and *P. monachus* were reported as the tastiest and most preferred species to hunt. Although, *A. seniculus* was reported as a hunted primate, it was not one of the preferred edible species. Some respondents claimed that its meat is less tasty, possibly due to their leaf-eating habit, as opposed to other frugivorous monkeys (Kay, 1990; Di Fiore *et al.* 2011). Moreover, Maijuna traditional beliefs regarding this species, which is considered a sorcerer monkey by Maijuna ancestors, could also reflect cultural attitudes against its consumption. Similarly, the Matsigenkas (Shephard, 2002), and Matses in Peru (Voss and Fleck, 2011), and Barí in Venezuela (Lizarralde, 2002) claimed that howler monkey meat is avoided due to its distasteful meat and cultural taboos (i.e., possessors of spiritual hazards).

The capture of primate infants as pets is commonly reported in the Amazon as a byproduct of hunting (Mittermeier, 1987; Chapman and Peres, 2001; da Silva *et al.* 2005). It is done through seeking female primates with their infants and retrieving them from their mothers when both have fallen to the ground. Although data to support this information was not gathered, it is considered relevant to highlight that selective hunting of females represents a serious challenge for the sustainability of primate populations and subsistence hunting. Selective hunting of females leads to skewed sex ratios in primate populations, which is exacerbated by their low reproductive rates (Redford and Robinson, 1985), especially for Atelines, reported as the preferred primate prey and pet among several indigenous communities in the Amazon (Mittermeier, 1987; Shepard, 2002; Cormier, 2006; Di Fiore *et al.* 2011; Papworth *et al.* 2013). During this study, woolly monkeys were the only primates being kept as pets by one Maijuna woman in the village and the two monkeys were treated almost like family members (e.g. she gives them *masato*, treats them with medicines if they have malaria or other illnesses) and given personal names.

TEK about natural resources, particularly about species that are commonly consumed as food or used within cultural traditions, is gathered throughout an individual's life and is a faithful reflection of the way of learning from and about the environment (Winter, 2000). Understanding the use and cultural importance of particular primates species for an indigenous community represents an important factor to assess primate populations for numerous reasons. First, indigenous communities are an incredible source of traditional knowledge, repositories of innumerable experiences and observations linking humanity with its ancient origins (Gray, 1999; Bennett, 1999). Second, TEK provides an interactive association between anthropology and primatology, needed to develop effective conservation strategies that will allow the survival of both human and nonhuman primates in the same area (Dolhinow, 2002; Parathian and Maldonado, 2010). In this respect, primate conservation not only requires the collection of ecological data, critical to environmental monitoring and to successfully create management plans for primates' species. But it also requires the complete understanding of complex issues and conflicts of nonhuman primates and humans who live alongside them (Pavelka, 2002; Parathian and Maldonado, 2010). The complexity and uncertainty of ecological processes are based on interrelationships between nature, people and culture. Only integrating them into a single framework will provide us with a better understanding which is especially critical for effective conservation and management.

Maijuna traditional stories disentangle primate natural history such as the origins, traits and interrelationships between species found in the Sucusari River basin, making these a rich and important source of information to explain primate diversity as well as other important biological characteristics. For instance, *L. lagotricha* (***naso***) and *S. nigricollis* (***chichi***) were associated in the Maijuna monkey creation story (Appendix V. A.) told by three interviewees; the individual who wanted to become a ***naso*** did not replicate its powerful call. Thus, *Maineno* converted him into a smaller black primate, *S. nigricollis* (***chichi***). A similar situation occurred between *A. seniculus* and *Callicebus* *spp.* These transformations could represent the imposing appearance of these two large-bodied species (*L. lagotricha* and *A. seniculus*), making them difficult to match with other primates. Furthermore, the description of particular traits, such as the hyoid bone and red color characteristic of *A. seniculus* were explained through the placement of a calabash fruit (*Crecentia cujete*) into the throat of the individuals that were converted into this species and the use of *achiote (Bixa orellana)* to paint their bodies red, respectively.

Traditional stories for indigenous people symbolize unity, creation of their own bonds, and shared understanding (Dallam, 1991). Most of these stories document the creation of their lands by their ancestral beings and provide ethical and moral foundations on which indigenous people are built (Bennett, 1999). The Maijuna monkey creation story is rooted in their mythology, and reflects the close relationship between humans and nonhuman primates. Likewise, the Barí indigenous group explained the origin of monkeys through the transformation of Barí people to monkeys by their creator *Sabasebae*, as a means to obtain fruits from trees (Lizarralde, 2002). Maijuna traditional stories are an example of how all elements of nature are part of a complex web of interactions that emphasize the symbiotic character of humans and nature, making no distinctions between empirical and spiritual values (Posey and Dutfield, 1996; Nakashima and Roué, 2002).

Conservation implications

Current conservation efforts highlight the importance of using interdisciplinary approaches as a way to gain a better understanding of the ecosystem. Wildlife, in this case primate populations, exist within a complex ecosystem, sharing space with other species including humans. Although, the latter point is well known by conservationists, the participation of indigenous people in conservation efforts is not fully recognized and difficult to accomplish (Huntington, 2000).

The main reason for this failure is due to the continuous marginalization of indigenous people (Huntington, 2000). Our environment and society need urgent and rapid conservation efforts. Conservationists need to start thinking across boundaries, accepting different ways of seeing the world, new ways of designing research, and more importantly accepting new ways of learning.

The importance of the role of indigenous people in conservation is increasing (Redford and Stearman, 1993; Charnley *et al.* 2007; Prado *et al.* 2014; Parry and Peres, 2015). For the Maijuna, the increased contact with outsiders and missionaries, a western education system that does not value TEK, the entry of mestizos into their communities, and their integration into market economies has led to a disconnection with their cultural practices, causing a rapid loss of their traditional knowledge (Gilmore *et al.* 2013), commonly recognized as *acculturation* (Reyes-García *et al.* 2014). In the community of Sucusari, acculturation is manifested in younger generations, where cultural knowledge – especially the Maijuna language and traditional stories – is being lost at fast rates, thus endangering cultural and biological diversity (Gilmore *et al.* 2013; personal observation). Despite this situation, villagers still rely on traditional food sources and maintain some of their cultural traditional beliefs. Their degree of connection with certain species more than others could explain the main findings of this research.

The results of this work demonstrated that the villagers of the community of Sucusari were aware that the term monkey belongs to a specific group of animals that live in trees. Even though the majority of interviewees did not distinguish primates from other arboreal non-primate mammal species, respondents were capable of recognizing the primate diversity within the Sucusari River basin. Abundant, large-bodied, or culturally important primate species (e.g., *S. nigricollis, S. sciureus, Callicebus spp*., *P. monachus, A. seniculus*, and *L. lagotricha*) were more frequently listed and recognized by almost all the respondents. In terms of ecological data for species – group size and habitat use – large-bodied and culturally important primates, such as *L. lagotricha,* were the species that generally shared more similarities between TEK and scientific data. The cultural reasons that could explain this outcome for *L. lagotricha* are: (1) given its size and flavor it is the preferred edible primate species, (2) it is frequently kept as a pet, (3) they have been used as an important ceremonial food by Maijuna ancestors, and (4) they are included in Maijuna traditional stories. Some ecological considerations are their large body size and the formation of large troops, making them easier to spot.

TEK is an important tool to enhance high-cost and time-intensive scientific sampling methods**,** especially for large-bodied primate populations and those significant to local cultural traditions. It should be used cautiously and target local community experts (e.g., male Maijuna hunters). Moreover, TEK provides a better understanding of the significance of primates in people's lives, thus its study and documentation is critical for primate conservation in areas where humans and primates coexist. Complementary use of TEK and scientific knowledge is highly recommended, not only because they are both important in terms of resource management, but also because the advantages and disadvantages of each of them counterbalance to accomplish effective conservation planning and sustainable management. Firstly, the diachronic nature (long time series) of TEK can overcome some of the inherent difficulties of primate monitoring such as low encounter rates and non-detection of certain species (e.g., *C. pygmaea*), strengthening scientific data. Secondly, collecting TEK in addition to scientific data allows for a more holistic approach, which is required for successful conservation and sustainable management (Mazzocchi, 2006). Nevertheless, one of the main disadvantages of TEK was the occurrence of *underdifferentiation* (e.g., titi monkeys), which happens when a single folk-biological name is attributed to more than one biological species. Thus, relying solely on TEK would not have been sufficient to identify with certainty all the primate species found within the Sucusari River basin.

Further research regarding hunting practices and pressure should be taken into account given that larger species, like *L. lagotricha* and *A.seniculus*, were found in the middle and upper part of the Sucusari River basin but were absent in the vicinity of the village, and far from the river margins. Shepard (2002) and Aquino *et al.* (2008) found the same distribution pattern along the Itaya River (Loreto-Peru), especially for *Lagothrix poeppigii*. Hunting pressure pushes larger species to take refuge in remote or inaccessible areas, possibly explaining the low encounter rates of these two species. Finally other aspects of primate assessments, such as abundance or population density and geographic distribution should be considered.

The results of this work stress the importance and benefits of including TEK within conservation efforts, highlighting the reliability of data from large-bodied and cultural important primate species. Documenting TEK enriches scientific work, but more importantly it ensures indigenous knowledge endures and is valued by future generations.

Appendix I. Questionnaire

1. Name
2. Age
3. Gender
4. Are you Maijuna?
    4.1 Yes
    4.2 No
        4.2.1 If No, what group do you belong?
5. Where were you born?
6. How long have you been living in Sucusari?
7. How many years did you attend school?
8. How often do you go to the forest?
9. How often do you go fishing?
10. Do you hunt?
    10.1 Yes, since when?
    10.2 No
    10.3 Before, not anymore. Why? For how long?
11. What types of monkeys live in Sucusari? *Freelisting*
12. What is a monkey for you?
13. What is the name of this monkey? *Photo identification*
14. Does it live in Sucusari?
    14.1 Yes
    14.2 No
15. Do you hunt it? Do you eat it? Do you use it for anything else?
16. Does this monkey have a story, song, and/or belief?
17. In what type of forest do you find them? (Upland, Floodplain, *Mauritia flexuosa* palm swamp)
    17.1 Do you see it during the whole year? Or just during some months?
18. How many do you see per group now? (Min-Max)
19. What is a buri-buri?
20. Does the buri-buri live in Sucusari?
21. How do you differentiate between a buri-buri and musmuqui?

Appendix II. A. Backward Stepwise Logistic Regression for predictor variables influencing the correct identification of primate species from photos; beta values, odds ratio (OR), X2 and significance of the Full and Reduced Model

	Aotus vociferans		***Callicebus lucifer***		***Cebus albifrons***		***Sapajus macrocephalus***	
	B	Odds ratio	B	Odds ratio	B	Odds ratio	B	Odds ratio
Full Model								
Constant	-5.046		-1.058		-1.908		-1.841	
Age	0.083	1.086*	0.064	1.066	-0.014	0.986	0.024	1.025
Ethnicity (1)	-1.28	0.278	0.854	2.35	2.877	17.762**	0.088	1.091
Education	0.107	1.113	-0.347	0.707	0.28	1.323	0.029	1.03
Gender (1)	0.76	2.138	4.062	58.087**	1.286	3.619	1.958	7.082**
X^2	9.819		28.016		14.623		11.434	
Omnibus Test (p)	0.044		0.000		0.006		0.022	
Reduced Model								
Constant	-3.592		2.156		-2.575		-0.619	
Age	0.074	1.077*						
Ethnicity (1)	-1.274	0.28			2.756	15.743**		
Education			-0.422	0.656*	0.303	1.354		
Gender (1)			4.336	76.432**	1.256	3.512	2.005	7.429**
X^2	7.667		24.759		14.413		10.484	
Omnibus Test (p)	0.022		0.000		0.002		0.001	

*p<0.05, **p<0.01, ***p<0.001

(1) Maijuna and Male

Appendix II.B. Backward Stepwise Logistic Regression for predictor variables influencing the correct location of primate species from photos; beta values, odds ratio (OR), X2 and significance of the Full and Reduced Model

	Cebuella pygmaea		***Aotus vociferans***		***Callicebus discolor***		***Callicebus lucifer***		***Cebus albifrons***	
	B	Odds ratio	B	Odds ratio	B	Odds ratio	B	Odds ratio	B	Odds ratio
Full Model										
Constant	-2.123		-5.623		3.213		-4.935		-2.569	
Age	0.021	1.021	0.078	1.081*	0.01	1.01	0.134	1.143	0.007	1.007
Ethnicity (1)	-0.005	0.995	-0.387	0.679	-1.472	0.23	1.608	4.993	2.237	9.370*
Education	0.074	1.077	0.11	1.116	-0.368	0.692*	-0.281	0.755	0.234	1.263
Gender (1)	1.477	4.378*	0.306	1.357	3.451	31.521*	5.288	197.923**	1.173	3.231
X^2	7.571		6.614		13.937		35.015		13.004	
Omnibus Test (*p*)	0.109		0.158		0.007		0.000		0.011	
Reduced Model										
Constant	-0.847		-4.278		2.61		-1.931		-2.223	
Age			0.062	1.064*			0.126	1.135		
Ethnicity (1)									2.288	9.85**
Education					-0.303	0.738	-0.358	0.699	0.221	1.247
Gender (1)	1.54	4.667*			2.844	17.177*	4.920	137.024**	1.185	3.271
X^2	6.609		5.18		12.22		33.505		12.943	
Omnibus Test (*p*)	0.01		0.023		0.002		0.000		0.005	

*p<0.05, **p<0.01, ***p<0.001

(1) Maijuna and Male

Appendix II.C. Multiple linear regression for predictor variables influencing the correct identification of the primate community in the Sucusari River basin from photos; beta values, standardized coefficients (β), significance and R2

	B	β
Step 1		
Constant	0.43	
Age	0.003	0.222
Years of education	0.006	0.104
Ethnicity	0.057	0.148
Gender	0.228	0.583***
Step 3		
Constant	0.473	
Age	0.004	0.251*
Gender	0.231	0.590***

R^2 = .472 for Step 1, ΔR^2 = -.016 for Step 3

*p<0.05, **p<0.01, ***p<0.001

Appendix II.D. Multiple linear regressions of the predictor variables influencing the correct location of the primate community in the Sucusari River basin from photos; beta values, standardized coefficients (β), significance and R^2

	B	β
Step 1		
Constant	0.402	
Age	0.002	0.185
Years of education	0.004	0.064
Ethnicity	0.072	0.197
Gender	0.212	0.568***
Step 3		
Constant	0.511	
Ethnicity	0.096	0.261*
Gender	0.221	0.592***

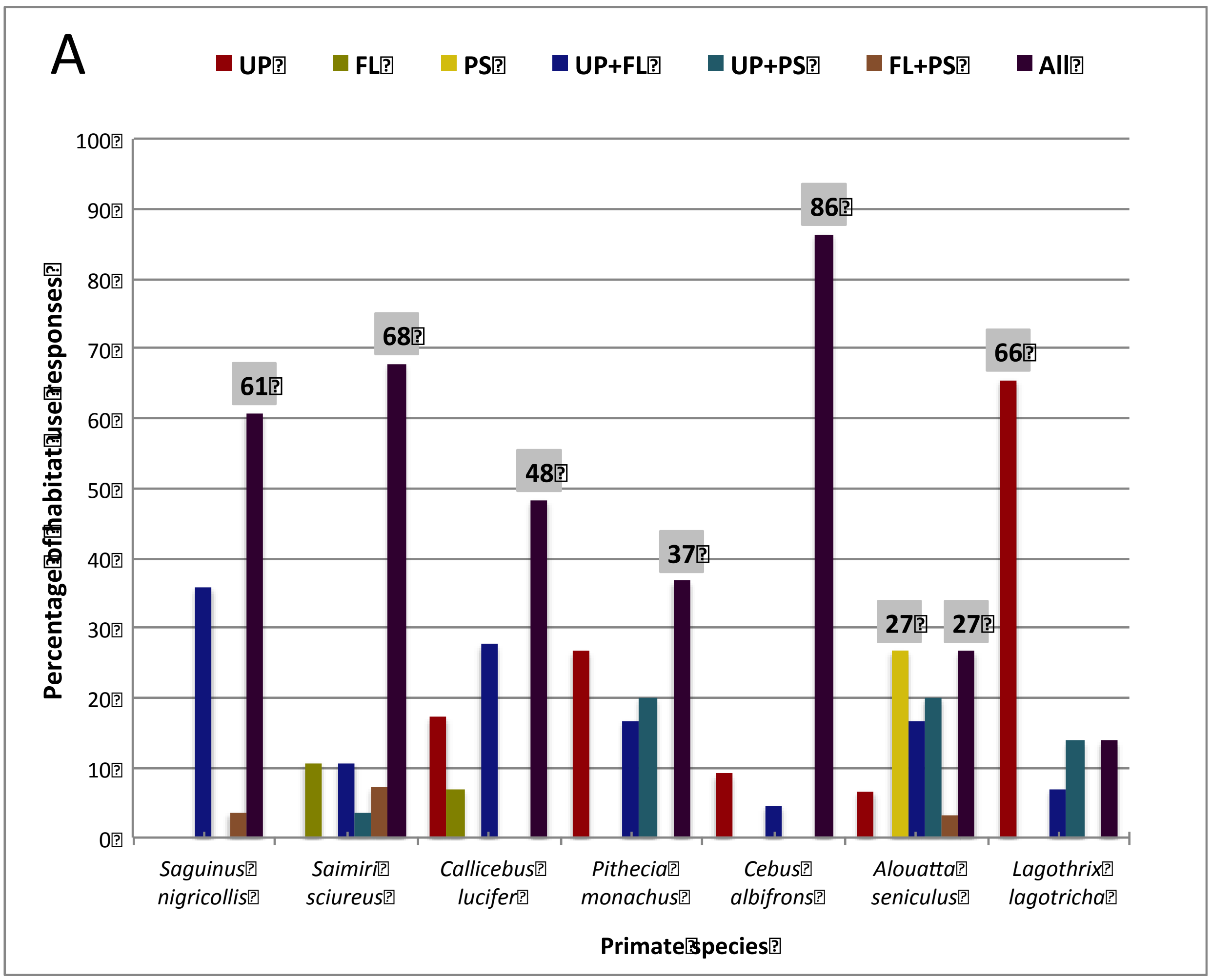
R^2 = .454 for Step 1, ΔR^2 = -.022 for Step 3

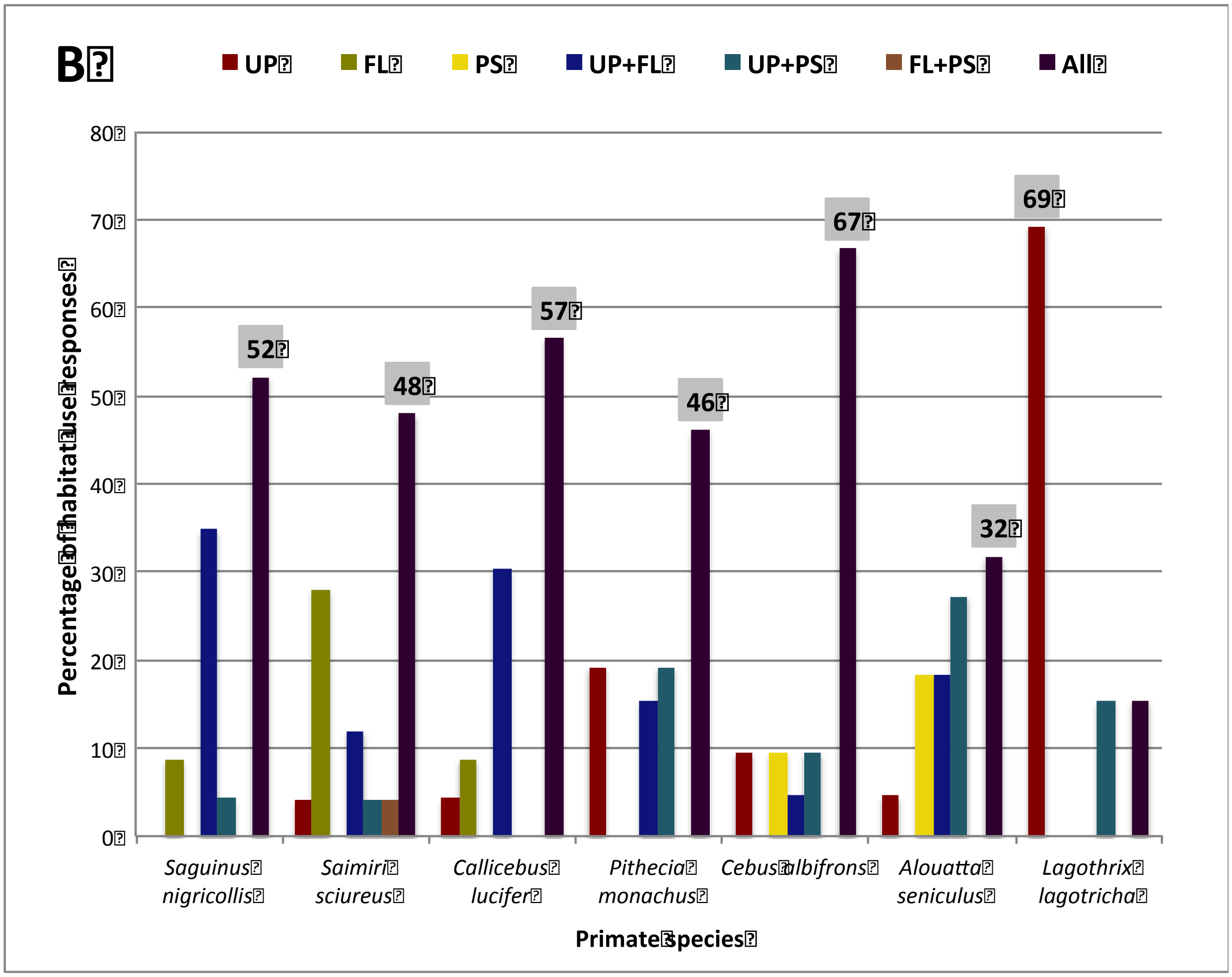
*p<0.05, **p<0.01, ***p<0.001

Appendix III. Profile of the six survey sites: transects, transect length (km), number of visits per transect, total distance walked (km) and percentage of habitat proportion (%), total distance walked per site (km), and cumulative sampling effort (km)

Site	Transects	Transect length (km)	Number of visits per transect	Total distance walked per habitat (percentage of habitat proportion)			Total distance walked (km)
				Upland	Floodplain	*Mauritia flexuosa* palm swamp	
Repartimiento	W0	5.2	11	102.60 (70%)	37.90 (29%)	1.67 (1%)	46.65
	W1	4.9	16				53.44
	W2	4	11				24.94
	W3	4	7				17.15
							142.18
BogoYa	W4	4	11	162.54 (73%)	61.27 (25%)	5.01 (2%)	39.69
	W5	5	14				62.04
	W6	4.4	18				66.26
	W7	4.1	18				60.84
							228.83
Belisario	W8	4.1	13	76.81 (64%)	27.58 (25%)	13.07 (11%)	43.56
	W9	4.5	12				42.45
	W10	3.8	10				31.45
							117.46
Colombiano	E0	3.4	13	117.74 (72%)	46.66 (27%)	0.75 (1%)	40.55
	E1	3.8	14				52.98
	E2	4.7	13				44.78
	E3	4.3	8				26.84
							165.15
Sancuduyo	E4	4	11	144.36 (61%)	72.59 (35%)	11.32 (5%)	38.13
	E5	5	19				68.78
	E6	4	15				50.22
	E7	4	21				71.13
							228.27
Chontilla	E8	4.3	13	82.92 (67%)	38.55 (32%)	1.76 (1%)	47.97
	E9	4.4	12				39.22
	E10	4.1	10				36.04
							123.23
Cummulative sampling effort (km)							**1005.11**

Appendix IV. Percentage of habitat use responses per primate species using (A) Males (n=30), (B) Maijuna (n=26) data. Habitat abbreviations are: (UP) Upland, (FL) Floodplain, (PS) *Mauritia flexuosa* palm swamp, (UP + FL) Upland & Floodplain, (UP + PS) Upland & *Mauritia flexuosa* palm swamp, (FL + PS) Floodplain & *Mauritia flexuosa* palm swamp, and (All) Upland, Floodplain and *Mauritia flexuosa* palm swamp. Species are in order of increasing body mass.




B
UP
FL
PS
UP+FL
UP+PS
FL+PS
All
Percentage of habitat use responses
0
10
20
30
40
50
60
70
80
52
48
57
46
67
32
69
Saguinus nigricollis
Saimiri sciureus
Callicebus lucifer
Pithecia monachus
Cebus albifrons
Alouatta seniculus
Lagothrix lagotricha
Primate Species

Appendix V.A. English translation of the traditional Maijuna monkey creation story, told by Samuel Rios Flores. A Maijuna version of this story is presented in Appendix V.B. The numbered sentences in the English version of this story correspond exactly to the Maijuna version.

[1]"We want to eat fruits," [said the group of people]. [2]"You want to eat fruits?" [asked the Creator]. [3]"Yes, we wish we could go up and eat them," [replied the group of people]. [4]"If you want fruits then untie the rope from your hammock and place it down toward your butt (to make a tail)," [said the Creator]. [5][In the meantime] the Creator was grating *huito* fruits (*Genipa americana*). [6]After grating the fruit he rubbed it on their faces and mouths (*huito* is used as a black dye and, according to Maijuna traditions, this is why *Lagothrix lagotricha* monkeys have black faces.) [7]"Who wants to be a ***naso*** (*L. lagotricha*)?" [he asked]. [8]"I do," [a woman replied]. [9]"What does a ***naso*** (*L. lagotricha*) sound like while eating fruits?" [asked the Creator]. [10]She listened to him, climbed a tree, and said: "chichi, chichi, chichi." [11]"You are a ***chichi*** (*Saguinus nigricollis*). [12]You are not a real ***naso*** (*L. lagotricha*)," he said. [13]"This is what I will be then," the women said. (At this moment she became a ***chichi*** monkey.) [14]"Who is going to be a ***naso*** (*L. lagotricha*)?" [the Creator asked again]. [15]"Me," [replied a man]. [16]"What does a real ***naso*** (*L. lagotricha*) sound like?" [asked the Creator]. [17]The man climbed a tree and happily gathered fruits. [18][He then called out], "Choyoro, choyoro, choyoro." [19]"Yes, you are a ***naso*** (*L. lagotricha*)," [said the Creator]. [20]"Now, who will be a ***jaiquɨ*** (*Alouatta seniculus*)?" [asked the Creator]. [21]"Me. [22]I want to be a ***jaiquɨ*** (*A. seniculus*)," [a women replied]. [23]"Let me hear you. [24]Sing so I can hear how a ***jaiquɨ*** (*A. seniculus*) sings," [requested the Creator]. [25]"Oju, oju, oju, oju," [she sang]. [26]"You are a ***bao*** (*Callicebus lucifer*)", [said the Creator]. [27]"This is what I will be then," [replied the woman]. [28]"Now, who will be a ***jaiquɨ*** (*A. seniculus*)?" [asked the Creator]. [29]"Me," [a man replied]. [30]The creator then placed a small ***bichibɨ*** (gourd) into the man's throat. [31]Then, the creator

rubbed *achiote* (annatto) over his entire body. [32]"Sing so I can hear if you are really a ***jaiquɨ*** (*A. seniculus*). [33]How will you sing when it rains?" [asked the Creator]. [34]"Ogu, ogu, ogu, oguuu," [he howled]. [35]"Yes, you are a ***jaiquɨ*** (*A. seniculus*)," [said the Creator]. [36]The end.

Appendix V.B. Maijuna version of the traditional Maijuna monkey creation story, told by Samuel Rios Flores.

[1]Acue acueyo oiyi yiquɨa. [2]Mɨsa acue oiye. [3]Quima mɨni acueyo oiyi. [4]Acue oijɨ ani mɨsa jaɨoma josema mɨsajuna bari oje tatecachi. [5]Be ɨrɨguɨ. [6]Be ɨrɨre yia quɨrɨguɨ yobɨ tea. [7]Nebɨ naso bayo ijɨ. [8]Yi bachi ico. [9]Quima jɨcaquɨ naso acue acuequɨ ani. [10]Asare mɨico chi, chi, chi, chi ico. [11]Chichina ja. [12]Aje nasona ja ijɨ. [13]Cao ñi bachi ico. [14]Nebɨ bayo. [15]Yia ijɨ. [16]Quima jɨcaquɨ naso debɨ ani. [17]Mɨni acue tɨtequɨ chibajɨ. [18]Choyoro, choyoro, choyoro. [19]Ase caɨta nasona chibajɨ. [20]Jana igueca ne bayo jaiquɨ. [21]Yia ico. [22]Yi jaiquɨ bachi. [23]Ja jɨcama asayi. [24]Ja yima asayi jaiquɨ quima yiquɨ. [25]Oju, oju, oju, oju. [26]Baonata. [27]Caoñi bachi ico. [28]Jana igueca ne bayo jaiquɨ. [29]Yia ijɨ. [30]Bichibɨ tatecaquɨ. [31]Bosa socaquɨ. [32]Ja yima asayi jaiquɨ ani. [33]Ocotu quima yiquɨ bachi. [34]Ogu, ogu, ogu, oguuu. [35]Ase caɨta jaiquɨna ja chibajɨ. [36]Casoa ja.

Appendix V.C. English translation of the traditional Maijuna story of the red titi monkey (*Callicebus discolor*), told by Romero Ríos

There was a lazy man, who never wanted to work or walk. For him it was a problem and he didn't know what was a matter. A wise person came and told him, "You have some animals in your body." The man asked, "How can we kill these animals?" "We are going to offer them *anonas* (*Annona spp.*) so that they come down to eat. We will kill them when they come down to eat and you will become a hard-working person," answered the wise man. When the fruits (*anonas*) were set down, monkeys descended from the man's shoulders and started to eat the fruits. However, one monkey didn't go down, it stayed inside the man's body. The rest of the monkeys were killed by the man. With fewer burdens on his body, the man began to work and he was no longer lazy. All of these animals were ***ñame bao*** (*Callicebus discolor*), for this reason they are called the "lazy monkeys." The end.

Appendix V.D. English translation of the traditional Maijuna story of the common squirrel monkey (*Saimiri sciureus*), told by Felipe Navarro

The people were looking at the trees. They really wanted to eat the *shimbillo* fruits (*Inga spp*.). They asked themselves, “How can we reach the fruits?” At this moment, Maineno appeared. “What are you talking about?” asked Maineno. “We want to eat *shimbillo* fruits but we are not able to”, replied the group of people. Maineno then let them climb the trees and said, “Now you will all be ***bo chichi*** (*Saimiri sciureus*).” That is how ***bo chichi*** were created.

Appendix V.E. English translation of the traditional Kichwa story of the red titi monkey (*Callicebus discolor*) and red howler monkey (*Alouatta seniculus*), told by Orlando Coquinche

The red titi monkey (*Callicebus discolor*) had its little drum (referring to the modified hyoid bone used for vocalization) similar to the red howler monkey (*Alouatta seniculus*). The drum of the red titi monkey was louder [than that of the red howler monkey]. One day, the red titi monkey lent his drum to the red howler monkey because the howler's was not producing a strong sound. After lending his drum to the red howler monkey, the red howler monkey never gave it back. For this reason, the red titi monkey no longer sings loud and now the red howler monkey beats it at singing and sings much louder.

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BIOGRAPHY

As a child I always enjoyed family vacations that involved being surrounded by nature, which grew my interest in Biology. During my undergraduate studies, I had the opportunity to learn about different ecosystems within my country, Peru. When I did my first internship in the rainforest with ProNaturaleza, I was taken by the biodiversity of the ecosystem, and by the warmth of the people that inhabit the area. Wildlife conservation became my passion. My hope is that I can contribute to the small but growing field of conservation and restoration of biodiversity in Peru - a country with a rich diversity in ecosystems and natural resources. My field experiences have taught me the importance of working and collaborating closely with native and local communities to develop effective conservation projects. Local and native communities are in direct and permanent contact with nature and wildlife, and their insights are twofold: both because of their local knowledge and because their activities impact species.

I received my Bachelor of Science in Biology from Universidad Peruana Cayetano Heredia in 2011. During my Master's program, I was employed as a Graduate Teaching Assistant in the Biology Department for two years, and received my Master of Science in Environmental Science and Policy from George Mason University in 2016.