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Perception and attitudes of local communities towards vertebrate fauna in the Andes of Colombia: Effects of gender and the urban/rural setting

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ABSTRACT

This study aimed to assess the attitudes and perceptions of inhabitants in the Andean region of Colombia towards 17 native terrestrial vertebrate species and the associated sociodemographic factors, such as gender and locality. The data was collected through semi-structured surveys of 100 participants, and five variables were evaluated on a Likert scale measuring people's perceptions (level of liking, medicinal use, detrimental to daily activity, disease transmission, and folklore traditions). The respondents' attitudes were also measured by asking if they agreed that the government should protect or eradicate some species in the region. The perception of liking varied significantly between the town and the countryside for five species (eagle, owl, bat, snake, and lizard), and folklore only varying for the owl between town and countryside. The species with the highest frequency of negative perceptions were native rat, bat, and snake species, which varied according to locality and gender. Conversely, birds like the canary and hummingbird species had predominantly positive perceptions. Owl, snake, and bat species had the greatest diversity of folklore traditions, primarily associated with death and bad luck. Although most respondents supported conserving all species, there was a preference for birds and some mammals and reptiles. The study highlights the importance of understanding people's perceptions of using charismatic species and implementing awareness campaigns on the ecological importance of species less liked by local communities. The results can guide future conservation initiatives to ensure that conservation strategies align with the attitudes and beliefs of local communities.

Keywords: Biological Conservation; Folklore Traditions; Tropical humid forest; Traditional Medicine; Silvania.

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SIGNIFICANCE STATEMENT

Human attitudes and perceptions determine the degree to which people can coexist with biodiversity. This study seeks to understand perceptions, attitudes, myths, and legend-type superstitions or folklore towards 17 native vertebrate species of four biotic groups (amphibians, reptiles, birds, and mammals) by local human communities living in rural and urban areas in the Colombian Andes. Sociodemographic variables such as gender and locality (urban or rural) were analyzed, along with people's attitudes in conserving or eliminating some of these groups from their regions. The results of this study show that there are vertebrates that humans view positively and others view negatively. Therefore, it is crucial to implement awareness campaigns on the ecological importance of animals that are less liked by local communities; such campaigns could demystify negative stories and beliefs about the transmission of diseases, attacks on domestic animals, or damage to crops.

INTRODUCTION

The millenary interaction between human beings and fauna has allowed local communities to benefit from the ecosystem services provided by species from their domestication and hunting as clothes and tools or their use for medicinal and magical-religious purposes (Alves and Souto 2015; Holley 2009). Some of these human-faunal relationships go beyond the survival of people since they have an influence on human well-being by setting up effective relationships with certain animals used as pets (Alvard et al. 1997; Alves et al. 2009; Alves & Pereira Filho, 2007; Inskip & Zimmermann, 2009; Prins et al. 2000). However, the conflicts that arise with the interaction of people with wildlife cause the death of some animals because of a perceived need to retaliate or aversions that constitute a challenge to the conservation of some species (Dickman 2010). These conflicts can be accentuated by traditional folk beliefs (folklore traditions) that are transmitted from generation to generation (Silva-Rodriguez et al. 2019) and that are defined as a "prognosis, favorable or adverse, superstitiously formed by unfounded signs or accidents" (Real Academia Española 2021).

Given the above, ethnozoology seeks to understand how human beings conceive and relate to other animals from historical, economic, sociological, cultural, and environmental dimensions (Alves and Souto 2015). Studying of people's attitudes towards wildlife is vital to knowing a local human community's behavior toward the wildlife with which it coexists but with a gender approach (Campos et al. 2013). Some studies suggest that women are more inclined to favor pleasant, cute animals (positive species such as horses or butterflies), while men tend to prefer less attractive species, those that generate disgust, phobia and/or fear (negative perceptions toward species such as snakes, or toads) (Hills 1989; Herzog et al. 1991). However, these perceptions cannot be generalized since the relationships between animals and humans can be positive or negative depending on the biotic group and the previous experiences that people have had with members of the group (Kellert & Berry, 1987; Herzog et al. 1991; Lute et al. 2016).

Perceptions are influenced by the origins of people who live in rural or urban areas (Campos et al. 2013). Triguero-Mas et al. (2009) showed that several positive attitudes and perceptions about fauna occur in rural locations because they find economic benefits in the species, while in urban locations, these positive perceptions are generated by the value of conserving wildlife. People who live in cities tend to know foreign species better, while in rural areas, people may have greater knowledge of native species (Campos et al. 2013). However, many farmers tend to have a low level of liking toward wild animals because they perceive them as animals that they cannot control. They often have conflicts due to damage to their crops or attacks on domestic animals. As a result, they feel at risk or in danger against some aggressive or poisonous species (Costa et al. 2013).

Attitudes serve as a reference to organize people's cognitive perceptions, classifying them as positive and negative and approaching an understanding of the interactions between society and nature (Alves and Souto 2015). When people have negative perceptions towards fauna, they can overexploit their populations, showing little interest in learning about the species and their conservation (Alves et al. 2010; Alves & Albuquerque, 2012; Vergara-Rios et al. 2021). In contrast, positive perceptions occur when the community knows the species and understands their functional role in the ecosystem, so the people begin to position themselves conservation agents (Manzano-Garcia et al. 2017).

Recent studies in ethnozoology demonstrate the importance of associating sociodemographic factors with people's degree of perception and attitude to determine the incidence of environmental education programs and the positions adopted by local human communities toward the conservation of wildlife (Toro-Julio et al. 2021). The gender perspective is critical in this type of research since women tend to worry, express themselves, and care more for fauna, which is why women make up most of the activist groups in

defense of animal rights, compared to men (Herzog et al. 1991). In contrast, men tend to show less sensitivity when dealing with wild animals. Although men perceive animals with a utilitarian vision, they see them less favorably than women (Herzog et al. 1991). Campos et al. (2013) found that in rural areas, men had greater knowledge about species related to hunting, and women were more familiar with pets and charismatic mammals.

Thus, within rural communities, some people have a great deal of knowledge about wildlife that generates positive attitudes toward species and represents opportunities for their conservation (Chand & Shukla, 2003; Reyes-Garcia et al. 2005; Pilgrim et al., 2008). In this sense, working on wildlife conservation programs with women from rural communities is more efficient than with women who live in urban areas (Campos et al. 2013). The success of environmental education initiatives on wildlife depends on the differentiation that can occur at the gender level and by the urban or rural environment of the people (Vergara-Rios et al. 2021).

Colombia has a high number of threatened and endemic species (IUCN 2020), as well as ecosystems in danger of collapsing (Etter et al. 2021) that justifies a search for strategies to conserve wildlife and their habitats through management strategies and regions that involve local communities (Santamaría et al. 2018). However, conservation programs in Colombia lack the vital component of evaluating the perceptions and attitudes of people in local communities (Ministry of Environment and Sustainable Development 2022), and this endangers the persistence of initiatives over time and management by not counting on the participatory action of local human communities (Costa et al. 2013). In addition, studies in ethnobiology are scarce in Colombia, and very few relate sociodemographic variables to the general perceptions and attitudes toward fauna (Albuquerque et al. 2013), let alone towards species of amphibians and reptiles (Urbina-Cardona et al. 2023). For these reasons, this study seeks to (a) determine the effect of urban or rural habitation and gender on people's perceptions of 17 common species of four biotic groups of wildlife in an area in the Andes of Colombia; (b) describe the folklore traditions (myth and legend-type superstitions) that people have about them; and (c) determine people's attitudes by asking whether they prefer to conserve or eliminate some of the vertebrate species included in this study from their regions.

MATERIAL AND METHODS

Study Area

The municipality of Silvania is between 1,200 and 2,700 meters above sea level and is in a valley of the Eastern Andes cordillera in the department of Cundinamarca, 40 km south of the city of Bogotá, capital of Colombia (Figure 1). The average annual rainfall is 1,653 mm; the highest is November (211.2 mm/year), and the driest month is August (58.1 mm/year). The average temperature is 20.5°C with a variation of 1.4°C (Roveda et al. 2013; Sánchez and Barrera 1990). The municipality has a total area of 163 km2, where 95.3% corresponds to the rural area constituted by 13 villages, while less than 5% is an urban area, the total population of the municipality is approximately 21,000 inhabitants, where 35% of the population lives in the urban area and 65% lives in the rural area (DANE 2018). According to DANE (2018), an urban area "corresponds to being conformed by sets of buildings and contiguous structures grouped in blocks, which are mainly delimited by streets, roads or avenues." It generally provided essential services such as water, sewage, electricity, hospitals, and schools". This category includes capital cities and the remaining municipal capitals, so the area of Silvania is considered urban. In this town, people are engaged in activities such as construction, medical services, engineering, and electricians, among others.

The municipality is mainly dedicated to agriculture and livestock. Due to the fertility of its soils, the main crops in the municipality are coffee, blackberries, and tree tomatoes (Granda-Rodriguez et al. 2021). The natural ecosystems in Silvania correspond to medium-dense forests and xerophytic shrublands of the orobiomes of the tropical humid forest or zonobiome (Walter 1979) and do not meet the threat criteria (Etter et al. 2021). During the last 20 years, the loss of vegetation has been no greater than 6% due to the illicit activities of illegal armed groups that controlled the territory, preventing deforestation (Aguilar et al. 2015; Calle-Rendón et al. 2018; Granda-Rodriguez et al. 2021).

Research design

For this study, the urban center of Silvania (4°24'10.70"N and 74°23'13.95"W) and two rural villages Loma Alta (4°24'47.06"N and 74°25'29.31"W) and Subía (4°28'09.07"N and 74°23'02.84"W) were prioritized, since they were areas of safe access, where the greatest population of the municipality congregates.

To determine the clarity of the survey questions for the residents of Silvania municipality, a validation matrix was created, and a pilot test was conducted with 30 participants aged between 12 and 75 years old

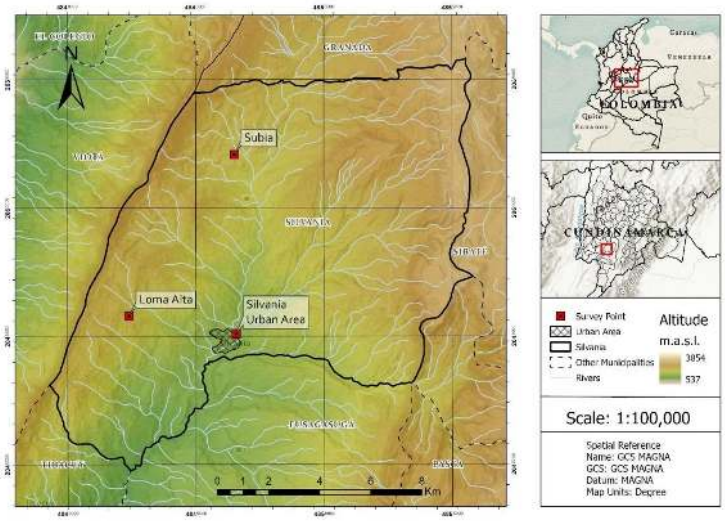

Figura 1. Study area in the municipality of Silvania, the red dots are the localities where the surveys were carried out.

in the urban area of the municipality. This test had positive results where all the participants stated that they clearly understood all the questions. Therefore, the data from the pilot survey were not considered for the data analysis.

Between February and March 2021, 100 semi-structured surveys were conducted in the municipality of Silvania, to people between the ages of 7 and 75 years old. These were conducted in person, printed, and in Spanish since many areas did not have internet or electricity to be done digitally, the surveys were not recorded, and the extra information the respondents gave was written down. Respondents were chosen randomly, so there were different numbers of women and men (54 and 46 individuals, respectively). Before conducting the survey, each participant was approved to participate in the study, and their anonymity was guaranteed (ethics committee Act 01-2021). In the case of the 42 minors (between 7 and 17 years of age) surveyed, parental authorization was obtained. Although, for the urban area, 45 surveys were conducted in marketplaces and parks of the municipality, approximately 120 people did not want to answer the survey because we were in the pandemic season for Covid 19 and they were afraid of being infected or did not show interest. In the rural area, we first made appointments with the inhabitants. Due to the Covid 19 pandemic, most rural areas were off-limits to people from outside the localities, and some inhabitants did not allow people to enter their properties. In the rural area, 55 people living on farms and engaged in agriculture were surveyed in person. The survey took approximately 20 minutes on average to complete in the urban area and 25 minutes on average in the rural area.

Because of the Covid 19 pandemic, access restrictions in some areas of Colombia resulted in only 100 surveys being conducted. This sample size equates to a 90% confidence level with an 8% margin of sampling error for a population of 21,000 inhabitants, as calculated using the Survey Monkey sample calculator (`https://es.surveymonkey.com/mp/sample-size-calculator`).

The survey sought to quantitatively assess people's perceptions towards 17 species or species groups of native vertebrates (7 species of mammals, 5 of birds, 3 of reptiles, 2 of amphibians) found in the municipality of Silvania (Additional File 1). The study was complemented with a qualitative analysis of people's folklore traditions and attitudes towards those vertebrate faunal species. The selection criteria for the vertebrate species were that (a) they had a confirmed distribution in the region, confirmed from the records in different biological collections in Colombia (SiB Colombia 2022), and (b) it is animal's body shape was very different from other species of the biotic group inhabiting this region (Additional File 1). During the survey, each participant was presented with the black silhouettes on a white background of the 17 species of animals printed on sheets 6 cm high by 9 cm wide. These silhouettes were chosen so the respondents could quickly differentiate them and not include the bias that the photographs might present due to their angle, lighting, and coloration (Cerda et al. 2018; Munita 2018). The first section of the survey made it possible to characterize the people surveyed based on their spatial location and sociodemographic conditions such as age, occupation, religion, level of education, and whether the person lived or worked in a rural or urban location (Additional File 2). The se-

cond part of the survey presented for each of the species the following questions about the perceptions of people (1) the level of liking, (2) if it could be harmful in their usual activities, (3) if they believed that the species could transmit any disease, (4) if the species brought some medicinal benefit, (5) and if they knew of any traditional legend, story, or myth (folklore traditions) about the species. If the previous answers were affirmative, the person was instructed to briefly explain the story they believed represented the species (Additional File 2). Each of the previous perceptions was expressed on the Likert scale of five possible and exclusive states in the responses, ranging as follows: 1= totally disagree; 2 = disagree; 3 = neither agree/-nor disagree; 4 = agree; 5 = totally agree. The participants were asked if they would agree that the municipality works to protect these species. They were then instructed to please mention the species they would prioritize protecting; if not, they were asked if they would agree to the municipality working to remove some species from the region (Additional File 2).

Data Analysis

The ages of the people were divided into age categories based on four stages of the life cycle (Vergara-Rios et al. 2021): adolescence = 7-18 years; young adults = 19-30 years; adults = 31-60 years; older adults = older than 61 years. The values of the responses (on a Likert scale) on the perceptions of the 100 people about the 17 species were converted to a square root. Then a Euclidean distance matrix was calculated for 1700 responses for each of the five species. The response variables on perceptions were rated as follows: 1 = level of liking; 2 = if it was harmful to their daily activity; 3 = if it transmitted some disease; 4 = if the species was medicinal; and 5 = if they had some old story (folklore) for that species. For each perception response variable, a multivariate analysis of variance based on permutations (PERMANOVA) was performed with a partial sum of squares (type I) and 9,999 permutations of residuals under a reduced model. PERMANOVA makes it possible to demonstrate, based on permutations, the effect of factors with a different sample size between study levels (Anderson et al. 2008). The experimental design consisted of four factors: biotic group (fixed factor with four levels: amphibians, reptiles, birds, and mammals); species of fauna nested in biotic groups (random factor with 17 levels); the locality (fixed factor with two levels, urban and rural); and gender (fixed factor with two levels: male and female), and their interactions. In addition, three covariates were included in the model as follows: age range (fixed factor with four levels: (1) adolescent, (2) young adult, (3) adult, and (4) older adult); religion (fixed factor with 3 levels: Catholic, Christian and non-believer); and time living in the region (fixed factor with 5 levels: (1) less than 1 year, (2) between 1 and 3 years, (3) between 4 and 7 years, (4) between 8 and 12 years, (5) more than 12 years). A posteriori pairwise comparison was made with the t-statistic based on 9,999 permutations to determine the differences between factors. The effect size of each factor and covariate were calculated from the estimated components of variation (Anderson 2017). This routine was run in PRIMER v7 & PERMANOVA+ add-on (Anderson et al. 2008; Clarke et al. 2014)

For each species, the association index of Whittaker (1952) was calculated for each person's perceptions. Then, a multivariate classification of the species was carried out, and its statistical validation (using the similarity profile test - SIMPROF (Clarke et al. 2014), based on the frequency of responses by people with the 5 response variables (level of pleasure; if it was detrimental to their daily activity; if it transmitted some disease; if the species was medicinal; and if they had any inherited stories or myths associated). Whitakker's association index ranges from 0 to 3, showing a color pattern in which the species that has the highest values on the Likert scale (that agreed or totally agreed with that perception) for a particular perception are highlighted with warmer colors. Finally, polygon maps were generated to assess the perception of the type of story per species and people's attitudes towards them (Carrot Search 2019). In these maps, the available space is divided into polygons that represent the different categories of analysis (e.g., type of myth or folkloric story nested in the species) and whose size represents the number of people who mentioned the species.

RESULTS

Level of liking

The level of liking varied between people with different age ranges (Pseudo-F=45.157; p-perm=0.001); religion (Pseudo-F= 23.474, p-perm=0.001); time in the region (Pseudo-F= 5.9818; p-perm=0.013); and gender (Pseudo-F=14.194, p-perm=0.001). There was also variation between the biotic groups (Pseudo-F=60.819; p-perm=0.001), the species (Pseudo-F=76.54; p-perm=0.001), the locality (Pseudo-F=22.278; p -perm=0.001), and the interaction between species and locality (Pseudo-F=3.3193; p-perm=0.001) (Table 1). The only species whose perception of liking varied significantly between the city and the countryside were the eagle *Pandion haliaetus* (t=2.01; p(perm)=0.04), the owl *Megascops choliba* (t=3.89; p(perm)=0.0001), the bat *Molossus molossus* (t =2.34; p(perm)=0.02), the snake *Mastigodryas boddaerti* (t=3.68; p(perm)=0.0003) and the lizard

Anolis tolimensis (t=2.33; p(perm)=0.02). The largest component of variation occurred at the level of the species studied, with an effect size of 39.17% of the estimated component of variation. The species that presented a higher percentage of positive liking among the people surveyed were the canary *Sicalis flaveola* (94%), the hummingbird *Amazilia* sp. (93%), the spectacled bear *Tremarctos ornatus* (93%), the deer *Mazama temama* (91%), the parakeet *Brotogeris jugularis* (91%), the rabbit *Sylvilagus brasiliensis* (90%), the turtle *Chelonoidis carbonarius* (83%) and the sloth *Bradypus variegatus* (81%). The category with the highest level of negative liking was the native rat *Nectomys magdalenae* (62%), the bat *Molossus molossus* (60%), the snake *Mastigodryas boddaerti* (55%), and the opossum *Didelphis marsupialis* (44%; Additional File 1).

Given that animals such as owls (*Megascops choliba*), rabbits (*Sylvilagus brasiliensis*), hummingbirds (*Amazilia* sp.), parakeets (*Brotogeris jugularis*), the spectacled bear (*Tremarctos ornatus*), deer (*Mazama temama*), sloths (*Bradypus variegatus*), turtles (*Chelonoidis carbonarius*), and eagles (*Pandion haliaetus*) show positive values of liking by people, they were classified as a relatively homogeneous group within the heat map (Figure 2). In contrast, native snakes, bats, and rats showed a negative level of liking and high values in the perception of disease transmission, for which they were grouped differently from the rest of the animals (Figure 2).

Harmful in your daily activities

The animals that most people considered harmful in their daily activity were snakes (38%), rats (34%), and bats (16%); the other species had values lower than 8%. This perception varied between people with different age ranges (Pseudo-F= 48,702; p-perm=0.001) and time living in the region (Pseudo-F= 14,753; p-perm=0.001), and locality (Pseudo-F= 32.421; p-perm=0.001). There were also differences between the biotic groups (Pseudo-F= 31,339; p-perm=0.001) and species (Pseudo-F= 14,759; p-perm=0.001) (Table 1). The largest component of variation occurred at the level of the species studied, with an effect size of 10.86% of the estimated component of variation.

They transmit diseases

The animals that most of the respondents considered could transmit diseases were native rats (75%), bats (54%), and snakes (21%); the other species had values lower than 12%. These perceptions varied between people with different age ranges (Pseudo-F= 64.019; p-perm=0.001), religion (Pseudo-F= 8.4669; p-perm=0.005), locality (Pseudo-F= 37.78; p-perm=0.001) and gender (Pseudo-F= 23,223; p-perm=0.001). There were also differences between the biotic groups (Pseudo-F= 49.72; p-perm=0.001) and species (Pseudo-F= 29.576; p-perm=0.001). The largest component of variation occurred at the level of the species studied, with an effect size of 19.33%.

Medicinal

The species that the respondents considered to have some medicinal values were snakes (22%), frogs (13%), and rabbits (11%); the other species had values less than 10%. This perception varied according to the age range (Pseudo-F= 17.044; p-perm=0.001) and the gender of the person (Pseudo-F= 49.063; p-perm=0.001). There were also differences between species (Pseudo-F= 2.0262; p-perm=0.018). The largest component of variation occurred at the level of the gender of the person surveyed, with an effect size of 5.22%.

Myths and legends

Of the 17 native species, only 9 had some folk legends. This perception varied between people with different age ranges (Pseudo-F= 4.401; p-perm=0.038) and locations (Pseudo-F= 4.0306; p-perm=0.042). There were also differences between species of species groups (Pseudo-F= 10.165; p-perm=0.001) and in the interaction between locality and species (Pseudo-F= 2.2365; p-perm=0.006). The folk legends of people varied between urban and rural localities only for the owl (t=2.85; p-perm= 0.0054). The largest component of variation occurred at the level of the species studied, with an effect size of 7.89.

For owls, 28% of people associate them with values associated with death; rabbits are mainly associated with luck; snakes are associated with gossip and death; hummingbirds with luck and visits; and bats are associated with death and bad luck (Figure 3).

Vertebrate fauna conservation interest

All 17 native vertebrate species were chosen by the people surveyed to be conserved in their regions; however, frequencies varied between species (Figure 4). Among the animals most frequently considered for protection were the sloth, the spectacled bear, the canary, hummingbirds, eagles, turtles, deer, and parakeets. However, some people (41 persons) suggested removing six animals from their region, of which the most frequent were native rats, snakes, and bats (Figure 5).

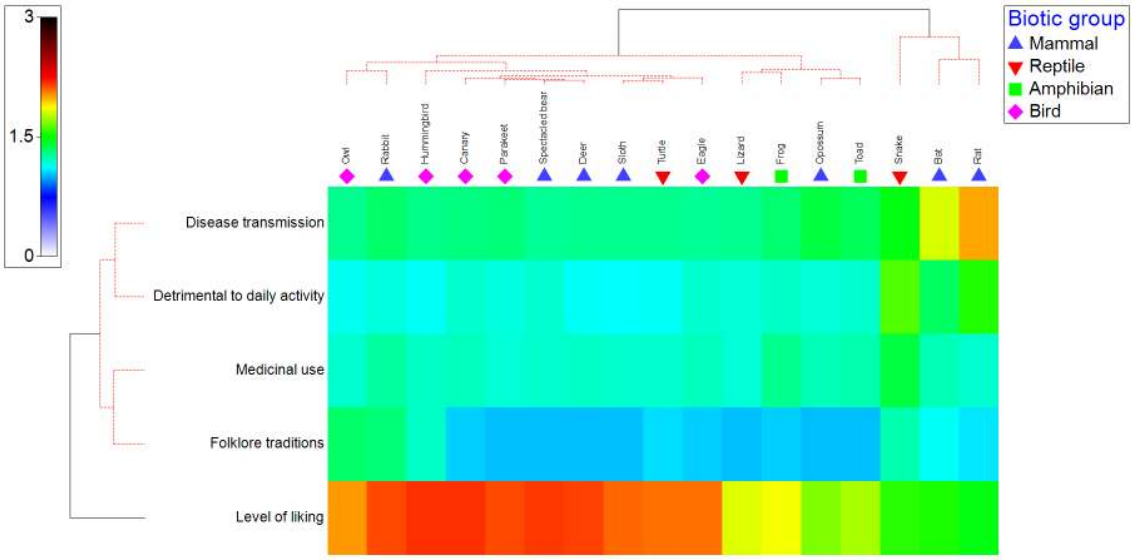

Figura 2. Heat map that represents the degree of association of the species (Additional File 1) by the evaluated perceptions. Warmer colors represent a higher degree of association in the Whittaker index (1952).



Figura 3. Visualization of the polygon map that shows the frequency of the responses of the respondents towards the species that could cause some folklore traditions.



Figura 4. Visualization of the polygon map that shows the frequency of the responses of the respondents towards the species that they consider ought to be conserved in their region.

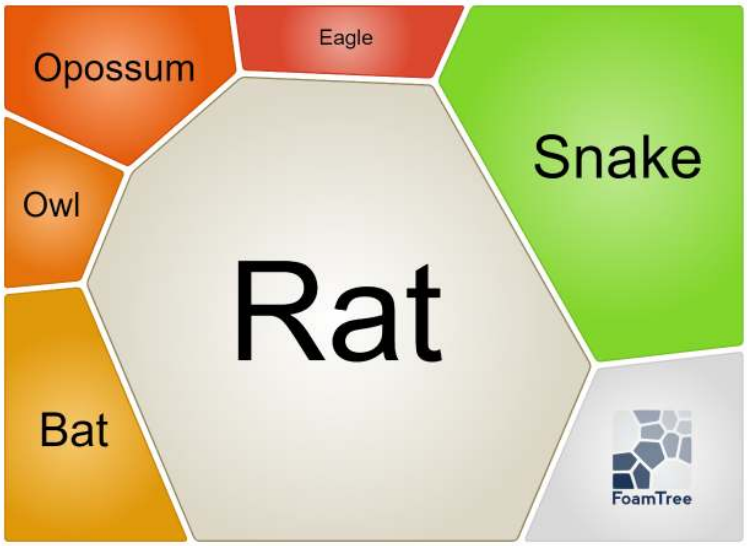

Figura 5. Visualization of the polygon map that shows the frequency of the responses of the respondents towards species that they consider should be eliminated in their region.

Tabela 1. Results of the PERMANOVA analysis of the five response variables based on the biotic group factors, species of fauna nested in biotic groups, locality, gender, and their interactions, as well as the covariates of age range, religion, and time living in the region.

							Estimates of components of variation		
	Source	**df**	**SS**	**MS**	**Pseudo-F**	**P(perm)**	**Estimate**	**Sq.root**	**Effect size**
Level of liking	Age Range	1	51.775	51.775	45.157	0.001	0.029781	0.17257	1.34717399
	Religion	1	26.914	26.914	23.474	0.001	0.015267	0.12356	0.69061836
	Time in the Region	1	6.8584	6.8584	5.9818	0.013	0.0035169	0.059303	0.15909057
	Biotic Group	1	69.732	69.732	60.819	0.001	0.040345	0.20086	1.82504733
	Species (Sp.)	15	1316.4	87.758	76.54	0.001	0.86611	0.93065	39.1793715
	Locality (Lo)	1	25.542	25.542	22.278	0.001	0.031536	0.17758	1.42656321
	Gender (Ge)	1	16.274	16.274	14.194	0.001	0.018531	0.13613	0.83826873
	SpxLo	16	60.891	3.8057	3.3193	0.001	0.05372	0.23178	2.43007913
	SpxGe	16	16.765	1.0478	0.91386	0.553	0.0019975	0.044694	0.09035896
	LoxGe	1	0.56685	0.56685	0.4944	0.483	0.0014629	0.038247	0.06617578
	SpxLoxGe	16	17.657	1.1036	0.96252	0.49	0.0017603	0.041956	0.07962897
	Residuals	1629	1867.7	1.1466			1.1466	1.0708	51.8676235
	Total	1699	3477.1						
Detrimental to daily activity	Age Range	1	45.295	45.295	48.702	0.001	0.026097	0.16155	2.21681149
	Religion	1	0.02837	0.02837	0.030504	0.864	0.00053424	0.023114	0.04538105
	Time in the Region	1	13.721	13.721	14.753	0.001	0.0078755	0.088744	0.6689849
	Biotic Group	1	29.146	29.146	31.339	0.001	0.016598	0.12883	1.40991827
	Species (Sp.)	15	205.89	13.726	14.759	0.001	0.12796	0.35772	10.8695711
	Locality (Lo)	1	30.153	30.153	32.421	0.001	0.037777	0.19436	3.2089699
	Gender(Ge)	1	0.45242	0.45242	0.48644	0.493	0.00058512	0.024189	0.04970306
	SpxLo	16	17.486	1.0929	1.1751	0.29	0.00329	0.057358	0.27946928
	SpxGe	16	9.766	0.61037	0.65628	0.842	0.0064651	0.080406	0.54917837
	LoxGe	1	0.51976	0.51976	0.55885	0.471	0.0010354	0.032177	0.08795213
	SpxLoXGe	16	7.4733	0.46708	0.50222	0.955	0.018964	0.13771	1.6108983
	Residuals	1629	1515	0.93005			0.93005	0.96439	79.0031621
	Total	1699	1875						

Disease transmission	Age Range	1	89.391	89.391	64.019	0.001	0.051762	0.22751	2.50877017
	Religion	1	11.823	11.823	8.4669	0.005	0.0061774	0.078597	0.29940259
	Time in the Region	1	1.6975	1.6975	1.2157	0.25	0.00018541	0.013617	0.00898634
	Biotic Group	1	69.426	69.426	49.72	0.001	0.040018	0.20004	1.93956888
	Species (Sp.)	15	619.46	41.297	29.576	0.001	0.39901	0.63167	19.338982
	Locality (Lo)	1	52.754	52.754	37.78	0.001	0.066389	0.25766	3.217703
	Gender (Ge)	1	32.426	32.426	23.223	0.001	0.038013	0.19497	1.84239172
	SpxLo	16	4.8627	0.30392	0.21766	1	0.022069	0.14856	1.06962731
	SpxGe	16	8.0153	0.50096	0.35877	0.996	0.018108	0.13457	0.87764789
	LoxGe	1	0.16738	0.16738	0.11987	0.728	0.0031012	0.055688	0.15030714
	SpxLoxGe	16	13.705	0.85658	0.61345	0.875	0.022109	0.14869	1.07156601
	Residuals	1629	2274.6	1.3963			1.3963	1.1817	67.675047
	Total	1699	3178.3						
Medicinal use use	Age Range	1	17.963	17.963	17.044	0.001	0.0099467	0.099733	0.83688317
	Religion	1	2.0219	2.0219	1.9184	0.171	0.00057352	0.023948	0.04825412
	Time in the Region	1	2.3714	2.3714	2.2501	0.129	0.0008112	0.028482	0.06825174
	Biotic Group	1	0.096969	0.096969	0.092007	0.769	0.00056293	0.023726	0.04736311
	Species (Sp.)	15	32.032	2.1355	2.0262	0.018	0.010816	0.104	0.91002326
	Locality (Lo)	1	0.12013	0.12013	0.11398	0.718	0.0012071	0.034744	0.10156149
	Gender (Ge)	1	51.71	51.71	49.063	0.001	0.062055	0.24911	5.221107
	SpxLo	16	10.589	0.66184	0.62797	0.846	0.0079211	0.089001	0.66645574
	SpxGe	16	4.5075	0.28172	0.2673	0.998	0.015617	0.12497	1.31396387
	LoxGe	1	0.10624	0.10624	0.1008	0.771	0.0023915	0.048903	0.20121308
	SpxLoxGe	16	7.9808	0.4988	0.47327	0.959	0.022739	0.15079	1.91318592
	Residuals	1629	1716.9	1.0539			1.0539	1.0266	88.6717375
	Total	1699	1846.4						
Folklore tradicions	Age Range	1	2.7383	2.7383	4.401	0.038	0.0012448	0.035281	0.17231017
	Religion	1	1.4997	1.4997	2.4103	0.118	0.00051991	0.022801	0.07196801
	Time in the Region	1	0.018558	0.018558	0.012001	0.63	0.00039453	0.019863	0.05461241
	Biotic Group	1	1.4174	1.4174	2.2781	0.142	0.00046779	0.021628	0.06475335
	Species (Sp.)	15	94.867	6.3245	10.165	0.001	0.057023	0.23879	7.89335064
	Locality (Lo)	1	2.5078	2.5078	4.0306	0.042	0.0024375	0.049371	0.33740845
	Gender (Ge)	1	0.022097	0.022097	0.035514	0.861	0.00073515	0.027114	0.10176239
	SpxLo	16	22.265	1.3916	2.2365	0.006	0.015542	0.12467	2.1513855
	SpxGe	16	6.0908	0.38067	0.61182	0.864	0.0048846	0.06989	0.67614577
	LoxGe	1	2.4637	2.4637	3.9596	0.051	0.0046469	0.068168	0.64324239
	SpxLoXGe	16	14.768	0.92303	1.4835	0.09	0.012322	0.11101	1.70566029
	Residuals	1629	1013.6	0.6222			0.6222	0.7888	86.1274006
	Total	1699	1162.2						

DISCUSSION

Positive perceptions of local communities

Research on local communities perceptions, attitudes, uses, and myths is essential for understanding human-wildlife relationships and how they can coexist in the same region (Campos et al. 2013). Animals such as the canary, the hummingbird, the spectacled bear, the deer, the parakeet, the rabbit, the turtle, and the sloth showed a high percentage of liking in this research (Figure 2). The positive factor for birds such as the canary (*Sicalis flaveola*), the hummingbird (*Amazilia* sp.), and the parakeet (*Brotogeris jugularis*) was due to their color and song that is attractive to people, in addition to the ecosystem services they provide such as pest control, pollinators, seed dispersers, carrion consumption, among others(Whelan et al. 2008; Zoeller et al. 2020).

In the present study, a 63-year-old woman who lives in an urban area mentioned: "Hummingbirds are beautiful and charming, and every time I see one, it brings me good luck, that's why I like to see them."

In San Antonio del Tequendama, Cundinamarca, respondents considered the hummingbird to be the folklore tradition of visits, similar to the results in this study (Osbahr and Morales 2012).

Owls (*Megascops choliba*) were also animals classified with a high level of liking. Still, they were categorized with greater negative stories among all the species analyzed, such as death or bad luck (Figure 3). According to Pejenaute-Rubio (2007), various human communities have consider owls for a long time as species that herald death; when they perch on the roof of a house, people believe that someone is going to die (Bagde and Jain 2015; Pejenaute Rubio 2007). Respondent # 94 (man from an urban area, age 62) responds: "When I was young when we saw an owl on a roof, the first thing we did was throw stones at it to ward off death and bad energies."

Similar results were found by Osbahr and Morales (2012), who mention in their study that the inhabitants believe that when the "curruco" (owl) sings, it is because someone is going to die. However, the respondents also associated it with wisdom, mystery, and intelligence; in Colombia, some activities relate it to esotericism and witchcraft, and in Bogotá, they sell products with owl advertising to attract love, ward off death, and attract good luck.

Mammals such as the rabbit (*Sylvilagus brasiliensis*), the spectacled bear (*Tremarctos ornatus*), the sloth (*Bradypus variegatus*), and the deer (*Mazama temama*) showed positive perceptions in these biotic groups, perhaps because the inhabitants consider these groups to be aesthetically attractive or their role in natural ecosystems and their importance in sport hunting and feeding. Many people enjoy observing them in their natural habitat and consider their presence an indicator of ecosystem health and diversity.(Batt 2009; Campos et al. 2013; Petrescu and Petrescu-Mag 2018; Stinchcomb et al. 2022; Teixeira et al. 2020). Unfortunately, local rural communities use biodiversity for consumption purposes, which generates a threat to species. Still, it has an essential role in the diet and culture of people as food, which generates a high social value (Restrepo 2012).

In the present study, a 29-year-old woman from a rural town mentioned, "Many years ago, one or another deer was seen in the parts of the village where there were no houses, but that was years ago. They were not seen again, and I think they became extinct due to hunting."

Similarly, a 24-year-old man from a rural locality also mentioned, "It was usual to see sloths on the sidewalks, and the environmental authority protected them a lot."

The positive perception of turtles (*Chelonoidis carbonarius*) is surprising since most people dislike reptiles. However, in Colombia, some tortoises are used as pets and offered as gifts between families in the Caribbean region (De La Ossa-Lacayo and De La Ossa 2012; Osbahr and Morales 2012). Some people surveyed in this study mentioned that they had kept turtles as pets in childhood (a 22-year-old man and an 18-year-old woman from a rural locality). The morrocoy turtle *Chelonoidis carbonarius* is a species categorized as vulnerable (VU) according to the resolution 1912 of 2017 of the Ministerio de Ambiente of Colombia and is in CITES II due to illegal trafficking and consumption of its meat in some regions of Colombia, so having this species as a pet affects its population in the wild.

According to some perception studies on amphibians in Colombia, positive and negative perceptions of amphibians vary between location, gender, age groups, and level of study (Nates-Jimenez and Lindemann-Matthies 2015; Riós-Orjuela et al. 2020; Vergara-Rios et al. 2021). These are not herpetofauna species that generate aversion, such as snakes (Tomažič 2011). In this study, the toads had a positive perception of 38% and a negative one of 40%, unlike the frogs, which had a negative perception of 50% and a positive perception of 24%.

A woman from a rural area, age 21, mentioned amphibians: "Seeing a toad makes me sick, but frogs like banana trees (*Boana platanera*) are prettier."

A respondent related the frog to money (Figure 3); in Colombia, there is a popular belief that if you look at the belly of a frog or toad, you can see some numbers related to lottery results.

Negative Perceptions

For the people surveyed in this study, the species with the lowest level of liking were the native rat (*Nectomys magdalenae*), the bat (*Molossus molossus*), the snake (Mastigodryas boddaerti non-venomous species) and the possum (*Dildephis marsupialis*) (Additional File 1) due to what could affect their daily activity such as damage to crops, bites, or transmission of diseases. The heat map grouped these animals very clearly (Figure 2). The negative perception towards these species can be largely influenced by dislikes, disgust, phobias, folklore, myths, or disease transmission (Ceríaco 2012; Costa et al. 2013; Knight 2008; Tomažič 2011). In this study, an effect of sociodemographic variables such as locality, gender, age range, and religion was found towards the level of liking for the 17 species of vertebrate fauna, and some of the testimonies of the present study reinforce these attitudes. People tend to feel empathy for organisms more akin to humans, which supports the high percentage of respondents who preferred birds and some mammals, as opposed to snakes, toads, opossums, or bats, because people's perception of them is that they are unpleasant or dangerous (Campos et al. 2013), which could be reflected in a decrease in support for these species for conservation projects or work. The influence of the media in society regarding wildlife is strongly linked to the aesthetic aspect of these, which leads environmental organizations to be more interested in showy animals such as birds or mammals. In Brazil Nemesio et al. (2013) reviewed which animal or plant species were more used or considered in postal service stamps, which resulted in birds and mammals having a greater representation than other vertebrate groups such as amphibians or reptiles, data that affirm the premise of the prevalence of charisma and aesthetics when it comes to conserving species.

For example, a 25-year-old man who lives in a rural area mentioned: "For me, all snakes are the same, and when I see them in the field, I kill them." (Respondent #51, male aged 25 in a rural area).

Other testimonies show some of the bases of these negative perceptions: "Bats transmit Covid 19, and because of this species, we are experiencing the pandemic." (Respondent #8, male from an urban. area and aged 56 years). "The possum is a species that shows up on the sidewalk a lot, and they are mistreated, beaten with stones and shovels; they are also run over by cars and hunted by dogs." (Respondent #83, 43-year-old woman from a rural location).

Rats have historically been considered harmful pests for humans. For this reason, the local communities of the region have a low level of liking for them (Benitez-Capistros et al. 2018; Ospina-Pinto et al. 2017) for which it was common to hear from the respondents the following:

"Rats generate disgust and are full of diseases such as rabies." (Respondent #22, male age 25, urban location). For the rat, this perception is because they can affect crops or are associated with areas with garbage and can transmit diseases (Brown et al. 2007). For example, in West Africa, some rural people (men and women) are considered a "bad" species that could affect their crops (Costa et al. 2013).

A 47-year-old woman from a rural town mentioned rats: "They disgust me and can transmit diseases such as Leptospirosis through their excrement and urine."

Rats, especially the species of the *Rattus*, *Mus*, and *Apodermus* genera, are known to be asymptomatic carriers of pathogenic microorganisms that cause infections such as leptospirosis, brucellosis, salmonellosis, among other diseases that are transmitted through their feces and urine, contaminating the environment (Céspedes 2005; Gegúndez and Lledó 2005; Ospina-Pinto et al. 2017; Stuart et al. 2011). In the present study, the most frequent folklore about rats was that of poverty (Figure 3), which can be explained by the fact that unsanitary conditions favor the spread of rats and outbreaks of infections harmful to humans and other animals (Céspedes 2005; Gegúndez and Lledó 2005; Ospina-Pinto et al. 2017; Stuart et al. 2011).

Regarding bats (*Molossus molossus*), it was another animal considered to have a low level of liking, perhaps due to their physical appearance, and popular myths that they suck blood, or that they can transmit diseases (Eklöf and Rydell 2021; Rocha et al. 2021). In a perception study in Mexico, people expressed a negative perception of bats, stating that they are ugly and unpleasant and generate fear due to their physical appearance. The fear of bats is founded on the fact that they can bite, and a few species feeds on blood or can transmit some disease, such as rabies, to humans or their domestic animals (Monter et al. 2017). In the dry forest of Colombia, Ramírez-Fráncel et al. (2021) determined that the perception of local human communities about bats depended on the educational level and gender, and 69% of the respondents had a positive perception when recognizing the ecosystem services that were provided such as pollination (Kunz et al. 2011); but they were not clear if they were species that should be conserved (Ramirez-Francel et al. 2022; Ramírez-Fráncel et al. 2021). In this study, some respondents associated bat stories with death and bad luck (Figure 3). For studies in Brazil, 89% of those surveyed considered bats bad, associating them with beliefs such as sucking blood and that they are dangerous (Rego et al. 2015). Some inhabitants of Silvania have negative perceptions towards bats that they can transmit some diseases; however, no respondent mentioned

that they had problems with this group of animals in their daily activities. Bats are essential since they provide ecosystem services such as pollination, seed dispersal, and pest control. Still, their inconspicuous appearance generates fear and disgust, added to the misinformation in the media and social networks that allows them to generate negative perceptions and attitudes, a future problem if comprehensive conservation strategies are to be generated (Knight 2008; Kunz et al. 2011; Paterson et al. 2014; Ramírez-Fráncel et al. 2021; Rego et al. 2015). Bats can transmit rabies to humans and farm animals (Lawson et al. 2019; Rocha et al. 2021). Bats are reservoir hosts for pathogenic viruses such as the Australian bat lyssavirus (*Pteropus alecto*), which has caused several deaths in people in the state of New South Wales and other towns in the country (Paterson et al. 2014). In West Africa, several species of fruit and insectivorous bats are natural reservoirs of viruses that cause highly contagious and fatal human diseases, such as henipavirus (Pigott et al. 2014). The interactions between humans and bats are the main source of the spread of this type of disease. In Ghana, bats are used for consumption and hunting. This is a fairly common activity among the area's inhabitants; however, the people's low awareness about the consequences of these interactions has given way to devastating spillover events such as the Ebola outbreak in 2014 (Lawson et al. 2019). In addition to this, erroneous communications on social networks and the media have mentioned that bats caused the COVID-19 pandemic, which has increased the general public´s negative perception towards these species (Lu et al. 2021; MacFarlane and Rock 2020). For example, a 21-year-old woman from a rural location mentions: "Bats are ugly and can transmit rabies; they are also the cause of Covid 19."

Snakes are the most rejected and feared animals by local human communities and are very unpopular in Western culture (Kontsiotis et al. 2022; Prokop and Fančovičová 2013; Staňková et al. 2021; Stanley 2008). Negative perceptions towards snakes are forged by their appearance and the fear and phobias they produce in people (Herzog Jr and Burghardt 1988). This attitude is reinforced by the Judeo-Christian religion that personifies Satan in snakes and prevents people from wanting to conserve them (Knight 2008). Furthermore, I limited knowledge of local communities about their functional role in ecosystems and the services they provide to humanity means that people do not value snakes positively (Valencia-Aguilar et al. 2013). This type of negative attitude reduces interest in conserving snakes and generates repulsion, persecution, and sacrifice of these species (Ali et al. 2017; Janovcová et al. 2019). Studies of seventh graders in Slovenia rated snakes among the most fearful of animals (Tomažič 2011), and studies in central Europe surveyed snakes as the most fearful of small vertebrates (Staňková et al. 2021). Studies carried out in Colombia, in a region close to the region in this study, showed that the inhabitants kill animals that they consider poisonous, such as some snakes (Osbahr and Morales 2012).

Some of the testimonies in this study reinforce these attitudes": "I like the colors and skin of snakes, but seeing them makes me afraid because they are animals of the devil" (Respondent #14, 23-year-old woman, urban area).

Snakes are associated with gossip, death, and bad luck in this study (Figure 3) (female respondent #88, rural location and age 30 years mention") "When seeing a snake in the field, the first thing I do is cross myself".

In San Antonio del Tequendama, Osbahr and Morales (2012) report the belief that dreaming of snakes is because an undesirable visitor with gossip is about to arrive, similar to this study.

In Colombia, there are many negative perceptions towards venomous snakes, mostly known as it is "mapaná" or "talla" x" (*Bothrops asper* and *Bothrops atrox*), the rattlesnake (*Crotalus durissus*) and corals (*Micrurus* spp). However, the most feared is the "mapanás" since it is a very poisonous species that cause tissue damage due to its hemotoxicity, and there is a belief that when found in the field, it chases you until it kills you (Lynch 2012).

As for corals, people believe that it stings with its tail and head, which is why they kill it when they see them. Lynch (2012) mentions that the owners of farms asked him to remove all the snakes from their land when he was collecting. The inhabitants of the rural locality mainly considered the snakes detrimental to their daily activities.

For example, a 70-year-old man from a rural town mentions that "snakes like *talla* x *Bothrops* sp. could bite me at work, and I could die from their venom." According to Lynch (2012), the fear and hatred towards snakes in Colombia derive from people's lack of knowledge about these species' role in the ecosystems they inhabit (Valencia-Aguilar et al. 2013).

The fear of snakes may be innate in primates. This hypothesis is because the fear of these predators has partially shaped the brain of mammals. Therefore, they subconsciously react to fear (Öhman 2005, 2007; Stanley 2008). In most human societies, there is fear and rejection of this group of fauna (Alves et al. 2012; Stanley 2008). As for snakes, no studies have been related to the fact that they can transmit diseases to humans, and the respondents did not mention any disease.

For example, a 70-year-old man from a rural town mentioned, "*Talla X* when biting a person can rot your skin." This type of perception may be be-

cause some snakes are poisonous, and these poisons, whether hemotoxic or neurotoxic, cause different reactions that people associate with diseases. According to Lynch (2012), in Colombia, thousands of snakes are killed annually by peasants and other people working in the fields, which could affect the functioning of ecosystems, such as an increase crop pests.

The opossum is a mammal of the *Didelphis* genus belonging to the Didelphidae family. It is one of the various marsupial species that exist in the country (Solari et al. 2013). In Colombia, these species are considered harmful for destroying crops and eating chickens (Osbahr and Morales 2012; Parra-Colorado et al. 2014). This level of dislike has historical roots that go back to the Quimbaya indigenous people who gave the species the common name of "Chucha" referring to an ugly and smelly animal (Parra-Colorado et al. 2014). In Brazil, the interaction between species of the *Didelphis* genus and humans can occur through hunting for meat consumption or to obtain therapeutic products (de Oliveira Carneiro et al. 2019), such as in Mexico, where indigenous people from the Tehuacán-Cuicatlán valley use this species for medicinal purposes (Solís and Casas 2019). In Colombia, there are reports of their use of various species as food, and medicinal uses of the marsupial and liver as a stimulant for childbirth (Cuesta-Ríos et al. 2007; De La Ossa-Lacayo and De La Ossa-Lacayo 2015; De La Ossa-Lacayo and De La Ossa 2012; Osbahr and Morales 2012).

In our study, a 56-year-old man who lives in a rural town commented about opossums "It is a predatory species that eats chickens and makes me sick."

CONCLUSION

The Andes of Colombia is a highly biodiverse area, and they host a great richness and abundance of vertebrate species globally. However, research on the perceptions and attitudes of local communities is scarce, so it is necessary to increase this type of work to better guide the participatory implementation of actions related to vertebrate wildlife species. This study found that sociodemographic variables are important in local communities' perception of native fauna. Variables such as gender, locality, age, time living in the region, and religion influenced the 17 vertebrate species we evaluated. This is why the local communities attitudes and perceptions must be considered in biodiversity conservation programs. Species such as hummingbirds (*Amazilia* sp.), canaries (*Sicalis flaveola*), eagles (*Pandion haliaetus*), the spectacled bear (*Tremarctos ornatus*), deer (*Mazama temama*), rabbits (*Sylvilagus brasiliensis*), and turtles (*Chelonoidis carbonarius*) had a higher level of liking, which is why they can be flagship species for conservation in the study area allowing the protection of habitat for these species and others that have a low level of likeability. However, the conservation of non-charismatic species that do not enjoy a high level of liking, like native rats (*Nectomys magdalenae*), snakes (*Mastigodryas boddaerti*), bats (*Molossus molossus*) and opossums (*Didelphis marsupialis*), is a greater challenge, so the conservation of these species should be focused on environmental education towards the role that they play in ecosystems. Finally, folklore traditions (myth and legend-type superstitions) about fauna are necessary to evaluate in Colombia since the country has great cultural miscegenation and, therefore, positive and negative superstitions that influence people's attitudes.

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DATA AVAILABILITY

The raw data will be available for free download from Mendeley Data when the manuscript is accepted for publication. The survey format and the species information sheets are in the additional files.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

CONTRIBUTION STATEMENT

MMR, JDG, and HGR formulated the study and created the survey; MDV, HGR, MMR, JD,G and DRB conducted the surveys; NUC and HGR, designed and conducted the analyses; All authors helped writing the article.

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