










## Potential conflict as an opportunity for coexistence: cosmovision and attitudes of Arhuaco people towards jaguars

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### ABSTRACT

Human responses to alterations caused by wildlife in human livelihoods depend on psychological and cultural factors, in addition to tangible factors. The ideas of transforming the discourse of conflict into a vision of coexistence, as well as of promoting a dialogue between science and ancestral knowledge, have been increasingly valued in biodiversity conservation. In ten communities of the Arhuaco people (Sierra Nevada de Santa Marta, Colombia), we qualitatively explored the role of the jaguar (*Panthera onca*) and its main prey (deer, peccary and paca) in the Arhuaco cosmovision (vision and interpretation of the world and cosmos) as well as how these people interpret and manage the alterations caused by these species on their livelihood from a cultural perspective. We also evaluated quantitatively their cognitive, affective, and behavioral attitudes towards coexistence with these species. Our findings show that attitudes towards coexistence with the jaguar and its main prey were significantly more positive among those who have been affected by wildlife (i.e., livestock depredation and crop consumption) or who, according to their occupation (ranchers-farmers), have a higher risk of being affected. These attitudes could be better understood in light of the principles of the Arhuaco cosmovision, that have a profoundly ecological ethic, in which the jaguar plays a primordial role in the spiritual, cosmogonic, and natural order. Guaranteeing the protection of Arhuaco culture and territory could be very valuable for the conservation of the jaguar and biodiversity in the ecoregion of the Sierra Nevada de Santa Marta.

**Keywords:** Indigenous Peoples; Sierra Nevada de Santa Marta; Wildlife; Biodiversity Conservation; Culture.

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## SIGNIFICANCE STATEMENT

The present study represents an approach not yet considered in the literature, where psychological (attitudes) and cultural (cosmovision) aspects are evaluated together in the context of the coexistence of indigenous populations with the jaguar (*Panthera onca*). The findings of this study of the Arhuaco people are novel and show a pattern of positive attitudes amongst people whose livelihoods have been affected by jaguars and by their principal prey species (deer, peccary, and paca), compared to those who have not been affected by these species. This can be understood thanks to the principles of the cosmovision of this Colombian ethnic group, that is based on a profound ecological ethic and in which the animals, particularly the jaguar, play a primordial role in the spiritual, cosmogonic, and natural order. These cultural aspects allow Arhuaco communities to coexist with wildlife, even though it might threaten their livelihoods. Our study shows the value of including non-hegemonic cultural visions in the search for human-wildlife coexistence.

## INTRODUCTION

Human responses to wildlife disturbance are not only determined by direct impacts on human livelihoods and economy, but often depend on psychological and cultural factors such as behavior, personal values, beliefs, and worldviews (Dickman and Hazzah 2016; Hiller and MacMillan 2021; Jordan *et al.* 2020). In biological conservation the strategies implemented for resolving human-wildlife conflict have been, in many cases, ineffective because they have not considered the underlying psychological, social, and cultural aspects of human communities (Pooley *et al.* 2017). Therefore, it is imperative to develop approaches that allow an understanding of the complexity of human-wildlife interactions from different perspectives (Bennett *et al.* 2017; Echeverri *et al.* 2018; König *et al.* 2020; Zimmermann *et al.* 2021).

One of the first steps to understand conflict and coexistence with wildlife must be the evaluation of human attitudes (Lyamuya *et al.* 2014; Mannelqvist 2010), since attitudes guide human behavior (Ajzen and Fishbein 2000) and human behavior affects wildlife (Manfredo and Dayer 2004). As a matter of fact, attitudes are considered as one of the main causes of the decline of large carnivores (Echeverri *et al.* 2018; Lyamuya *et al.* 2014; Mannelqvist 2010). Attitudes are defined as positive, negative, or neutral evaluations about a subject (e.g. object, being, group, idea) (Albarracin *et al.* 2018; Cárdenas 2019; Tormala and Rucker 2018); and they include three components: cognitive (e.g. beliefs, thoughts, and information), affect (tastes, emotions and feelings) and behavior (actions performed or tendency to perform them) (Cárdenas 2019; Hogan 2015; Morales-Vallejo 2006). Attitudes are often influenced by beliefs (Ajzen and Fishbein 2000; Albarracin *et al.* 2018). These beliefs, structured in the cosmovision which is the result of historical processes that acquire their cosmological nature when they are assimilated and reinterpreted by

a community, guide the community's actions (López Austin 2012). Broda (2001, p. 16) agrees, defining the cosmovision as “that structured vision by means of which the members of a community coherently combine their notions about the environment in which they live and about the cosmos in which they situate human life”.

To understand conflict and coexistence with wildlife it is also necessary to include the cultural dimension and to involve a knowledge dialogue between western science and traditional knowledge since factors such as religion and belief systems can determine levels of tolerance for wildlife (Baynham-Herd *et al.* 2018; Inskip and Zimmermann 2009; Ruan-Soto *et al.* 2018). In addition, they facilitate the generation of culturally coherent solutions that can be more easily appropriated by the communities (Ruan-Soto *et al.* 2018). This type of approach is often underexplored (Baynham-Herd *et al.* 2018; Pooley *et al.* 2017) and is key to developing more socially just and ecologically effective strategies (Bennett *et al.* 2017).

Studies of human-wildlife interactions tend to focus on the conflicts between humans and wildlife (Bhatia *et al.* 2020; König *et al.* 2020; Pooley *et al.* 2021). However, since the last decade, research has been promoted to understand and manage these interactions from a non-antagonistic perspective, where coexistence is encouraged (König *et al.* 2021; Lute *et al.* 2020; Peterson *et al.* 2010). Human-wildlife conflict is defined as “situations that arise when behavior of a non-pest, wild animal species poses a direct and recurring threat to the livelihood or safety of a person or a community and, in response, persecution of the species ensues” (Inskip and Zimmermann 2009, p. 1). Coexistence, however, is “a sustainable though dynamic state, where humans and wildlife coadapt to sharing landscapes and human interactions with wildlife are effectively governed to ensure wildlife populations persist in socially legitimate ways that ensure tolerable risk levels” (Pooley *et al.* 2021, p. 785). In

order to contribute to this path, it is necessary to explore interactions from different perspectives while avoiding universalizing Western value systems (Pooley *et al.* 2021). For example, by integrating the cosmological belief systems of indigenous peoples to complement conservation strategies based on Western science (Dickson 2018), as there is evidence that the belief systems of indigenous peoples promote coexistence with wildlife (Athreya *et al.* 2018; Nair *et al.* 2021; Ocholla *et al.* 2013). The need of incorporating the views of indigenous peoples to improve interactions with the jaguar (*Panthera onca*) has recently been emphasized (Castaño-Uribe 2016; Marchini *et al.* 2022).

The jaguar is the largest feline in the neotropics with a historical distribution from the southern United States to central Argentina (Swank and Teer 1987). Due to habitat loss, depletion of the prey base, and retaliation for livestock depredation, its historical range has decreased by 54% (Sanderson *et al.* 2002). Although it is almost endangered globally (NT) (IUCN 2022), most subpopulations are Critically Endangered (CR) or Endangered (EN) (De La Torre *et al.* 2018). At the cultural level this feline represents the main symbol of sacredness in the cosmology of many indigenous peoples (Benson and Coe 1972; Castaño-Uribe 2016; Morales and Morales 2021; Reichel-Dolmatoff 1978). However, since colonization a feline-phobic vision and a process of persecution and commercialization of the jaguar has been encouraged (Benson and Coe 1972; Castaño-Uribe 2016; Morales and Morales 2021). Currently, no general pattern has been found with respect to human attitudes and tolerance towards the jaguar (Zimmermann *et al.* 2021) and although there are negative attitudes and jaguar retaliatory hunting in some human contexts, this animal continues to be a highly valued and recognized species in other contexts, such as of indigenous peoples (Castaño-Uribe *et al.* 2016; Gómez and Payán 2017). Nevertheless, little attention has been paid to the study of attitudes towards the jaguar from indigenous peoples, with few exceptions (e.g. Figel *et al.* 2011; Knox *et al.* 2019; Saenz-Bolaños 2021; Steinberg 2016).

In the southern sector of the Sierra Nevada de Santa Marta ecoregion (SNSM), Colombia, the Arhuaco people have cohabited with big cats that prey on their livestock since the time of colonization, when domestic animals were introduced in the region (Castaño-Uribe *et al.* 2019). This ecoregion is a priority for jaguar conservation because it is one of the few areas in the Colombian Caribbean with sufficient viable habitat for this species and where the present subpopulation is Critically Endangered (De La Torre *et al.* 2018). Based on that and considering that the cosmovision can strongly influence the

attitude towards biodiversity conservation in indigenous contexts (Dickson 2018), research was conducted for the present study in Arhuaco communities. The study sought to understand, through the cosmovision of these communities and from a qualitative approach, the following: 1) the symbolic and cultural role of the jaguar and its main prey, 2) how jaguar attacks on livestock and crop consumption by the main prey of the jaguar are interpreted; and from a quantitative approach, 3) the evaluation of attitudes for coexistence with the jaguar and its main prey. We expect that this research will provide guidance for working with indigenous communities in the SNSM, particularly the Arhuaco people, in order to develop strategies and plans for the promotion of human-wildlife coexistence that are culturally coherent and therefore more likely to be appropriated by people. We also hope to highlight the need to take into account indigenous cosmovision in biodiversity conservation.

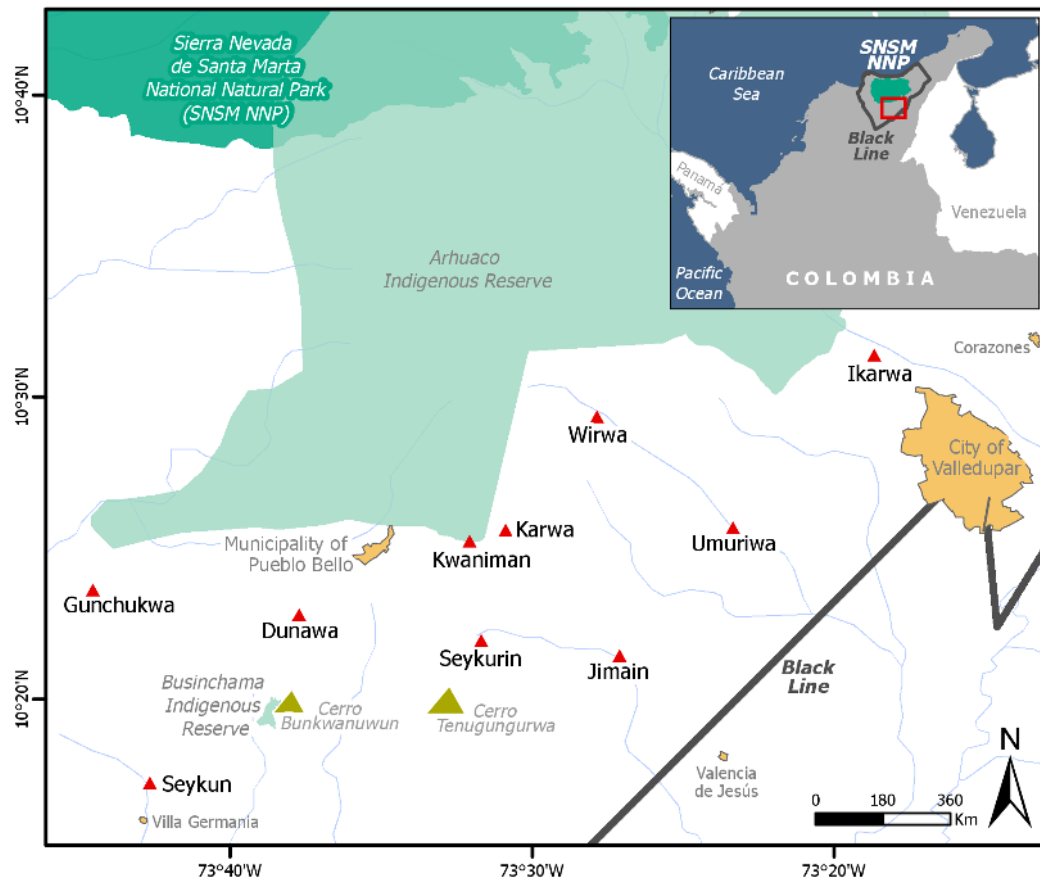
## MATERIAL AND METHODS

### Study area

This study was conducted in ten communities of the Arhuaco or Iku People, situated at between 200 and 2000 masl in the southern Sierra Nevada de Santa Marta (SNSM) ecoregion in northern Colombia (73°30' W - 10°40' N) (Figure 1). The SNSM is the highest coastal mountain in the world with an altitudinal variation from 0 to 5568 masl (Zárrate-Charry *et al.* 2018). The SNSM National Natural Park was catalogued as one of the most irreplaceable protected natural areas on the planet due to its high endemism and species richness (Le Saout *et al.* 2013). There, 84% of the areas suitable for jaguar conservation and management are on private land and the main threat to biodiversity is the expansion of agricultural and livestock activities that interrupt ecological connectivity; therefore, for jaguar conservation, it is necessary to take into account the different social actors in the territory (Zárrate-Charry *et al.* 2018).

The study communities differed in size (between 197 and 1239 inhabitants) and accessibility (the most easily accessible is on a road and the most remote requires a three-hour walk along a footpath). The communities are located on private communal lands, outside of the natural protected area and outside of the two Indigenous Reservations (Arhuaco and Businchama), where they are organized under their traditional system. The main productive activity is agriculture, with fruit harvesting, domestic animal husbandry and fishing as complementary activities (Botero 1987).

The Arhuaco, as well as the Kogi, Wiwa and Kankwamo peoples, are descendants of the Tayrona



**Figure 1.** Location of the ten Arhuaco communities that were part of this research. SNSM NNP= Sierra Nevada de Santa Marta National Natural Park; northern Colombia.

culture, belong to the Chibcha linguistic family and each group speaks their own language, Ikun being the language of the Arhuaco (Reichel-Dolmatoff 1949). These peoples have a common cultural base, but also differentiated knowledge and practices that interact with and complement each other (Arenas 2020b). In addition, they share the same ancestral territory, which is demarcated by the Black Line (*Línea Negra*, see Figure 1), a space that has as its epicenter the SNSM, where there are numerous sacred spaces that, according to their cosmovision, are very sensitive and regulate the balance for the maintenance of life, health and well-being on the planet (Confederación Indígena Tayrona 2015a, 2018). In these spaces, rituals known as Payments (*Pagamentos* or *trabajos tradicionales*) are often performed to give back the vital force to nature and to mediate with the spiritual parents (Arenas 2020a). The way of life of those peoples is based on the Law of Origin, which is the “universal mandate that governs all forms of existence in *Zaku* (i.e., Mother Nature)” (Confederación Indígena Tay-

rona 2018, p. 2). The *Mamos* are the traditional authorities of profound knowledge who guide the development of the individual, social, civil, and spiritual dimensions in coherence and compliance with the Law of Origin (Botero 1987).

## Ethical aspects

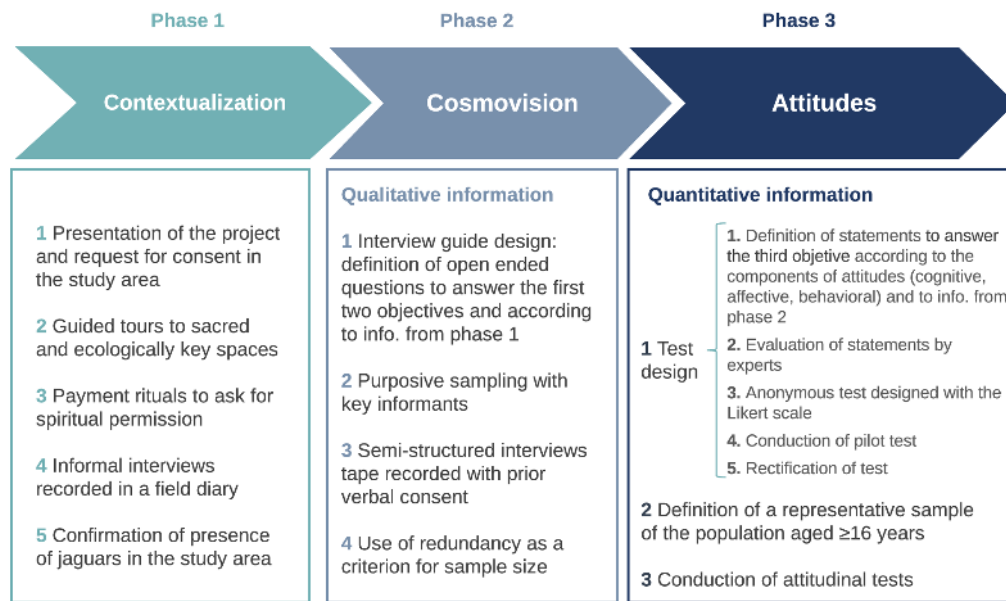
This study was conducted in accordance with the guidelines of the Code of Ethics of the Latin American Society of Ethnobiology (Cano-Contreras et al. 2015) and cohering to the Resolution 3760 of 2017 that approves the Special Plan for the Safeguarding of the Ancestral Knowledge System of the peoples of the SNSM (Ministerio de Cultura Colombia 2017). At the time of publication of this article the official representative of the Arhuaco central government had not yet been defined. In order to obtain permission to carry out the study, an agreement was signed with the authorities of each community in which it was accorded to share the results with them by means of an informa-

tive booklet. It was also agreed that the information published would be faithful to the Arhuaco vision. In this regard, it is important to mention that one of the authors of this research (ABRC) is an Arhuaco and was the field coordinator, translator, and cultural adviser during the process.

## Study design

A qualitative approach was used to learn about the Arhuaco cosmovision and a quantitative approach was used to evaluate attitudes, incorporating the scientific rigor of each methodological tradition (Teel *et al.* 2018). The fieldwork had an adaptive design developed in three phases (Figure 2).

1. Contextualization period: in September 2018, within the framework of the project “Ecological Connectivity Plan for the Conservation of Sacred and Strategic Spaces: Conexión Jaguar” (Castaño-Urbe *et al.* 2019), the research proposal was presented to the Arhuaco authorities and consent to conduct the research was requested. Guided tours were made to some sacred and ecologically key spaces where, led by the *Mamos*, Payment rituals were performed to ask for spiritual permission to start this research. Contextual information was obtained through informal interviews and recorded in a field diary. The presence of jaguars was recorded in the study area by camera traps (Castaño-Urbe *et al.* 2019).
2. Cosmovision: through purposive sampling (Albuquerque *et al.* 2014), between 2018 and 2019, 18 face-to-face semi-structured interviews were conducted with key informants (cultural and territorial Arhuaco experts) such as *Mamos*, political authorities and elders. These were conducted in Spanish or in Ikun (Arhuaco language) with the support of the translator, tape recorded with their prior verbal consent and had an average duration of 58.2 ( $\pm 33.4$ ) minutes. The interview guide included open-ended questions to answer the first two objectives regarding the cultural symbolism of the jaguar and its main prey as well as the understanding and management of the alterations caused by these species, from the point of view of the cosmovision (Additional File 1). To select the jaguar’s main prey for this study, first, according to scientific literature, the most common mammals in its diet (Crawshaw and Quigley 2002; Hernández-SaintMartín *et al.* 2015; Scognamillo *et al.* 2003) that have been reported in the sector (Castaño-Urbe *et al.* 2019) were considered. Then, during the interviews, key informants were asked if they recognized these species as the main prey of the jaguar in the area by using illustrations. Although the howler monkey (*Alouatta seniculus*) is not one of the jaguar’s most common prey according to the literature and interviewees, it was included as a control species because it is a conspicuous mammal that does not generate alterations in the livelihoods of people. The sample size was defined taking redundancy as a criterion, ending the sampling when no new relevant information was received from new experts interviewed (Patton 2014). Additionally, during four days, Payment rituals and informal interviews about the cosmovision regarding the jaguar were held with *Mamos* in Nabusimake, the sacred city and capital of the Arhuaco people, outside the study area.
3. Attitudes: for the third objective, regarding attitudes towards coexistence with the jaguar and its main prey, a test was designed and implemented following Cárdenas (2019), who developed a protocol for standardizing attitudinal tests as a methodological tool in the context of human-animal conflict and coexistence. The statements corresponded to the three components of attitudes (cognitive= thinking; affective= feeling; behavioral= acting) and to three thematic axes defined from the qualitative information obtained (tolerance; cosmovision; community organization for conservation). To guarantee the representativeness and relevance of the test statements, an evaluation was carried out by four expert researchers who rated each of the 55 initial statements in terms of comprehensibility/clarity, representativeness and ambiguity, giving them values between 1 and 4 (e.g. 1= incomprehensible, lengthy or lacking conciseness, 4 = clearly understood, concise, and direct). When averaging these scores, statements with values  $\leq 2$  were eliminated. Once the test was reformulated, an anonymous pilot test with 50 statements was applied to 10 members of the Arhuaco communities; it was rectified again and finally consisted of 43 statements. To measure attitudes, a Likert scale was used with five options: SA (strongly agree=very positive), A (agree=positive), I (indifferent=neutral), D (disagree=negative), and SD (strongly disagree=very negative) (Cárdenas 2019; Petty and Cacioppo 2018). These options were rated from 1 to 5, with the highest value given to the most positive attitude. Questions on personal socio-demographic information were added to the anonymous sur-



**Figure 2.** Adaptive study design for the fieldwork and data collection.

vey format, as well as a direct question on whether each of the study species had ever altered the crops or attacked the animals of people surveyed (Additional File 2). The minimum sample size was calculated in the survey system web page (<http://www.surveysystem.com/sscalc.htm#one>) using a confidence level of 95% and a confidence interval of 10 for a total population of 2581 inhabitants from the age of 16 onwards in the ten communities. Traditionally, in the Arhuaco culture, people can assume adult responsibilities around that age. The sample size had to be at least 93 people. Attitudes surveys were conducted face-to-face between 2021 and 2022.

## Data analysis

The recordings of the semi-structured interviews about Arhuaco cosmovision were transcribed verbatim. An inductive analysis was made through categorical analysis assigning *a priori* categories according to the first two objectives of this study and creating emergent categories for new topics that emerged, following Echevarria (2005). The information was coded and categorized using the qualitative analysis software ATLAS.ti (version 7).

For the analysis of the attitudes (objective 3), an exploratory factor analysis (EFA) was performed fol-

lowing the recommendations of Lloret-Segura *et al.* (2014). First, the inter-statement correlation by Pearson's correlation was explored to detect extreme levels of correlation. Correlations that are too high ( $> 0.8$ ) are an indicator that the statements are too similar; correlations that are too low ( $< 0.3$ ) are an indicator that one statement (or several) is not measuring the same construct as the rest. Therefore, the statements were removed when necessary. To ensure the suitability of the participants' data for factor analysis, the Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy (Kaiser 1970) and Bartlett's test of sphericity (Bartlett 1950) were calculated. The Kaiser–Meyer–Olkin measure ranges between 0 and 1. A value of 0 indicates a diffusion in the pattern of correlations between statements (i.e., the data are not suitable for factor analysis), whereas a value close to 1 indicates that the patterns of correlations are compact and so factor analysis should output distinct and reliable factors. The statements that accounted  $> 0.7$  in KMO were chosen (Costello and Osborne 2005; Ferrando and Anguiano-Carrasco 2010). Bartlett's measure tests the null hypothesis that the statements included in the factor analysis are not inter-correlated (Bartlett test =  $p < 0.05$ ). The Horn's parallel analysis (with 1000 resamples) and the optimal coordinates indicator were used for selecting the optimal number of factors. The extraction was performed through maximum likelihood factor analysis, with polychoric

correlation matrix and oblique promax rotation. The factor loadings above 0.4 were retained (Williams *et al.* 2010). The adjustment indices considered were the root mean square error of approximation (RMSEA), which is a measurement based on approximation errors that assesses whether the model is a good fit, the Tucker–Lewis index (TLI) comparative fit indices based on the comparison of the approximation error of the proposed model, and the independence model and the statistical significance of  $X^2$  to answer the question to what extent is each of the models considered to be adequate. When TLI was  $> 0.95$  and RMSEA was  $< 0.05$  they were considered a good fit; likewise, when TLI was  $> 0.90$  and RMSEA was  $< 0.08$  they were considered to be acceptable (Kline 2015). For the EFA the *fa* function was used from *psych* package (Revelle 2019) in R (version 4.1.0 R Core Team, 2021).

The relationship between each factor resulting from the AFE with the social-demographic characteristics of the collaborators (gender, age, education level, occupation, Ikun language proficiency and alterations by species) were evaluated with generalized linear models (GLM) fit with gaussian error distributions. The model with the lowest  $\Delta$ AIC score (Akaike's information criterion) was considered the best-fitting model (Burnham and Anderson 2002). The Akaike weight (*w<sub>i</sub>*) was calculated for each model that ranged from 0 to 1 and was interpreted as the relative probability that a model is the best among all those plausible combinations. This means that models with higher *w<sub>i</sub>* values will be the most probable and will have a greater explanatory power for the response factors. For the selected models, the relation between variables was calculated by extracting the P value and slope from the GLM test. The GLM was performed with the *nlme* package and for fitting maximum likelihood models the *bbmle* package from the statistical program R was used (version 3.2.0) (Bolker 2020; Pinheiro *et al.* 2016; R Core Team 2013).

## RESULTS

### Arhuaco's cosmovision regarding the jaguar, its main prey, and the alterations they cause

According to the *Mamos* interviewed, the principles of the Arhuaco cosmovision are common to all Arhuaco communities, including those outside the study area, as they are based on the same foundations.

### Cosmogonic context of the origin of the universe

In the Arhuaco cosmovision everything that manifests itself physically has a spiritual counterpart or an immaterial force called *anug'we*, which from now on we will call spiritual. Every existing being and element is the material manifestation of particular spiritual characteristics of *Zaku* or Mother Nature. The history of the universe is divided into two phases, before and after the dawn. In the before there was no light, everything was in darkness and animals and humans existed only in a spiritual or thinking (*pensamiento*) state. In the after, when the sun rose, the world materialized as it is now.

### Role of the jaguar in origin stories

According to one origin story, before sunrise, the jaguar *Mamo* that inhabited the Nabusimake area was the one holding the function of preserving ancestral or traditional knowledge. The jaguar *Mamo*, looking for someone to whom he could entrust the important function of preserving this knowledge, met a human *Mamo* to whom he asked from which side the sun rose and which side it set. The human *Mamo* consciously said that the sun rose in the west and set in the east. Upon hearing this answer the jaguar *Mamo* observed that this human understood the principles of ancestral knowledge, and therefore decided to give him the function of preserving it. Within this knowledge, the jaguar *Mamo* gave the Law of Origin, the *ayo* or coca seeds (*Erythroxylum novogranatense*, sacred plant), the *poporo* (sacred device used by men to store sea shell powder which, with a stick, is mixed with coca leaves in their mouths) and the musical instruments. The Law of Origin is found in all the elements of nature and its functioning, and it is the *Mamos* who have the knowledge to interpret it.

“The jaguar is the owner of all this territory, not humans. The jaguar as *Mamo* performed all the ritual ceremonies (Payments) and by delivering the ancestral knowledge, he ordered humans to fulfill them as well, and in accordance with his function also ordered to do so to other animals that are considered *Mamos*” (*Mamo* of Jimain).

In another cosmogonic interpretation, the jaguar is described in a spiritual state as the one who holds the sun over the horizon, maintaining the balance of the cardinal points (east, west, north and south). Thanks to this, the sun does not touch the ground, nor dry the crops, or create fires. Earthquakes occur because the jaguar force, in a spiritual state, changes position in the support of the earth when humans generate imbalances that become a heavy burden and weaken the strength of Mother Nature.

## Jaguar in sacred iconography

According to Arhuaco iconography the jaguar is part of the sacred system of government. In the Arhuaco cosmogonic map, a representation of the region of the Sierra Nevada de Santa Marta (SNSM) as sacred territory, there is a central figure that corresponds to *Kaku Serancua* (Father Creator). To the right is the jaguar and to the left is the puma (*Puma concolor*). Four points represent the four indigenous peoples of the SNSM and the figure is delimited by a circle that corresponds to the Black Line, their ancestral territory. The *Mamos* consider that, because of its sacred character, the interpretation of this cosmogonic map should be limited and the image only can be reproduced as the logo of the Confederación Indígena Tayrona (Figure 3), to underline the identity of their traditional government.

## Elder Brothers (Hermanos Mayores)

In Ikun, the Arhuaco language, *Gwia* means Elder Brother. It is the name given to the jaguar and puma and also the name given in Ikun to the four indigenous groups of the SNSM with respect to non-indigenous society, who are the Younger Brothers. As the Elder Brothers are the ones who set the example, the jaguar is the one who sets the example to all the other animals through the fulfillment of the Law of Origin and the jaguar carries the messages to humans. Likewise, the four indigenous groups of the SNSM are the bearers of the knowledge of the Law of Origin and have the mission to watch over the balance of the forces that regulate Mother Nature. Also, they must teach and set an example to the rest of humanity about the responsibility of all to maintain the natural balance for the well-being of humanity.

“When the Younger Brothers do something bad or against Mother *Zaku*, the Arhuacos must pay. We, being the Elder Brothers, have more responsibility to maintain the balance” (authority of Karwa).

## Main prey of the jaguar and howler monkey

According to the Arhuaco cosmovision all elements of nature, including animals, fulfill important functions. Regarding the Jaguar, its main preys identified in the area are the deer (*Mazama gouazoubira* and *Odocoileus cariacou gymnotis*) and the peccary (*Pecari tajacu*). These were domestic animals that escaped from humans and became wild after sunrise, while the paca (*Cuniculus paca*) is descended from two species of snakes that mated before dawn. Deer and paca are considered *Mamos* animals. The deer are the spiritual owners of the seeds and they, as well as the peccary, must be rewarded in Payment

rituals before farming. If the sowing and the necessary rituals are not properly done, those animals consume and trample the crops. The hunting of wild fauna is prohibited by the Arhuacos and only allowed for some species in important rituals (e.g. baptism or marriage). For this, permission is required from the political authorities of each community and from the *Mamos*, who, through Payments, request permission of the spiritual parents. The howler monkey received from the thunder (jaguar energy) the knowledge about the weather and the function of announcing the rainy and dry seasons when they howl. This primate is also considered *Mamo*, is rewarded with Payments to regulate the weather, and it is never hunted.

## Interpretation of jaguar attacks on livestock

For the Arhuacos, jaguar attacks on their domestic animals and the alterations caused by other species (e.g. jaguar prey) to their own personal safety and their crops do not represent animal damage or conflict. They are rather a sign or message of a spiritual nature and of forceful intention that is related to possible omissions, non-compliance, or contraventions due to individual or collective behavior within the community that clearly violate the basic principles defined by the Law of Origin. The indigenous interpretation of the presence or eventual attack of the jaguar as a superior being may be related to serious faults that must be corrected. The management of these cases within the territory are attended through the spiritual world by the *Mamos* through ritual practices and ceremonies. These are known as Payments that must be agreed upon with the permission of the spiritual parents, to restore the “order” and “balance” as well as to reward *Zaku* Mother Nature. Concepts that imply an antagonistic relationship with wildlife are incompatible with the Law of Origin. Therefore, it is recommended to use neutral terms, which only indicate an effect or change, such as “alteration”.

“When people do not make the Payments to ask for permission and to reciprocate Mother Nature, then the jaguar and other animals are sent to alarm and to charge... but since many do not know how to interpret this, they say: this animal damages me” (*Mamo* of Umuriwa).

The *Mamos* have prepared themselves throughout their lives to understand the functioning of nature from the spiritual and material dimensions. There are three types of messages from the jaguar’s attacks, and it is *Mamos* who have the knowledge to interpret them. These are:

“You did not warn me before; you have debts or you cannot be here.” The jaguar’s message when it at-



**Figure 3.** Logo of the Confederación Indígena Tayrona representing the sacred government system of the four indigenous peoples of the Sierra Nevada de Santa Marta (Confederación Indígena Tayrona 2022).

tacks is: “knowing that this should not be done, why did you do it? Why didn’t you warn me that you were going to do it?” (*Mamo* of Seykurin).

Another way in which the jaguar’s force manifests itself to deliver messages to humans is spiritually through lightning and thunder, which are also considered the “voice” of the jaguar. Likewise, when there are accidents, bloodshed, and attacks between humans, it is because the spiritual force of the jaguar is very intense. All this can be interpreted as subliminal ways in which the jaguar reiterates its messages.

### Prevention of alterations caused by wildlife

“For us, the measures should be first to protect the mountain, and then make Payments and respect the animals in the forest” (*Mamo* of Kwaniman).

The *Mamos* believe that if they make the appropriate Payment rituals before and after carrying out any activity (especially the use of natural resources) in their ancestral territory, an adequate way to maintain reciprocity and balance is guaranteed; and, therefore, problematic situations for humans are reduced. Considering that all domestic animals have their counterparts in wild animals, in order to ensure the welfare of domestic animals, their corresponding wild animals must be cared for and reciprocated, as well as the sacred spaces that they are related to.

“For us to have domestic animals, we must conserve their representative animal form in nature. For example, if we want to keep pigs, we must take care of the peccary. If we want to have chickens, we must take care of the curassow. And if we damage the sacred sites of these wild animals, it also affects our domestic animals” (*Mamo* of Kwaniman)

They consider incongruous with the Law of Origin measures that imply driving away or repelling wild animals. It is more appropriate to give them back the

territory they are claiming, particularly in the case of jaguar attacks. This leads many families to relocate to other areas with a lower incidence of attacks, which is increasingly difficult because the territory owned by the Arhuacos is not sufficient.

### Management of alterations caused by wild fauna

When alterations caused by wildlife occur, direct contact with those wild animals should not be encouraged. Management should always be guided by the *Mamos*, who identify the cause of the ecological imbalance created by humans that generates this behavior in wild animals, as well as the way to solve it. Then, in sacred spaces associated with the particular spiritual force of such imbalance, the *Mamos* conduct Payment rituals where affected people reflect and try to regulate this imbalance using natural materials. Then, if the *Mamo* considers it necessary, practical or physical measures are implemented. For example, one of the most common solutions is to “sow the farm or make the jaguar’s pantry”. During this kind of Payment, the affected people reflect on the decrease of the jaguar’s wild prey due to human alterations of the ecosystem (Figure 4). They are then led to spiritually protect their domestic animals by imagining a shield around their farms while holding in their hand plants such as chili, which symbolize defense. Then, they receive sea shells where they mentally kept all the jaguar’s wild prey to be offered by the *Mamo* as spiritual food to this animal. Finally, in the holes of a sacred stone representing the jaguar, the *Mamo* insert corn husks, symbolizing that he is feeding the jaguar with its natural prey (Figure 5). The practical action associated with this Payment is to promote ecological connectivity by protecting the forest, collecting seeds, inducing germination, and planting native fruit trees to ensure that the jaguar and its prey have enough



**Figure 4.** Ritual Payment performed as a measure to spiritually handle jaguar attacks on livestock in Jimain.



**Figure 5.** *Mamo* during the ritual Payment on a sacred stone representing the jaguar in Jimain.

food and can move around their territory.

Regarding the consumption of crops by wildlife, there is a high tolerance because this represents a retribution to Mother Nature for allowing them to use the land. During the field data collection only one case of attempted retaliatory hunting of a jaguar by an Arhuaco was reported. The cost of killing a jaguar or puma, on a spiritual level, is so high that even when the non-indigenous people do it, it is the Arhuacos as the Elder Brothers who must assume the consequences and manage the triggered imbalance through *Payments*.

## Sacred spaces

There are many sacred spaces in the ancestral territory (hills, wetlands, valleys, stones, etc.) that are interconnected and function as regulatory centers of the immaterial or spiritual force so that in the physical dimension there is balance. The jaguar travels in a spiritual and physical state between these spaces to manage the territory. Different forces act in them, complementing each other and guaranteeing balance, making existence possible. Among the many sacred spaces in relation to the jaguar the most representative are two hills, Tenungurwa and Bunkwanuwun (see Figure 1). Outside the study area, the Tigrigaka sector in Nabusímake is also an Arhuaco sacred area

in relation to the jaguar and the territory. Many of the sacred spaces are located in the lands of the non-indigenous who have often degraded them and in some cases do not allow Arhuacos to enter to make Payment rituals. This prevents them from carrying out the necessary actions to maintain the balance.

### Jaguar lineages and relationships with other species

There are four jaguar lineages: *Seykunuma* is the black jaguar, *Bunkunuma* is the white, *Munkunuma* the yellow and *Gunkunuma* the red. Just like humans, all animals have a form of organization and knowledge, and the jaguar is the *Mamo* of the other animals, guiding them in the fulfillment of the Law of Origin. The lineages of the Arhuaco people are associated with animals. Men inherit their fathers' lineage and women inherit their mothers', and this largely determines their function in life and society. The Arhuaco belonging to the jaguar lineage are descendants of the Kogi people and it is recognized that this people have a deep-rooted relationship with the jaguar and a profound knowledge of the Law of Origin. It should be noted that, as a legacy of colonization in the region, the jaguar is called *tigri* or "tiger" and the puma "*lion*".

### Attitudes towards jaguars and their main prey

A total of 98 Arhuaco collaborators from 16 to 64 years old were surveyed, 59% men and 41% women, mainly engaged in agriculture and home duties (Table 1). The majority had a primary or secondary school education and speak the Ikun language well. Seventeen percent reported they were affected in their livelihoods by the jaguar and 35% by the jaguar's main prey.

In the exploratory factor analysis (EFA) the statements with low relation ( $KMO < 0.7$ ) were removed. The quality of the data with the resulting statements for applying EFA was good ( $KMO = 0.78$ ). Bartlett's test showed that the correlation matrix was statistically significant (Bartlett's K-squared = 571.36,  $df = 23$ ,  $p < 0.001$ ). These values ensured the suitability of the respondent's data for factorial analysis. Consequently, an EFA was done with the 25 selected statements (out of 43). As a result, a structure of three factors explaining 62% of the variance was obtained (Table 2). The resulting model had an acceptable fit ( $RMSEA = 0.0683$ ;  $TLI = 0.83$ ;  $X^2 = 401.59$ ,  $p < 0.001$ ).

The three factors identified through the EFA were associated with the dominant components of attitudes

(cognitive, affective, and behavioral). The variables that influenced those factors were as follow (Table 3).

### Factor 1. Possibility of coexistence with the species (cognitive component)

The five statements of this factor correspond to the cognitive component and reflect the opinion of the collaborators surveyed on the possibility of humans "living in harmony" with the jaguar, its main prey, and the howler monkey (see Table 2). The average factor was 3.59 ( $\pm 0.25$ ). The statement associated with the possibility of living in harmony with the jaguar tended to be more neutral and the same statement associated with the howler monkey tended to be more positive (see Figure 6). The variable that influenced this factor was "alterations caused by species". People who were affected by attacks attributed to the jaguar ( $P < 0.001$ ,  $w_i = 0.6$ ), as well as those who were disturbed by jaguar prey (deer, peccary and paca) in their crops ( $P < 0.01$ ,  $w_i = 0.6$ ), have a significantly positive attitude with respect to those who were not affected (see Table 3).

### Factor 2. Compliance with Arhuaco norms for biodiversity conservation (behavioral-cognitive component)

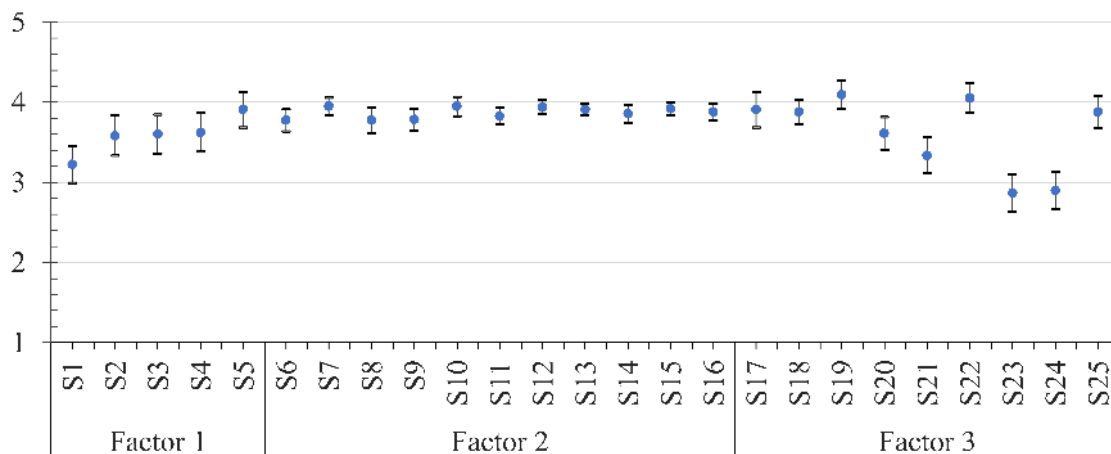
Of 11 statements, five corresponded to the behavioral component, four to the cognitive, and two to the affective. These statements reflect the opinions regarding human responsibility for wildlife impacts on human livelihoods, also the willingness to comply with the Law of Origin, with the rules for biodiversity conservation, the indications of the *Mamos*, and to participate in community decisions (see Table 2). The factor score average was 3.87 ( $\pm 0.07$ ). All statements tended to be positive (see Figure 6). The variable that influenced this factor was "occupation". People engaged in agriculture and cattle raising had significantly more positive attitudes than those engaged only in agriculture, while those engaged only in agriculture had significantly more positive attitudes than students ( $P < 0.05$ ,  $w_i = 0.7$ ) (see Table 3).

### Factor 3. Appreciation and cultural recognition of the species (affective-cognitive component)

Out of nine statements, five corresponded to the affective component and four to the cognitive component. They reflected the appreciation for the species evaluated and the rejection of their hunting and persecution, as well as the recognition in their cosmovision of some of these species as *Mamos* of other animals (see Table 2). The factor score average was

**Table 1.** Sociodemographic characteristics of the surveyed collaborators including the presence of alterations by species in their livelihoods.

Variable	Levels	N	Variable	Levels	N	
Gender	Female	40	Age	Young (16-25 años)	26	
	Male	58		Adult (25-49)	67	
Education level	Tecnician	1		Elder (>50)	5	
	Secondary	36	Perfect	0		
	Primary	51	Ikun language proficiency	Good	79	
	None	10		Limited	16	
Occupation	Agriculture	49	Alterations caused by species in the livelihoods	None	3	
	Agriculture and livestock	10		Jaguar	19	
	Livestock	2		Peccary	25	
	Home duties	27		Main prey of the jaguar	Deer	6
	Student	6		Paca	9	
	Other	4	Howler monkey	0		
			None	54		



**Figure 6.** Mean scores and confidence intervals (99%) of collaborators’ attitudes towards coexistence with the jaguar and its main prey. On the x-axis: statements ID (S-ID, see Table 2). On the y-axis: Likert scale for attitudes: 5 = SA (strongly agree=very positive), 4 = A (agree=positive), 3 = I (indifferent=neutral), 2 = D (disagree=negative), and 1 = SD (strongly disagree=very negative).

3.61 ( $\pm 0.47$ ). Attitudes ranged from neutral to positive with two exceptions that tended towards negative (see Figure 6). These corresponded to the idea that deer and peccary are spiritually *Mamos* of other animals. The variable that influenced this factor was “al-

terations by species”, since the people who had their crops altered by deer, peccary and paca were those who presented a significantly more positive attitude with respect to those who were not affected ( $P < 0.05$ ,  $w_i = 0.5$ ) (see Table 3).

**Table 2.** Results of the exploratory factor analysis (EFA) of collaborators' attitudes towards coexistence with the jaguar and its main prey.

Comp.	S-ID	Statement per factor	Factor loading	$\bar{x}$	$\pm$
<b>Factor 1. Possibility of coexistence with the species</b>					
Cog	S1	In my community it is possible to live in harmony with the jaguar	0.8	3.22	0.89
Cog	S2	In my community it is possible to live in harmony with the deer	0.9	3.58	0.96
Cog	S3	In my community it is possible to live in harmony with the peccary	0.9	3.60	0.94
Cog	S4	In my community it is possible to live in harmony with the paca	0.9	3.62	0.93
Cog	S5	In my community it is possible to live in harmony with the howler monkey	0.8	3.91	0.86
<b>Factor 2. Compliance with Arhuaco regulations for biodiversity conservation</b>					
Cog	S6	All of us in the community are responsible for protecting these animals	0.5	3.78	0.53
Cog	S7	These animals affect crops or attack livestock because humans have destroyed their forests	0.5	3.95	0.42
Cog	S8	At the spiritual level the jaguar is the most important animal	0.6	3.78	0.62
Beh	S9	The people in my community do their best to comply with the Law of Origin	0.7	3.79	0.52
Beh	S10	I am willing to follow all the indications of the <i>Mamos</i> and to do all that they recommend	0.8	3.95	0.46
Beh	S11	On a personal level, I fully comply with the rules of behavior that I know are related to the Law of Origin	0.85	3.83	0.41
Cog	S12	All the norms and agreements of the Arhuaco people for the conservation of nature are adequate	0.8	3.94	0.35
Afe	S13	My opinions are heard in meetings with the authorities of my community	0.8	3.91	0.29
Afe	S14	The sanctions imposed for non-compliance with the rules in my community are fair	0.8	3.86	0.43
Beh	S15	I am willing to comply with all the rules and agreements defined by the Arhuaco authorities	1	3.92	0.31
Beh	S16	I always participate in the meetings and decisions of my community	0.6	3.88	0.41
<b>Factor 3. Appreciation and cultural recognition of species</b>					
Cog	S17	In my community it is possible to live in harmony with the howler monkey	0.5	3.91	0.89
Afe	S18	I would not be concerned if I know that the paca is near my house	0.5	3.88	0.56
Afe	S19	I would not be concerned if I know that the howler monkey is near my house	0.6	4.09	0.66
Afe	S20	I would be upset to know that a jaguar was killed	0.4	3.61	0.78
Afe	S21	I would be upset to know that a deer was killed	0.5	3.34	0.87
Afe	S22	I would be upset to know that a howler monkey was killed	0.6	4.05	0.69
Cog	S23	At the spiritual level the deer is <i>Mamo</i> of other animal species	0.7	2.87	0.88
Cog	S24	At the spiritual level the peccary is <i>Mamo</i> of other animal species	0.7	2.90	0.89
Cog	S25	At the spiritual level the howler monkey is <i>Mamo</i> of other animal species	0.7	3.88	0.76

**Legend:** component (Comp.), statement ID (S-ID), cognitive (Cog), affective (Afe), behavioral (Beh), average score ( $\bar{x}$ ) and standard deviation ( $\pm$ ) of each statement. Here are 25 statements (out of 43) that had factor loadings above 0.4. Variance explained (%) of each factor: F1= 18%; F2= 26%; F3= 17%; Total= 62%.

**Table 3.** Results of the GLMs for the sociodemographic characteristics, including the existence of alterations by the species, that influenced the scores of each factor (EFA) of the attitudes.

Factor (AFE)	Response variable	Socio-demographic characteristics	Pr(>Chi)	df	Contrast	Estimate	t value	p	Resid. Dev	ΔAIC	AIC	wi
F1	Score	Saturated model	<i>Ns</i>	<i>Ns</i>	-	-	-	-	50.6	247.3	12.2	0
	Score	Alterations by species	***	2	Jaguar: None	-0.7	-3.5	***	<b>58.6</b>	<b>235.7</b>	<b>0</b>	<b>0.6</b>
F2	Score	Saturated model	<i>Ns</i>	<i>Ns</i>	-	-	-	-	5.5	30.7	9.8	0
	Score	Occupation	**	5	Agriculture-Cattle:	0.22	2.4	*	<b>6.15</b>	<b>20.86</b>	<b>0</b>	<b>0.7</b>
					Agriculture:	-0.29	-2.6	*				
F3	Score	Saturated model	<i>Ns</i>	<i>Ns</i>	-	-	-	-	1.6	157.1	15.3	0
	Score	Alterations by species	*	2	J-Prey: None	-0.48	-4.4	*	<b>1.75</b>	<b>141.84</b>	<b>0</b>	<b>0.5</b>

**Legend:** Significant results in bold.  $P < 0.05 = *$ ,  $P < 0.01 = **$ ,  $P < 0.001 = ***$ , df degrees of freedom. AIC Akaike's information criterion, AIC difference in ΔAIC compared to the best model, *wi* Akaike weight. Note that GLMs were fit with gaussian error distributions and identity link.

## DISCUSSION

In this study we found that the jaguar is a central element in the cosmovision of the Arhuaco people and that the alterations caused by this feline and its main prey (deer, peccary and paca) on human livelihoods are interpreted and managed with a vision that promotes coexistence. In the attitudes of the Arhuacos towards these species we identified three factors that were associated with the dominant component of the attitudes: the cognitive component, the affective-cognitive component, and the behavioral-cognitive component. Within these, the two socio-demographic characteristics (including alterations by species) that most influenced attitudes towards the jaguar and its main prey were “alterations by species” and “occupation”. Surprisingly, we found that, within these three factors, people who have ever been affected by livestock depredation and crop disturbance consider that there is a greater probability of living in harmony with and have a greater appreciation and cultural recognition for these species. Also, people exposed to alterations by wildlife such as those engaged with livestock and agriculture were the most willing to contribute to compliance with the Arhuaco cultural norms for biodiversity conservation. Our results prove the profound ecological awareness of the Arhuaco people since several studies of other human communities show that people affected by livestock predation and who have more frequent contact with jaguars tend to have more negative attitudes than those who are less likely to have contact, regardless of their ethnicity (Figel *et al.* 2011; Fort *et al.* 2018; Marchini *et al.* 2019; Saenz-Bolaños 2021). It has also been reported that cognitive and affective components are important in attitudes towards predators (Davenport *et al.* 2010; Landon *et al.* 2020), beliefs being the determining aspects (Perry *et al.* 2022).

Considering that the cosmovision of the Arhuaco people is based on the fulfillment of the Law of Origin, the jaguar has an essential role; it is the one delivering to humans the ancestral knowledge containing this Law. This feline is part of the sacred government, a messenger between the spiritual parents and humans and integrator of the ancestral territory for the ecological balance through the sacred spaces. Like the four ethnic groups of the SNSM (Arhuaco, Kogi, Wiwa and Kankwamo), the jaguar has the function of being an Elder Brother, giving example and sharing with humanity the message about the importance of the ecological balance for life on earth and human welfare. They also have a greater responsibility for being bearers of the knowledge of the Law of Origin. The deer, the peccary, and the paca check that humans cultivate crops in accordance with the Law of Origin, and the jaguar is their *Mamo* or guide. Among the

attitudes we also found that the Arhuaco people tend to agree that the jaguar could be the most important animal on a spiritual level. The average score of this attitude is 3.78 from a maximum score of 5.

The Arhuaco attitudes were nudging towards agreement, largely grouped between neutral and positive (Figure 6). We believe that this skewing towards positive attitudes is based on several principles of the Arhuaco cosmovision that shape their beliefs. One of these principles points out that unexpected natural phenomena and unusual wildlife behaviors are the product of ecological imbalances caused by humans. Predation of livestock and consumption of crops by wildlife represent messages from nature for humans to solve such imbalances. It is then considered incoherent and illogical to persecute or to hunt these animals that fulfill the function of alerting or making people pay for their wrongdoings. Therefore, for the Arhuacos concepts such as animal damage or human-wildlife conflict are inadequate; and the Arhuacos recommend that these situations be denominated with neutral terms such as “*alteraciones*” or alterations. In this regard, it has been argued that when encounters between humans and predators are treated as conflict, there is a redefinition and negative polarization of a natural situation that could be perceived as a normal occurrence (Macdonald *et al.* 2010; Pooley *et al.* 2017). In other indigenous contexts, human responsibility for the depredation of cattle by felines has also been recognized, such as the Warlis in India, who attribute predation on cattle to human carelessness (Nair *et al.* 2021), of the Buddhists of Nepal who see such predation as retribution of nature for their bad deeds (Ale 1998) or as several ethnic groups in Sumatra that perceive the killing of cattle or humans by tigers (*Panthera tigris sumatrae*) as retribution when people violate moral codes (McKay *et al.* 2018). Regarding quantitative results, the collaborators surveyed had an attitude skewing towards positive in recognizing human responsibility for the alterations caused by wildlife (3.95/5).

Another principle of the cosmovision states that everything exists first in an immaterial stage and then in a material stage and that these dimensions - spiritual and material - complement each other (Confederación Indígena Tayrona 2015b). Consequently, the prevention and management of wildlife alterations must be done first on the spiritual level in the retributive rituals or Payments and then with practical actions, according to the indications of the *Mamos*. In the Payments, the *Mamos* guide people such as those involved in agriculture and cattle raising, who were affected by wildlife. During those rituals, the *Mamos* suggest to people to reflect on these situations, recognizing human responsibility and the importance of protecting wildlife and ecosystems in order to prevent

attacks on cattle and crop alterations. This possibly promotes for the people involved the development of more positive attitudes than for those who have not gone through this process, which can be explained by the cultural, social and psychological function of the Payments.

From a cultural perspective the Payments are the main element of the exercise of the principles that come from the Law of Origin and are the means of generating awareness in the community members for achieving the ultimate goal of conservation of their culture and territory (Barragan 2010). At the social level, the Payments are the main way to raise awareness about collectivity and interdependence between humans and between them and other beings, thus generating social cohesion (Confederación Indígena Tayrona 2015a; Horta 2014), with social cohesion being an important motivator of attitudes and behaviors of group members (Friedkin 2004). Arenas (2020b) also argues that the relationship schemes developed during the Payments can organize affect and thought, guiding people's actions. From psychology it is considered that thanks to ritual practices human attitudes are formed, strengthened, or transformed (Wojtkowiak 2018). This ritual transformation requires three conditions: 1) the stimulation of emotions and memory, 2) the performative and symbolic aspect, and 3) that it be a collective experience (Wojtkowiak 2018). All these aspects are present in the Arhuaco Payments, that can be collective and individual, along with the perception of animals as spiritual entities that influences the way in which people later relate to wildlife (Nair *et al.* 2021).

With practical actions the Arhuacos have sought, over the last 500 years to conserve the forest and promote ecological connectivity (Castaño-Urbe *et al.* 2019). But in order to achieve this, they consider it is essential to recover their lands and sacred spaces. In association with the other three indigenous peoples of the SNSM, they have delimited the Black Line (*Seykukunumaku* in Ikun language), a system of sacred spaces that has been recognized by the Colombian government for several decades (Resolutions 000002 of 1973 and 837 of 1995 of the Ministry of the Interior). Recovering only a part of this territory has entailed a great effort for those indigenous peoples. Currently, the land where many sacred and key connectivity spaces are located is still owned by settlers, who tend to make unsustainable and extractive use of the land. To recover them, public and private financial support is needed. In addition, it would be necessary to create agreements for conservation of sacred spaces with those settlers who are not interested in selling the land (Barragan 2010).

Another cultural principle has to do with the fact that the *Mamos*, thanks to their knowledge, guide

behavior in the Arhuaco communities by promoting positive attitudes and coexistence with wildlife. The *Mamos* enjoy great respect and recognition, reflected in an attitude skewing towards positive of those surveyed for following their recommendations (3.95/5). Other aspects that may promote coexistence with the jaguar are that, according to Arhuaco cosmovision, hunting of wild animals is only permitted for important rituals and that wild animals must be cared for and repaid to guarantee the welfare of their domestic animals. These aspects are seen as beneficial, considering that in the region hunting by villagers decreases jaguar prey abundance and increases the probability of depredation on livestock and conflict (González-Maya *et al.* 2010).

The jaguar's relevance for equilibrium in the Arhuaco cosmovision converges with its ecological importance. As the largest neotropical terrestrial predator, the jaguar plays a critical role in trophic cascades and in the regulation of ecosystems (Estes *et al.* 2011); and is a key element in maintaining ecological integrity (Miller and Rabinowitz 2002). The role of the jaguar in the Arhuaco vision could also be associated with the Kogi, another of the Elder Brothers, who consider themselves the jaguar-people. Their territory belongs to the father of the jaguars, and this feline is central to their stories (de Friedemann and Arocha 1982; Reichel-Dolmatoff 1949). While the Arhuaco *Mamos* interpret the messages brought by the jaguars from the spiritual parents, according to Reichel-Dolmatoff (1985), the Kogi *Mamos* transform themselves into jaguars to mediate between the physical and spiritual dimensions.

Just as for the peoples of the SNSM, for the Yoruk in Canada and the Taita in Africa, the management of the spiritual and material dimensions are important for coexistence with wildlife and ecological balance (Mwamidi *et al.* 2012; Ramos 2022). As has been argued by Berkes (2017) in indigenous contexts ecological aspects cannot be separated from social and spiritual ones; and as described by different authors, our results suggested that for Arhuaco people, the attitudes towards wildlife were strongly influenced by beliefs resulting from the cultural context (Dickman and Hazzah 2016; Hiller and MacMillan 2021; Inskip *et al.* 2016; Zimmermann *et al.* 2005). This is often the case in collectivist societies, such as indigenous societies, where there is greater social interdependence (Prislin and Wood 2005).

Different attitudes towards the jaguar have been reported in other indigenous peoples. Some are positive due to beliefs (Figel *et al.* 2011), some are negative due to high exposure to jaguar interactions (Saenz-Bolaños 2021; Steinberg 2016) and others are polarized between women and men (Knox *et al.* 2019); suggesting that attitudes towards the jaguar

in indigenous peoples may be consistent with the absence of a general pattern (Zimmermann *et al.*, 2021). Situations similar to our study, of more positive attitudes in people more exposed to jaguar attacks, are rare, occur in non-indigenous contexts, and are often associated with economic motivations (Caruso *et al.* 2020; Soto-Shoender and Main 2013; Zimmermann *et al.* 2005, 2021).

To prevent livestock depredation by wild cats and alterations in human livelihoods caused by other species in the territory of the indigenous peoples of the SNSM it is recommended to always count on the guidance of the *Mamos* to implement measures consistent with their cosmovision. For example, it is important to avoid measures that scare the felines away. Likewise, taking into account that the Arhuaco cosmovision is profoundly conservationist, in order to promote coexistence with wildlife in the SNSM, it is central to support the safeguarding of their culture and the recovery of their ancestral territory, especially the sacred spaces, that are usually the most ecologically important places. Furthermore, it is essential to integrate their cosmovision and their own forms of management into the policies to be implemented in the territory (Nair *et al.* 2021).

We also recommend that spaces for dialogue should be created in order to reach management agreements between the indigenous and non-indigenous inhabitants with the support of government authorities and other institutions. This, considering that there is no conflict between the Arhuacos and wildlife, but rather a conflict of visions with the majority of society, particularly with settlers, who are the ones that mainly persecute the jaguar. Many of the settlers also own farms where numerous sacred spaces are located, often ecologically degraded, where the Arhuacos are sometimes not allowed to enter to perform Payments, undermining ecological and cultural integrity. In this regard, it has been reported that most of the situations considered human-wildlife conflicts are actually human-human conflicts between those seeking to achieve conservation objectives and those who have other objectives (Baynham-Herd *et al.* 2018; Redpath *et al.* 2015). Therefore, for technical solutions to the human-wildlife conflict and coexistence to work, it is necessary to address the underlying human conflicts by building trust and understanding between groups (Redpath *et al.* 2015), as well as to seek a broader vision of the conflict to include all its dimensions (Baynham-Herd *et al.* 2018). It would also be worthwhile to delve into the cultural relevance of the puma, another big cat present in the SNSM, which also preys on cattle and possibly occupies a relevant place in the Arhuaco cosmovision.

Finally, it would be valuable to adapt, test and, if efficient, incorporate strategies developed by in-

digenuous peoples during their long history of coexistence with wildlife in conflict management in non-indigenous contexts. For example, to take into account aspects of the Arhuaco people that seem to be successful in transforming attitudes such as the leadership of local authorities respected by the communities, the identification of the causes of attacks, the recognition of human responsibility and the importance of protecting wild prey species and ecosystems. Likewise, to carry out reflexive educational exercises similar to the Payments that fulfill the three conditions of transformative rituals identified by Wojtkowiak (2018).

## CONCLUSION

Our result that people who have been affected by jaguars and/or their prey have more positive attitudes than people unaffected may be associated with the fact that the Arhuaco People have a profound ecological ethic at the core of their cosmovision that, moreover, is persistently promoted by their traditional authorities or *Mamos*, who seek to reinforce positive attitudes or transform negative ones through reflective and retributive rituals called Payments (*Pagamentos*). All of this has the ultimate goal of acting in coherence with the law of nature or Law of Origin, on which the culture of the four peoples of the SNSM is based and from where the principles for the planning and management of their ancestral territory originate, as well as their knowledge, norms and practices.

The results of this research reaffirm that the cultural system developed by the Arhuaco people that is reproduced in the form of social, political, economic and cultural organization to guarantee the permanence and harmony of all that exists is very valuable for coexistence with wildlife. Therefore, the protection of Arahuaco culture and the recovery of their ancestral territory should be supported. Furthermore, the jaguar has a relevant cultural foundation as an emblematic species for the conservation of biodiversity and the safeguarding of Arhuaco culture and territory. This is particularly valuable given the ecological importance of the jaguar and of the ecoregion of the Sierra Nevada de Santa Marta, one of the most irreplaceable protected areas on the planet.

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## DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

## CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

## CONTRIBUTION STATEMENT

Conceived of the presented idea: MPM, CCU, JCSS, JPT.

Carried out the field study: MPM, ARC.

Carried out the quantitative data analysis: JFA.

Carried out the qualitative data analysis: MPM.

Wrote the first draft of the manuscript: MPM, JFA.

Review and final write of the manuscript: MPM, JCSS, CCU, JPT, DSF, ABRC.

Supervision: CCU, JCSS, DSF.

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## Additional Files

**Add File 1.** Interview guide for conducting semi-structured interviews about cosmovision of Arhuaco people regarding the jaguar and its main prey

*Remember: to inform the objectives of the study and to ask for verbal consent to tape record the interview reassuring the confidentiality of the recorded material. Also, to show the images of the species.*

Interview N° \_\_\_\_\_ Date:\_\_\_/\_\_\_/\_\_\_ Community: \_\_\_\_\_  
Name: \_\_\_\_\_ Age: \_\_\_\_\_  
Occupation: \_\_\_\_\_

1. Do you recognize these animals (deer “cauquero”, deer “ramazón”, peccary, paca and howler monkey) as the main prey of the jaguar in your community?
2. **Cultural symbolism of the species (jaguar or “tiger”, deer “cauquero”, deer “ramazón”, peccary, paca and howler monkey)**
  - a. What is the role on a cultural and spiritual level of these species?
  - b. Are there any ancestral tales about these species?
  - c. Are these species sacred or are they considered *Mamos* animals?
  - d. What is the cultural and spiritual relationship of these species with humans?
  - e. Are there any spiritual offering or ritual such as Pagamento involving these species? What for?
  - f. Are there any traditional songs or dances about these species?
  - g. Are there any symbols or figures that represent these species? Are they carved in stones; painted or represented in some way?
  - h. Are the bodies or body parts of these species used for anything (food, medicine, rituals, sell)? Why?
  - i. Are there cultural norms for the management or prohibition of use of these species?
  - j. Are there sacred spaces in the territory related to these species? What is the relation with them?
  - k. Are there Arhuaco lineages related to these species?
3. **Alterations by species to human property (jaguar or “tiger”, deer “cauquero”, deer “ramazón”, peccary, paca and howler monkey)**
  - a. Does this species generate any kind of problem to the people in your community, their crops, fruit trees or domestic animals? Why does this happen from a physical and spiritual perspective?
  - b. Spiritually, do the activities of the people in your community affect these species? How and why?
  - c. From a cultural and spiritual perspective, why does the tiger (jaguar) attack people’s animals? How do the deer, peccary and paca affect crops?
4. **Management of alterations caused by wildlife**
  - a. What are the indications of the *Mamos* to prevent attacks on livestock and crop disturbances by these species?
  - b. What are the indications of the *Mamos* after attacks on livestock and crop disturbances?
  - c. For the Arhuacos what do these attacks mean? What would be the concept or the adequate definition? In the Ikun language, how is this called?
  - d. In addition to the Pagamentos, the *Mamos* consider that it is adequate to avoid “tiger” (jaguar) attacks by establishing:

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King of measure	Measures	Yes or no and why
<b>Management</b>	Barbed fences	
	Electric fences	
	Night livestock corrals	
	Change of farm design and operation	
<b>Compensation</b>	Change of breed to Criollo cattle	
	Cattle bank for the "tiger" (jaguar)	
<b>Repellent</b>	Use of herding dogs and donkeys	

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5. **Influence of the cosmovision on species management**

- a. What does the Law of Origin consist of?
- b. How is the Law of Origin applied in the conservation and management of these species?
- c. In addition to the Law of Origin, are there other considerations for species conservation and management?

6. **Additional question**

- a. Is there anything else you would like to add?

**Add File 2:** Survey format for evaluating attitudes of the Arhuaco people towards the jaguar and its main prey

*Remember: to inform the objectives of the study, to ask for verbal consent to perform the survey and to show the images of the species.*

<b>Date:</b>	<b>Community:</b>
<b>Gender:</b> <input type="checkbox"/> Male <input type="checkbox"/> Female	<b>Education level:</b>
<b>Age:</b>	<b>Ikun language proficiency:</b> <input type="checkbox"/> Perfect <input type="checkbox"/> Good <input type="checkbox"/> Limited <input type="checkbox"/> None
<b>Occupation:</b> <input type="checkbox"/> Agriculture <input type="checkbox"/> Livestock <input type="checkbox"/> Home duties <input type="checkbox"/> Leader <input type="checkbox"/> Student <input type="checkbox"/> Other	
<b>Have any of these wild animals altered your crops or attacked your animals?</b> <input type="checkbox"/> Jaguar <input type="checkbox"/> Deer <input type="checkbox"/> Peccary <input type="checkbox"/> Paca <input type="checkbox"/> Howler monkey <input type="checkbox"/> None	

**Please say if you:** SA = strongly agree; A = agree; I = indifferent/undecided; D = disagree; SD = strongly disagree. If it is difficult to choose only one answer, think about what your opinion is most of the time. Please answer honestly and remember that this survey is completely anonymous.

<b>1</b> I think it is possible that in my community we live in harmony with these animals	Jaguar / "Tiger"	SA	A	I	D	SD
	Deer	SA	A	I	D	SD
	Peccary	SA	A	I	D	SD
	Paca	SA	A	I	D	SD
	Howler monkey	SA	A	I	D	SD
<b>2</b> I would not be concerned if I knew that this animal was near my house	Jaguar / "Tiger"	SA	A	I	D	SD
	Deer	SA	A	I	D	SD
	Peccary	SA	A	I	D	SD
	Paca	SA	A	I	D	SD
	Howler monkey	SA	A	I	D	SD
<b>3</b> I would be upset to know that this animal was killed	Jaguar / "Tiger"	SA	A	I	D	SD
	Deer	SA	A	I	D	SD
	Peccary	SA	A	I	D	SD
	Paca	SA	A	I	D	SD
	Howler monkey	SA	A	I	D	SD
<b>4</b> I consider that on a spiritual level this animal is <i>Mamo</i> of other animal species	Jaguar / "Tiger"	SA	A	I	D	SD
	Deer	SA	A	I	D	SD
	Peccary	SA	A	I	D	SD
	Paca	SA	A	I	D	SD
	Howler monkey	SA	A	I	D	SD

5	I believe that all of us in the community are responsible for protecting these animals	SA	A	I	D	SD
6	Considering the current situation in the Linea Negra, I am concerned that in the future these animals will disappear	SA	A	I	D	SD
7	I would participate in meetings and projects to protect and conserve these animals	SA	A	I	D	SD
8	I promote respect for nature in my family and friends	SA	A	I	D	SD
9	I believe that these animals affect crops or attack livestock because humans have destroyed their forests	SA	A	I	D	SD
10	I believe that the way we Arhuacos handle wildcats attacks is not enough and we need support from external institutions	SA	A	I	D	SD
11	I do not feel anger when these wild animals affect my crops or attack my animals	SA	A	I	D	SD
12	I am not afraid that the jaguar or “tiger” might attack me or my family	SA	A	I	D	SD
13	I would consult the <i>Mamo</i> whenever the wild animals affect my crops or attack my animals	SA	A	I	D	SD
14	I would be willing to take better care of my crops and domestic animals if these wilds animals affect them or attack them	SA	A	I	D	SD
15	I believe that on a spiritual level the jaguar or “tiger” is the most important animal	SA	A	I	D	SD
16	I consider the <i>Mamos</i> to be the main authority of the Arhuaco people at all levels of organization	SA	A	I	D	SD
17	I feel that the people of my community do their best to comply with the Law of Origin	SA	A	I	D	SD
18	I respect the Law of Origin from my heart and not just as a responsibility	SA	A	I	D	SD
19	I am willing to follow all the indications of the <i>Mamos</i> and to do all that they recommend	SA	A	I	D	SD
20	On a personal level, I fully comply with the rules of behavior that I know are related to the Law of Origin	SA	A	I	D	SD
21	I agree that hunting of animals is prohibited and only allowed for special cases when the <i>Mamos</i> believe it is necessary	SA	A	I	D	SD
22	I agree that all the norms and agreements of the Arhuaco people for the conservation of nature are adequate	SA	A	I	D	SD
23	I feel that my opinions are heard in meetings with the authorities of my community	SA	A	I	D	SD
24	I feel that the sanctions imposed for non-compliance with the rules in my community are fair	SA	A	I	D	SD
25	I am willing to comply with all the rules and agreements defined by the Arhuaco authorities	SA	A	I	D	SD
26	I would report to the Arhuaco authorities if I observe that someone is breaking the rules related to conservation of nature	SA	A	I	D	SD
27	I always participate in the meetings and decisions of my community	SA	A	I	D	SD