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A long and troublesome journey: People's perceptions and attitudes along the migratory path of a scavenger bird

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ABSTRACT

In recent decades, there has been a growing interest in integrating the social sciences and conservation studies to inform a more realistic management approach. Indeed, an understanding of people's perception of fauna helps in the evaluation of possible conflicts with humans, and provides tools to solve these conflicts. However, perceptions may change along a species geographical distribution. Scavenger birds are not exempt from these conflicts as many farmers blame them for attacking and killing livestock. We evaluated the knowledge, perceptions and attitude of people regarding New World vultures along a migratory path in South America. We conducted 114 interviews with farmers in six different localities between Argentine Patagonia and central Bolivia. About half (48.2%) of the interviewees considered vultures harmful to livestock and a substantial number (24.5%) considered killing these birds as a solution for the conflict. The perception of the damage caused by these birds was worse in vultures wintering and breeding areas, than along the migration route. People with a higher level of education and greater numbers of livestock exhibited more negative perceptions. However, many people (53%) still believed that scavenger birds are important for the environment. Our results suggest that acknowledgment of services provided by scavengers makes killing of scavengers less likely. Educational strategies are needed to increase levels of appreciation toward the ecosystem services provided by vultures, over those of perceived damages.

Keywords: Ethnobiology; Vultures; Ecosystem service; Conflict

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INTRODUCTION

In the last few decades, socio-economic aspects have been increasingly included in conservation research, acknowledging the bidirectional and dynamic relationship between people and nature (Mace 2014, Alves et al 2012). The interdisciplinary approaches proposed by ethnobiology bringing together social sciences and biology, create an opportunity for more realistic and inclusive conservation strategies (Ban et al. 2013; Bennett et al. 2017b). The relationship of people with animals involves several kinds of interactions since they have been used as

food sources (Alves 2012; Bezerra et al. 2012; Serjeantson 1997), tools, decoration (eg., horns, musical instruments, decorative feathers), and for transport. Moreover, they have been important as mythological or religious symbolisms (linked to positive and negative figures) (Alves 2012; Alves et al. 2018; Bezerra et al. 2012; Jacques-Coper et al. 2019; Vargas Clavijo and Costa Neto 2008) and have been involved in human health (eg., disease vectors, drugs source, and traditional medicine) (Bezerra et al. 2013; Jacobo-Salcedo et al. 2013; Martínez 2013).

The relevance of a species to a particular society is reflected on its biocultural significance, which is related to the way it is known and perceived. Perception is determined by biological and cultural influences through which the stimuli received by sensory organs are interpreted (Vargas Melgarejo 1994). This includes people's traditional ecological knowledge, and the practices and beliefs about the relationship of living beings with one another and their environment. This type of knowledge is tested by trial and error, and is transmitted orally or by shared practical experiences, maintaining biocultural memory throughout the generations (Berkes et al. 2000; Huntington 2000; Toledo and Barrera-Bassols 2009). Traditional and experiential knowledge is a relevant source of information to inform guidelines for conservation and environmental management and is highly consistent with scientific knowledge regarding the scavenging services provided by vertebrates (Morales-Reyes et al. 2018).

Among animals, scavenging birds have disparate symbolic interpretations in traditional societies of South America. The Black vulture has been recognized as an important symbol in funeral rituals and in human spirit liberation (Vargas-Clavijo and Costa Neto 2008). The Andean condor has been considered as a link between divine and mundane world by Incas, and symbolizes the Andes for the Mapuche culture (Rozzi 2004). In turn, it has been represented in various artistic manifestations (Manzano-García et al. 2017). Despite this, ethnobilogical studies about biocultural memories, have shown the Andean condor has gone from being biocultural keystone species to having a limited presence in cultural expressions (Ibarra et a. 2012; Jacques-Coper et al. 2019). Added to this, in the current popular jargon, scavenger birds have a more negative and contemptuous connotation, because they represent a rogue, ambitious and ill-intentioned person (Vargas-Clavijo and Costa Neto 2008).

In an agro-livestock context, perceptions regarding scavenger birds are variable. Some people recognize the ecosystem services they provide, such as carcass removal (Morales-Reyes et al. 2017), human organic refuse removal (Gangoso et al. 2013), potential help to limit disease transmission (Ogada et al., 2012), and tourist attraction (Cortés-Avizanda et al. 2018). Others believe scavengers are a source of medicine and consume certain parts of the bird for supposed curative effects (Sánchez-Pedraza et al. 2012) or to provide certain abilities (Pfeiffer et al. 2015). However, many people have negative perceptions of scavengers, mainly born from the belief that they kill livestock, resulting in intense conflicts with human populations (Margalida et al. 2014; Messmer 2009).

Damage to agricultural crops and attacks on domestic animals are the most common factors of conflicts in the world and socioeconomic factors seem to be correlated with their incidence (Torres et al. 2018). The conflict between scavenger birds and

livestock has been increasing in recent years worldwide (Duriez et al. 2019). These conflicts play an important role in population declines of several scavengers worldwide (Buechley and Şekercioğlu, 2016; Ogada et al., 2012). In addition to their direct persecution through poisoning (Ogada et al. 2016; Plaza et al. 2019), one important threat to scavenger birds is indirect poisoning from baits used to kill carnivorous mammals (Pauli et al. 2018).

Migratory birds move through different geographic areas, and are thus exposed to different political environments, and social and cultural realities. However, initiatives for the conservation of migratory birds mostly focus on preserving the physical environment and resources, particularly in breeding, wintering and stopover areas (e.g. Robinson et al., 1995; Taylor, 2017). There is a lack of concern about the impacts resulting from perceptions of human´s populations about birds with a termporary presence in the area. In this sense, the same species can be perceived as beneficial to the environment and human activities in some areas, but harmful in others (Morales-Reyes et al. 2017; Saunders and Luck 2016). Therefore, in addition to biological knowledge of species (e.g., reproductive behavior, diet, etc.), there is a need for ethnobiological knowledge on the perceptions, interests and attention of different social actors for the fauna present in a region, in order to conserve the species and their services (Bennett et al., 2016).

Scavenger birds from the American continent forage in groups of mixed species, such that resources can be used by more than one species as well as by carnivores such as pumas and foxes (Elbroch and Wittmer 2013). This leads to a situation in which negative perceptions about a species can indirectly affect an entire guild (Devault et al. 2016). Scavengers are affected directly and indirectly by human persecution (Pauli et al. 2018; Wiemeyer et al. 2017). For instance, the Andean condor (*Vultur gryphus*) is threatened by beliefs that it predates on cattle (Cailly Arnulphi et al. 2017), and the black vulture (*Coragyps atratus*) is negatively perceived due to damage to properties and cattle (Avery and Cummings 2004; Lowney 1999). However, perceptions of the turkey vulture (*Cathartes aura*) have not been studied, probably because of fewer reports of impacts on economic commodoties (Lowney 1999). This species has a broad distribution, from central Canada to Tierra del Fuego and Islas Malvinas, and performs long migratory movements (Grilli et al. 2017). Thus, the species, and even a single individual, faces different socio-economic and cultural realities that may influence perceptions in many ways. Our main aim is to reveal the knowledge, perceptions and attitudes of people about vultures in different localities along one of the migratory paths of turkey vultures in South America, under the hypothesis that differences on perception will be found along the different locations and will be influenced by socio-demographic characteristics of respondents. Therefore, we expect that the proportion of respondents that consider scavenger birds harmful will differ according to different cultural realities.

MATERIAL AND METHODS

Study area

The survey was performed along the migratory path of the turkey vulture population breeding around San Carlos de Bariloche, northwest Patagonia, Argentina (Graña Grilli et al. 2017). Over a distance of

2,755 km, we analyzed people's perceptions of turkey vulture by carrying out interviews at six localities, five in Argentina and one in Bolivia: San Carlos de Bariloche, Río Negro (41°8'S, 71°18'W); Santa Isabel, La Pampa (36°13'S, 66°56'W); Dean Funes, Córdoba (30°24'S, 64°22'W); Taco Pozo, Chaco (25°36'S, 63°16'W); Tartagal, Salta (22°31'S, 63°48'W); and Santa Cruz de la Sierra, Bolivia (17°46'S, 63°10'W) (Figure 1).

Most of the study area has extensive livestock farming, with sheep predominant in southern Argentina, and goats and cows predominant in the central and northern areas of the country (SENASA 2017). The northwest Patagonian region includes large range farm, totalizing 201,807 sheep heads (SENASA, 2017). The locality of Santa Isabel is characterized by a large number of small farms mainly focused on goat production (Bedotti et al. 2014). The other three Argentine localities considered here include mainly bovine, and secondarily goat and sheep, production in high numbers (SENASA 2017). Santa Cruz de la Sierra is the Bolivian department with the highest level of bovine production (INE 2016).

Data collection

We visited and conducted 114 semi-structured interviews with farmers (39 in Bariloche, 15 in Santa Isabel, 15 in Dean Funes, 15 in Taco Pozo, 12 in Tartagal, and 18 in Santa Cruz de la Sierra; see Figure 1). The questionnaire was structured into four sections: i) Socio-demographic characteristics of respondents (i.e., age, gender, occupation, time in cattle-rearing, the amount and type of cattle); ii) Knowledge of interviewees on scavenger birds located in the area; to this end, we used videos and photographs of the birds to determine if the interviewee was familiar with the bird and how they referred to the species. The cases in which the turkey vulture was not differentiated from other American vultures, the conflated species were grouped together in the same taxon for the analysis; and iii) The perception of the birds and/or the ecosystem services provided. We asked: a) if they think the birds attack live cattle, if they have seen any attacks, the degree of damage caused by the birds over the course of a year (none, low or high), and b) if they consider the presence of the birds important or unimportant for the environment and why. These latter questions were asked in only 87 interviewees. The interviews were conducted with farmers in their workplace or their own homes.

Data analysis

To analyze the effect on the perception of different socio-demographic factors associated with livestock activity, we used Generalized Linear Models (GLM) with a binomial distribution. As a response variable, we assigned (1) if people considered scavenger birds harmful to livestock or (0) if they did not. We used social factors and rancher characteristics as explanatory variables. Variables included in the model were: gender, education level, location, type and number of heads of livestock and farm experience (estimated as years working on the farm) (Table 1). The selection of models was made using the Akaike Information Criteria (AIC), selecting those models with the lowest Akaike index (>2 AIC were considered different). All analyses were done using the MASS package in RStudio software and the results were expressed in percentages using the plogis function. We extracted the variables that best explained perceptions and show them graphically using te curve funcion (R Development Core

Team 2018).

To evaluate the relationship between the locality and the annual livestock damage caused by vultures, we used a correspondence analysis. In this analysis, the relative position of the points reflects the degree of association between them. We then evaluated the geographical distance of each locality and the differences in the perceptions of vultures throughout the area using a Mantel test (Bonnet and Van de Peer 2002). We constructed a matrix of geographical distances and a matrix containing the Euclidean distance of variables considered important for each locality: 1) ability to distinguish among vultures species, 2) belief that vultures are harmful, and 3) estimation of the degree of damage produced throughout the year.

Table 1. Variables studied

Variable	Type of variable	Response
Gender	Categorical	Male/Female
Education level	Categorical	Elementary school High school University
Location	Categorical	1 (Santa Cruz de la Sierra) 2 (Tartagal) 3 (Taco Pozo) 4 (Dean Funes) 5 (Santa Isabel) 6 (Bariloche)
Farm experience	Continuous	1 a 91
Livestock heads	Continuous	1 a 26040
Livestock type	Categorical	Sheep Goat Horse Cow Pig

Legend: Explanatory variables used to analyze people's perceptions of New World vultures.

RESULTS

The interviews were conducted with people of both sexes (20% females and 80% males), with age ranging from 18 to 91 years old (mean=47.8, standard deviation=16.65 years). All interviewees distinguished New World vultures (three species in the study area) from other species, but more than half (65%) did not distinguish between vulture species inhabiting in their localities. For this reason, we carried out the statistical analyses considering the perception of all vultures together. Thus, in Santa Cruz de la Sierra, Tartagal and Taco Pozo, the category "vultures" may include *C. burrobianus* and *C. atratus* in addition to *C. aura*; and for the rest of the localities, this category includes only *C. atratus* and *C. aura*. Almost half (48.2%) of the interviewees considered vultures as harmful to livestock, even though 21.8% of them never witnessed an attack by these birds. A quarter of the interviewees (24.5%) considered the elimination of these birds as a solution to avoid this conflict. Despite the negative perception, 53% of respondents thought vultures are important for the environment, mainly because they may provide a service by cleaning farms of decomposing corpses (e.g., interviewees said: "[when] the animal dies, they come and disarm it in 3 days and there is no more dead animal. They are part of nature and they always existed"; ID 53B, Santa Isabel), or because they indicate the location of dead animals (e.g., "Oh!, when you see a flock of birds turning around, my dear, it's because a cow died"; ID 40B, Dean Funes) (Figure 1). Of those who considered vultures important to the environment, 93.5% did not purposefully kill them.

Within the subgroup of people who considered that vultures are harmful, 52.7% declared that the annual damage to their livestock is low, while 40% claimed high levels of annual damage and the remaining 7.3% did not know the degree of annual damage (Figure 2). There was a low but significant positive correlation across the geographical distance between localities and

the perceptions of the interviewees (Mantel test: 0.067, p = 0.002).

Most people (56%) who perceived vultures as harmful used lethal strategies to decrease the incidence of attacks (eg., "They are not important, they attack the cattle and generate losses, what if one day, they turn out to be attacking people? They have to be eliminated", ID 10Bb, Santa Cruz de la Sierra). Almost half of them (47.2%) considered traps and/or shotguns to be the best methods for elimination. A smaller, but relevant percentage (10.1%) recognized using, or having used, poison to kill these birds ("The poison has to be put in the meat of a dead animal.", ID 21B, Taco Pozo). One of the poisons used is strychnine, which is forbidden, and they reflected on the current challenge of obtaining it due to the ban. On the other hand, they also report the use of non-lethal strategies to control the attacks. The most mentioned non-lethal methods were the surveillance of livestock through continuous rounds (12.7%), or putting the cattle in pens during calving (12.7%) (e.g., "We try to shepherd the goats when they are giving birth, and take care that they do not go with the calf to the field", ID 47B, Santa Isabel). Finally, 7.2% recognized the shepherding dog as a good strategy to avoid attacks from scavenger birds.

The descriptions of the attacks were similar throughout the study area. The interviewees who claimed that vultures are harmful, stated that sheep (56.3%) and cow

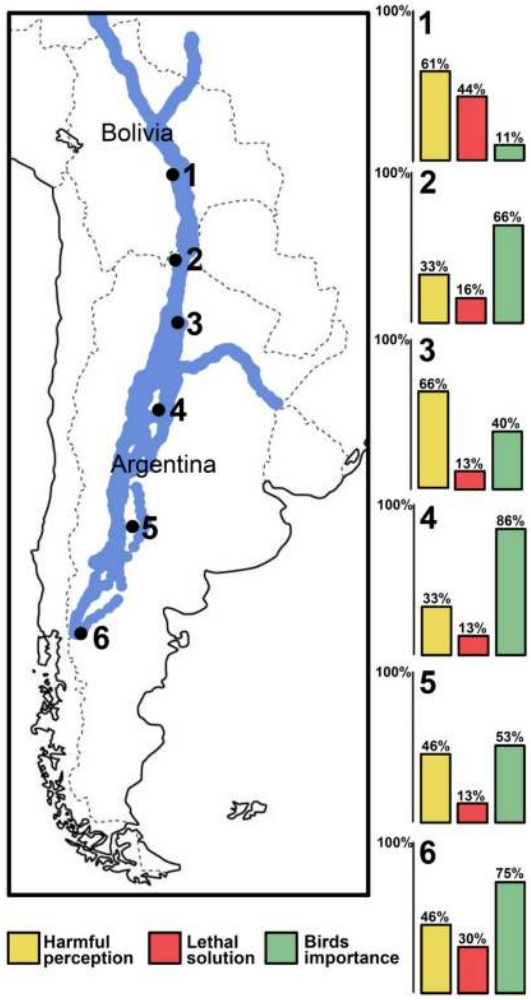

Figure 1. Studied locations in southern South America. 1, Santa Cruz de la Sierra (Bolivia); 2, Tartagal; 3, Taco Pozo; 4, Dean Funes; 5, Santa Isabel; and 6, Bariloche (Argentina). The bar graphs show the percentages of all interviewees from each location who perceived the birds as harmful (yellow); believed that removing the birds from the environment is the solution to the conflict (red); and considered that birds are important for the environment (green). The blue line is a schematic representation of the migratory path of a turkey vulture population from Patagonia (taken from Graña-Grilli et al 2017).

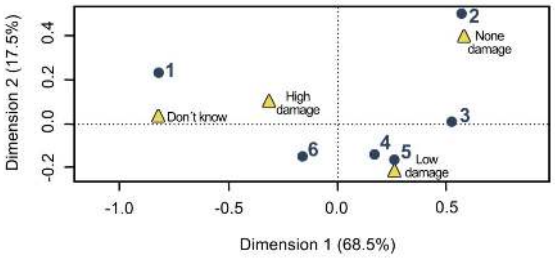

Figure 2. Correspondence analysis relating people´s perception of the degree of damage caused by scavenger birds, and the location of the interviewees (see reference on locations in Figure 1).

(54,5%) are the most affected livestock. They described birds perching in large numbers around the mother during calving or minutes after labor finishes, and then pecking the newborn in the anus and eyes until its death (eg., "If one does not attend the goats when they are giving birth, they [vultures] attack the goatling. They sting their eyes and snout, but only when they are newborns" (ID 8B, Tartagal). The neonates were indicated as the most affected by scavenger birds (41%). However, they also reported attacks on adult livestock when they are sick or “bad fallen” (35%) ("mal caídas" in Spanish), a term that refers to cattle that cannot move or get up due to a variety of factors (e.g., "When the animal is bad fallen, which is to say, is cast down, they eat the eyes and the udder", ID 44, San Carlos de Bariloche).

We obtained two equivalent models to explain the harmful perceptions of vultures by interviewees (Model 1= Education level and head of livestock, AIC= 155.1, ΔAIC= 0.0 (Figure 3); Model 2= head of livestock, AIC=156,8, ΔAIC= 1,75). These models suggest that as the number of livestock managed by the interviewees and their education level increase, the negative perception of scavenger birds increases, with the birds considered more harmful (Figure 3).

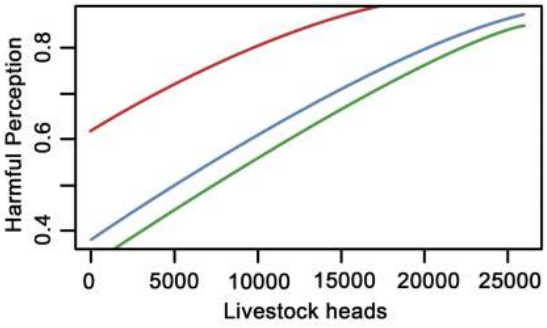

Figure 3. Relationship between the perception of vultures as harmful (in % of interviewees) and the amount of livestock based on generalized linear models. We separated this relationship by each education level. Red, university; Blue, elemenetary school; Green, high school.

DISCUSSION

Extensive livestock farming increased in a relatively short time scale in Argentine Patagonia since the exclusion of indigenous groups by Argentine military. This has produced important changes in the diet of predators and scavengers, incorporating livestock as an important part of energy in trophic networks (Novaro et al. 2000; Ballejo et al. 2017; Lambertucci et al. 2009). The modern use of livestock farming, not only generated a new interaction with wildlife, but also with people, accelerating the loss of traditional knowledge and practices that are resulting in an erosion of biodiversity and loss of regulating ecological services (Barthel et al. 2013; Toledo and Barrera-Bassols 2009).

We found that nearly half of the people interviewed along turkey vultures migratory path in South America considered New World vultures as harmful to livestock. Moreover, a relevant proportion (~25%) considered the elimination of these birds as a solution to this conflict. People with higher levels of formal education, and with higher numbers of livestock considered vultures as more harmful, and thus had a more negative perception. However, despite the negative perception of respondents, many of them (53%) thought vultures are important for the environment.

Each locality has particular socio-cultural and biophysical characteristic that influence people’s perceptions and actions. It is notable that the two most extreme localities-—Santa Cruz de la Sierra, Bolivia in the North and San Carlos de Bariloche, Argentina in the South—are the locations

where more interviewees considered scavenger birds as damaging to livestock, while in Salta (the closest locality to Santa Cruz de la Sierra), most respondents considered them unharmful (Figure 2). These localities correspond to the wintering (Santa Cruz de la Sierra) and breeding (Bariloche) areas, respectively (Grilli et al. 2017). In the North, the migrant birds overlap with resident populations, and thus these higher population numbers may negatively affect farmers' perceptions (Margalida et al. 2014). In the South, in the breeding grounds, vultures foraging needs may be higher since adult birds are feeding their young (Dodge et al. 2014). This may also influence the perception of damage produced by these birds.

At a regional scale, almost half of the interviewees considered vultures harmful to livestock, with a description of attacks similar to those described for black vulture in other regions where groups of birds are blamed for surrounding adults or neonates, pecking them in the anus or in the eyes until their death (Avery and Cummings, 2004; Lowney, 1999). We found that lethal control strategies are the most often used to avoid attacks, contrary to other results for Patagonia (Gáspero et al. 2018). Although the use of poison was not the main control method mentioned, it is likely that its illegality has an influence on the affirmation of its use. Poison is concerning since it may affect the entire guild of scavenger birds, because they often feed communally (Pauli et al. 2018). Large numbers of individuals from different species can be poisoned at a single carcass (Devault et al. 2016; Plaza et al. 2019). In turn, people's inability to differentiate vulture species can mean that the use of deadly strategies like shotguns or traps, not only affect the target species but also threaten those considered less harmful. In this sense, previous work has indicated that the black vulture shows more predatory behavior than the turkey vulture (Lowney 1999). Thus, the morphological similarity between species may mean that people's perception of one species affects the entire assemblage.

More than half of the interviewees considered scavenger birds as important species for the environment, which agrees with another study on Andean condors in Argentina (Cailly Arnulphi et al., 2017). It is interesting that many of the interviewees considered the birds both harmful and as providers of services to their farms, by cleaning corpses and controlling diseases. Similar results have been found in Spain with Old World vultures (Morales-Reyes et al. 2017). However, this does not necessarily imply a contradiction, but could express a complex dynamic with a cost-benefit relationship between humans and fauna, where the perceived damage may be higher than the benefits acquired and vice versa.

The farmers amount of livestock and their education levels are the variables that best explain the perception of vulture damage. Unexpectedly, people with a university-level education tended to consider vultures more harmful than those with lower educational attainment. Education level has been indicated as a factor that improves tolerance (Cailly-Arnulphi et al. 2017; Torres et al. 2018). This appears to contradict our results, however, the higher educational levels considered by Cailly Arnulphi et al. (2017) correspond to school teachers who are not ranchers. In our study, people with university degrees, like agronomists, veterinarians and engineers, seem to percieve scavengers as more harmful than school teachers did in the ealier study.

In this sense, the traditional ecological knowledge gain importance because it is acquired independently from formal

education and is mainly transmitted orally (Huntington 2000). Universities may be the places where the loss of biocultural memory occurs the most (Núñez-García et al. 2012), and it has been shown that some cultures have lost part of the biocultural memory associated with scavengers birds (Jacques-Coper et al. 2019). The traditional ecological knowledge is related to more positive attitudes towards conservation and participation in conservation (Shen et al. 2012). Traditional methods of agricultural and livestock production take advantage of ecosystem services provided by the environment and prioritize diversification in their production systems, minimizing or eliminating mechanization and the use of external inputs and instead prioritizing ecological processes and natural resource conservation (Kross et al. 2018; Silva-Andrade et al. 2016). The perception of scavengers as providers of ecosystem services depends on preserving traditional livestock practices, such as transhumance and the abandonment of livestock carcasses in the field (Morales-Reyes et al. 2017). The recognition of the services provided by scavenger birds, may imply that the people do not kill them.

Oposite to traditional methods of livestock production, in extensive livestock farming, large numbers of livestock are associated with large range farms, where animals graze free, without vigilance, and the disappearance or death of an animal is rarely witnessed by anyone. This can lead to many natural deaths being attributed to attacks by native fauna (eg. pumas, foxes, etc.) or even scavenger birds, because the evidence of an attack is lost once the scavenger feeds on the carcass (Margalida et al. 2014). On the other hand, on small farms with few animals, livestock can be better managed, allowing surveillance and the ability to enclose and protect pregnant livestoock (Shelton 2004).

The Bolivian locality (Santa Cruz de la Sierra) differed notably from the Argentinean localities (Figure 1) in the importance attributed to scavenger birds in the environment and to the ecosystem services that they recognized. The farmers interviewed in Bolivia did not seem to recognize any services provided by the birds to the environment. Livestock production plays an important role in the economy of Santa Cruz de la Sierra, as this is the Bolivian department with the highest production and exportation of meat (INE 2016). The risk of economic losses for people whose livelihood focuses on livestock production could play an important role in the negative perceptions of fauna (Messmer, 2009 and this work). Education has an important influence on what people believe about scavenger birds. However, the degree of damage caused by these birds, as well as the conditions in which these attacks occur, are not well known and can be overestimated by the livestock producers. Thus, educational strategies will fail if they are not complemented with information on the actual impacts produced by these birds.

CONCLUSIONS

Our results suggest that an acknowledgment of the services provided by vultures and of the actual damages produced could lead to less killing of vultures by farmers. Therefore, it is necessary to promote educational strategies focused on the ecological services provided by scavengers to livestock production and people. Thus, the services that these birds can bring to a farm should be promoted, including: 1) cleaning corpses and their associated pathogens (Ogada et al. 2012b),

as they can consume dead cattle in short time periods (Ballejo et al. 2016), avoiding the time and money needed for removing carcasses (Graña Grilli et al. 2019; Morales-Reyes et al., 2017); 2) the control of other more dangerous scavenger species such as wild dogs and rats, which in the absence of native scavengers could occupy their niche and introduce diseases such as rabies (Markandya et al. 2008); and 3) the income that can be generated by taking advantage of these birds as tourist attractions (Becker et al. 2005).

The promotion of these services can generate a cost-benefit relationship between ecosystem services and perceived damages that can be positively compensated. Education about the services can help lessen hostility, but such deep-seated preconceptions tend to be hard to over-come and must be considered in conflict studies (Dickman 2010). However, to achieve more accurate estimations of this cost-benefit ratio, it is necessary to obtain more empirical data, and not rely solely on personal testimonies that can be influenced by numerous social factors (Vargas Melgarejo 1994). Therefore, it is necessary to carry out studies that quantify the real damage to livestock caused by scavenger birds.

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