Climate change contributing to conflicts between livestock farming and guanaco conservation in central Chile: a subjective theories approach

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Abstract Negative interactions between guanacos *Lama guanicoe* and ranchers have recently intensified in central Chile because guanacos are perceived to be competing with livestock for pasture resources. We examined this conservation conflict with a novel approach that considers ranchers' subjective theories, to better understand the origins of the conflict and to identify effective conservation measures based on the participants' explanations. Our findings indicate that ranchers see the source of the current problem in a shift towards increasingly arid conditions associated with climate change. We suggest the ranchers' perceived problems are not only caused by interspecific resource competition arising from this climatic shift, but also by reported difficulties in negotiating with governmental institutions. This study adds to knowledge of human–wildlife interactions by exploring a further dimension of the complex ecological and social interactions taking place on livestock farms. We recommend identifying effective, acceptable solutions by considering and understanding the everyday knowledge of the conflict's protagonists and their potential for change.

Keywords Beliefs, climate change, conservation conflict, conservation psychology, human–wildlife interactions, interspecific competition, subjective theories

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Introduction

An emergent field of research (Cronin et al., 2014) is focused on negative interactions between humans and wildlife, often referred to as human–wildlife conflicts or conservation conflicts. Negative human–wildlife interactions are a global priority for biodiversity conservation (Manfredo, 2015) because they can jeopardize rural livelihoods, especially in poor communities, which can in turn reduce support for conservation projects (Rust & Marker, 2014). The conflicts arising from human–wildlife interactions comprise two components: (1) 'impacts that deal with direct interactions between humans and wildlife species (Young et al., 2010)' and (2) 'conflicts between humans themselves over how to manage the impacts between humans and wildlife' (Kansky et al., 2016, p. 137).

Conservation conflicts also occur when wildlife is perceived to threaten humans, their security, crop and livestock production, or property (Rust & Marker, 2014), regardless of the actual impacts. Social aspects have thus become increasingly relevant for understanding drivers of real and perceived impacts of wildlife on people, as well as for implementing effective conservation measures (Rust et al., 2016). Conservation social science helps in understanding how humans affect nature (and vice versa) and has the capacity to improve conservation practices (Newing, 2010; Bennett et al., 2016). Qualitative social science in particular is relevant in contexts such as ingrained conflict, where in-depth knowledge of complex problems is required (Inskip et al., 2016; Rust et al., 2017).

Along with social aspects of interactions between people, a person's willingness to tolerate potentially damage-causing wildlife is strongly influenced by complex subjective psychological factors, such as beliefs, values and attitudes (Bruskotter et al., 2009). For example, beliefs and perceptions about tiger *Panthera tigris* population trends can predict tolerance towards these felids (Inskip et al., 2016), and preferences of local communities regarding future wildlife population sizes are primarily influenced by beliefs about the species in question and the risks associated with them (Carter et al., 2012). Beliefs about certain species may be based on beneficial attributes (e.g. cultural, ecological, economic or religious; Kellert, 1985) or undesirable impacts such as resource competition (Carter et al., 2012). For example, religious tolerance towards Asian elephants *Elephas maximus*, particularly the belief in the elephant as

a god and avenger, has positive implications for elephant conservation in India, where people's willingness to tolerate elephants and the damage they can cause is rooted in religious belief systems, rather than in compensation schemes designed to mitigate impacts (Gogoi, 2018). Research in various disciplines has established the impact of traditional knowledge on people's behaviour, specifically how such knowledge supports the development of personal explanatory beliefs used to guide and justify people's actions (Flick, 1992). Collectively, these studies convey the importance of exploring and understanding the psychological factors that encourage tolerance towards species of conservation concern.

Beliefs are important psychological factors, shaping how people perceive and act towards wildlife. Beliefs can be defined as associations or relationships established between attitude objects and various attributes (Eagly & Chaiken, 1993), but the term is polysemous and has been defined only vaguely in psychological research (e.g. Pajares, 1992). In contrast, the concept of subjective theories was developed through an empirical approach that yielded a specific definition: beliefs of a particular type (Groeben & Scheele, 2010) characterized by the generation of non-scientific (subjective) hypotheses that are used to predict, justify and orient a person's behaviours. For example, a person stung by a bee as a child may remember this as an experience of fear and could therefore grow up believing bees should be feared. This concept has proven useful in the fields of education, learning, health, instruction and ecological projects (Flick, 1992; Flick et al., 2004; Menzel & Bögeholz, 2009; Cuadra et al., 2017). Subjective theories provide orientation (when dealing with specific situations) and justification or a posteriori explanations of certain events (Flick, 1992). People make decisions following these experience-based personal theories (Kolbe & Boos, 2009), such as avoiding bees in the example above. It is therefore relevant to understand how subjective theories can contribute to the analysis of conservation conflicts. However, to our knowledge, no studies have yet utilized this approach to examine conservation conflicts in detail. Deeper understanding of the perceptions or beliefs of those involved in such conflicts could illuminate how subjective theories contribute to maintaining certain conflicts or hindering their resolution.

The guanaco *Lama guanicoe*, a wild camelid native to South America, is categorized on the IUCN Red List as Least Concern across its range (Baldi et al., 2016). Within Chile, the species is categorized as Vulnerable in central Chile and as Least Concern in the extreme south of the country, where its populations are managed (MMA, 2012). In pre-Columbian times, the guanaco coexisted with human settlements, was used for its meat and to make leather, and was of cultural and mythological relevance for Andean Indigenous communities (Garrido, 2010). Following the Spanish colonization, the species was driven to near extinction though overexploitation, compounded by competition for resources and displacement resulting from livestock introduction (Miller, 1980). Nevertheless, in some regions of the country guanacos are still culturally relevant, as evidenced by their depiction in local handicrafts, and continue to be valued despite their limited presence (Bonacic et al., 2014).

In central Chile, conflicts with large ungulates such as guanacos have emerged as a significant problem since 2005, with ranchers claiming that guanacos negatively impact their herds (Vargas & Castro, 2018). A perceived recovery in guanaco numbers in this area has raised concerns amongst ranchers who share grazing resources with guanacos and have reported income losses resulting from an apparent increase in grazing competition. Similar issues have also been identified in the Patagonia region in Chile and Argentina (Iranzo et al., 2013), where extraction for sustainable use was initiated in the early 2000s (through the use and valuation of products such as meat) ahead of an anticipated recovery of local guanaco populations (Gonzalez et al., 2013; Soto et al., 2018). However, according to farmers' protests (La Prensa Austral, 2016), sustainable use has neither resolved the problem nor mitigated the conflict (Hernández et al., 2017), possibly because this approach does not address the deeper social aspects of the problem (Rust et al., 2016).

In central Chile, ranchers demand the government focuses on population control of guanacos in the parts of their range that overlap with livestock grazing. The institution in charge of livestock and agriculture, the Servicio Agricola y Ganadero, has rejected this request because there are no recent population data for guanacos. The most recent available data were generated in 1992, based on an undefined methodology (Cunaza, 1991). The agency has also stated it does not have the technical expertise to resolve these issues (Vargas & Castro, 2018), but has offered to collaborate with research institutes to gain knowledge about the characteristics of high-altitude wetlands (so-called *vegas*) and environmentally friendly agricultural production. However, this has failed to address livestock ranchers' concerns. Ranchers and government bodies have met on several occasions during 2012 (M. Soriano, Office holder of Petorca Province, Servicio Agricola y Ganadero, 2018, pers. comm.), but no progress was made on this issue. In addition to Servicio Agricola y Ganadero and the ranchers, a new participant, the Agricultural and Livestock Development Institute of the Ministry of Agriculture, joined the discussions in 2012, sympathetic to the farmers' interests. Following these meetings, participants indicated that no agreement was reached that satisfied both parties' needs, and that a lack of understanding on both sides may have contributed to the stagnation of conflict resolution efforts.

Understanding the beliefs of livestock ranchers about guanacos could help identify the underlying drivers of conflict and may thus be key in identifying better conflict mitigation measures. We therefore adopted a novel approach to this conservation conflict by examining livestock ranchers' beliefs based on their subjective theories. We used these theories as tools to (1) help understand the origins of the conflict, (2) explore ranchers' traditional knowledge with respect to guanacos, and (3) identify ranchers' explanations of the causes of the perceived conflict that can inform effective conservation measures.

Study area

This study was conducted in Petorca Province in the Valparaíso Region of central Chile, in the Alicahue Valley, where ranchers use montane areas as summer pastures for livestock (cattle and horses; Fig. 1). Here, the livestock ranching organizations of Alicahue and Paihuén (with a combined total of 55 members as of 2016) together administer a community livestock management system across c. 30,000 ha, where livestock graze freely. In the summer (January–March) livestock are taken to higher altitudes (c. 2,500 m), close to high-altitude wetlands, where they have access to water and forage. During this period, livestock are largely left to fend for themselves, being checked by ranchers c. once per week, and may interact with wild animals, including guanacos. The majority of ranchers in the area are men, which is typical for livestock production in Chile (INE, 2015). In the Valparaiso Region, most farmers (62%) are > 60 years old (INE, 2015).

Methods

We interviewed 16 livestock ranchers from Alicahue and Paihuén (from a total population of 55) in the summer of 2016 (December), and used the data collected to reconstruct their subjective theories. Prior to that, we conducted a pilot in spring 2016 to test the interview questions with a subset of the target population, in a different ranching community. A large sample size is not required for research on subjective theories as the research is qualitative in nature (Castro et al., 2017). Sampling was opportunistic because many residents were away from their households, working on their lands, when we conducted interviews. Interviews were in person, either in the ranchers' homes or places of work, and ranchers were invited to participate voluntarily. Prior, informed consent was obtained from all respondents. The interviews were undertaken in Spanish, audio-recorded and later transcribed. Three interviewees did not agree to be recorded and their responses were excluded from the analysis.

The interview questionnaire had two parts: a structured section aimed at capturing ranchers' socio-economic data, and an open-ended section that explored their views on guanacos and their relationship with the species (Supplementary Material 1). Open-ended questions covered a range of topics related to the guanaco, including the issues associated with the species, its historical presence in the area, beliefs about the species, the ranchers' relationship with governmental institutions, and proposed solutions to the conflict. We used the open-ended questions to construct the farmers' subjective theories.

We analysed the transcripts with *Atlas.ti 7.5* (Muhr, 2016) to identify the participants' subjective theories, using

FIG. 1 The study area, Alicahue and Paihuén community summer grazing area, in the Valparaíso region of central Chile.

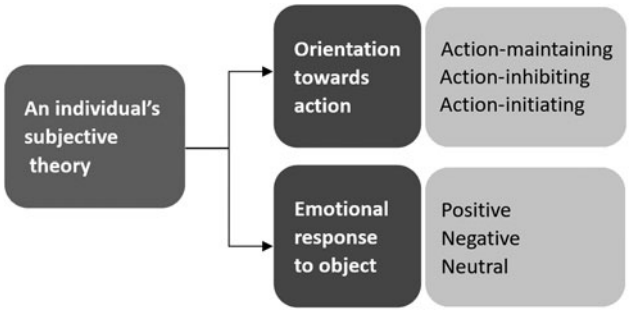

FIG. 2 Organization of subjective theories.

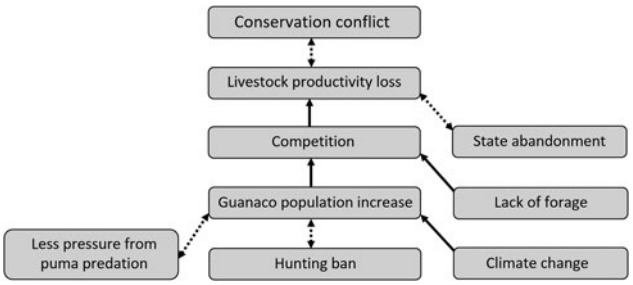

FIG. 3 Model constructed from the interviewees' subjective theories about the origin of the conservation conflict (dotted line = associated with; solid line = leads to).

grounded theory procedures, an inductive process intended to produce an explanatory model based on the data obtained (Strauss & Corbin, 1990). The codes used in this phase were subjective theories reconstructed on the basis of verbatim quotes. The initial process involved reconstructing implicit or explicit subjective theories in excerpts of the interviewees' utterances, arranging them into a hypothesis-like structure of the if–then type. Thus, the process began with an open coding procedure that made it possible to group subjective theories into categories or types.

We initially identified 12 types of subjective theory, which were reduced to six by merging those that contained similar ideas. These six types were categorized following the analysis system recommended by Catalán (2016). Thus, in an emergent manner, based on the interviewees' narratives, we selected two subjective theory analysis axes: (1) orientation towards action and (2) emotional response to the object (Fig. 2).

In the orientation towards action category, subjective theories are regarded as guiding people with respect to themselves and the world, which enables them to make predictions, grounds their actions and gives meaning to their experience. A person's subjective theories can maintain, inhibit and initiate actions: (1) Action-maintaining subjective theories tend to support actions conducted recurrently or habitually; they justify the continued performance of an action. (2) Action-inhibiting subjective theories tend to free those who hold them from engaging in actions that the person considers undesirable; they are arguments for not performing certain actions. (3) Action-initiating subjective theories provide arguments for engaging in new actions or changing usual ones; they may involve expectations of change.

In parallel, subjective theories also have an object to which an emotional meaning is attached (Catalán, 2016). Therefore, the category emotional response to the object refers to the emotional meaning of the subjective theory. This category contains positive subjective theories; i.e. theories that show greater closeness, pleasure or acceptance towards the object of the theory, and negative subjective theories whereby a person shows greater distance, annoyance or rejection towards the theory's object.

In both cases the positive or negative views represent extremes, with some intermediate degrees or neutral emotional responses towards the object. Finally, we constructed a model based on the interviewees' subjective theories about the origins of the conflict. A scheme showing the mapping of subjective theories is shown in Fig. 2.

Results

Fifteen of the 16 livestock ranchers interviewed were men. Nine interviewees were from Alicahue and seven from Paihuén, and the respondents' mean age was 63 years. We grouped responses into types that emerged during data analysis based on a number of themes expressed by the ranchers. Figure 3 shows the model constructed on the basis of the interviewees' subjective theories about the origin of the conservation conflict. The ranchers interviewed thought that the conflict resulted from two main factors: a guanaco population increase in the area and the lack of forage, both of which have the same cause, climate change. The hunting ban imposed in the 1990s was another element that in their opinion contributed to the population increase. These factors, combined with state abandonment, led to livestock productivity loss, which interviewees thought intensified their conflict with guanacos. The following sections cover the most relevant characteristics of each type.

Subjective theories regarding the causes of the conflict

These subjective theories are related to causal explanations of the competition for forage. When asked to provide more in-depth explanations of this competition, respondents focused on two types of arguments: some thought the forage competition was a result of increased guanaco numbers, whereas others identified low forage availability as the cause of the problem, thus not directly blaming the guanaco. Yet both groups perceived climate change as the underlying cause of this situation. According to the interviewees, precipitation in the area has declined, including both rainfall and fallen and accumulated snow. Most respondents referred to

the recent period as the 'bad years', compared to past years with higher precipitation (> 15–20 years ago). Snow is perceived to have two key effects on guanaco populations: (1) it acts as a natural barrier, preventing movement across the cordillera from or to Argentina and other regions, and (2) heavy snow at high elevations results in high guanaco mortality (guanacos remain in the mountains during winter).

Thus, the reduction in precipitation is thought to affect conditions that would naturally limit the guanaco population, causing lower mortality and an overall increase in guanaco numbers. According to respondents, declines in precipitation in the 'bad years' resulted in reduced forage availability, particularly in high-altitude wetlands, which comprise the primary spring and summer grazing resource for livestock. The guanacos' ability to modify their food intake and nutritional requirements according to resource availability, and to adapt to arid conditions, together with the lack of harsh winter conditions that would regulate their populations, provides them with key advantages over livestock in such circumstances.

One participant stated 'The guanaco survives because it eats very little, grass specifically... but they are also able to eat bushes, whereas cattle do not, they graze only grass... In conditions of scarcity guanaco will eat shrubs... Now [the grass] is almost at ground level, and the [recent] years [with low precipitation] have not helped either. The *vegas* are drying up, many have turned yellow... and... the cattle only graze the *vegas*... [The *vegas*] have shrunk and some have dried up, and that's [because of] the drought and the lack of rain.' These statements suggest ranchers understood climate change to be the underlying cause of the competition for forage between livestock and guanacos. The subjective theories included here are action-maintaining: they justify the ranchers' continued complaints about the damage caused by guanacos, and their continued demands to government authorities.

Subjective theories about guanaco population increase

These subjective theories are also related to causal explanations of the increase in guanaco numbers, with two dominant arguments: (1) the guanaco hunting ban and lack of natural self-regulation of its population, and (2), to a lesser extent, suggestions that pumas *Puma concolor* no longer prey on guanacos because they have changed their prey preferences. Hunting of wildlife was banned in this area in the early 1990s. Historical records indicate there had been an agreement amongst landowners to establish a hunting-free zone, with the aim to protect wildlife such as the guanaco (since 1999; Decreto No. 65, 1999). Some respondents thought this triggered an increase in guanaco numbers in the area. Together with the arguments expressed in the previous type (i.e. recent climate change, with decreased precipitation and associated declines in guanaco mortality), this is regarded as another factor leading to an increased guanaco population. Some respondents considered guanaco population growth to be uncontrolled. As in the first type, action-maintaining subjective theories explained the perceived uncontrolled population increase and provided support for the ranchers' complaints. An example statement falling into this category was 'Because the climate is changing, and given the protection of the guanaco, the population increased quickly.'

Subjective theories about the guanaco's importance for people

Responses grouped in this type stated guanacos were considered important as a source of nutrition and for traditional medicine (guanaco feet are valued as a popular remedy for facial paralysis). These arguments are categorized as action-maintaining subjective theories, because they justify the preservation of traditional guanaco meat consumption. To a lesser extent, interviewees also valued the guanaco for its uniqueness as a species in mountainous areas and its ecological role in these habitats, factors highlighting the species' status as part of Chile's natural and cultural heritage. These arguments were categorized as action-initiating subjective theories, with expectations of change and willingness to engage in new actions for the species' conservation.

Interviewees noted hunting was common until the mid 1990s, particularly during the military occupation of the mountainous areas during 1973–1990, when military troops hunted guanacos for food. The oldest interviewees in particular valued the species as a food resource, and consumption of guanaco meat appeared to be rooted in local ancestral tradition. The majority of interviewees reported having consumed guanaco meat, stating they valued it for its taste and low cholesterol content. Respondents mentioned guanaco meat can sell for USD 17–40/kg on the illegal wildlife market. In central Chile traded guanaco meat is sourced by illegal hunting; controlled harvest is legal only in Patagonia, with meat selling for USD 4.4–17.4/kg on the legal market.

Subjective theories about the role of the puma

We identified two dominant views of the puma's ecological role: (1) as controller of guanaco populations, and (2) as controller of exotic animals (rabbits *Oryctolagus cuniculus*). Some interviewees regarded pumas as controllers of the guanaco population, noting that the absence of guanacos could result in increased livestock depredation. One rancher stated: 'If we do not have problems with the puma, then it is because it preys on guanaco, and in the absence of guanaco it would prey on livestock'. This reflects a positive emotional response, a feeling of satisfaction or pleasure rooted in

the positive consequences of the puma's prey preference for guanacos over livestock. Other interviewees suggested guanacos comprise a negligible part of the puma's diet and thought they mainly preyed on hares *Lepus europaeus* and rabbits, reflecting a neutral emotional response with respect to the guanaco. A minority of ranchers considered pumas harmful because they prey upon cattle, although most did not know whether livestock losses they experienced were a result of predation or cattle theft, admitting that it is difficult to identify the cause of animal mortality or loss in the absence of clear evidence.

Subjective theories about the guanaco's ecological role

The interviewees held a variety of views regarding the guanaco's impact on the area's soil. Some regarded guanacos as harmful, similar to goats, which are considered to damage soil by overgrazing and compaction. Others considered the species' impact comparable to that of cattle, classing it as neutral, and some suggested guanacos were less damaging to the soil than cattle. These arguments show that the emotional response towards guanacos can be negative, neutral or positive. Some interviewees were concerned guanacos could transfer diseases to livestock, as illustrated in the statement 'If the guanaco transits to Argentina then it could transport the foot-and-mouth disease virus'. This reflects a negative emotional response to the species. At the same time, interviewees also considered guanacos to be relevant for the preservation of the natural balance of mountainous areas, which we categorized as a positive emotional response.

Subjective theories about proposed solutions

The dominant view amongst the interviewees was that the conservation conflict was partly a result of what they referred to as 'abandonment by the state'. Participants thought the state carried most of the responsibility for solving the conflict and complained about the state's inaction regarding guanaco population control, and the lack of mitigation or support measures in response to ranchers' reduced productivity. These views are illustrated in the statement 'Because guanacos are a species protected by the state, we ask the state to take charge and help us.' Subjective theories about proposed solutions included two major arguments. Firstly, the interviewees identified the state's role in addressing the problem, mainly through compensation. This argument is based on ownership of the land, because the land on which the guanaco graze is under private tenure. The ranchers reasoned that the presence of the guanaco (an animal protected under the state's laws) on their privately-held land represented a loss of income to them, because a proportion of forage is consumed by guanacos and thus unavailable for livestock production. Economic compensation by the state would ease financial pressures on ranchers. These subjective theories were classed as action-initiating because they constitute arguments for starting new actions that could generate expectations of change and conditions for coexistence. Secondly, population control also emerged as a possible solution to the perceived resource competition between guanacos and livestock, either through lethal or non-lethal measures. Authorized lethal control was advocated in pro-hunting arguments, which can be categorized as action-initiating subjective theories related to existing measures to manage the guanaco.

Some ranchers argued for non-lethal control via translocation of guanacos, which can be categorized as action-initiating subjective theories that justify the reduction in guanaco numbers. The arguments for the eradication of guanacos to eliminate competition with livestock are not compatible with coexistence.

Discussion

The primary objective of this study was to understand the underlying drivers of negative interactions between ranchers and wild guanacos in central Chile. According to the interviewees, contributing factors included environmental change and socio-political circumstances, supporting findings from other studies on the complexity of the drivers of conservation conflicts (Madden & McQuinn, 2014; Rust et al., 2016). This study also demonstrates the relevance of subjective theories for understanding interactions between local communities and wildlife.

Our second objective was to examine ranchers' traditional knowledge regarding guanacos and their beliefs about the factors contributing to negative interactions. Our findings suggest ranchers perceived climate change, specifically a decline in precipitation, to have an impact on conservation conflicts. They described two effects of decreased precipitation: (1) lower forage availability because of drier conditions, and (2) guanaco population increase as a result of reduced snowfall and thus lower winter mortality. Ranchers considered precipitation a natural population control factor, because guanacos can adapt to arid conditions, and hard winters are important in regulating their populations (Cajal & Ojeda, 1994). Compared with earlier studies that focussed solely on the abundance of guanacos as the origin of negative interactions between guanacos and livestock ranchers (Hernández et al., 2017), this reflects a deeper understanding of ecological relationships between guanacos and livestock (i.e. exploitative competition).

Climate change predictions indicate that over the next few decades there will be an increase in mean temperatures and a decrease in snowfall and water availability in the study area (MMA, 2017). This could severely affect water availability for agriculture and domestic consumptive needs

(Vicuña et al., 2011), with negative impacts on the productivity of livestock ranching and food security (Rojas-Downing et al., 2017) These effects are likely to be most serious for extensive livestock ranching in mountainous areas, particularly in arid and semi-arid regions, and in cases where ranchers largely or entirely depend on this activity for their livelihoods (Rojas-Downing et al., 2017). However, it is unclear how these changes could affect guanaco populations and consequently the conflict with livestock ranchers; if the ranchers' perceptions are correct, changing climatic conditions could be favourable for the guanaco. Compared to cattle, guanacos metabolize low-quality forage more efficiently and need less water (Fowler, 1998) so they are able to adapt to and thrive in arid environments (Gonzalez et al., 2013). Climate change under arid and semi-arid conditions could intensify conservation conflicts because of decreasing habitat suitability for livestock grazing, which could lead to economic and cultural losses. Links between climate change, habitat loss and increasing conservation conflicts have been reported (e.g. Kanagaraj et al., 2019), and climate change is likely to be one of the main threats facing people and wildlife within the next decades (Nyhus, 2016). Further in-depth socio-ecological studies are needed to determine the possible connection between climate change and the intensification of future conflicts.

Livestock ranchers' views of guanacos in Chile's central Andes were probably affected in two ways by the socio-political climate in the 1980s and 1990s. Firstly, the hunting ban was perceived negatively by the local rural population, who traditionally consumed guanaco meat. Secondly, it could be that the hunting ban did result in increased guanaco numbers, potentially increasing competition between guanaco and livestock, but there is no detailed information on the intensity of historical use, nor the state of the guanaco population prior to the hunting ban to confirm whether or not the hunting ban led to a recovery of the guanaco population. Official records suggest that the hunting-free area was the result of a consensual agreement between landowners and the state, and that the establishment of hunting restrictions was based on the guanaco's conservation status. However, there are no records available of guanaco population sizes or of consensual agreements between the state and landowners, nor is there any information regarding the efficacy of prohibition measures (G. Vargas, Servicio Agricola y Ganadero Valparaíso, 2018, pers. comm.). The hunting of guanacos for human consumption is a well-established custom throughout their historical range, but is generally poorly documented, with most reports being from northern Chile (Bonacic et al., 2014). Nevertheless, according to Servicio Agricola y Ganadero, regular but low-intensity illegal hunting continues in the study area and in other regions of the country (Bonacic et al., 2014). Despite the lack of baseline data, evidence from other sites suggests that prohibition measures probably did contribute to population recovery (Puig et al., 2003).

Subjective theories addressing our third objective, understanding the ranchers' perspective on the conflict, were mostly of the action-maintaining type. These subjective theories preserve behaviour that leads to conflict, rather than contributing to a solution. The conflict is an existing situation, thus the predominance of subjective theories of the action-maintaining type amongst ranchers contributes to the continuation of the conflict. Nevertheless, we observed some subjective theories that can contribute to human–guanaco coexistence, such as the pursuit of compensation. Although we did not explore the feasibility of state compensation for losses perceived to be caused by guanacos, this approach appears to offer an opportunity for increasing tolerance of guanacos in the study area. In addition, we identified a positive emotional response amongst ranchers who regarded the species as a preserver of ecosystem balance in mountainous areas. Compensation for losses could be adopted for the puma, which some interviewees view as a natural controller of guanaco populations and that does not appear to generate high-intensity conflict with livestock ranchers.

Historical conflicts and cultural beliefs affect people's perceptions and influence their willingness to participate in conflict mitigation initiatives (Karanth & Kudalkar, 2017). There is often a long delay between ranchers submitting complaints to the state about damage caused by guanacos and the state acting on these complaints. This delay has added tension to the relationship between ranchers and the state, has contributed to ranchers' negative attitudes towards the guanaco, and has made it more difficult to establish constructive dialogue. During our interviews, ranchers not only voiced their unhappiness at government inaction, but also blamed the state for protecting a species that negatively affects their livelihoods. The guanaco conflict is perceived by ranchers as not only an ecological issue involving resource competition, but also a negotiation process with governmental institutions.

This study shows that negative human–wildlife interactions are driven by complex socio-economic, psychological, political and ecological factors. Mixed-method studies conducted in complex social contexts are necessary for an in-depth examination of the underlying factors of conservation conflicts. Failure to understand such factors makes it impossible to mitigate conflicts, given the insufficiency of merely technical approaches, such as putting up game fencing, to reduce negative interactions (Rust & Taylor, 2016).

Our findings offer a more nuanced understanding of the perceptions of livestock ranchers, while also enabling us to identify potential underlying ecological factors that were previously absent from the discourse. Subjective theories take into account the everyday knowledge of the protagonists and the potential for change. The present study

thus provides a baseline for future analyses of conservation conflicts, and we recommend the use of this method for emerging conservation conflicts. Local institutions and conflict managers should address the problem with a multidisciplinary approach, incorporating studies in ecology, agriculture and socio-cultural aspects. We further recommend that the necessary tools to help farmers deal with the negative impacts of climate change are developed and implemented as a priority, particularly in more vulnerable areas such as mountainous and arid/semi-arid environments. Conservation conflicts are not only an ecological issue linked to resource competition, but also highlight the difficulties communities experience in negotiating with governmental institutions. With an improved understanding of the drivers of conflict, future research should focus on identifying solutions that enable guanaco–livestock coexistence. Coexistence strategies should be location-specific, incorporate cultural values, beliefs and environmental conditions, and be designed such that return on financial investment can be evaluated (van Eeden et al., 2018).

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Ethical standards The research abided by the *Oryx* guidelines on ethical standards. Ethical approval was received from the Universidad de La Serena ethics committee.

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