

# ARE INSTITUTIONAL INTERVENTIONS EFFECTIVE IN MITIGATING HUMAN-FELID CONFLICT? A CASE STUDY IN NORTHERN COSTA RICA

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## 1. Introduction

Local benefits of the presence of large carnivores are not always understood by the coexisting human communities. Unfortunately, the negative outcomes of the presence of large carnivores, such as economic and psychological impacts, are widely perceived. These negative interactions result in human-wildlife conflict (Inskip and Zimmermann, 2009). Retaliatory killing in response to conflicts is one of the most important threats to many large carnivores, particularly felids (Ripple et al., 2014).

Livestock husbandry methods have a great influence on predation (Peña-Mondragón et al., 2016) and in most cases appropriate practices can reduce felid predation significantly (Distefano, 2005). There is a considerable literature about measures to reduce predation (e.g. Amit et al., 2009; Azuara et al., 2010; Hoogesteijn and Hoogesteijn, 2011). Nevertheless, preventive measures are not always applied or evaluated adequately (Dickman et al., 2011; Eklund et al., 2017).

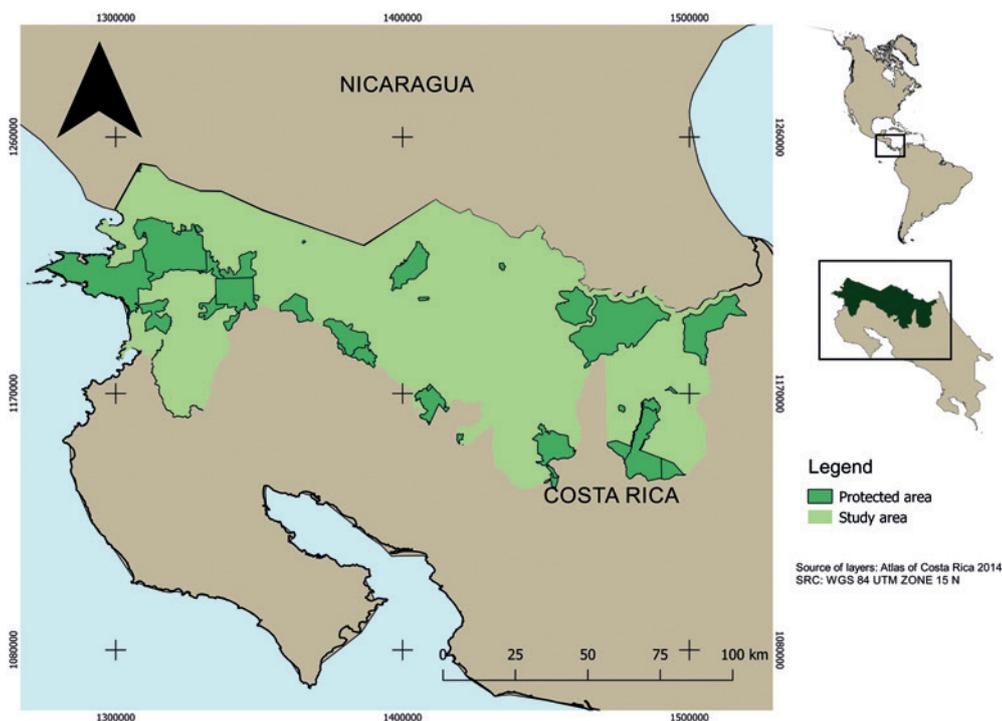
Besides technical solutions, an essential component of conflict mitigation is addressing human attitudes to-

ward coexistence with carnivores (Carter et al., 2014). Attitude can be defined as a mental structure based on cognitive and affective components that affect our evaluation of attitude objects (Eriksson et al., 2015). This evaluation can be positive or negative. Undeniably, a change of attitudes is needed to increase tolerance towards large carnivores (Thorn et al., 2015). As attitudes and perceptions are constructed solidly over values, beliefs, education, religion and economic status it is difficult to change them (Inskip and Zimmermann, 2009). Few intervention strategies have been scientifically proven (Inskip and Zimmermann, 2009).

The aim of this paper is to evaluate the intervention of institutions in human-felid conflict in northern Costa Rica and its relation to ranchers' attitudes towards two native felids, the cougar (*Puma concolor*) and the jaguar (*Panthera onca*), and to evaluate the effectiveness of preventive measures from the ranchers' point of view. In Costa Rica, the assumption that technical assistance may improve attitudes towards felids has not been fully validated. As we are dealing with a dynamic process, evaluation of attitudinal change and the perceptions of people involved in the conflict must be continuous.

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**Fig. 1.** Location of the study area, comprising most of Chorotega and Huetar Norte regions of Costa Rica, with fourteen protected areas.



## 2. Study area

The Chorotega and Huetar Norte regions of northern Costa Rica comprise around 22,413 km<sup>2</sup> and form a continuous block from the Pacific coast to the interior (Fig. 1). Huetar Norte is the most important region in the country for livestock productivity, with a total of 12,055 ranches registered in 2013 and around 91,973 head of cattle (Madrigal and Fallas, 2013). The Chorotega region has 7,210 ranches with approximately 79,143 head of cattle (Madrigal and Fallas, 2013).

There are two large carnivores in the study area: the jaguar and the cougar. The jaguar is the largest felid in the Americas (Fig. 2A). Its distribution extends from northern Mexico to northern Argentina. At the international level, the jaguar is listed by the IUCN as Near Threatened (Caso et al., 2008). The cougar (Fig. 2B) is found from the centre of Canada

to southern Argentina and Chile. It is one of the most widely-distributed mammals in the Western Hemisphere and it is listed as Least Concern (Nielsen et al. 2015). These species also coexist with smaller carnivores such as coyote (*Canis latrans*), ocelot (*Leopardus pardalis*), margay (*L. wiedii*), jaguarundi (*Herpailurus yagouaroundi*) and others.

In Costa Rica, felid attacks on livestock have been recorded throughout the country (Fig. 3). Economic losses in 1991–1998 totalled 60,000 USD (54,081 EUR), and 21 jaguars were poached in the same period (Saenz and Carrillo, 2002). The most affected areas of the country are found in the north (Amit et al., 2009). Furthermore, an annual rate of 15.9 felid attacks per year was estimated for the sector of San Cristóbal, in the Guanacaste Province (Amit, 2006), which is inside our study area.



**Fig. 2.** Large felid predators of the study area. A) Jaguar (*Panthera onca*), B) Cougar (*Puma concolor*). Both pictures were taken in the study area, in Santa Rosa National Park, Chorotega Region, Costa Rica. Photos: Sergio Escobar-Lasso.



**Fig. 3.** Mule injured by jaguar (*Panthera onca*) at the Península de Santa Elena, in northern Costa Rica, May 2017. Photo: Eduardo Carrillo.

### 3. Materials and Methods

#### 3.1. Sampling and interviews

We gathered data on conflicts and attitudes using a semi-structured interview protocol. A total of 153 ranchers were interviewed in 2015. Ranchers were contacted from a database of people who had previously experienced felid attacks provided by the Programa Jaguar research group at the Universidad Nacional de Costa Rica. This included information from Ronit Amit, Carolina Sáenz-Bolaños and Francisco Morazán-Fernández. From this database, all functional phone numbers were used. Additional ranchers were contacted at livestock auctions. Furthermore, we made a random selection from the ranchers' telephone database of the National Service of Animal Health (SENASA). We applied the snowball method to reach more ranchers with felid problems.

The structure of the interview was based on a psychometric test of attitudes towards tigers (Thorn et al., 2015, Appendix). The interview considered three main topics: coexistence with big cats, illegal killing and perceptions of institutions responsible for addressing conflicts. Interviews were conducted as an open conversation, leaving space for ranchers to answer freely (Peña-Mondragón et al., 2016). They were carried out either face-to-face at livestock auctions (13.1%) or by telephone (86.9%). Most of the interviews were conducted by Margarita Gil-Fernández (96.7%). The rest of the interviews were carried out by two women with previous experience who worked in the research group. We did not record interviews to reduce mistrust from the ranchers. During the interview brief notes were written, and completed afterwards. Since the interviews were conducted as conversations, their duration was highly variable, from 20 to 80 minutes.

#### 3.2. Institutions and type of institutional intervention

The institutions considered in this research are:

- a) Programa Jaguar - which has given technical assistance since 2011;
- b) UACFel, Unit of Attention to Conflict with Felids - an agreement between the NGO Panthera and the Ministry of Environment and Energy of Costa Rica (MINAE), which has responded to reports of felid attacks since 2013, giving technical assistance and partial economic resources for the implementation of preventive measures;
- c) Las Pumas Rescue Center - occasionally responds to reports and gives general information;
- d) Gente y Fauna - which has conducted interviews and workshops since 2015.

Owing to the variable types of intervention, we put ranchers into five groups according to the level of institutional intervention they received:

- 1) no attacks by felids at the ranch (44 ranchers);
- 2) no damage reported to institutions and no intervention (58 ranchers);
- 3) no institutional response to reported felid attacks (18 ranchers);
- 4) moderate intervention from institutions (only interviews or visits) (13 ranchers);
- 5) complete intervention of institutions (workshop, technical assistance) (20 ranchers).

Groups 2 and 3 were distinguished because ranchers in group 3 were expecting an answer from the institutions in response to a reported felid attack but were ignored, whereas ranchers in group 2 never reported attacks to institutions. In contrast, those in group 5 attended workshops which included detailed explanations of the felid attack protocol and information about preventive measures.

#### 3.3. *In vivo* codes analysis of attitudes towards big cats

We created a series of *in vivo* codes to analyse the information of the interviews. This consisted of a line-by-line reading of the transcript information to identify the ideas related to the research objective. Each code represents an idea related to the research topic. These codes were modified during the analysis to better reflect the content of the interviews. A network of codes was developed in relation to attitudes toward felids and a narrative was constructed based on these relations.

We included a network of codes related to perceptions of the institutions dealing with conflict. Perceptions of institutions were classified as positive or negative. The number of phrases and individuals who mentioned them were used to assess the importance of each code.

### 3.4. Comparative analysis of intervention and attitudes toward felids

All interviews were analysed with Atlas.ti, version 7 (Friese, 2013). To examine the relationship between perceptions of institutions and their levels of intervention, three categories were created: 1) coexistence with big cats; 2) elimination of big cats; and 3) perception about institutions. The number of positive and negative phrases was quantified to allow comparison among the five levels of intervention.

### 3.5. Analysis of the efficacy of preventive measures

A series of in vivo codes was created to understand perceptions of preventive measures. In addition, a comparison of the percentage of application of preventive measures by the level of institutional intervention was

made. To compare the efficacy of preventive measures they were grouped into three categories: 1) livestock management practices, including changing livestock areas and use of enclosures; 2) felid deterrence by loud noises, bells, and livestock guardian dogs; 3) illegal retaliatory killing of felids by ranchers. A contingency table was used to compare the categories of measures and their effectiveness.

## 4. Results

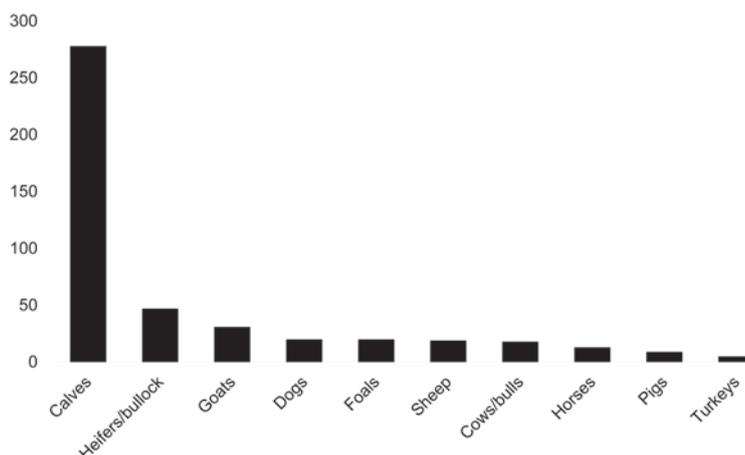
### 4.1. Sample and farm characteristics and predatory impact

Almost all the 153 interviewees were men (92.8%). Most of them applied primarily extensive livestock husbandry (75.8%), although a few maintained livestock in rotative extensive husbandry (5.2%), semi-enclosures (9.2%) or enclosures (2%). There was no information available for the remaining 7.8%. In rotative extensive husbandry, there were several divisions in the ranch and livestock was moved among them from time to time (Fig. 4B). In semi-enclosures, livestock was not permanently locked in the pen but moved freely in and out (Fig. 4C).



**Fig. 4.** Husbandry practice among the interviewees. A) Extensive livestock husbandry, B) Rotative extensive husbandry, C) Semi-enclosure husbandry, and D) Enclosure husbandry. Photos: Margarita Gil-Fernández.

**Fig. 5.** Number of domestic animals reported killed by large felids by 103 ranchers during interviews in 2015.



Twenty percent of ranchers had suffered an attack by felids on their livestock within the last year, 30% 1–2 years before the interview and 18.9% more than 3 years before the interview, with a maximum of 15 years before. Only the attacks of the Programa Jaguar database had been assessed to confirm the kill and the species responsible (40.5% of the interviews).

A total of 580 felid kills of domestic animals (excluding missing animals) were reported by 103 ranchers. Unfortunately, the complete time period over which these losses occurred is unknown because we only asked the date of the most recent loss. Of the total losses, 460 were identified by domestic species and age (Fig. 5). Most of the reported losses (60.4%) were of calves.

#### 4.2. *In vivo* codes analysis of attitudes towards felids

In the following text, the percentage of people supporting each idea is shown in parentheses. Many ranchers considered felids to be pests (because of their abundance and predatory behaviour), in some cases, they thought problematic felids needed to be controlled by elimination (31%). People mentioned that killing felids was the main solution to the problem or the most practical (10%). The second reason to kill felids was the lack of support from institutions (5%). The least mentioned reason for elimination of felids was killing for amusement (1%).

Some respondents mentioned that coexistence would be possible mainly without human hunting of wild prey (20%). These ranchers mentioned that hunting makes natural prey scarce, inducing felids to kill livestock. For some, tolerance is imperative to allow coexistence (12%), while others said that coexistence is possible without livestock damage (7%).

The strongest reason to support coexistence was the intrinsic value of felids (14%). Felids were appreciated by a minority of ranchers for their important ecological role, which includes the regulation of wild herbivores or mesocarnivores such as coyotes (8%).

Also, felids were perceived as being good for tourism (4%). Finally, it was mentioned that felids are an endangered species (1%). Some people mentioned coexisting with felids without major problems (5%).

#### 4.3. Analysis of attitudes towards institutions

Perceptions of institutions were mostly negative, with 47% of ranchers using 89% negative phrases (Fig. 6). Negative phrases fell into three main categories: i) institutions have no credibility (26%); ii) they provide bad assistance (18%); or iii) there is a lack of information (16%). Some respondents thought that institutions imprison those who harm felids (5%) while others mentioned that they release felids near ranches (5%), and some do not have information about institutions in charge (5%).

Only 8% of the statements about institutions were positive. People mentioned that they were a good option in case of attacks (3%), and showed interest in the conflict (2%). A minority mentioned that the response to reported depredation was satisfactory (3%).

#### 4.4. Comparative analysis of intervention

The group using a higher percentage of phrases in favour of killing felids was the group that did not receive an answer when reporting felid attacks (100%) (Fig. 7). On the contrary, the groups least supportive of elimination were those who had attacks but never reported them (55.6%). Ranchers reporting moderate intervention and complete intervention used 53.8% and 33.3% of phrases against elimination, respectively.

The group with more phrases in favour of coexistence contained people with no intervention by institutions (68%) (Fig. 7). In contrast, the group with the lowest percentage of pro-coexistence phrases was that which received no response to damage reports (38.1%). The groups with moderate and complete intervention each used 50% of phrases in favour of coexistence.

Ranchers with the most negative positions toward institutions were those who had received no response or

no intervention from the institutions (100%) (Fig. 7). However, even people with the highest level of intervention had a marked negative perception of institutions (73.3%).

**4.5. Analysis of the efficacy of preventive measures**

Two thirds of ranchers (69.3%) said they applied measures to prevent felid attacks on livestock. The group with the highest application of preventive measures were ranchers who received moderate institutional intervention: 84.6% of them applied at least one measure to prevent felid attacks on cattle. On the other hand, the group with the lowest percentage of preventive measure usage were ranchers without felid attacks, where only 56% used preventive measures. Regarding the ranchers who did not receive a response from institutions, 58.8% used preventive measures.

The most common category of preventive measure was a change in management practices. Forty percent of interviewees applied management measures including calf enclosures, night enclosures, moving livestock away from the forest and fencing. Deterrent measures such as fireworks, fladry lines, vigilance, bell collars, light installation, fire and guardian dogs were used by 17.6% of ranchers. A combination of management and deterrent measures was used in 11.8% of cases.

A large majority (83%) of interviewees who applied preventive measures perceived them to be effective. Deterrent measures were effective for 92% of ranchers and livestock management practices for 77% (Table 1). Seven ranchers (4.6%) admitted having practiced retaliatory killing of felids, and 42 (27.5%) mentioned that they had heard of or observed retaliatory killing.

Perception of preventive measures were categorized into eight main codes (Fig. 8). Most of the respondents considered measures to be ‘successful’ (26%). However, another frequently mentioned code (more phrases) was that measures are not applicable (19%). The latter was subdivided into three explanations: measures are

Codes related to attitude towards felids in northern Costa Rica

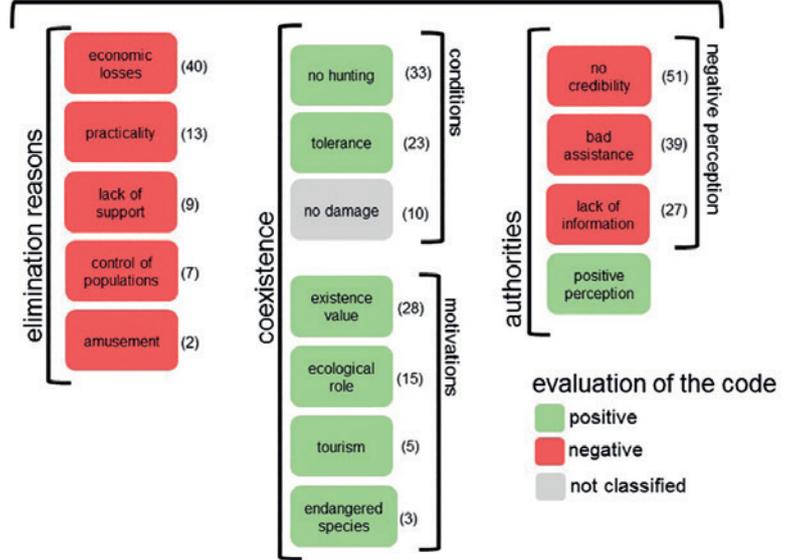


Fig. 6. Codes used to classify statements made by ranchers in northern Costa Rica to evaluate their attitudes towards large felids and management institutions. The number of phrases for each code is shown in parentheses.

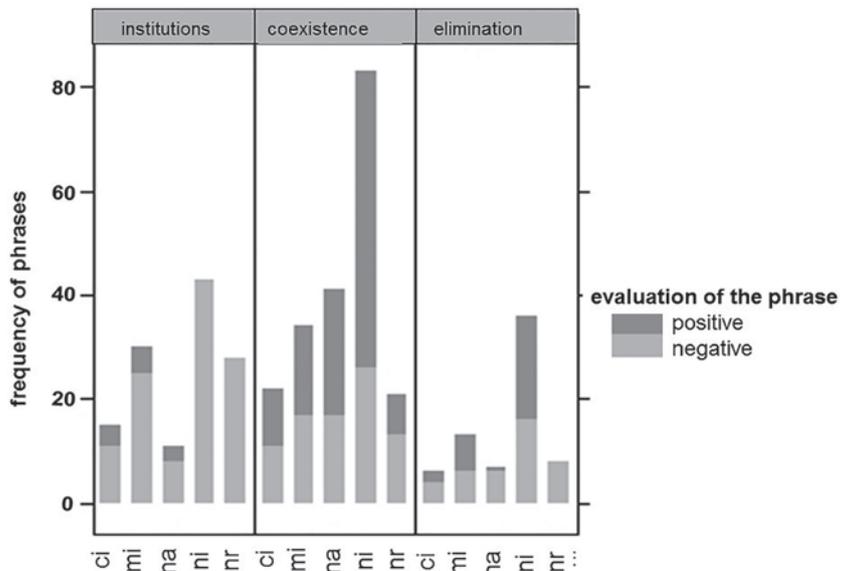


Fig. 7. Number of positive and negative phrases in each evaluated category concerning human-felid conflict in northern Costa Rica. The x-axis shows the level of intervention of institutions in case of reported attacks by felids on livestock: ci=complete intervention (workshop, technical assistance), mi=moderate intervention (interviews, visits), na=no attacks reported, ni=no intervention, and nr=no response.

not practical (13%), are expensive (5%) or cause other problems (1%). Among those who had used such measures, some respondents had doubts about their success (12%), attributing the lack of attacks to the absence of felids in the area due to their high mobility (9%).

Preventive measures were reported to have failed at some ranches (12%). This was said to be primarily because felids learnt how to avoid them (9%). A small

**Table 1.** Perceived effectiveness of measures used to prevent felid predation on livestock in northern Costa Rica.

Category of measure	n	Reported percentage of success		
		successful	uncertain	unsuccessful
Management practices	61	77	16.4	6.6
Felid deterrence	27	92	0	8
Combination*	18	88.2	0	11.8
All non-lethal measures	106	83	9.7	7.3

\* Use of livestock management practices and felid deterrence at the same time.

minority of ranchers who used livestock guardian dogs reported that felids were not deterred by them and that they could even eat such dogs (3%). A group of ranchers had not used preventive measures but believed them to be ineffective, which is an *a priori* negative perception (5%). Another group believed that measures could be efficient, but have not tried them yet (3%). Some mentioned that they would use such measures only if they had an attack (6%). Finally, some individuals did not know anything about preventive measures (9%).

## 5. Discussion

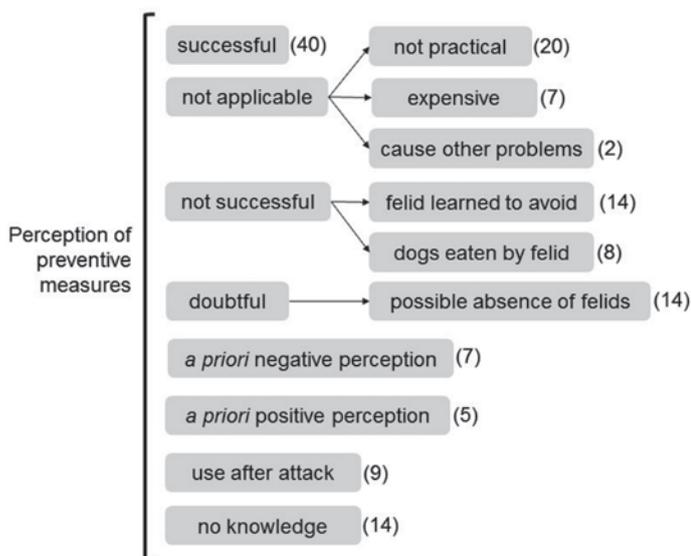
Historically, management of carnivores worldwide has been characterised by attempts to eradicate them followed by tolerance of remaining low populations. In fact, this situation is common throughout the range of big cats (Peña-Mondragón et al., 2016). In our study, only seven ranchers admitted having killed felids, but 27.5% of respondents had seen or

heard about illegal killing. Similarly, in the Brazilian Pantanal at least 33% of ranchers still use killing as a preventive measure (Boulhosa and Azevedo, 2014). Nevertheless, retaliatory killing is not easy to assess due to its illegal and therefore clandestine nature (Liberg et al., 2011).

Coexistence is possible and even desirable, as has been proven in several contexts (Dorresteijn et al., 2014). According to our results, felids are appreciated for their ecological function and because they are threatened with extinction. The possible touristic value of felids was also mentioned, thanks to which perceptions towards carnivores may improve, as has been observed in other regions (Bhattarai and Fischer, 2014). However, it should be stated that felids might not be an ideal focus for touristic activities, as they may be dangerous for humans (Neto et al., 2011).

Some of our respondents were certain about the harmfulness of big cats. In fact, there is a real risk: the cougar and the jaguar can both kill humans (Neto et al., 2011). Fear and social motivations must be understood in order to design appropriate conservation interventions in our study site, because these can be even more important than economic losses (Bhattarai and Fischer, 2014). However, it should be highlighted that reports of felid attack on humans are especially scarce in Central America (Amit et al., 2009). Most of the scientific reports of jaguar attacks on humans are from South American countries (e.g. Neto et al., 2011), whereas reports of cougar attacks on humans are more common in North America (e.g. Mattson et al., 2011).

One outstanding finding of our study is that people mentioned that hunting of wild prey was one of the main barriers to coexistence. This has not been reported from other sites (Boulhosa and Azevedo, 2014). In sites with people who understand ecological relations there is a more positive position about coexistence (Dorresteijn et al., 2016).



**Fig. 8.** Codes used to classify perceptions of measures to prevent attacks on livestock by large felids in northern Costa Rica (The number of ranchers supporting each code is shown in parenthesis).

Lack of knowledge about institutional actions could act as a brake on any effort (Dorresteijn et al., 2014). Few respondents in our study reported complete ignorance of institutions, but there was some misinformation among them. This leads, along with a lack of trust, to negative perceptions of authorities (Dorresteijn et al., 2016). Ranchers also mentioned a lack of action by institutions, as reported by Dorresteijn et al. (2016). Trust is fragile and negative actions tend to have greater impacts than positive actions (Sponarski et al., 2014). Ignoring people that have reported attacks can have serious negative effects on attitudes towards felids and responsible institutions. Killing felids may not only be an act of vengeance on the big cat itself, but also on authorities (Dorresteijn et al., 2014).

With regard to the efficiency of preventive measures, a high proportion of interviewees reported that measures were effective, which corroborates the findings of a study carried out on 30 ranches in several sites of Costa Rica (Quigley et al., 2015). Nevertheless, there are external factors, such as low economical resources and social acceptance, that can prevent the ap-

plication of such measures (Rust et al., 2016). Prevention is not a static behaviour: it requires maintenance and constant monitoring (Amit and Jacobson, 2017).

Previous research in Costa Rica concluded that the influence of institutions over the application of preventive measures was unclear (Amit and Jacobson, 2017). We found that the group with the highest application of prevention measures had received institutional intervention, although the group without intervention also had a high rate of application. Nevertheless, a lack of response by institutions to reports of felid attacks could be related to a low disposition from ranchers to apply preventive measures. In fact, this group had almost the lowest application of such measures, only slightly more than ranchers who had no attacks by felids.

In conclusion, institutions can be effective in mitigating human-felid conflict in our study area. Nevertheless, damage reports should never be ignored, because this could have a very negative effect on trust in institutions and attitudes toward felids. Finally, there are positive values around felids to be reinforced and negative perceptions that should be more deeply understood.

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## Appendix

Interview protocol used to gather data on the attitudes of livestock farmers towards felids.

1. Have you suffered from attacks by jaguars or cougars on livestock at your farm?
2. Have you received any attention or recommendations from institutions or authorities about this problem?  
Which institution?
3. Have you applied any of the preventive measures suggested by this institution? Which measure did you apply?
4. Has this measure been effective in reducing the number of felid attacks at your farm?
5. Answer if you agree or disagree with the following statements (closed questions were asked, but a conversation about each key topic in the question was fostered).
  - a) Big cats and livestock can coexist without conflict
  - b) Big cats are dangerous to people
  - c) It would be fine if big cats disappeared completely
  - d) Felid attacks on livestock can be prevented
  - e) Authorities are helping to solve the conflict with big cats
  - f) Big cats should only live in nature reserves
  - g) Big cats are important for the forest
  - h) Big cats cause economic losses
  - i) Killing felids is simpler than applying preventive measures
  - j) If livestock losses are few, they can be tolerated