

# Factors affecting feelings of justice in biodiversity conflicts: towards fairer jaguar management in Calakmul, Mexico

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1 Factors affecting feelings of justice in biodiversity conflicts: towards fairer jaguar  
2 management in Calakmul, Mexico

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4 Abstract

5 Conservation focuses on environmental objectives, but neglecting social concerns can lead to  
6 a feeling of injustice among some actors and thus jeopardise conservation aims. Through a  
7 case study on a biodiversity conflict around jaguar management in the Calakmul region of  
8 Mexico, we explored actors' feelings of injustice and their associated determinants. We  
9 employed a novel framework distinguishing four dimensions of justice: recognition,  
10 ecological, distributive and procedural. By conducting and analysing 235 interviews with  
11 farmers and ranchers, we investigated what might drive their feeling of injustice, namely their  
12 perceptions of the injustice itself (i.e. location, intentionality, stability), individual  
13 characteristics (i.e. socio-economic status, motivation, environmental identity), and  
14 interactions with their environment (i.e. natural and social). We also asked the participants to  
15 choose one statement for each of the 10 pairs of statements that we presented to them, from  
16 18 statements that characterized their feeling of justice toward jaguar management based on  
17 different criteria. Using a pioneering statistical analysis, BTLasso, we showed the  
18 complexity of the drivers of feeling of justice. Self-interest assumptions were not upheld;  
19 feelings of fairness were only weakly influenced by experience of jaguar attacks. Feelings of  
20 justice were influenced mainly by factors related to actors' intra-and inter-group relationships  
21 (e.g. perception of collective responsibility, coherence perceived in the group to which they  
22 identified). Our analyses also allowed us to compare the effects of different factors on the  
23 assessment of criteria by diverse actors. For example, it revealed that differences in the  
24 organisations and groups perceived as being responsible for jaguar management modify a  
25 participant's perception of fairness. This nuanced understanding of how people build their

26 perception of justice can inform practitioners who seek fairer and more effective conservation  
27 approaches. Whilst details will be context specific, it emerged that supporting relationship  
28 building and enabling debate over ecological responsibilities are important and conservation  
29 efforts should go beyond merely offering financial compensation for livestock depredation.  
30 We conclude that perception of justice is a neglected but important aspect to include in  
31 integrative approaches to managing biodiversity conflicts, and that novel mixed methods can  
32 advance both conceptual and applied understanding in this area.

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34 Keyword: fairness, paired comparison, Bradley-Terry-Luce Lasso, self-interest motivation,  
35 group identity.

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## 38 1. Introduction

39 The conservation of large charismatic species can involve biodiversity conflicts in which  
40 disagreements between actors must be addressed (Redpath et al., 2013; White et al., 2009).  
41 Biodiversity conflicts are driven partly by competing visions of fairness (Müller, 2011;  
42 Redpath et al., 2013), and feeling of justice can be a good predictor of people's attitudes and  
43 behaviours regarding conservation (Martin et al., 2014; Sikor et al., 2014)<sup>1</sup>. Someone  
44 perceiving a lack of fairness might resist conservation rules (Dawson et al., 2017) or limit  
45 their endorsement of pro-environmental action (Kals and Russell, 2001). Perceived unfairness  
46 can result also in profound resentment and social conflict (Schlosberg, 2007). Conversely,  
47 positive feelings of justice increase trust in decision-makers (Lauber, 1999), acceptance of  
48 decisions by locals (Davenport et al., 2007), overall effectiveness of conservation actions  
49 (Oldekop et al., 2016), and reduce conflict (Lind and Tyler, 1988). Consequently, research

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<sup>1</sup> Fairness and feeling of justice here are both used as synonym to talk about subjective justice.

50 focusing on, and policies supporting, the incorporation of justice into environmental issues  
51 has been increasing, especially issues related to climate change (Agyeman et al., 2016),  
52 payments for ecosystem services (Martin et al., 2014), protected area management (Dawson  
53 et al., 2017), and large carnivore conservation (Bredin et al., 2018; Jacobsen and Linnell,  
54 2016). In this study, we adopted a justice approach to jaguar management around the  
55 Calakmul Biosphere Reserve, Mexico. Specifically, we used an empirical approach to identify  
56 factors affecting the feeling of justice in local farmers and ranchers. In doing so, we offer new  
57 insights for theoretical considerations of justice while proposing practical steps to manage  
58 biodiversity conflicts.

59         Feelings of justice represent actors' positions on particular issues, at a specific time  
60 and in a particular context (Martin et al., 2014; Schlosberg, 2007; Sikor et al., 2014). Those  
61 feelings are based on a plurality of views of justice that calls for an approach encompassing  
62 several dimensions of justice. We used a framework that accounts for four dimensions of  
63 justice: distributive justice (fair distribution of the costs and benefits of conservation),  
64 procedural justice (fair decision-making process), ecological justice (fair treatment of the  
65 natural world), and justice-as-recognition (fair integration of group identity, lifestyle,  
66 knowledge and viewpoints) (Lecuyer et al., 2018). While recent studies have often proposed  
67 frameworks where justice-as-recognition includes ecological justice (e.g., Jacobsen and  
68 Linnell, 2016; Martin et al., 2016; Schlosberg, 2007), we have previously shown that  
69 ecological justice can be a distinct dimension that may be addressed differently from justice-  
70 as-recognition (Lecuyer et al., 2018). These four dimensions of justice enabled us to broadly  
71 frame local actors' perception of justice and to explore variability among the dimensions.

72         Divergent viewpoints on fairness may be a major obstacle for mutual understanding  
73 (Müller, 2011), the latter being necessary to manage biodiversity conflicts effectively. It is  
74 thus important to test empirically how the factors influencing feelings of justice vary among

75 individuals. The issue itself (characteristics of the conflict i.e. location, intentionality,  
76 stability), the individual (i.e. socio-economic status, motivation, environmental identity), and  
77 the context (i.e. natural and social) can all influence one's feelings of justice (see Table 1 for  
78 more complete definitions and references). People might perceive the dimensions of justice  
79 differently and employ different criteria to explain their perception of it (e.g. Lauber, 1999;  
80 Martin et al., 2014; Zafra-Calvo et al., 2017). In the example of jaguar management,  
81 perception of distributive justice might depend, for instance, on socio-economic status or  
82 previous experience of jaguar attack. Researchers have disputed the motives driving people's  
83 desire for fairness, some attributing them to self-interest and others to group identity (Lind  
84 and Tyler, 1988; Skitka et al., 2010). The self-interest assumption implies that people's main  
85 motivation is to maximize their reward (Skitka et al., 2010). The group identity assumption  
86 proposes that relationships within and between groups are potent determinants of fairness  
87 judgments (Lind and Tyler, 1988; Skitka et al., 2010). According to their own subjective  
88 judgment, individuals could thus adopt different criteria to achieve perceived justice.

89         In this paper, we employed a novel mode of analysis that uses a mixed-method  
90 approach to achieve a comprehensive analysis of all justice dimensions. We propose a  
91 systematic and quantitative investigation of the determinants of feelings of justice that  
92 accounts for the multi-dimensional facets of justice and its perception. Research on the  
93 plurality of, and individual variation in, justice perception has been qualitative in many cases  
94 (Coolsaet, 2016; Martin et al., 2014; Smith and McDonough, 2001; but see Zafra-Calvo et al.,  
95 2017), while studies using a quantitative approach have often focused on a single dimension  
96 of justice, usually procedural justice (e.g. Lauber, 1999). Here, we used an enhanced version  
97 of the Bradley-Terry model (Schauberger and Tutz, 2017) to develop interdisciplinary enquiry  
98 around the concept of justice and to inform future research using quantitative methods in  
99 combination with qualitative data to reveal patterns of feelings of justice.

100           We explored factors affecting feelings of justice held by different actors involved in  
101 jaguar management around the Calakmul Biosphere Reserve in Mexico. We investigated the  
102 jaguar conflict in Calakmul to examine factors influencing feelings of justice within a  
103 theoretical framing of multiple dimensions of justice. This study complements the work of  
104 Lecuyer et al. (2018), which used qualitative data to explain how feelings of injustice in local  
105 communities surrounding jaguar management in Calakmul are constructed. Here, we aimed to  
106 (1) identify factors influencing local actors' perceptions of justice; (2) assess how the criteria  
107 that local actors used to describe their feelings of justice cluster; (3) offer practical advice on  
108 strategies to achieve 'justice' and support 'fair' management actions; and (4) present a novel  
109 methodology for the analysis of empirical data on local perceptions of justice. We thus  
110 contribute to theorization in this area, but also offer practical recommendations for  
111 biodiversity conflict management. By helping to develop mutual understanding and foster an  
112 open dialogue among actors, our research facilitates fair and effective conservation action.

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Table 1. External factors of justice extracted from the literature and arranged according to whether they depend on the resources or injustice considered, on the individual, or on the context in which the situation takes place.

Category of external factor	External factor	Definition	Reference
Related to the injustice itself	Responsibility	Who/what is held responsible for the injustice: an individual, an organization or intangible factors	Ohl et al., 2008; Utne and Kidd, 1980
	Intentionality	Whether the injustice is caused voluntarily or not by one (or more) actors.	Della Fave, 1986; Ohl et al., 2008; Utne and Kidd, 1980
	Duration	Whether the injustice and its cause(s) are temporary or long lasting.	Ohl et al., 2008; Utne and Kidd, 1980
Related to the individual	Individual characteristics	Socio-economic and demographic attributes, and previous experience of the actors.	Clayton and Opotow, 2003; Kellerhals et al., 1997
	Motivation	The actors' objectives and expectations regarding the situation.	Parris et al., 2014
	Environmental identity	Whether and how the environment plays an important part in someone's identity.	Clayton et al., 2016; Clayton and Opotow, 2003; Müller, 2011; Parris et al., 2014; Stets and Biga, 2003
Related to contextual factors	Physical environment	The physical environment influences how an actor perceives place identity and connects to the natural world.	Agyeman et al., 2016; Marques et al., 2015; Parris et al., 2014
	Intra-group relationships	Observation of others' behaviour in the group is used to interpret if one's behaviour is appropriate in a given situation. Social norms to which members of a social group state adherence are likely to strongly benefit or legitimize that group.	Clayton et al., 2016; Clayton and Opotow, 2003; Colvin et al., 2015; Lute and Gore, 2014; Marques et al., 2015; Parris et al., 2014
	Inter-group relationships	Perception of the legitimacy of an external group that promotes a certain behaviour. Such legitimacy influences how people act in accordance with each other and supports a legitimated norm or set of behaviours.	Clayton et al., 2016; Clayton and Opotow, 2003; Colvin et al., 2015; Lauber, 1999; Lute and Gore, 2014; Parris et al., 2014;

354 2. Methods

355 2.1. Species of interest and study area

356 As a top predator and flagship species, the jaguar is a focal species for environmental  
357 protection and biodiversity conservation (Sanderson et al., 2002). However, it also represents  
358 a threat to livelihoods because of livestock depredation (Zarco-González et al., 2013). This  
359 has resulted in hunting and poisoning of jaguars, representing a significant threat to the  
360 survival of certain jaguar populations (Inskip and Zimmermann, 2009). In Mexico, the jaguar  
361 is considered an endangered species (SEMARNAT, 2010). Recent studies showed that the  
362 Yucatán peninsula, especially the region encompassing the Calakmul Biosphere Reserve and  
363 its surroundings, hosts one of the largest continuous areas highly suitable for jaguars  
364 (Rodríguez-Soto et al., 2011).

365 The Calakmul region broadly corresponds to the municipality of the same name,  
366 which covers almost 14,000 km<sup>2</sup>, half of which corresponds to the Calakmul Biosphere  
367 Reserve. The municipality is home to 28,424 people, living in 62 *ejidos* distributed around the  
368 reserve (INEGI, 2015). An *ejido* is a land tenure system often combining both individual and  
369 communal land rights and in which decisions affecting *ejido* life are taken collectively among  
370 the *ejidatarios*, the land-tenure right holders (Warman and Warman, 2001). A large influx of  
371 people arrived in the Calakmul region between the 1970's and the mid 1990's, mainly from  
372 the Gulf coast and central regions of Mexico. In this region, people engage in a wide range of  
373 natural resource-based activities, including honey production and logging, although most  
374 depend on subsistence maize agriculture (Turner et al., 2004). In addition, many families in  
375 the region own livestock, mostly cattle and sheep. Government programmes have sponsored  
376 sheep production, hence there has been a recent increase in families owning small flocks of  
377 sheep to provide additional income (Schmook and Radel, 2008).



378           The co-occurrence of livestock and jaguars and pumas makes Calakmul a high-risk  
379 zone for large cats' attacks on livestock. Marshall et al. (under review) found that over 30% of  
380 the ranchers suffered at least one attack between 2013 and 2015 in the Calakmul region, two-  
381 thirds of which they attributed to jaguar. Widespread large cats' depredation affects mostly  
382 sheep owners, partly because of livestock husbandry practices (Lecuyer et al., unpubl. data).  
383 To compensate for economic losses from predators, a national compensation scheme was  
384 created in the late 2000's. The scheme is funded through the National Confederation of  
385 Livestock Organizations (*Confederación Nacional de Organizaciones Ganaderas*), and is  
386 accessible to any livestock rancher who can provide evidence of ownership, without any  
387 insurance cost to the claimant. Furthermore, the Reserve and a local non-governmental  
388 organization (PRONATURA) have been helping local ranchers to complete and submit the  
389 required report after an attack. The Reserve also plays a role in jaguar management through  
390 biological monitoring, including monitoring undertaken by local groups trained by the  
391 Reserve. Additionally, the Reserve sporadically delivers technical and financial support to  
392 communities to implement mitigation measures, like electric fences, to limit the risk of attack.  
393 PRONATURA has been providing camera traps to ranchers to identify the predator in case of  
394 an attack; PRONATURA also carried out an awareness campaign, and was involved in  
395 multiple events regarding jaguar conservation (pers. obs). Despite these efforts, jaguar  
396 management is causing a latent and, at times, intense biodiversity conflict among the region's  
397 actors, leading to feelings of injustice in local populations (Lecuyer et al., 2018).

398

## 399 2.2. Data collection

400 We conducted interviews in 45 *ejidos* located in the Calakmul region with both ranchers (i.e.  
401 people primarily practising livestock production) and farmers (i.e. people primarily practising  
402 agriculture and not owning livestock). We proposed that ranchers might perceive fairness in  
403 relation to the jaguar differently from farmers as ranchers are directly affected by predation;

404 whilst farmers could offer more of an outsider perspective, possibly reacting similarly to  
405 ranchers, but tending to reflect greater concerns for the community (Parris et al., 2014).  
406 Farmers were selected randomly, while ranchers were selected using a snowball technique  
407 (Coleman, 1958), where we randomly chose a house in each community to ask members of  
408 the household if they could provide us with the names of livestock owners in the community.  
409 This approach was used due to the limited number of ranchers in most communities. As the  
410 main interest of this study was to understand ranchers' perceptions of justice, we interviewed  
411 more ranchers (n=144) than farmers (n=91). Of those people who were at home when we  
412 visited the communities, only three individuals refused to participate in the interviews,  
413 because of lack of time. None of the people interviewed refused to answer any question from  
414 the survey questionnaire.

415         Our questionnaire used closed and open-ended questions and was divided into two  
416 sections. The first section comprised demographic and a series of categorical questions to  
417 investigate external factors that can influence feeling of justice. We adapted factors identified  
418 in Table 1 for the case of jaguar management (Table 2). As categorical questions might not  
419 capture the complexity of a particular situation, we asked questions based on information  
420 provided by local people in previous studies (see Lecuyer et al., 2018). Indeed, while some  
421 questions were simple to adapt, others required an understanding of the region and several  
422 iterations of pilot interviews with local actors to articulate clearly (see appendix 1). Because  
423 of the limited number of variables we could include in the analysis, in Table 2 we present  
424 only the questions from which we extracted the variables included. Some questions originally  
425 included more potential answers; answers that were never selected by participants were  
426 excluded from the analysis.

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428

429 Table 2. Questions to assess external factors regarding jaguar management.

Category of external factor	External factor	Question asked
Related to the injustice itself	Responsibility	<ul style="list-style-type: none"> <li>Who do you think is responsible for jaguar management in the region? 1) Individuals, 2) Government, 3) Reserve, 4) NGOs, 5) <i>Ejido</i> authorities</li> <li>Do you think the responsible (chosen above) 1) Is investing enough effort to avoid jaguar attack on livestock? 2) Does not care about jaguar attack on livestock? 3) No opinion</li> <li>In your opinion, in which order (from most to least) do these predators perpetrate attacks? Jaguar, Puma, Dogs, Coyotes, Other (If no risk was associated with a species, a zero was written)</li> </ul>
	Intentionality	<ul style="list-style-type: none"> <li>Do you think jaguar attacks are 1) Controllable? 2) Non-controllable?</li> </ul>
	Frequency*	<ul style="list-style-type: none"> <li>How do you perceive jaguar attack? 1) Uncommon, 2) Frequent</li> </ul>
Related to the individual	Individual characteristics	<ul style="list-style-type: none"> <li>Activity: 1) Rancher, 2) Farmer</li> <li>Gender</li> <li>Age</li> <li>Education</li> <li>Number of sheep</li> <li>For farmers only: Did any jaguar attack on livestock ever occur in your community?</li> <li>For ranchers only: Have you ever experienced a jaguar attack on your livestock?</li> </ul>
	Motivation	<ul style="list-style-type: none"> <li>In light of the current situation surrounding the jaguar, would you like to: 1) Permit an equilibrium between jaguar protection and livestock production? 2) Increase livestock production?</li> </ul>
	Environmental identity	<ul style="list-style-type: none"> <li><i>Choice of propositions to categorize their environmental identity (see Stet and Biga, 2003)</i> Creation of an index centred on 0, varying from -1 to 1.</li> </ul>
Related to contextual factors	Physical environment	<ul style="list-style-type: none"> <li>How often do you go into the forest? 1) Every day, 2) Once a week, 3) Once a month, 4) Once a year</li> <li>How often do you see wild animals? 1) Every day, 2) Once a week, 3) Once a month, 4) Once a year</li> </ul>

- Intra-group relationships
  - How do you best identify yourself? 1) By your activity (rancher or farmer), 2) By your status in your community (*ejidatario* or non *ejidatario*), 3) By the community in which you live (name of the community)?
  - Within the group you best identify yourself, regarding jaguar management, do you: 1) Share the same opinion? 2) Have a different opinion?
- Inter-group relationships
  - Which of the following actors do you think have the right to be involved in jaguar management? (several answers possible) 1) Government, 2) Reserve, 3) NGOs, 4) *Ejidors* authorities, 5) Individuals
  - Do you think the jaguar management actions implemented by this/these actor(s) have been adequate? 1) Yes, 2) No

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430 \* We replaced the external factor "duration" (of attacks taking place) by "frequency" (of attacks) to avoid biases  
 431 caused by respondents being engaged in this activity for very different durations.  
 432

433           The second section of the questionnaire was an assessment of participants' feelings of  
 434 justice. During previous research in the region, we identified 16 criteria that people used to  
 435 build their perceptions of justice according to the four dimensions of justice considered here  
 436 (Lecuyer et al., 2018). Those criteria were described in 18 statements (Table 3, Appendix 1).  
 437 We first asked participants if they agreed or disagreed with these statements to confirm our  
 438 framing of the criteria of justice. Following, we asked them to select the 10 most important  
 439 statements for them, without ranking. Out of those 10 statements, participants had to choose  
 440 the most important statement out of each pair of statements (45 paired comparisons in total).  
 441 We chose paired comparisons because according to previous studies (Cattelan, 2012) and our  
 442 experience in the region, people struggle to rate or rank several items and our pilot interviews  
 443 showed that it was easier to compare pairs of items. The interview ended with open questions  
 444 about how respondents felt about the criteria and justice toward jaguar management in  
 445 general.

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449 Table 3. Statements that were the objects of paired comparisons and represent different justice  
 450 criteria that are associated with different justice dimensions. The letters associated with the  
 451 criteria are not in alphabetical order because we wished to present the criteria randomly to our  
 452 participants without the possibility for preconceived ranking.

Theme	Criterion	Statement
Distributive environmental justice: the fair distribution of costs and benefits related to jaguar management	i. Need-Benefit	Support should be provided to the livestock breeders who need it most
	k. Equality-Benefit	The same support should be provided to everyone
	m. Merit-Cost	Conservationists should pay for the cost of living with jaguars
	o. Merit-Benefit	Support should be provided to those who take measures to coexist with, and protect, jaguars
	r. Equality-Benefit	The cost of living with the jaguar should be distributed among all
Procedural environmental justice: the fairness of the processes of jaguar management (daily based operation)	c. Compliance	Everybody should respect the decisions taken
	d. Consistency	There should be no interest group favoured during the decision-making process
	j. Opportunity for revision	If I disagree with a decision, I should be able to give my opinion
	l. Trust	People in charge of making decisions should be people I trust
	p. Representation	Everyone should have the opportunity to give their opinion during the decision-making process
	q. Respect	Those responsible for jaguar management should treat me with respect
Ecological justice: the fair and respectful treatment of jaguar	a. Right of the environment	Jaguars have the right to live
	f. Responsibilities towards other species	I am responsible for not putting at risk a jaguar and its habitat
	n. Responsibilities to future generation	I want to protect the jaguar for my children and grandchildren to be able to know it
Justice as recognition: acknowledging land-use rights, values and knowledge systems	b. Plurality of interest	Those responsible for jaguar management should recognize the importance of everyone's interest
	e. Land-use right	I should have the right to do what I want, if a jaguar is on my land
	g. Neutral approach	Those responsible for jaguar management should be neutral
	h. Knowledge	Jaguar management should be based on what we know about the jaguar

453

### 454 2.3. Data analysis

455 Our analysis presupposed that study participants make choices between different criteria of  
456 justice to build their overall perception, and that those choices will be influenced by external  
457 factors (covariate) related to the injustice, the individual and the context. Those choices are  
458 not identical with ranking or grading a proposition as we had multiple cases of non-  
459 transitivity in our dataset (i.e. a participant might rank  $a > b > c$  but  $c > a$ ). In fact, our dataset  
460 showed an appreciable number of non-transitivity cases: 3218 cases of non-transitivity out of  
461 28200 (11.41%). Thus, we decided not to include the implicit comparisons between the 10  
462 criteria selected and the 8 unselected criteria in our analyses. The analysis of the effect of the  
463 external factors focused only on the explicit comparisons made among the 10 criteria selected  
464 by each participant. These choices can be analysed with the Bradley-Terry-Luce model using  
465 paired comparisons (Bradley and Terry, 1952). However, the Bradley-Terry-Luce model  
466 assumes that the strengths of the objects compared are equal for all subjects selecting them  
467 (Cattelan, 2012). Schauburger and Tutz (2017) proposed a methodology that accounts for  
468 heterogeneity of both the subject (person) making the comparison, and the object (criteria)  
469 being compared. They incorporated a LASSO penalty to select subject-specific or criteria-  
470 specific covariates into the Bradley-Terry-Luce model. By using a penalized likelihood  
471 approach, the Bradley-Terry-Luce model with LASSO penalty (BTLLasso) allowed us to 1)  
472 compare pairs of criteria from choices made by different participants; 2) identify clusters of  
473 criteria influenced similarly by a covariate; and, 3) assess the subject-covariate that influenced  
474 choices among pairs of criteria (Schauburger and Tutz, 2017). In short, the BTLLasso  
475 proposes the modulation of justice criteria by subject-specific covariates selected using a  
476 LASSO penalty weighted by a tuning parameter. Because the importance of the LASSO  
477 penalty may vary depending on the data in question, we used a cross-validation to choose the

478 tuning parameter and thus a penalty level adequate for the data for which the model was  
479 constructed. By choosing an appropriate penalty level, we can visualize justice criteria that  
480 share the same strength as well as those that can be distinguished from other justice criteria  
481 (Schauberger and Tutz, 2017). To evaluate the quality of the models obtained, we randomly  
482 sampled the data with replacement (bootstrap) 200 times and used these bootstrap iterations to  
483 build 95% confidence intervals. By using BTLasso, we represented 1) how external factors  
484 influenced the perception of the subjects among justice criteria and 2) the influence that  
485 specific external factors have on the different justice criteria. All Bradley-Terry-Luce models  
486 were constructed using the BTLasso R package. More details about the Bradley-Terry-Luce  
487 models we built can be found in Supplementary material 2.

488 In addition, we explored how similarly justice criteria were affected by external factors.  
489 We built a matrix of estimated effects (i.e. the effect values for the optimal model) for each  
490 criterion of every group of external factors and for every external factor. We then used K-  
491 means partitioning (Legendre and Legendre 2012, section 8.8) to group criteria based on how  
492 similarly they are influenced by external factors. K-means partitioning assigns each criterion  
493 to a specific cluster and optimizes the assignment through an iteration process. In K-means  
494 partitioning, the number of clusters is defined *a priori*. Here, we intended to group criteria in  
495 two to ten clusters. To find the optimal number of clusters we used the Calinski-Harabasz  
496 criterion (Calinski and Harabasz, 1974). To perform this analysis, we used the cascadeKM  
497 function available in the vegan R package (Oksanen et al. 2017).

498

### 499 3. Results

#### 500 3.1. General results on external factors

501 Our interviews provided information on the participants and allowed us to explore people's  
502 perception of the injustice itself and of their interaction with their social and natural  
503 environment (Table 4).

504



505 Table 4. Results to the questions asked to assess external factors regarding jaguar  
 506 management.

Category of external factor	External factor	Results
Related to the injustice itself	Responsibility	<ul style="list-style-type: none"> <li>• <i>Ejido</i> authorities = 12 (Positively = 8, Negatively = 3, No opinion = 1)</li> <li>• Everyone = 22 (Positively = 5, Negatively = 13, No Opinion = 4)</li> <li>• Government = 75 (Positively = 24, Negatively = 45, No Opinion = 6)</li> <li>• NGO = 20 (Positively = 7, Negatively = 12, No Opinion = 1)</li> <li>• Reserve = 106 (Positively = 32, Negatively = 64, No Opinion = 10)</li> <li>• Species deemed responsible: Range = 0-1; Average score: Jaguar = 0.9; Puma = 0.4</li> </ul>
	Intentionality	<ul style="list-style-type: none"> <li>• Jaguar attacks are: Controllable = 73; Non-controllable = 162</li> </ul>
	Frequency	<ul style="list-style-type: none"> <li>• Frequency: Uncommon = 124; Frequent = 111</li> <li>•</li> </ul>
Related to the individual	Individual characteristics	<ul style="list-style-type: none"> <li>• Activity: Rancher = 144; Farmer = 91</li> <li>• Gender: M= 160; W= 75</li> <li>• Age: Range = 19-83; Mean = 47; SD = 15</li> <li>• Education (number of years): Range = 0-15; Mean = 6 ; SD = 4</li> <li>• Number of sheep: Range = 2-300; Mean = 32; SD = 27</li> <li>• Farmers only: Attack in community= 54; No attack in community = 37</li> <li>• Ranchers only: Attack = 100; No attack = 44</li> </ul>
	Motivation	<ul style="list-style-type: none"> <li>• Equilibrium between jaguar protection and livestock production =126</li> <li>• Increase livestock production = 109</li> </ul>
	Environmental identity	<ul style="list-style-type: none"> <li>• Environmental identity index: Range = -0,66-1; Mean = 0.28; SD = 0.45</li> </ul>
	Physical environment	<ul style="list-style-type: none"> <li>• Number of days per year during which they go into the forest and/or observe wild animals: Range= 2-730; Mean = 258; SD = 237</li> </ul>
Related to contextual factors	Intra-group relationships	<ul style="list-style-type: none"> <li>• Activity = 44 (Same opinion =17; Various opinions =27)</li> <li>• Status = 84 (Same opinion =31; Various opinions =53)</li> <li>• Community = 107 (Same opinion =33, Various opinions =74)</li> </ul>
	Inter-group relationships	<ul style="list-style-type: none"> <li>• Government: Not adequate = 95, Not involved = 30, Adequate = 110</li> <li>• Reserve: Not adequate = 63, Not involved = 26, Adequate = 146</li> <li>• NGO: Not adequate = 65, Not involved = 38, Adequate = 132</li> <li>• <i>Ejido</i> authorities: Not adequate= 57, Not involved= 29, Adequate = 149</li> <li>• Everyone: Not adequate = 37, Not involved = 30, Adequate = 168</li> </ul>

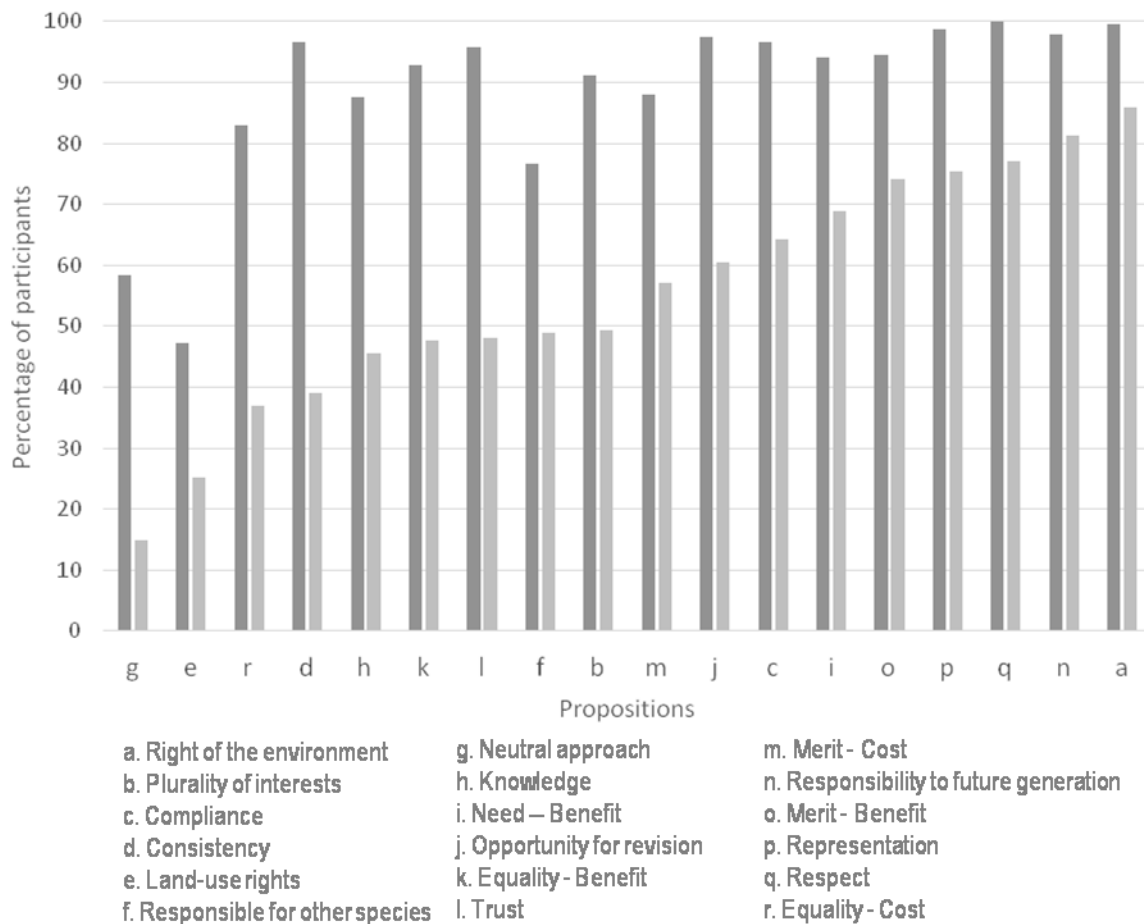
507

508

509

510 3.2. Criteria selection

511 The first part of the interview indicated if participants (n=235) agreed with the statement  
 512 related to each criterion (dark shaded column, Fig. 1) and which ones they selected as their  
 513 ten most important (light grey column, Fig. 1). Some criteria (*a, n, o, p, q*) stood out since  
 514 almost 95% of the participants agreed with these statements and because they were often  
 515 chosen in the ten most important criteria (> 74%). Conversely, a few criteria showed lower  
 516 levels of agreement (45-60%) among participants (*e, g*) or had lower importance (10-40%) (*d, e, g, r*).



518  
 519 Figure 1. Agreement with the criteria presented (dark grey) and criteria selected among the  
 520 ten most important (light grey) by participants (n=235). Criteria are presented in increasing  
 521 order of selection by participants among the ten most important criteria.  
 522

523

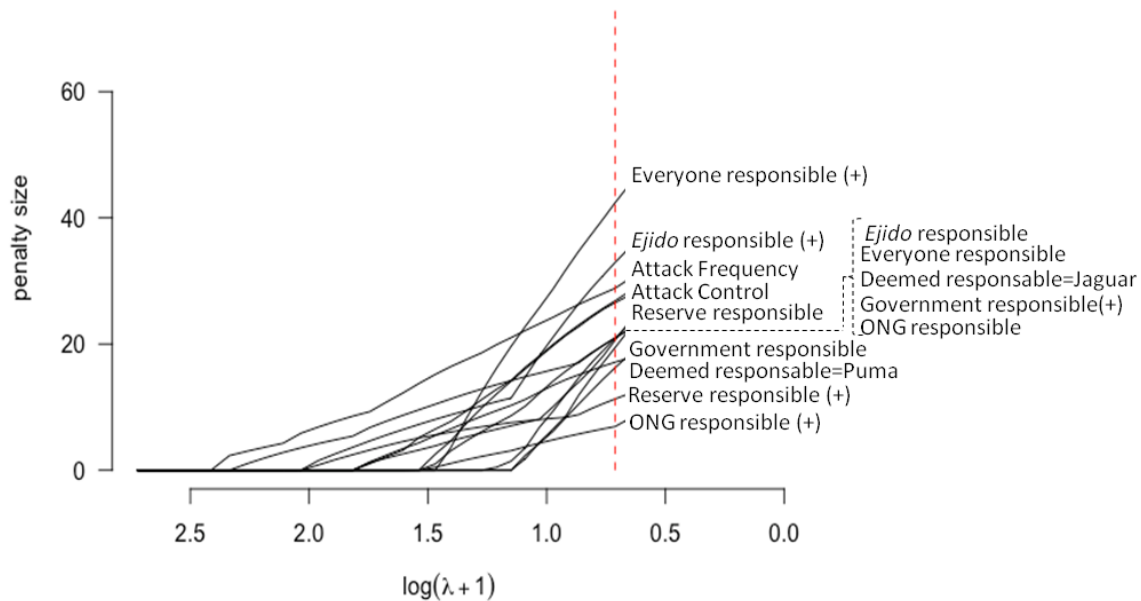
524 3.3. Importance of external factors

525 The BTLasso analyses resulted in 43 plots (see Appendix 2). Due to the high number of  
526 resulting figures, we created three sub-figures to visually synthesize our results and show  
527 some of the main trends (Fig. 6). However, each individual result is also of interest and while  
528 we cannot illustrate all of these in the results, we use some findings to illustrate points made  
529 in the discussion.

530 *Injustice itself* – Looking at factors related to the injustice itself allowed us to explore  
531 the effects of the nature of the injustice in question on participants' perception of justice.  
532 First, we found that the effect of who participants perceived to be responsible is not  
533 straightforward; if participants felt that those they believed were responsible for jaguar  
534 management were undertaking their roles effectively, this had a stronger effect than merely  
535 attributing responsibility (Fig. 2). Second, feeling that everyone (including themselves) or the  
536 *ejido* authorities was responsible (either if they were fulfilling their roles effectively or not)  
537 influenced strongly participants' feelings of justice. There was less influence if responsibility  
538 was allocated to an entity such as the reserve or NGOs<sup>2</sup>. Third, the perceived control and  
539 frequency of attacks were important in determining the feelings of justice of participants.

---

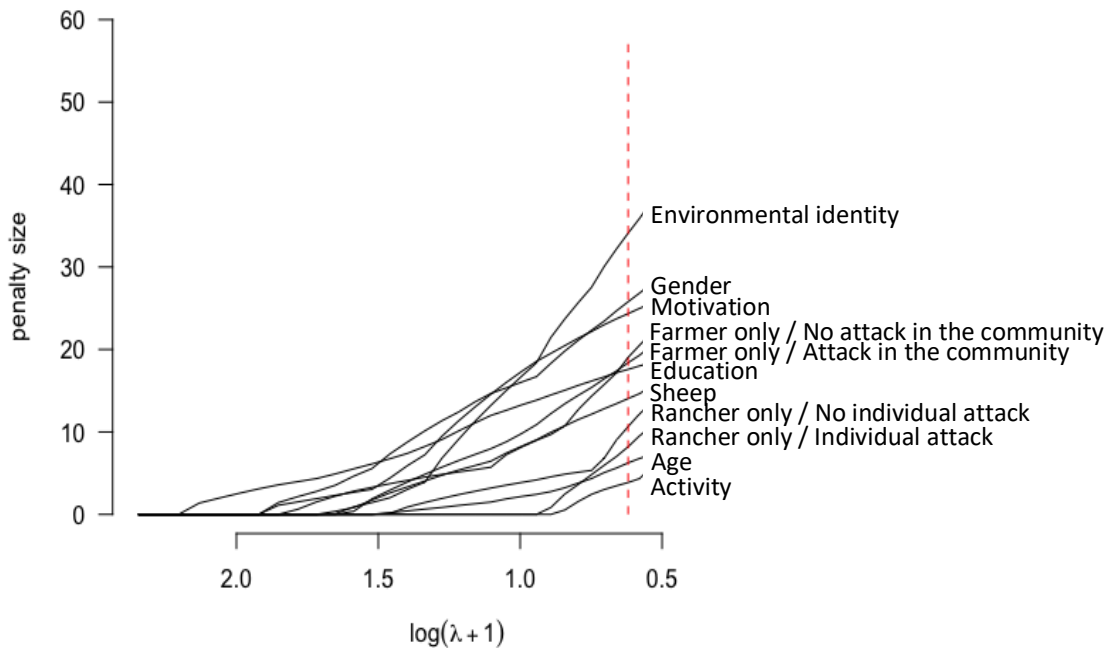
<sup>2</sup> External factors highlighted as influential were not necessarily selected by a majority of participants. For example, only 22 participants perceived individuals to be responsible for jaguar management, against 135 who perceived the Reserve to be responsible. Moreover, the way the 22 participants perceived individuals to be responsible led them to perceive and prioritize the criteria of justice differently in comparison to the other participants.



540  
 541 Figure 2. Penalty paths for injustice factors.  $\lambda$  (a tuning parameter) specifies the seriousness of  
 542 the penalty term. The dashed red line represents the optimal model following a 5-fold cross-  
 543 validation. Subject-specific covariate “Everyone responsible (+)” had the largest penalty for  
 544 the single model component at the optimal value of the tuning parameter; hence, it was the  
 545 covariate that most influenced participants’ choices among the criteria evaluated.

546  
 547 *Individual* - At the individual level (Fig. 3), environmental identity was the factor that  
 548 most influenced participants’ perception of fairness. Environmental identity was followed by  
 549 gender, personal motivation regarding jaguar management (i.e. more livestock or an  
 550 equilibrium between jaguar protection and livestock production), farmers’ knowledge of  
 551 jaguar attack occurrence in their community, and education. However, factors related to a  
 552 rancher’s experience were relatively unimportant (e.g. previous experience of attacks, number  
 553 of sheep owned). External factors such as activity and age were not very important either.

554



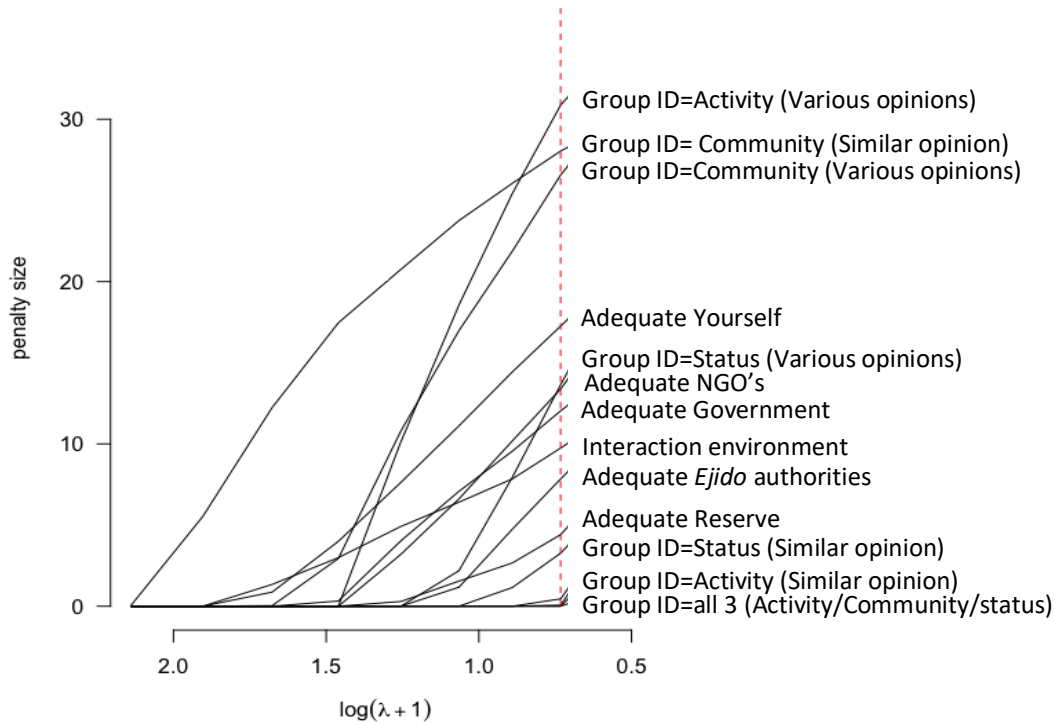
555

556 Figure 3. Penalty paths for individual factors.  $\lambda$  (a tuning parameter) specifies the seriousness  
 557 of the penalty term. The dashed red line represents the optimal model following a 5-fold  
 558 cross-validation. Subject-specific covariate “environmental identity” had the largest penalty  
 559 for the single model component at the optimal value of the tuning parameter; hence, it was the  
 560 covariate that most influenced participants’ choices among the criteria evaluated.

561

562 *Context* - Coherence in the group to which participants felt they belong to (i.e. intra-  
 563 group relationships) was the most important factor explaining feelings of justice (Fig. 4). This  
 564 was especially the case when people defined their main group affiliation by their main activity  
 565 (i.e. farmer or rancher) and believed they had a different opinion toward jaguar management  
 566 from the rest of this group; or when they affiliated to the community with feelings that they  
 567 had either similar or divergent opinion with the rest of the community. Inter-group  
 568 relationships (i.e. how they perceived management entities) had less influence on feelings of  
 569 justice, but allowed us to evaluate how views on the efficacy of organisations influenced their  
 570 feelings. Interaction with the physical environment had very little effect on people’s

571 perception of justice. Finally, feeling affiliated to a group (without accounting for group  
 572 coherence) appeared to have no effect on participants' feelings of justice.



573  
 574  
 575 Figure 4. Penalty paths for contextual factors.  $\lambda$  (a tuning parameter) specifies the seriousness  
 576 of the penalty term. The dashed red line represents the optimal model following a 5-fold  
 577 cross-validation. Subject-specific covariate “Group ID=Activity (Various opinions)” had the  
 578 largest penalty for the single model component at the optimal value of the tuning parameter;  
 579 hence, it was the covariate that most influenced participants' choices among the criteria  
 580 evaluated.

581

### 582 3.3. External factors influence on criteria

583 The BTLLasso analysis also made it possible to study the effects of external factors on the  
 584 selected criteria. The effects of individual external factors (n=43) are shown in detail in  
 585 Appendix 2; we present here one original graph that was a direct output from the BTLLasso  
 586 analysis and additional selected results in figure 6 built from data obtained through BTLLasso

587 results. As it would be impossible to present all the results in detail here, for the purpose of  
588 this paper we show how the results can be analysed in different ways. We display examples  
589 of the effects of *one specific factor* on every criterion, a *comparison of the effects of various*  
590 *external factors* on the criteria, and how *one specific criterion* is influenced by all external  
591 factors.

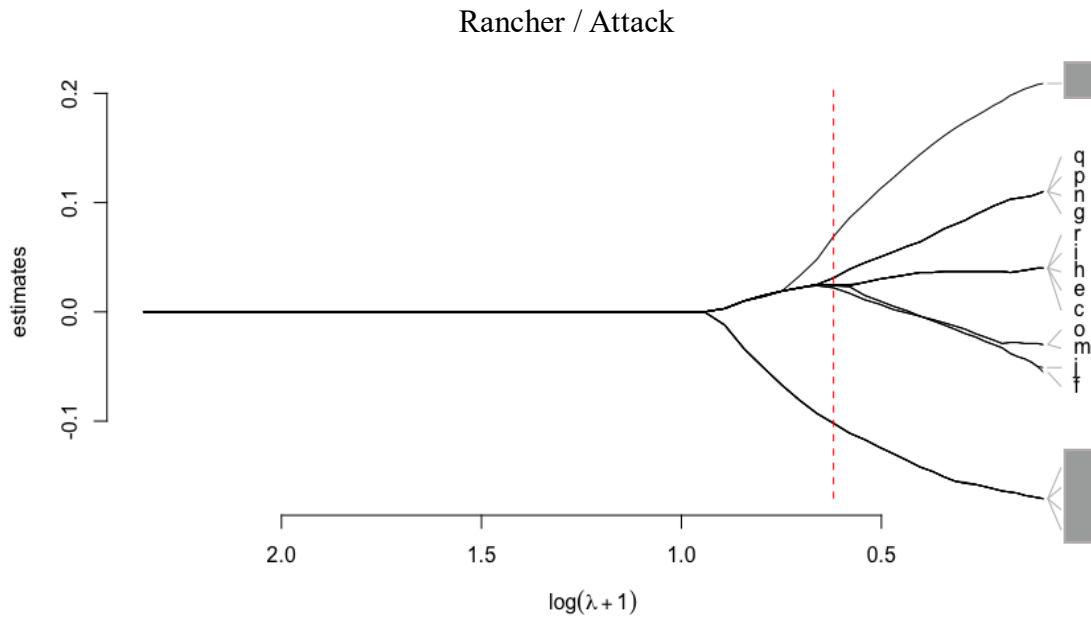
592 *Specific factors* - We wanted to understand how the effect of suffering jaguar attacks  
593 might affect different criteria of justice (Fig. 5), even though jaguar attack had less influence  
594 on feelings of justice than many other external factors (see Fig. 4). This analysis demonstrated  
595 that ranchers who suffered an attack perceived the *right to live of the jaguar (a)* to be more  
596 important than ranchers who had never experienced an attack. The former placed less  
597 importance on having an *equal share of the benefit of living with jaguars (k)*, *not favouring*  
598 *any interest group* during the decision-making process (*d*) or having those responsible for  
599 jaguar management *recognizing the importance of everyone's interest (b)*. They also  
600 considered *trust (l)* in the decision maker to be less important.

601

602

603

604



605

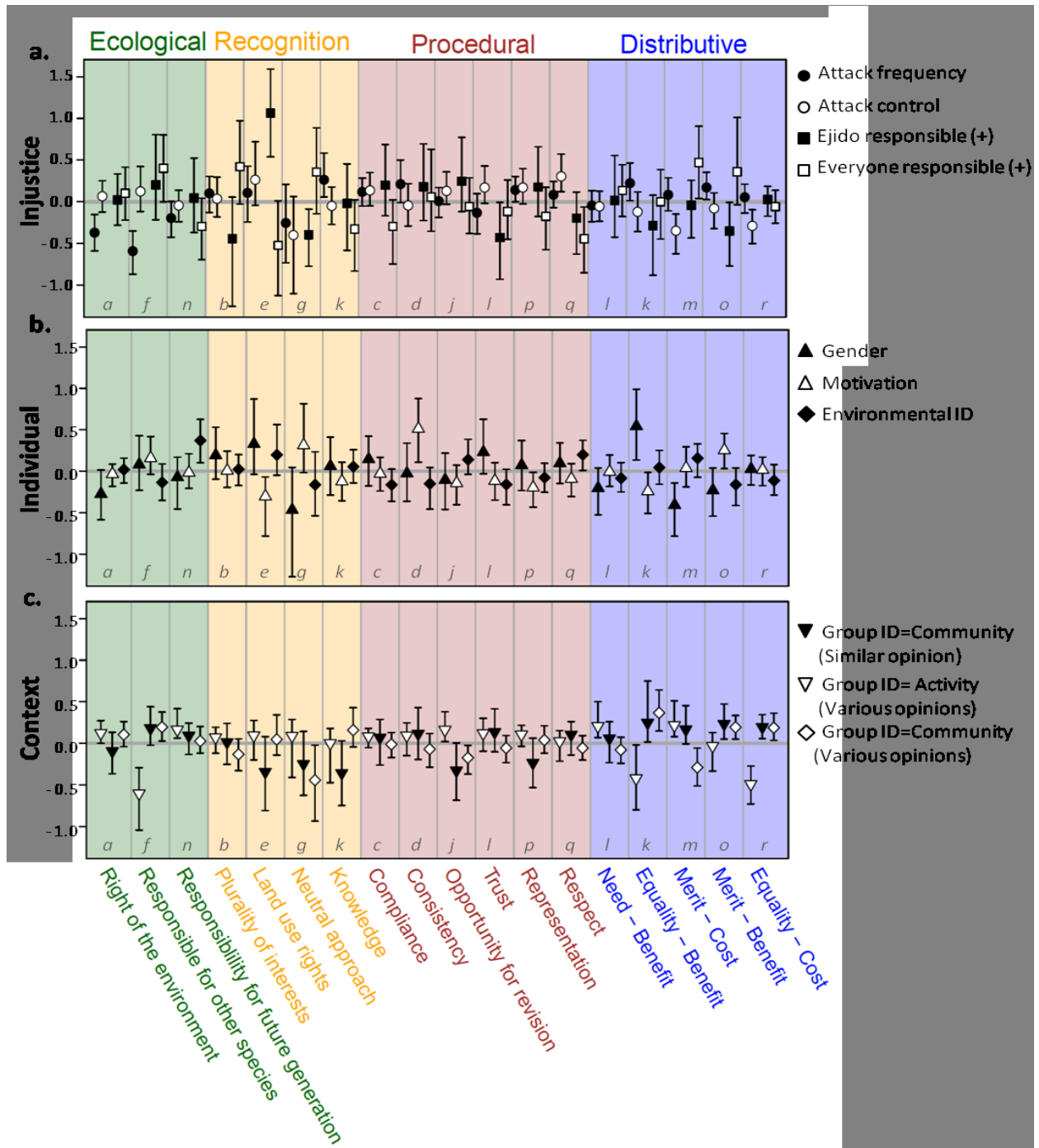
606 Figure 5. Parameter paths for the subject-specific variable, when participants were ranchers  
 607 who had suffered a livestock attack.  $\lambda$  (a tuning parameter) specifies the seriousness of the  
 608 penalty term. The dashed red line represents the optimal model following a 5-fold cross-  
 609 validation. The plot is centered on 0 on the Y-axis. Parameter paths with a positive (negative)  
 610 value indicate a positive (negative) relationship of the criteria for the variable of interest. For  
 611 the optimal model (dashed red line), criteria following the same paths (e.g. *g* and *o*) should be  
 612 given equal importance in the interpretation. See figure 1 for the list of criteria.

613

614 *Comparison of the effects of various external factors* – When comparing external  
 615 factors, it was possible to compare, for example, how different perceptions of jaguar  
 616 management held within the same group influenced jaguar management (Fig. 6c). The  
 617 participants who expressed a strong sense of belonging in their community and who perceived  
 618 that they shared the same opinion regarding jaguar management as their community were less  
 619 inclined toward an *equal distribution of costs and benefits (k,r)*, and more toward helping  
 620 people with greater *needs (i)*; they felt that conservationists should bear the *costs of living*  
 621 *with jaguars (m)*. These participants also considered *individual responsibility (f)* to be less  
 622 important in jaguar management. On the other hand, participants who expressed a strong  
 623 sense of belonging in their community, but who said that opinions regarding jaguar  
 624 management diverged within their community, had different priorities regarding justice.



625 Criteria they felt were important included *equal distribution of costs and benefits (k, r)*,  
626 recognition of efforts to coexist with jaguars (*merit, o*), *individual responsibility (f)* and  
627 recognition of their *knowledge (h)*.  
628



629

630 Figure 6. Summary of the effects of the most influential external factors (i.e. highest penalty  
 631 size) on the perceived importance of justice criteria for (a) external factors related to the  
 632 injustice, (b) external factors related to the individual, and (c) external factors related to the  
 633 context. Criteria are grouped by dimension of justice: ecological, justice-as-recognition,  
 634 procedural and distributive. The Y-axis of each figure represents the estimates of the effect  
 635 and is centered on zero. Positive (negative) value indicate a positive (negative) relationship of  
 636 the criteria for the variable of interest. Confidence intervals for subject-specific variables (e.g.  
 637 gender) are based on 200 bootstrapped samples.

638           *Specific criteria* – Another possible use of our results was to see which factors  
639 influenced a specific criterion. For example, which criteria relating to ecological justice affect  
640 perceptions of jaguar management? In Calakmul, feeling that everyone should be responsible  
641 for jaguar management was related to an increased sense of personal responsibility toward  
642 jaguar management (*f*) (Fig. 6a). Participants who identified strongly as community members  
643 were less willing to consider individual responsibility (*f*) when they thought that other  
644 community members had similar attitudes toward jaguar management (Fig. 6c). Respondents  
645 who showed a strong environmental identity indicated that their responsibility for future  
646 generations (*n*) was important (Fig. 6b). Finally, perceptions of attacks as being frequent led  
647 respondents to acknowledge that all three criteria linked to ecological justice (Fig. 6a) were  
648 less important.

649           To develop just and effective jaguar management plans, it is also necessary to explore  
650 what motivates people to consider that they have the right to do whatever they want with  
651 jaguars on their land (*e*). Our results indicated that respondents who both deemed attacks to be  
652 frequent and believed they cannot control attacks were more inclined to give importance to  
653 the right to do what they want when a jaguar is on their land (*e*) (Fig. 6a). Similar views were  
654 held by those who perceived positively the *ejido* authorities as responsible for jaguar  
655 management; on the opposite, it is not the case for those who perceive positively that  
656 everyone is responsible for jaguar management (Fig. 6a). Men were also more inclined to put  
657 more importance on land-use rights. Interestingly, those who expressed their wish to have  
658 more livestock gave less importance to land-use rights, while those with a strong  
659 environmental identity gave it more importance (Fig. 6b). Finally, participants who based  
660 their main group affiliation on their main economic activity (farmer or rancher) and who  
661 believed they had divergent opinions on jaguar management perceived their land-use right to  
662 be less important (Fig. 6c).

### 663 3.4. Grouping patterns of criteria

664 The K-mean partitioning did not allow identifying a clear number of groups using the  
665 Calinski-Harabasz criterion (see Appendix 3). However, the Calinski-Harabasz criterion  
666 yielded the largest increase when the criteria were partitioned in four groups. Using these four  
667 groups we compared our initial division of the criteria among the four dimensions of justice.  
668 We explored the effect of each group of external factors and of every external factor on each  
669 criterion, allowing us to identify trends (Table 5). The external factors related to injustice  
670 suggest that there may be specific influences, for example, on how people perceive their *land-*  
671 *use right (e)* and the importance of both a *plurality of interests (b)* and a *neutral approach (g)*,  
672 and the importance of both the *right to live of the jaguar (a)* and their *own responsibility for*  
673 *its survival (f)*. Furthermore, we were able to compare our initial grouping of the criteria  
674 (according to procedural, distributive, ecological and recognition forms of justice) with the  
675 final grouping of the criteria according to the influence of external factors (injustice,  
676 individual, context): 1) Each criterion of distributive justice (merit, *m, o*, need, *i*, equality, *k*,  
677 *r*) was represented in a different group; 2) Every criterion of procedural justice (*c, g, l, p, q*)  
678 was influenced similarly by the external factors of justice except for the *consistency* criterion  
679 (*d*), which was more associated with criteria related to justice-as-recognition: *neutrality (g)*  
680 and *plurality of interests (b)*; 3) *Knowledge* criteria (*h*) that were associated with justice-as-  
681 recognition seemed to be affiliated with procedural justice concerns and to be perceived more  
682 at the decision-making process level; 4) *Land-use rights (e)* criteria responded differently  
683 from all other criteria to the influence of external factors; 5) Ecological justice was divided in  
684 two: while the *rights of the species (a)* and *responsibilities to future generations(n)* seemed to  
685 go hand in hand with people's concerns regarding procedural justice and *the need (i)* for  
686 criteria of distributive justice, *individual responsibility (f)* for jaguar management seemed to  
687 be influenced differently and related to the *equality* criteria (*k, r*) of distributive justice.

688 Table 5. Grouping patterns of criteria according to the external factors evaluated (injustice,  
 689 individual, and context). The table shows the groups formed at level 4 of the K-mean  
 690 partitioning. Our original grouping of criteria included four dimensions of justice: ecological  
 691 (a, f, n; in green); recognition (b, e, g, h; in orange); procedural (c, d, j, l, p, q; in brown);  
 692 distributive (i, k, m, o, r; in blue).  
 693

External factor	Group 1	Group 2	Group 3	Group 4
Injustice	n h, c, d, j, l, p, q, i, k, m, o, r,	a, f	b, g,	e
Individual	a, n, e, h, j, q, i, m	f, b, c, l, p, k	g, d, o	r
Context	a, e, h, j, p,	n b, c, d, l, q, i, m, o,	g	f, k, r
All external factors together	a, n, h, c, j, l, p, q, i	g, b, d, m, o	e	f, k, r

694

695 4. Discussion

696 This study aimed to explore participants’ perception of justice regarding jaguar management  
 697 in the Calakmul region of Mexico. Our analysis did not identify a dominant perception of  
 698 justice (e.g. Sikor et al., 2014), but instead highlighted variability among people’s perception  
 699 of justice. Overall feeling of fairness meant different things for different people. For instance,  
 700 for some participants, unfairness lay in the killing of jaguars, while for others, unfairness lay  
 701 in the losses of livestock experienced by ranchers. Therefore, we focused on revealing the  
 702 varied nature of justice perception by making explicit the various criteria at play in local  
 703 actors’ perceptions of justice surrounding jaguar management, and linking them to social  
 704 dynamics. Our main finding was that an experience of jaguar attack had a weak influence on  
 705 actors’ perception of fairness; rather, perception of fairness was driven mainly by questions of  
 706 identity and assessments of inter and intra-group relationships. Certain criteria (e.g. *own sense*

707 *of responsibility toward jaguar survival*) were critical in enabling us to propose solutions  
708 toward fairer jaguar management. External factors also strongly influenced some criteria  
709 affecting perceptions of fairness (e.g. *land-use right*, for some participants). Using a powerful  
710 statistical approach, we were able to highlight patterns and relationships amongst criteria  
711 affecting perceptions of justice, enabling us to contribute to a more holistic perspective of  
712 feelings of fairness in conservation.

713

#### 714 4.1. Group identity and self-interest influences on feelings of justice

715 We assessed the importance of three groups of factors towards feelings of justice: the first  
716 related to the injustice in question, the second to individuals expressing their feelings about  
717 the injustice, and the third to the context of the situation. These groups of factors enabled us  
718 to explore the roles of self-interest and group identity. An assumption of self-interest indicates  
719 that people act mainly in order to maximise a reward (Skitka et al., 2010). However, we found  
720 that people did not think this way; being a rancher who had suffered an attack only weakly  
721 affected perception of justice. Others have also found that the role of previous experience has  
722 a limited influence on fairness perception (Clayton et al., 2016) and that feelings of justice are  
723 not related only to the object of the injustice (Kellerhals et al., 1988). More surprisingly,  
724 experience of attack at the individual and community levels, respectively for ranchers and  
725 farmers, actually increased the perceived importance of jaguars' right to live. Although  
726 looking at perception of frequency and control over attacks gave more complex answers, this  
727 does not support the assumption of self-interest in perceptions of fairness. However, whilst  
728 most perceptions of justice did not reflect self-interest, they did not necessarily reflect a  
729 concern for society either. Instead, people seemed to base their feeling of fairness on a  
730 common peasant-farmer (*campesino*) way of living across activities, expressed through their  
731 desire of being able to live a decent life in Calakmul. This finding reinforced our previous

732 research that local actors aspire to justice for those sharing the *campesino* identity (Lecuyer et  
733 al., 2018).

734 Our results also supported the group identity assumption that relationships within and  
735 between groups are potent determinants of fairness judgments (Lind and Tyler, 1988; Skitka  
736 et al., 2010). Actors not only took into consideration their own judgments, but also the  
737 conduct and opinions of group members while evaluating fairness (as shown by Clayton et  
738 al., 2016; Hegtvedt et al., 2003; Lauber, 1999; Ohl et al., 2008). More importantly, our results  
739 indicated that rather than the group with which they identified, it was the perception of the  
740 coherence in the opinions toward jaguar management within the group that mattered. This is  
741 important, as a lack of coherence within a given group also hinders the willingness of its  
742 members to participate in decision-making, because of the lack of a united front to present  
743 and defend ideas (Lind and Tyler, 1988). Of importance was also who was perceived as  
744 responsible for jaguar management and whether this management was perceived positively.  
745 Here, we show how external factors might influence people's sense of responsibility toward  
746 jaguar management, which could be of interest for jaguar conservation. Our comparison of  
747 intra- and inter-group relationships regarding jaguar management allowed us to uncover some  
748 of the influences of groups' values and dynamics on their perception of fairness.

749 Effects of self-interest and group identity are complex. External factors did not have a  
750 straightforward effect: while some individual factors led people to choose criteria that  
751 represent justice for all, including jaguars, external factors related to relationships with others  
752 sometimes influenced their choice of criteria in relation to self-interest (e.g. land-use rights).  
753 Participants modified their perception of justice not only according to the costs and benefits to  
754 be distributed and to whom, but also according to who is in charge of the distribution and how  
755 others act regarding jaguar management. Both self-interest and group identity are thus  
756 important assumptions to take into consideration for carnivore conservation. In effect, past

757 actions emphasized technical measures to reduce losses caused by depredation, assuming  
758 concern for self-protection was driving the surrounding conflict (Treves and Karanth, 2003).  
759 However, more recently researchers proposed that relational aspects are among the principal  
760 drivers of biodiversity conflicts (Redpath et al., 2013). Looking at the influence of external  
761 factors on criteria that Calakmul ranchers and farmers used to build their feeling of justice  
762 supported others' findings that people can care for both self-interest and group identity  
763 (Clayton and Opatow, 2003; Lind and Tyler, 1988).

764

#### 765 4.2. Recommendations for jaguar conservation

766 We believe acknowledging and exploring the variability in the criteria used by people to  
767 assess fairness in jaguar management can provide guidance for the implementation of  
768 management plans that encompass various perceptions of justice. One of our main findings  
769 was that the vast majority of local actors, ranchers included, recognized the intrinsic right of  
770 the jaguar to live and the importance of its survival for future generations. Even more  
771 importantly, we uncovered alternative narratives to those currently circulated by  
772 conservationists in Calakmul. For instance, even ranchers who had suffered attacks and  
773 subsequent losses reaffirmed the jaguar's right to live. Furthermore, people shared the same  
774 perception of procedural justice and perceived a clear distinction between the criteria of  
775 distributive justice, i.e. need and merit. Additionally, some of the criteria that were marginally  
776 important, such as individual responsibility for jaguar survival and land-use rights, should not  
777 be ignored as they might play an important role in people's frustration and in explaining  
778 potential retaliation.

779 Our results can inform practitioners of specific factors that can positively influence a  
780 change in people's perception of the criteria affecting their sense of fairness. For example,  
781 both the perceptions of frequency of attacks and of control over jaguar depredation influenced



782 people's views that they should be able to act freely on their land. Current programmes to  
783 reduce livestock predation should be reinforced to discourage people to retaliate against  
784 jaguars on their land. Furthermore, cooperation with ranchers might be improved by acting on  
785 those factors that influence the perception of individual responsibility toward jaguar  
786 management. Programs that allow the development of a shared sense of responsibility toward  
787 the jaguar would increase people's individual sense of responsibility. Furthermore, in  
788 Calakmul, considering the Reserve's actions to be adequate was related with an increased  
789 sense of personal responsibility toward jaguar management. However, this was not the case if  
790 it was considered that the NGO or the government acted adequately; rather, this led to the  
791 unwanted result that people reduced their own sense of responsibility (see appendix 2). We  
792 believe this result shows the relevance of programs that directly involve communities, such as  
793 the temporary employment program of the Reserve, where a contract between the Reserve  
794 and local actors is established, leading local actors to feel responsible for their actions.

795         Organizations and institutions should better understand how local people perceive  
796 their actions to adopt management practices that support positive feelings of fairness. For  
797 example, consideration of local knowledge seemed more important if people perceived NGOs  
798 were responsible for jaguar management (it was far less important if they perceived that *ejido*  
799 authorities or individuals were responsible) (see appendix 2). This demonstrated that people  
800 felt their knowledge had been ignored in previous NGO interventions. Imposition of dominant  
801 conceptions of knowledge can increase people's feelings of injustice and decrease support for  
802 a particular organization (Coolsaet, 2016). On the other hand, people stressed that the Reserve  
803 should adopt a neutral approach. This might reflect concerns that managers do not listen to  
804 local actors, even when consulting them, because their minds are made up in advance and  
805 they only support a conservation agenda (Lauer et al., 2017; Smith and McDonough, 2001). It

806 is important to consider those feelings of justice, since even minority groups can be vocal and  
807 stimulate conflict around species conservation (Lute and Gore, 2014).

808

#### 809 4.3. Approaches to fairness in environmental management

810 The novel and sophisticated quantitative approach we employed allowed us to demonstrate  
811 the power of using criteria selection to achieve a nuanced understanding of how people build  
812 their perceptions of justice. Using an enhanced version of the Bradley-Terry-Luce model, we  
813 analyzed the plurality of justice perception and how it is influenced by different covariates.

814 The strength of this statistical analysis is that it can reveal complex patterns of perceptions of  
815 fairness. Rather than assessing the dominant views of justice, our approach showed the  
816 importance of the variability in people's description of fairness. In addition, it highlighted the  
817 complexity of the criteria by which people construct their perception. Such statistical analysis  
818 might not be applicable for every biodiversity conflict study, but acknowledging that this  
819 complexity exists and the importance of identity and relationships are likely to be relevant to  
820 other conflicts.

821         People have diverse views of justice and justify their positions using criteria from all  
822 dimensions of justice. Importantly, success in addressing one dimension will not reduce the  
823 potential impact of failure to comply with another dimension (Zafra-Calvo et al., 2017).

824 Moreover, results are highly context-specific, so criteria should be based on local people's  
825 construction of justice. In addition, criteria can represent various points of view (e.g.  
826 representation can be a desire to voice their concerns or a wish to participate directly through  
827 voting; Smith and McDonough, 2001). This variability can add a layer of complexity in  
828 interpreting and translating the results into action, making it necessary to accompany such an  
829 approach with qualitative research allowing a deeper understanding of the situation. Whilst  
830 results from this study offer important new insights, it is the combined knowledge from both

831 our qualitative understanding of the situation (Lecuyer et al., 2018) and the quantitative  
832 results shown here that allow us to develop specific recommendations to support conservation  
833 efforts.

834 Our recommendations might help address particular feelings of justice and play a role  
835 in conservation success. It is clear that only addressing distributive aspects of justice, using  
836 schemes such as financial compensation for livestock losses, does not fully satisfy feelings of  
837 fairness and other aspects of fairness are considered to be more important for many people in  
838 counteracting biodiversity conflicts. We also agree with researchers who claim that there will  
839 be no single solution that will address everyone's feeling of justice (Jacobsen and Linnell,  
840 2016; Martin et al., 2014; Müller, 2011). Still, the complexity of the feelings of justice should  
841 not prevent us from seeking routes toward enhancing fairness in environmental management.  
842 The importance of group relationships supports the need to develop collaborative approaches  
843 (Lauer et al., 2017; Sikor et al., 2014; Dawson et al., 2017). However, approaches that only  
844 aim to aggregate local actor preferences to legitimate specific and predetermined conservation  
845 goals will not be sufficient to acknowledge people's multiple perceptions of fairness (Durand  
846 et al., 2014). To agree on conservation practices that will appear just and fair to different  
847 actors, researchers and managers must engage in a difficult dialogue where local actors  
848 openly verbalize their notion of justice, acknowledge their differences, build mutual  
849 understanding and trust, and try to help groups of actors develop common identities (Durand  
850 et al., 2014; Müller, 2011). The value in having such diverse perceptions of justice is that it  
851 opens the door for extensive debate and collective reflection, thus developing relationships  
852 among actors, which we believe is itself a step toward more sustainable solutions for jaguar  
853 conservation, and indeed conservation more widely.

854

855

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866

867 References:

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