Predicting intervention priorities for wildlife conflicts

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Abstract: There is growing interest in developing effective interventions to manage socially and environmentally damaging conservation conflicts. There are a variety of intervention strategies that can be applied in various contexts, but the reasons one type of intervention is chosen over another remain underexplored. We surveyed conservation researchers and practitioners (n = 427) to explore how characteristics of conflicts and characteristics of decision makers influence recommendations to alleviate conservation conflict. Using a full-factorial design, we experimentally manipulated 3 aspects of the descriptions of 8 different wildlife-conflict scenarios (development status of the conflict country, conflict framing, and legality of killing wild animals) and recorded which of 5 intervention types (wildlife impact reduction, awareness, enforcement, economic incentives, or stakeholder engagement) respondents prioritized. We also recorded information on respondents’ demographic and disciplinary backgrounds. Stakeholder-based interventions were recommended most often in the survey and in written feedback. However, when we fitted multinomial mixed logit models with fully completed scenario responses (n = 411), recommendations were influenced by small changes in the details of conflict and differed according to respondent characteristics. Enforcement and awareness interventions were prioritized relatively more for conflicts in more highly developed nations and by respondents with more natural science backgrounds and relatively less experience with conflict. Contrastingly, economic interventions were prioritized more when wildlife killing was described as illegal. Age, gender, and development status of the respondent’s home country also predicted some intervention decisions. Further, interrogating the influences shaping conservation decision making will further help in the development of evidence-informed interventions.

Keywords: behavior, coexistence, conservation, decision making, human-wildlife conflict, management, psychology

Predicción de Prioridades de Intervención para Conflictos de Vida Silvestre

Resumen: Existe un creciente interés en desarrollar intervenciones efectivas para gestionar conflictos de conservación social y ambientalmente dañinos. Hay una variedad de estrategias de intervención que pueden ser aplicadas en diversos contextos, pero las razones por las que se selecciona un tipo de estrategia han sido poco exploradas. Encuestamos a investigadores y a profesionales de la conservación (n = 427) para explorar cómo influyen las características tanto de los conflictos como de los tomadores de decisiones en las recomendaciones para mitigar conflictos de conservación. Mediante un diseño factorial completo, manipulamos experimentalmente 3 aspectos de las descripciones de 8 escenarios de conflictos de vida silvestre diferentes (nivel de desarrollo del país en conflicto, encaja del conflicto y legalidad de la matanza de animales silvestres) y registramos la priorización de 5 tipos de intervención (disminución del impacto de la vida silvestre, sensibilización, cumplimiento, incentivos económicos o participación de las partes interesadas) por los encuestados. También registramos información sobre los antecedentes demográficos y disciplinares de los encuestados. Las intervenciones basadas en las partes interesadas fueron recomendadas con mayor frecuencia en las encuestas y en la retroalimentación escrita. Sin embargo, cuando ajustamos los modelos logit mixtos multinomiales con respuestas de escenarios completos (n = 411), las recomendaciones se vieron influenciadas por pequeños cambios en los detalles del conflicto y diferían según las características de los encuestados. Las intervenciones de cumplimiento y sensibilización...
Introduction

Conservation conflicts are damaging for both people and wildlife and as such there is much interest in designing and implementing interventions to resolve or mitigate them (Redpath et al. 2013). Although conservation conflicts can involve clashes over any conservation objective (Redpath et al. 2015), conflicts centering on the impacts of wildlife on livelihoods are particularly widespread (Pooley et al. 2016). In these situations, which are often framed as human-wildlife conflict or coexistence problems, interventions commonly aim to mitigate the negative impacts of wildlife, reduce wildlife killings, or improve the relationships among stakeholders (Baynham-Herd et al. 2018).

The geographical distribution of interventions (Ravenelle & Nyhus 2017) and their effectiveness (Eklund et al. 2017; van Eeden et al. 2018) have been explored and variation in how practitioners and researchers prioritise interventions (Rastogi et al. 2013; Shiffman & Hammer-schlag 2016) was identified. For instance, how conflicts are framed by authors, whether they involve illegal behaviours and the development status of the countries in which they are located, has been hypothesized to influence intervention decisions (Baynham-Herd et al. 2018; Soliku & Schraml 2018). Moreover, it appears researchers and practitioners from different disciplinary backgrounds and regions tend to recommend different solutions (Lute et al. 2018). However, the underlying reasons accounting for this variation in intervention priorities has been less explored, in part, because much previous work in this area has been observational, making it harder to unpick potential relationships. Moreover, as intervention strategies used in conflicts can often be contested or controversial (López-Bao et al. 2017; Duffy et al. 2019), it is important to understand the factors driving support for such different approaches.

One pathway to better understand how decisions are made in conflicts is through exploring the social and psychological mechanisms underpinning conservation decision making (Papworth 2017). For instance, subtle changes in the way problems are framed often change how people suggest solving them (Sapiens et al. 2016). Such subtleties may be particularly important when people are making quick decisions with limited information. This is because under such circumstances people are thought to rely more on intuition and pattern matching compared with when they are making slower, more analytical decisions, based on multiple sources of information (Evans et al. 2008; Kahneman 2011). Furthermore, like all people (Schultz 2011), the priorities of conservation professionals differ (Sandbrook et al. 2019) and are likely shaped by predispositions, cognitive biases, and values (Sheil & Meijaard 2010; Kiik 2018). However, how such factors may influence conflict-intervention decision making remains underexplored.

We sought to test how particular characteristics of conflicts and of decision makers influence conflict-intervention priorities. To do this, we conducted an experimental survey of international conservation researchers and practitioners (n = 427), in which we presented participants with 8 different conflict scenarios and...
asked them to prioritize 1 (out of 5) intervention types to manage the conflict in each scenario. Drawing on similar strategies used in choice (Keane et al. 2016) and framing experiments (Sapiains et al. 2016), by offering limited information per scenario, we aimed to identify possible predispositions and tacit influences on decisions. Using a full-factorial design, we experimentally manipulated 3 factors hypothesized to influence conflict decisions: the framing of the conflict as being between people and wildlife or between groups of people, whether behaviours were reported as illegal, and the development status of the country where the conflict occurs. We experimentally manipulated these 3 factors—rather than other relevant factors, such as taxa or types of impacts—because their potential influence has been highlighted in a previous review (Baynham-Herd et al. 2018) but not yet tested.

We then used multinomial mixed logit regressions to test whether these manipulations and the characteristics of participants predicted intervention recommendations. These related to respondents’ disciplinary and demographic background and experience with conflicts on the ground and in the literature, which we hypothesized influence how respondents conceptualize conflicts and subsequently the extent to which stakeholder interventions are prioritized.

Methods

Survey Design

We designed and carried out a short (5–10 min) online survey with the Qualtrics (.qualtrics.com) platform. We used an online survey, rather than a written survey, to allow for greater flexibility over survey design (including randomization of the specific subset of scenarios presented to participants), to reduce the risk of biased responding (of socially undesirable answers) (Gnambs & Kaspar 2014), and to enable the survey to be disseminated internationally. The survey included an information sheet, a series of demographic questions, and then it presented participants with 8 different conflict scenarios in turn. Each scenario related to a real-world conflict described in the literature and involved a particular species of conservation concern and some kind of human activity that was threatening the species. The number of scenarios was constrained by survey length, and the cases selected had to appear in the conflict literature, have species’ ranges that encompassed at least one very highly developed country and one less highly developed country, and reflect a mix of herbivorous and carnivorous, marine and terrestrial mammals, and nonmammals (Table 1).

For each scenario, participants were asked to select 1 of 5 different intervention types, which they deemed of highest priority in that scenario. Following Baynham-Herd et al. (2018), we included 5 different conflict interventions types: wildlife impact reduction, awareness or training programs, enforcement, economic incentives or compensation, and stakeholder engagement. Scenarios (<100 words) and intervention options (<15 words) were described in brief and consistent manner and appeared in the same order for each participant (Supporting Information).

Between participants, a full-factorial design was used to systematically vary 3 aspects of scenario descriptions: whether they were framed as human–human or human–wildlife conflict, whether wildlife killing was described as illegal, and the country the conflict was located in (Supporting Information). Each scenario was adapted from existing literature and different pairs of countries were chosen on the basis of maximizing the variation in development status (as determined by the human development index [HDI] [UNDP 2016]) while keeping within a given species’ range (IUCN 2017). The final combination of scenarios was chosen to ensure a geographical spread across world regions (Table 1). For the geese and vulture scenarios, the precise species was not named because the conflicts related to different, but functionally similar species.

In each survey, we randomly varied the set of questions (A–H) seen by each participant with the question block randomization feature on Qualtrics. We also included questions on characteristics of the participants, including their disciplinary background, career role and position, nationality, gender, age, and familiarity with conflicts in the literature and on the ground. Last, we included a section for participants to give open-ended written feedback on both the survey design (e.g., intervention options) and the factors influencing their decisions.

Participant Recruitment

We first conducted a pilot study at the Scottish Conservation Conflict Research Group (https://www.conservationconflicts.info/) meeting in June 2018. After adapting the survey design, we recruited research participants at the 2018 European Congress for Conservation Biology in Finland—which was attended by international delegates with varying experience in conflicts and backgrounds. To include a wider range of responses, we conducted a literature search in ISI Web of Knowledge to identify authors who had recently published studies related to conflicts and emailed each corresponding author (n = 335) asking this person to complete the survey and invited people to share the survey on Twitter and via relevant mailing lists. Participants were invited to share their email address (to receive results), but participant anonymity was preserved. This study received ethical approval from the University of Edinburgh School of Geosciences Ethics panel.
Table 1. Description of the 8 wildlife-conflict scenarios presented in surveys to conservation professionals, and each of the 2 possible countries that each scenario was described as being located in.

| Conflict scenario                                      | Country          | Reference                                                                 |
|--------------------------------------------------------|------------------|---------------------------------------------------------------------------|
| American manatee (*Trichechus manatus*) Conflict between commercial fishing interests and manatee conservation; manatees drowning in fishing nets and being injured by boats in certain areas with speed restrictions | USA; Guyana      | Solomon et al. 2004; Castelblanco-Martinez et al. 2012; Mason et al. 2018 |
| Gray wolf (*Canis lupus*) Conflict between rural livestock herding and conservation interests; wolves preying on livestock and being killed in retaliation | Portugal; Nepal  | Fernández-Gil et al. 2016; Pimenta et al. 2017; Werhahn et al. 2017      |
| Saltwater crocodile (*Crocodylus porosus*) Conflict between human safety and conservation interests; crocodile-related injury and retaliatory killing | Australia; Papua | Fukuda et al. 2015                                                        |
| Goose (e.g., *Anser anser*, *Alopochen aegyptiaca*) Conflict between agriculture and conservation interests; crop raiding and retaliatory scaring or killing | Sweden; Ethiopia  | Tombre et al. 2013                                                        |
| Sea Eagle (*Haliaeetus albicilla*) Conflict between rural livestock farming and conservation interests; livestock depredation and retaliatory killing | Scotland; Pakistan | Marquiss et al. 2004                                                      |
| Vulture (e.g., *Gyps fulvus*, *Gypus africanaus*) Conflict between rural livelihoods and conservation interests; livestock depredation, perceived spread of disease and retaliatory killing | France; Zimbabwe | Margalida et al. 2014; Ogada et al. 2016                                  |
| Sea otter (*Enhydra lutris*) Conflict between fishing and conservation interests with competition for catch and associated killing | Canada; Mexico   | Carswell et al. 2015; Echeverri et al. 2017                               |
| Asiatic black bear (*Ursus thibetanus*) Conflict between agriculture and human safety and conservation interests with crop raiding, attacks, and retaliatory killing | Japan; Vietnam   | Takahata et al. 2013; Can et al. 2014                                    |

Analyses

We carried out statistical analyses with the statistical programming software R (R Development Core Team 2016) and the package mlogit. To analyze how different predictors influenced the choices between the 5 intervention categories, we used multinomial logit linear regressions, with random parameters to model the correlation between multiple responses (n = 8) from each individual. We used the stakeholder intervention type as the reference intervention in reported models (Supporting Information), but each other intervention type was used as a reference level in other models for comparison (Table 2).

Due to some missing responses, models with more variables had slightly reduced sample sizes. Explanatory-variable collinearity was checked using Spearman’s rho for numerical variables and 1-way analysis of variance for categorical variables. Because age was associated with both position (F<sub>2,400</sub> = 183.90, p < 0.01) and gender (F<sub>1,407</sub> = 35.42, p < 0.01), only the numerical variable age was included in models. Because role was associated with ground experience (F<sub>1,356</sub> = 7.081, p < 0.01), only the numerical variable ground experience was included in the models. Gender was analysed separately in models (model set 3) without age.

We analyzed the data collected from open-ended questions with the software package NVivo. Using a directed content analysis approach (Hsieh & Shannon 2005), we first grouped responses according to whether they addressed predetermined themes (each intervention type, development status, legality, framing, and taxa). Next, using an inductive approach, we added new themes and subthemes encompassing other commonly discussed subject areas that emerged during analysis (e.g., intervention combinations). We then calculated the frequency of respondents whose feedback was recorded in each given category and reflected on the content of the prevailing themes with regards to our survey results and interpretation.

Results

We received 634 responses. For analysis, we omitted those who identified as “not working in conservation” (n = 14) and insufficiently completed responses (<97% completed), leaving a sample of 427. For our models, we included only responses in which intervention priorities were chosen for all 8 scenarios answered (n = 411). Participants came from 52 countries (Supporting Information) and from across different career stages and ages (Table 1); 84 respondents identified as practitioners or other and 321 as researchers.

Across the analyzed sample (411 participants, 3,288 decisions), the stakeholder intervention type was the most popular but most people varied their priorities across scenarios. Stakeholder interventions were chosen 27% of the time, followed by awareness (25%), economic (20%),
Table 2. Results from multinomial logit regression models (model set 2) (see Table 3) of estimated conditional effects of different predictor variables (related to the description of conflict scenarios and respondents’ characteristics) on the likelihood of respondents prioritizing different conflict intervention types relative to other choices (stakeholder, enforcement, impacts, economic) across conflict scenarios presented in a survey of conservation professionals.

| Predictor variable | Awareness (stakeholder) | Enforcement (stakeholder) | Impacts (stakeholder) | Economic (stakeholder) | Awareness (enforcement) | Impacts (enforcement) | Economic (enforcement) | Awareness (impacts) | Economic (impacts) | Awareness (economic) |
|--------------------|-------------------------|----------------------------|-----------------------|------------------------|-------------------------|-----------------------|-----------------------|---------------------|-------------------|----------------------|
| HDI                | 1.31*                   | (1.06-1.63)                | 0.75**                | (0.60-0.93)            | 0.70**                  | (0.56-0.88)           | 1.18*                  | (1.02-1.36)         | 1.26**            | (1.07-1.47)         |
| HWC                |                         |                             |                       |                        |                         |                       |                       |                     |                   |                      |
| Illegal            | 1.45*                   | (1.05-1.99)                | 0.75**                | (0.60-0.93)            | 0.70**                  | (0.56-0.88)           | 1.18*                  | (1.02-1.36)         | 1.26**            | (1.07-1.47)         |
| Discipline         | 1.36***                 | (1.18-1.56)                | 1.47***               | (1.21-1.78)            | 1.17*                   | (1.01-1.35)           | 0.75**                 | (0.61-0.91)         | 1.21*             | (1.04-1.40)         |
| Ground             | 0.78**                  | (0.66-0.91)                | 1.47***               | (1.21-1.78)            | 1.17*                   | (1.01-1.35)           | 0.75**                 | (0.61-0.91)         | 1.21*             | (1.04-1.40)         |
| Literature         |                         |                             |                       |                        | 0.72**                  | (0.58-0.91)           |                       |                     |                   |                      |
| Age                | 0.77***                 | (0.68-0.88)                | 0.63***               | (0.52-0.76)            | 0.84*                   | (0.73-0.96)           | 1.31**                 | (1.07-1.59)         | 1.59***           | (1.30-1.95)         |
| Nation             |                         |                             |                       |                        |                         |                       |                       |                     |                   |                      |
| HDI                | 0.71***                 | (0.62-0.82)                | 0.74**                | (0.60-0.90)            | 0.85*                   | (0.73-0.99)           | 0.85*                  | (0.73-0.98)         | 0.80**            | (0.68-0.94)         |

*p < 0.05, **p < 0.01, ***p < 0.001.

Effects are presented as odds ratios (OR), showing the expected change in likelihood of choosing different interventions when each continuous variable increases by a unit of one or when each factor variable changes level from a baseline. The values in parentheses are 95% CI. The larger the OR, the greater the predicted strength of association. Only significant associations are shown. Probability

*HDI, human development index; HWC, human-wildlife conflict frame.
wildlife impact reductions (19%), and enforcement (9%). We found that 92% of participants chose at least 2 of the 5 intervention types, and 85% chose at least 3. Of those who did not deviate from 1 intervention type (n = 33), 85% chose stakeholder only, 6% enforcement only, 3% awareness, 3% wildlife impacts, and 3% economic only.

Intervention priorities varied dramatically across different conflict taxa. We found that 56% of participants recommended awareness interventions in the vulture conflict scenarios, but only 8% of participants did so for the wolf conflicts. Likewise, 49% of respondents suggested economic interventions in the wolf conflicts, compared with 1% for crocodile conflicts. Enforcement was most popular in the manatee conflicts (25%) and least in the geese conflicts (2%). Stakeholder interventions were most popular for sea otter conflicts (39%) and least for wolf conflicts (18%). Impacts-based interventions were favored most in bear conflicts (49%) and least in the vulture conflicts (4%). However, intervention decisions varied across the 2 locations in each scenario (Fig. 1).

Intervention prioritisations were predicted by the development status of the conflict location and whether illegal activity was reported, but not by the conflict framing variable (Fig. 2). These effects were consistent across multinomial mixed logit regression models, which controlled for the multiple responses per individual, respondent’s question blocks and the independent effect of each scenario (model set 1, n = 411), and those that also included the characteristic of respondents (model set 2, n = 341). Below, for each predictor variable, results are reported in order of decreasing effect size (odds ratio [OR]).

The higher the HDI of the conflict location, the more enforcement and awareness were prioritised. As HDI increased, the likelihood of choosing enforcement was greater than the likelihood of choosing economic interventions (p < 0.01, OR = 1.43, 95% CI: 1.13–1.79), impacts (p < 0.01, OR = 1.33, 95% CI: 1.08–1.67), or stakeholder interventions (p < 0.05, OR = 1.31, 0.95 CI: 1.06–1.63). Similarly, the likelihood of choosing awareness was greater than the likelihood of choosing economic interventions (p < 0.01, OR = 1.26, 0.95 CI: 1.07–1.47) or impacts (p < 0.05, OR = 1.18, 95% CI: 1.02–1.36). When wildlife killing was described as illegal, the likelihood of choosing economic interventions was greater than the likelihood of choosing awareness (p < 0.01, OR = 1.52, 95% CI: 1.12–2.08), impacts (p < 0.05, OR = 1.49, 95% CI: 1.07–2.07), or stakeholder interventions (p < 0.05, OR = 1.45, 95% CI: 1.05–1.99) (Table 3 & Fig. 3).

The characteristics of respondents also predicted intervention priorities. The more respondents’ disciplinary backgrounds were weighted toward natural science over social science, the more likely they chose enforcement and awareness. Specifically, as weighting toward natural science increased, the likelihood of choosing enforcement was greater than the likelihood of choosing stakeholder (p < 0.01, OR: 1.47, 95% CI: 1.21–1.78) or economic interventions (p < 0.01, OR: 1.33, 95% CI: 1.09–1.64), and the likelihood of choosing awareness was greater than the likelihood of choosing stakeholder (p < 0.01, OR = 1.36, 95% CI: 1.18–1.56), economic (p < 0.01, OR = 1.38, 95% CI: 1.18–1.63), or, to a lesser extent, impacts interventions (p < 0.05, OR = 1.21, 95% CI: 1.04–1.40).

As experience with conflicts on the ground increased, the likelihood of choosing awareness reduced. Specifically, as experience increased, the likelihood of choosing awareness was lower than the likelihood of choosing enforcement (p < 0.01, OR = 0.72, 95% CI: 0.58–0.91), stakeholder (p < 0.01, OR = 0.78, 95% CI: 0.66–0.91), or impacts interventions (p < 0.05, OR = 0.80, 95% CI: 0.68–0.95). As the HDI of participants’ home nation increased, the likelihood of choosing stakeholder interventions was greater than the likelihood of choosing awareness (p < 0.01, OR = 1.41, 95% CI: 1.21–1.61), enforcement (p < 0.01, OR = 1.35, 95% CI: 1.11–1.67), or, to a lesser extent, impacts interventions (p < 0.05, OR = 1.18, 95% CI: 1.01–1.37), and the likelihood of choosing economic interventions was greater than the likelihood of choosing awareness (p < 0.01, OR = 1.25, 95% CI: 1.06–1.47).

As respondent age increased, the likelihood of choosing both enforcement and awareness reduced. As age increased, the likelihood of choosing enforcement was lower than the likelihood of choosing stakeholder (p < 0.01, OR = 0.63, 95% CI: 0.52–0.76), or economic (p < 0.01, OR = 0.63, 95% CI: 0.51–0.77), or to a lesser extent, impacts interventions (p < 0.05, OR = 0.76, 95% CI: 0.63–0.93), and the likelihood of choosing awareness was lower than the likelihood of choosing economic (p < 0.01, OR = 0.75, 95% CI: 0.67–0.90) or stakeholder interventions (p < 0.01, OR = 0.77, 95% CI: 0.68–0.88). Male respondents were more likely than females to prioritize enforcement than stakeholder interventions (p < 0.01, OR = 1.42, 95% CI: 1.05–1.93), but less likely to prioritize awareness (p < 0.05, OR = 0.64, 95% CI: 0.49–0.84), or impacts (p < 0.05, OR = 0.62, 95% CI: 0.43–0.91). In most models, the variation between individual respondents was largest with regards to enforcement (Supporting Information) and generally the models explained a high proportion of the total variation (model set 2, mean R² = 0.21).

Respondents also highlighted the importance of local contextual and multifaceted interventions (often including stakeholder engagement as a starting point). Of the 166 respondents who gave written feedback, 43% described the need, or benefit, of combinations of interventions. In total 30% of respondents asked for more context or described contextual factors that would influence their decisions. However, only 7% mentioned the geographical location or development level of the conflict country, only 2% referenced the legality of behaviors,
and only 4% commented on the conflicts framing. Moreover, 7% requested information about the species (such as habitat and conservation status). Other interventions, which were suggested included hunting (2%), lethal control (2%), and other forms of nonlethal technical interventions (3%). In total, 23% of respondents outlined the need to prioritize stakeholder-based interventions first, to either increase buy-in (6%) or better understand a conflict (7%) (including drawing on community knowledge) and to help tackle the social roots at the heart of conflicts (4%). Only 4% discussed enforcement (Supporting Information).

**Discussion**

The results of the experimental survey suggest that particular characteristics of wildlife conflicts and the characteristics of decision makers influence intervention recommendations. Although it is known that people with different backgrounds and experiences favour different approaches for conservation generally (Sandbrook et al. 2019) and for conflicts specifically (Lute et al. 2018), our results shed further light on these differences and highlight the possible processes and factors influencing how conservationists make decisions.

Our results illuminate the importance of contextual cues on conservation decision making. Relatively, simple changes to the objective description of a conflict, such as the conflict location or whether a behavior is described as illegal, had large effects on intervention priorities. Likewise, contexts that appear comparable in terms of the general problem—wildlife impacts and retaliatory killing—and which differed only in terms of taxa, types of competing human interests and types of wildlife impacts, promoted different solutions. Impact-reduction efforts for instance are widely prioritized for crop-raiding bears, but are largely overlooked for fish-eating otters or lamb-raiding eagles. Such contextual effects could be generated by numerous mechanisms. For instance, they may represent a form of cognitive bias, reflecting fast, intuitive thinking (Papworth 2017), and the priming effects of specific words (Bargh 2006). Alternatively, they may reflect respondents’ values, assumptions and conceptualisations related to their understanding of specific species, countries, or conflict contexts (Game et al. 2013). For some respondents, their knowledge and experience (both on the ground and through literature) base may inform more deliberative, reflective decisions (Papworth 2017). Although our study does not illuminate which processes are dominant here,
managers generally rely more heavily on experience and intuition than on published scientific evidence (Walsh et al. 2015).

Beyond highlighting the general importance of context, we also identify specific associations between conflict characteristics and intervention decisions. Our finding that enforcement and awareness were favored more for scenarios situated in more highly developed countries, and by respondents from less highly developed countries was unexpected. In a previous review, enforcement appeared to be more commonly recommended by authors for conflicts in less highly developed nations, and awareness showed no associations (Baynham-Herd et al. 2018). However, that study was observational and, therefore, could not account for the additional variation between conflict situations as we did here. Instead, we propose 3 reasons to account for why enforcement (though generally prioritized the least) was favored in more developed countries: the possible widespread appreciation of the critiques of militarized and enforcement-based conservation in the Global South (Mabele 2017; Duffy et al. 2019), perceptions that wildlife-related killings are less legitimate in more highly developed countries (Dickman et al. 2015; Sheil et al. 2016), or the understanding that successful enforcement is contingent on effective governance (Sundström 2015). However, enforcement was infrequently discussed in the written feedback. Hence, further investigations would be needed to ascertain to what extent different practical and ethical reasons—such as cultural relativism (Dickman et al. 2015)—may account for this effect.

That economic interventions appeared to be more commonly suggested in less highly developed countries stands in contrast with the finding that conflict-related compensation is more common in highly developed countries (Ravenelle & Nyhus 2017). However, it is possible that the lack of incentives and compensation schemes in less highly developed nations may be a result of the greater structural challenges in providing them rather than varying priorities (DeMotts & Hoon 2012), despite the apparently healthy appetite for them among researchers and practitioners identified here. Survey feedback also hinted at the idea, common in the conservation literature (Salerno et al. 2016), that the material costs of conflicts may be relatively greater in less highly developed nations—such as where food insecurity or dependence on forest resources is high. However, the nonmaterial impacts of conflicts are also clearly significant in the Global South (Barua et al. 2013) and the social roots of conservation conflicts are likely to be just as strong between less and highly developed countries (Young et al. 2013). Moreover, given that conservation rule breaking everywhere is frequently associated with acts of resistance and not just material incentives (Holmes 2007), we also suggest a need for further investigation into the reasons why economic interventions were prioritized more when wildlife killing was described as illegal. This is particularly important given that conservation payments

Figure 2. Results from a multinomial mixed logit regression model (model set 1, reference level stakeholder) showing the predicted probability of choosing each intervention type: (a) increase awareness, (b) enforce laws, (c) provide economic incentive, (d) engage stakeholders, and (e) reduce impacts across the different combinations of the experimentally manipulated scenarios presented to survey respondents (see Table 3) (whiskers, 95% CI; HWC, human-wildlife conflict; HHC, human-human conflict; high, very highly developed nation; less, high, medium, or less highly developed nation; illegal, behavior described as illegal).
Table 3. Variables used in multinomial mixed logit models of the likelihood of different intervention types being prioritized across a series of conflict scenarios presented to 411 conservation professionals in a survey, including variables related to experimental manipulations in conflict-scenario descriptions and the personal characteristics of respondents.

| Predictor variable | Factor levels | Source | Descriptive summary (n) | Model set |
|--------------------|---------------|--------|-------------------------|-----------|
| Frame              | human-human conflict (HHC); human–wildlife conflict (HWC) | experimental manipulation | scenarios = HHC (1644), HWC (1644) | 1,2 |
| Illegal behavior   | illegal; legal | experimental manipulation | scenarios: illegal (1644), legal (1644) | 1,2 |
| Conflict HDI       |               | experimental manipulation (from UNDP*), mean = 0.75 (SD: 0.17), range = 0.45–0.94 | 1,2 |
| Question block     | A–H           | survey | scenarios: A (360), B (520), C (568), D (336), E, (368), F (320), G (408), H (408) | 1,2 |
| Scenario           | 1–8           | survey | scenarios: 411 each | 1,2 |
| Disciplinary background |               | survey (subjective scale) | mean = 75.9 (SD: 23.64), range = 0 (social sciences/humanities only)–100 (natural sciences/ecology only) | 2 |
| Ground experience  |               | survey (subjective scale) | mean = 62.16 (SD: 26.84), range = 0 (no experience)–100 (main specialization) | 2 |
| Literature knowledge |               | survey (subjective scale) | mean = 66.07 (SD: 22.73), range = 0 (no knowledge)–100 (main specialization) | 2 |
| Age                |               | survey | mean = 37.92 (SD: 10.99), range = 20–80 | 2 |
| Participant HDI    |               | survey | mean = 0.84 (SD 0.12), range = 0.42–0.95 | 2 |
| Gender             | early, mid, senior | survey | 207 females, 197 males | 3 |
| Career position    |               | survey | early (180), mid (112), senior (109) | - |
| Role               | researcher, practitioner, or other | survey | researcher (321), practitioner or other (84) | - |

*United Nations Development Program.

can also lead to reductions in previously unrewarded positive conservation behaviours (Fisher 2012). The lack of the importance of the conflict-framing variable was unexpected, suggesting either different conflict frames are less important than predicted (Baynham-Herd et al. 2018), or at least less salient than the other factors tested. Further work should explore the extent to which conservation researchers and practitioners may be influenced by perceptions and assumptions made about countries in different stages of development, which are often out-of-date or inaccurate (Rosling & Zhang 2011).

Our finding that respondent characteristics—such as disciplinary background, age, and conflict experience—predict their intervention decisions highlights the importance of sociodemographic influences on conservation decision making (Papworth 2017). This supports previous findings that conflict management priorities differ across regions and respondents’ backgrounds (Lute et al. 2018). We suggest further work explore whether disciplinary backgrounds and experience of conflicts on the ground shape the way decision makers conceptualize conflicts—such as the emphasis placed on social relations (Sandbrook et al. 2013).

Although we cannot provide as clear explanations to account for the apparent effects of age, gender, and development status of respondents’ home nation, these factors have also been shown to predict conservation priorities more generally. For instance age, gender, and regional origin all predict respondent general conservation rationale and support for market-based conservation (Sandbrook et al. 2019), and gender can predict local management preferences (Keane et al. 2016) and attitudes to particular taxa (Suryawanshi et al. 2014).

We cannot say from our data whether prioritisations were also influenced by the factors not experimentally manipulated such as taxa, previous knowledge, actual prevalence, likelihood of each described conflict, impact severity, or conservation status. Likewise, although we instructed respondents to ignore the issue of resources, it is possible that perceived differences in management
Figure 3. Results from a multinomial mixed logit regression model (model 2) (see Table 3), showing estimated conditional effects of each predictor variable on the likelihood of a respondent choosing each of the 4 other intervention types compared with the likelihood of them choosing stakeholder-based interventions (HDI, human development index; HWC, human-wildlife conflict frame; HHC, human-human conflict frame; discipline, disciplinary background; literature, knowledge of the literature). Odds ratios (solid circles) (converted model coefficient estimates) show the expected change in likelihood of a choice when each continuous variable increases by a unit of one or when each factor variable changes level from a baseline (open circles). Whiskers represent 95% CI. Variables with whiskers that do not cross zero are those predicted by the model to associate with intervention decisions (effect size is distinguishable from zero). The larger the odds ratios, the greater the predicted strength of association.

Costs (Iacona et al. 2018) may have tacitly influenced decisions. Similarly, although our sample size is appropriate, our conclusions are limited to generalizations about largely Anglo–European sample, which reflects the Anglo–European bias in conservation-conflict research (Baynham-Herd et al. 2018; van Eeden et al. 2018), but does not represent other voices in conservation decision making (Sandbrook et al. 2019).

These results have important implications for wildlife conflict management. First, if context-contingent intervention priorities, such as those identified here, are informed by reasoned thinking and evidence, they may produce effective outcomes (Sutherland & Wordley 2017). If, however, such decisions are more shaped by unknown biases and predispositions, they may not (Papworth 2017). Hence, decision makers could benefit both from further personal retrospection (identifying their own biases and assumptions) and from further studies which test prevailing assumptions in conflict management (van Eeden et al. 2018). Second, given that the characteristics of decision makers also shape intervention priorities, increasing the diversity of those involved in conflict decision making would not only be ethical but may improve decisions (Green et al. 2015). For instance, increased female (Leisher et al. 2016), community (Mishra et al. 2017), and interdisciplinary (Bennett et al. 2017) participation in decision making improves a range of conservation outcomes. Furthermore, although different conservation managers and stakeholders are unlikely to always agree—for both practical and value-based reasons (Rust 2017; St John et al. 2018)—better understanding others’ positions and increasing dialogue
helps foster more effective collaboration (Game et al. 2013; Lute et al. 2018). Third, both the survey results and feedback were consistent with recent scholarship (Redpath et al. 2017) that highlights participatory and stakeholder-first conflict interventions as best practice and advocates multipronged (Hazzah et al. 2014) and adaptive management strategies (Bunnefeld et al. 2017). Education and awareness programs were often cited in feedback as being necessary additions to any interventions. However, given the failures of many awareness-based conservation programs (Schultz 2011), a further exploration into why and where conservation decision makers deem them most appropriate is important. Approaches that are specifically aimed at a particular audience, such as social marketing (Salazar et al. 2018), may be more effective than simple information provision or—often-problematic—enforcement (Duffy et al. 2019). However, how different interventions compliment, or negate, each other is an area in need of greater exploration (van Eeden et al. 2018).

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Supporting Information

Further information on the scenario presentation (Appendix S1), sample (Appendix S2), additional results (Appendix S3), and the full survey (Appendix S4) are available online. The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

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