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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. Recent studies have identified a wide variety of different intervention strategies in various contexts but the reasons why one type of intervention is chosen over another remain underexplored. In this international study we surveyed conservation researchers and practitioners (N=427) to explore how the characteristics of conflicts and characteristics of decision-makers influence conflict recommendations. Using a fully-factorial design, we experimentally manipulated three aspects of eight different conflict scenarios – the development status of the country, the conflict framing, and whether wildlife killing was illegal – and recorded whether respondents prioritised one of five intervention types: wildlife impact reduction, awareness, enforcement, economic incentives or stakeholder engagement. 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, fitting multinomial mixed logit models with no missing scenarios (N=411), we find that recommendations are influenced by small changes in the details of conflict, and differ according to respondent characteristics. Enforcement and awareness interventions are prioritised more in conflicts in more highly developed nations and by respondents with more natural-science backgrounds and less experience of conflicts. Contrastingly, economic interventions are prioritised more when wildlife killing is described as illegal. Respondent age, gender and the development status of their home country also predicted some intervention decisions. Further interrogating the influences shaping conservation decision-making will help towards developing evidence-informed interventions.

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There is growing interest in developing effective interventions to manage socially- and environmentally-damaging conservation conflicts. Recent studies have identified a wide variety of different intervention strategies in various contexts but the reasons why one type of intervention is chosen over another remain underexplored. In this international study we surveyed conservation researchers and practitioners (N=427) to explore how the characteristics of conflicts and characteristics of decision-makers influence conflict recommendations. Using a fully-factorial design, we experimentally manipulated three aspects of eight different conflict scenarios – the development status of the country, the conflict framing, and whether wildlife killing was illegal – and recorded whether respondents prioritised one of five intervention types: wildlife impact reduction, awareness, enforcement, economic incentives or stakeholder engagement. 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, fitting multinomial mixed logit models with no missing scenarios (N=411), we find that recommendations are influenced by small changes in the details of conflict, and differ according to respondent characteristics. Enforcement and awareness interventions are prioritised more in conflicts in more highly developed nations and by respondents with more natural-science backgrounds and less experience of conflicts. Contrastingly, economic interventions are prioritised more when wildlife killing is described as illegal. Respondent age, gender and the development status of their home country also predicted some intervention decisions. Further interrogating the influences shaping conservation decision-making will help towards developing evidence-informed interventions.

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 centring 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 between stakeholders (Baynham-Herd, et al. 2018).

Recent research has explored the geographical distribution of interventions (Ravenelle & Nyhus 2017) and assessed their effectiveness (van Eeden et al. 2018; Eklund et al. 2017). Other studies have identified variation in how practitioners and researchers prioritise different interventions (Rastogi et al. 2013; Shiffman & Hammerschlag 2016). 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 have been hypothesized as to influence intervention decisions (Baynham-Herd, et al. 2018; Soliku & Schraml 2018). Moreover, it appears that 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 understanding 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 (Sapiains 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 to when making slower, more analytical decisions, using multiple sources of information (Evans 2008; Kahneman 2011). Furthermore, it is known, that like all people (Schultz 2011), the priorities of conservation professionals differ (Sandbrook et al. 2019) and these are likely shaped by predispositions, cognitive biases and values (Sheil & Meijaard 2010; Kiik 2018). However, how such factors might influence conflict intervention decision-making remains underexplored.

The purpose of this study is to test how particular characteristics of conflicts and of decision-makers influence conflict intervention priorities. To do this we conducted an experimental survey with conservation researchers and practitioners internationally (N=427), in which we presented participants with eight different conflict scenarios, and asked them to prioritise one (out of five) intervention types to manage the conflict in each scenario. Drawing upon 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 fully-factorial design, we experimentally manipulated three 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 three factors – rather than other relevant factors such as taxa or types of impacts – because their potential

influence had been highlighted in a previous review (Baynham-Herd, et al. 2018) but had not yet been 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 professional background, and experience with conflicts on the ground and in the literature – which we hypothesised might influence how respondent's conceptualised conflicts, and subsequently the extent to which stakeholder-interventions were prioritised in particular. We also recorded respondents' nationality, gender and age to determine the demographic of the sample given that personal characteristics of decision-makers has been found to shape conservation priorities, preferences and outcomes (Keane et al. 2016; Sandbrook et al. 2019). We then interpreted these results in light of qualitative insights derived from respondents' written feedback.

Methods

Survey design

We designed and carried out a short (5-10 minute) online survey using the platform 'Qualtrics' (qualtrics.com). We used an online survey, rather than a written survey to allow for greater flexibility over survey design (including randomization of the specific sub-set 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 eight different conflict scenarios in turn (Supporting Information, Appendix 3). Each scenario related to a

real-world conflict described in the literature, involved one 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 involved were selected on the basis of: a) appearing in the conflict literature, b) having species ranges that encompassed at least one very highly developed country and one less highly developed country, and c) reflecting a mix of herbivorous and carnivorous, marine and terrestrial mammals and non-mammals (Table 1).

For each scenario, participants were asked to select one of five different intervention types, which they deemed of highest priority in that scenario. Following Baynham-Herd et al., (2018) we included five 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 (Figure 1).

Between participants, a full-factorial design was used to systematically vary three aspects of scenario descriptions including: 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 (Figure 1). 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)), whilst 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 two scenarios – 'geese' and 'vulture' – the precise species was not named as the conflicts in question related to different, but functionally similar species.

In each survey, we randomly varied the set of questions (A to H) seen by each participant using 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. Lastly, 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 then recruited research participants at the European Congress for Conservation Biology in Finland, June 2018 – which was attended by international delegates with varying experience in conflicts and backgrounds. To include a wider range of responses, we also 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 them 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. In total we received 634 responses. For analysis, we omitted those who identified as 'not working in conservation' (N=14) and insufficiently competed responses (<97% completed) leaving a sample of 427. For our models, we only including responses with all scenarios eight answered (N=411). Participants came from 52 countries (Supporting Information Appendix 1) and from across different career stages and ages (Table 1), with 84 respondents identifying as 'practitioners' or 'other' and 321 as 'researchers'. This study received ethical approval from the University of Edinburgh School of Geosciences Ethics panel.

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147 **Analysis**

148 We carried out statistical analysis using the statistical programming software 'R' (R Development
149 Core Team 2016) and the package 'mlogit'. To analyse how different predictors influenced the
150 choices between the five intervention categories, we used multinomial logit linear regressions, with
151 random-parameters to model the correlation between multiple responses (N=8) from each
152 individual. We used the stakeholder intervention type as the reference intervention in reported
153 models (Figure 1), but each other intervention type was used as a reference level in other models for
154 comparison (Table 3).

155

156 Due to some missing responses, models with more variables had slightly reduced sample sizes.
157 Explanatory variable collinearity was checked using Spearman's rho for numerical variables and one-
158 way ANOVA's for categorical variables. As 'Age' was associated with both 'Position' ($F_{2,400}$ = 183.90, P
159 < 0.01) and 'Gender' ($F_{1,407}$ = 35.42, P < 0.01) only the numerical variable 'Age' was included in
160 models. As 'Role' was associated with 'Ground Experience' ($F_{1,356}$ = 7.081, P < 0.01), only the
161 numerical variable 'Ground Experience' was included in the models. 'Gender' was analysed
162 separately in models (Model set 3) without 'Age'.

163

164 We analysed the data collected from open-ended questions using the software package 'NVivo'.
165 Using a directed content analysis approach (Hsieh & Shannon 2005), we first grouped responses
166 according to whether they addressed pre-determined themes (each intervention type, development
167 status, legality, framing and taxa). Next, using an inductive approach, we added new themes and
168 sub-themes encompassing other commonly discussed subject areas which emerged during analysis

(e.g., intervention combinations). We then calculated the frequency of respondents whose feedback was recorded in each given category and reflected upon the content of the prevailing themes with regards to our survey results and interpretation.

Results

Across the analysed 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%), wildlife impact reductions (19%) and enforcement (9%). We found that 92% of participants chose at least two of the five intervention type and, 85% chose at least three. Of those who did not deviate from one 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 to 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 favoured most in bear conflicts (49%) and least in the vulture conflicts (4%) However, intervention decisions varied across the two locations in each scenario (Figure 2).

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 (Figure 3). These effects were consisted 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).

The higher the HDI of the conflict location the more enforcement and awareness were prioritised. With increasing HDI, the likelihood of choosing enforcement increased compared to economic interventions ($p < 0.01$, Odds Ratio 1.43, 0.95 CI: 1.13-1.79), or impacts ($p < 0.01$, Odds Ratio 1.33, 0.95 CI: 1.08-1.67), or stakeholder interventions ($p < 0.05$, Odds Ratio 1.31, 0.95 CI: 1.06-1.63). Similarly, the likelihood of choosing awareness increased compared to economic interventions ($p < 0.01$, Odds Ratio 1.26, 0.95 CI: 1.07-1.47), or impacts ($p < 0.05$, Odds Ratio 1.18, 0.95 CI: 1.02-1.36). When wildlife killing was described as illegal, the likelihood of choosing economic interventions increased compared to awareness ($p < 0.01$, Odds Ratio 1.52, 0.95 CI: 1.12-2.08), or impacts ($p < 0.05$, Odds Ratio 1.49, 0.95 CI: 1.07-2.07), or stakeholder ($p <0.05$, Odds Ratio 1.45, 0.95 CI: 1.05-1.99) (Table 2, Figure 4).

The characteristics of respondents also predicted intervention priorities. The more respondents' disciplinary backgrounds were weighted towards natural science over social science, the more likely they chose enforcement and awareness. Specifically, discipline most strongly predicted the likelihood of enforcement being chosen compared to stakeholder ($p < 0.01$, Odds Ratio, 1.47, 0.95 CI: 1.21-1.78), or economic interventions ($p < 0.01$ Odds Ratio, 1.33 0.95 CI: 1.09-1.64). Similarly,

discipline predicted the likelihood of awareness being chosen compared to stakeholder ($p < 0.01$, Odds Ratio, 1.36, 0.95 CI: 1.18-1.56), or economic ($p < 0.01$, Odds Ratio, 1.38, 0.95 CI: 1.18-1.63) or to a lesser extent, impacts ($p < 0.05$, Odds Ratio, 1.21, 0.95 CI: 1.04-1.40).

As experience of conflicts on the ground increased, the likelihood of choosing awareness reduced. Specifically, experience most strongly predicted the likelihood of choosing awareness compared to enforcement ($p < 0.01$, Odds Ratio, 0.72, 0.95 CI: 0.58-0.91), or stakeholder ($p < 0.01$, Odds Ratio, 0.78, 0.95 CI: 0.66-0.91), or impacts ($p < 0.05$, Odds Ratio, 0.80, 0.95 CI: 0.68-0.95). As the HDI of participants' home nation increased so did the likelihood of choosing stakeholder interventions. This effect was strongest in predicting stakeholder interventions being chosen compared to awareness ($p < 0.01$, Odds Ratio, 1.41, 0.95 CI: 1.21-1.61), or enforcement ($p < 0.01$, Odds Ratio, 1.35, 0.95 CI: 1.11-1.67), or to a lesser extent, impacts ($p < 0.05$, Odds Ratio, 1.18, 0.95 CI: 1.01-1.37). Participant HDI also predicted the likelihood of choosing economic interventions compared to awareness ($p < 0.01$, Odds Ratio, 1.25, 0.95 CI: 1.06-1.47).

As respondent age increased the likelihood of choosing both enforcement and awareness reduced. Age most strongly predicted the likelihood of choosing enforcement compared to stakeholder ($p < 0.01$, Odds Ratio, 0.63, 0.95 CI: 0.52-0.76), or economic interventions ($p < 0.01$, Odds Ratio, 0.63, 0.95 CI: 0.51-0.77), or to a lesser extent, impacts ($p < 0.01$, Odds Ratio, 0.76, 0.95 CI: 0.63-0.93). Similarly, age predicted the likelihood of choosing awareness compared to economic interventions ($p < 0.01$, Odds Ratio, 0.75, 0.95 CI: 0.67-0.90) or stakeholder interventions ($p < 0.01$, Odds Ratio, 0.77, 0.95 CI: 0.68-0.88). Male respondents were more likely than females to prioritise enforcement compared to stakeholder interventions ($p <0.01$, Odds Ratio, 1.42, 0.95 CI: 1.05, 1.93), but less likely to prioritise awareness ($p < 0.05$, Odds Ratio, 0.64, 0.95 CI: 0.49-0.84), or impacts ($p < 0.05$, Odds

241 Ratio, 0.62, 0.95 CI: 0.43-0.91). In most models, the variation between individual respondents was
242 largest with regards to enforcement (Supporting information Table S2) and generally the models
243 explained a high proportion of the total variation (Model Set 2, mean R^2 = 0.21).

244

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

258

259 **Discussion**

260 The results of the experimental survey suggest that particular characteristics of wildlife conflicts and
261 the characteristics of decision-makers influence intervention recommendations. Whilst it is known
262 that people with different backgrounds and experiences favour different approaches for
263 conservation generally (Sandbrook et al. 2019) and for conflicts specifically (Lute et al. 2018), this

study sheds further light on these differences and highlights the possible processes and factors influencing how conservationists make decisions.

This study illuminates 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 behaviour is described as illegal or not, had big effects on intervention priorities. Likewise, contexts which 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 prioritised for crop-raiding bears, but are largely overlooked for fish-eating otters or lamb-raiding sea-eagles. Such contextual effects could be generated by numerous mechanisms. For instance, they might represent a form of cognitive bias, reflecting fast, intuitive thinking (Papworth 2017) and the priming effects of specific words (Bargh 2006). Alternatively, they might reflect respondents' values, assumptions and conceptualisations related to their understanding of specific species, countries, or conflict contexts (Game et al. 2013). Indeed, for some respondents, such knowledge and experience (both first-hand and through literature) base might inform more deliberative, reflective decisions (Papworth 2017). Whilst this study doesn't illuminate which processes are dominant here, conservation managers generally more heavily upon experience and intuition than 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 favoured 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 three reasons to account for why enforcement (though generally prioritised the least) was favoured in more developed countries: the possible widespread appreciation of the critiques of militarised and enforcement-based conservation in the Global South (Duffy et al. 2019; Mabele 2017), 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 upon 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) – might 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 might 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 higher. However, the non-material 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 prioritised more when wildlife killing was described as illegal. This is particularly important given that conservation payments 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 might 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 socio-demographic 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 that further work should explore whether disciplinary backgrounds and experience of conflicts on the ground shape the way decision-makers conceptualise 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 or 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 costs (Iacona et al. 2018) may have tacitly influenced decisions. Similarly, although our sample size is appropriate, our conclusions are limited to generalisations 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 doesn't represent other voices in conservation decision-making (Sandbrook et al. 2019).

These results have important implications for wildlife conflict management. Firstly, 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). Secondly, 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 has been found to improve a range of conservation outcomes. Furthermore, whilst 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 other's positions and increasing dialogue helps fostering more effective collaboration

(Lute et al. 2018; Game et al. 2013). Thirdly, both the survey results and feedback support recent scholarship (Redpath et al. 2017) in highlighting participatory and stakeholder-first conflict interventions as best-practice and in advocating for multi-pronged (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. Indeed, more targeted approaches such as social-marketing (Salazar et al. 2018) might be more effective than simple information provision, or indeed – often-problematic – enforcement (Duffy et al. 2019). However, how different interventions compliment, or negate each other, is an area in need of greater exploration by both researchers and practitioners (van Eeden et al. 2018).

Supporting Information

Further information on the sample (Appendix S1) additional results (Appendix S2), and the full survey (Appendix S3) 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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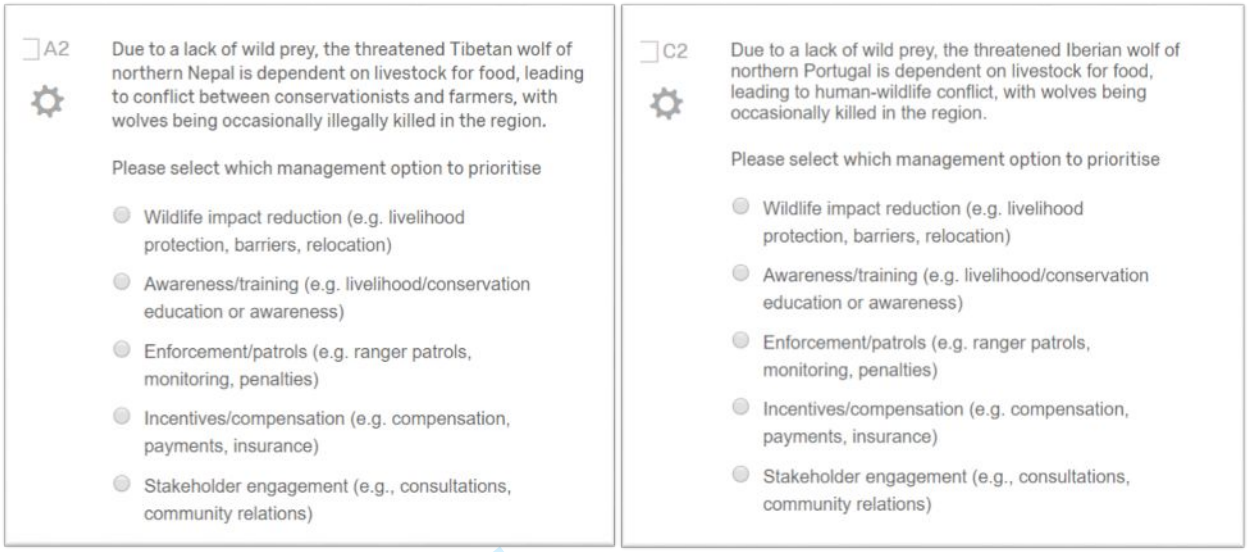
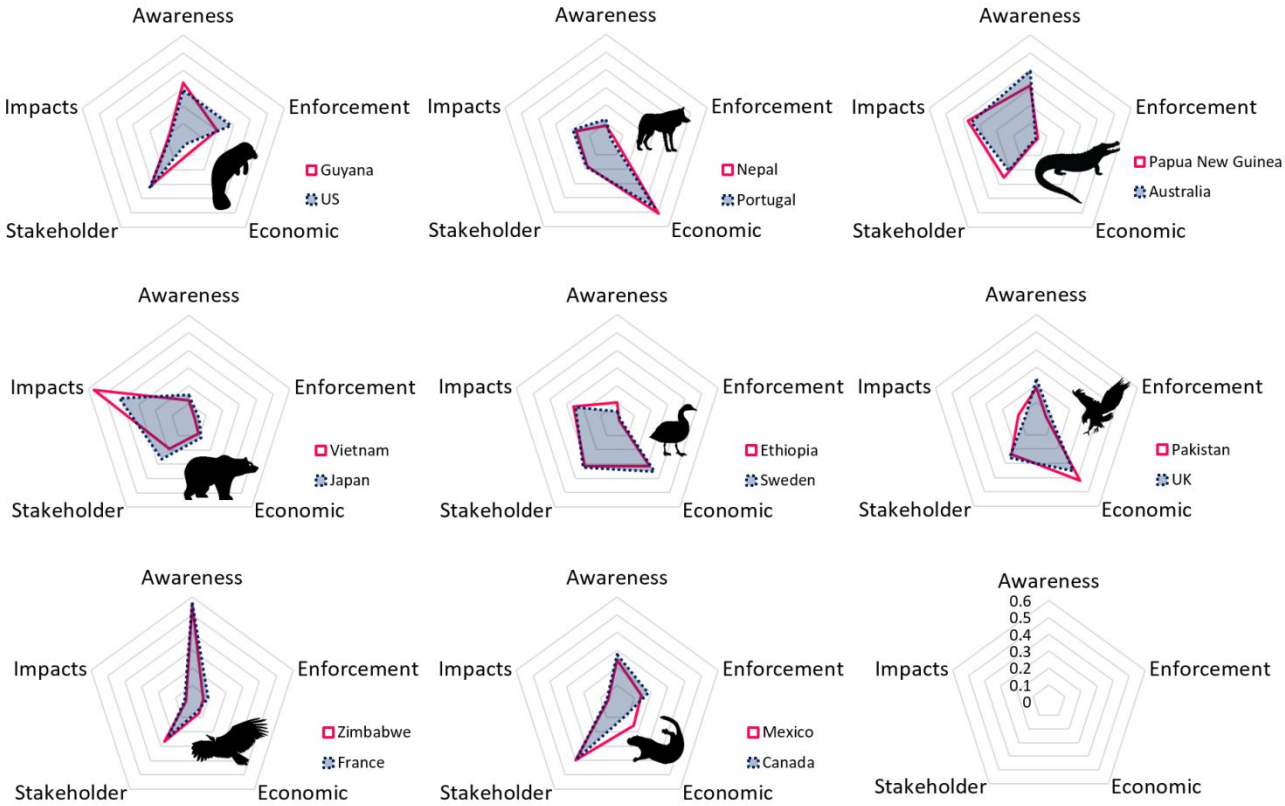


Figure 1: An example of two different versions of the same scenario which were presented to different participants, from two of eight different question blocks. In this case the location and framing, and the illegality of wildlife killing differs between the two scenarios.



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558 **Figure 2:** Radar charts showing the proportion of different intervention types suggested for each

559 country in each of the eight conflict scenarios

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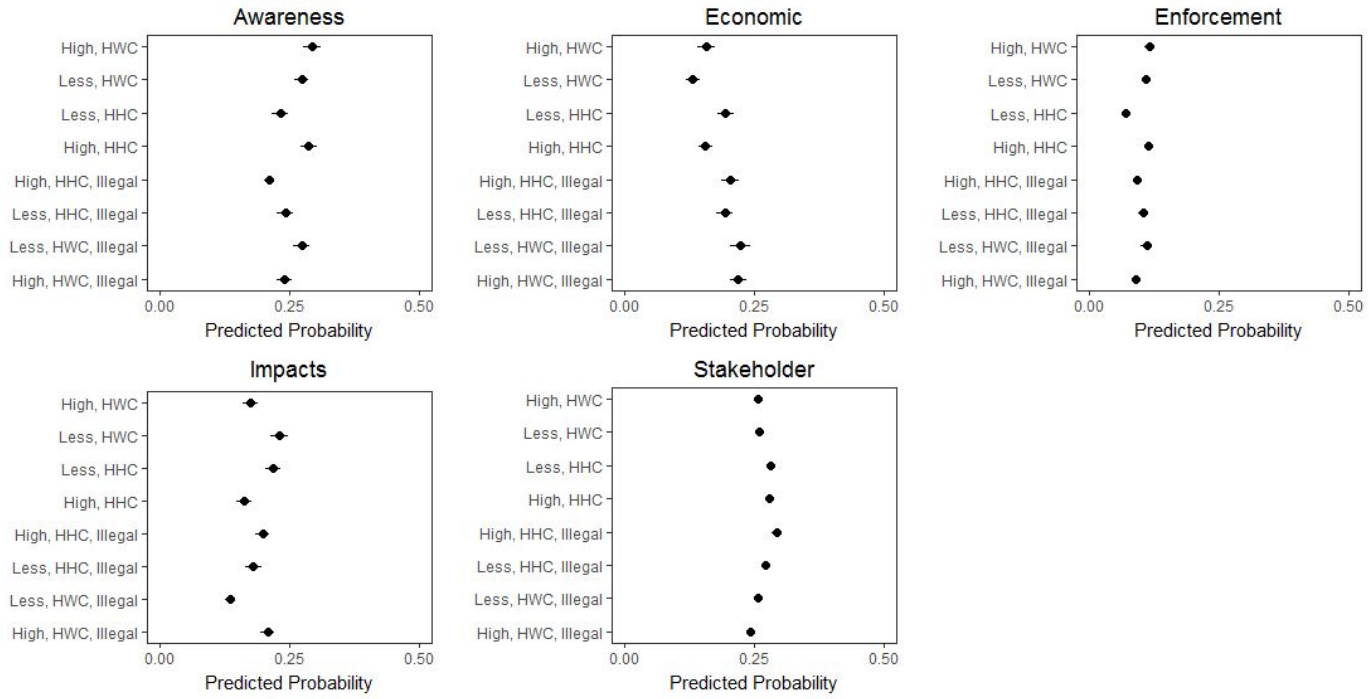

562

563 **Figure 3**: Results from a multinomial mixed logit regression model (Model Set 1, reference
564 level 'stakeholder'), showing the predicted probability of choosing each intervention type
565 (panels) under each of the eight framing combinations. Whiskers represent 95% CI. "HWC" =
566 Human-wildlife conflict, ""HHC" = Human-human conflict, "High" = "Very highly developed
567 nation", "Less" = "High, Medium or Less highly developed nation", "Illegal" = Behaviour
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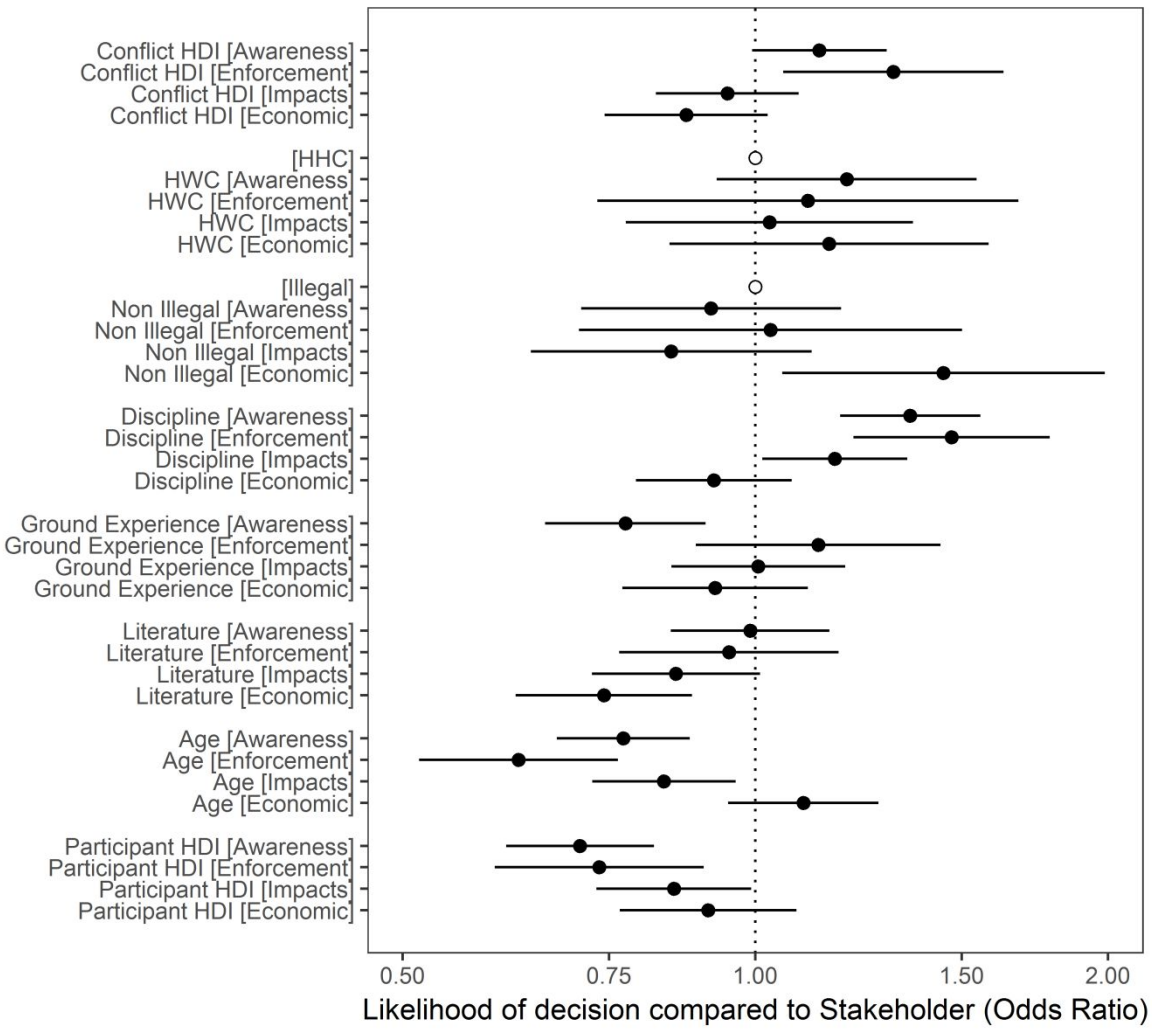

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571 **Figure 4**: Results from a multinomial logit regression model (Model 2), showing the estimated
572 conditional effects of each predictor variable on likelihood of choosing each intervention type
573 compared to stakeholder interventions. Filled dots represent model coefficient estimates converted
574 to odds ratios, which show the expected change in likelihood of a choice when each continuous
575 variable increases by a unit of one, or when each factor variable changes level from a baseline
576 (unfilled dots). Whiskers represent 95% CI, and variables with whiskers that do not cross zero are
577 those predicted by the model to associate with intervention decisions (effect size is distinguishable
578 from zero). Larger odds ratios indicate greater predicted strength of association. HDI = Human
579 Development Index, HWC = Human-wildlife conflict frame, HHC = Human-human conflict frame,
580 Discipline = Disciplinary Background, Literature = Literature knowledge.

581 **Table 1:** A short description of each of the eight conflict scenarios provided in each survey and the
582 two, systematically rotated, countries they were described as being located in.

Conflict scenario description	Countries	References
American manatee *(Trichechus manatus)* Conflict between commercial fishing interests and manatee conservation, with manatees drowning in fishing nets and being injured by boats in certain areas with speed restrictions.	USA Guyana	(Mason et al. 2018; Solomon et al. 2004; Castelblanco-Martínez et al. 2012)
Gray wolf *(Canis lupus)* Conflict between rural livestock herding and conservation interests, with wolves predating upon livestock and being killed in retaliation.	Portugal Nepal	(Pimenta et al. 2017; Fernández-Gil et al. 2016; Werhahn et al. 2017)
Saltwater crocodile *(Crocodylus porosus)* Conflict between human safety and conservation interests, with crocodile-related injury and retaliatory killing	Australia Papua New Guinea	(Fukuda et al. 2015)

Geese *(e.g., Anser anser, Alopochen aegyptiaca)* Conflict between agriculture and conservation interests, with 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, with livestock depredation and retaliatory killing	Scotland Pakistan	(Marquiss et al. 2004)
Vulture *(e.g., Gyps fulvus, Gyps africanus)* Conflict between rural livelihoods and conservation interests, with 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	(Echeverri et al. 2017; Carswell et al. 2015)
Asiatic black bear *(Ursus thibetanus)* Conflict between agriculture and human safety and conservation interests with crop-raiding, attacks and retaliatory killing	Japan Vietnam	(Can et al. 2014; Takahata et al. 2013)

583

584 **Table 2:** Descriptive summary of variables used in multinomial mixed logit models, using the sample
585 of 411 responses in which all eight scenarios (3,288 decisions) were completed.

Explanatory Variables	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 Behaviour	[Illegal] [Non Illegal]	Experimental manipulation	Scenarios: Illegal (1644), Non illegal (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 specialism)	2
Literature Knowledge		Survey (subjective scale)	Mean = 66.07, SD = 22.73, Range = 0 (no knowledge) - 100 (main specialism)	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	[Male] [Female]	Survey	Female (207), Male (197)	3
Career Position	[Early][Mid][Senior]	Survey	Early (180), Mid (112), Senior (109)	-
Role	[Researcher] [Practitioner/Other]	Survey	Researcher (321) Practitioner/Other (84)	-

591 **Table 3:** Results from multinomial logit regression models (Model Set 2), showing the estimated conditional effects of each predictor variable on the
592 likelihood of choosing each intervention type compared to the reference level in each model (in brackets), with effects presented as odds ratios (OR)
593 showing the expected change in likelihood of choosing different interventions when each continuous variable increases by a unit of one, or when each
594 factor variable changes level from a baseline.[a]

595

	Awareness [Stakeholder]	Enforcement [Stakeholder]	Impacts [Stakeholder]	Economic [Stakeholder]	Awareness [Enforcement]	Impacts [Enforcement]	Economic [Enforcement]	Awareness [Impacts]	Economic [Impacts]	Awareness [Economic]
HDI		OR 1.31* (1.06-1.63)				OR 0.75** (0.60-0.93)	OR 0.70** (0.56-0.88)	OR 1.18* (1.02-1.36)		OR 1.26** (1.07-1.47)
HWC										
Illegal				OR 1.45* (1.05-1.99)					OR 1.49* (1.07-2.07)	OR 0.66** (0.48-0.89)
Discipline	OR 1.36*** (1.18-1.56)	OR 1.47*** (1.21-1.78)	OR 1.17* (1.01-1.35)				OR 0.75** (0.61-0.91)	OR 1.21* (1.04-1.40)		OR 1.38*** (1.18-1.63)
Ground	OR 0.78** (0.66-0.91)				OR 0.72** (0.58-0.91)			OR 0.80* (0.68-0.95)		
Literature				OR 0.74*** (0.62-0.88)						OR 1.21* (1.01-1.45)
Age	OR 0.77*** (0.68-0.88)	OR 0.63*** (0.52-0.76)	OR 0.84* (0.73-0.96)			OR 1.31** (1.07-1.59)	OR 1.59*** (1.30-1.95)		OR 1.24** (1.06-1.44)	OR 0.75** (0.67-0.90)
Nation HDI	OR 0.71*** (0.62-0.82)	OR 0.74** (0.60-0.90)	OR 0.85* (0.73, 0.99)					OR 0.85* (0.73-0.98)		OR 0.80** (0.68-0.94)

596 [a] The values in brackets represent 95% CI and larger odds ratios indicate greater predicted strength of association and only significant associated are presented. HDI =

597 Human Development Index, HWC = Human-wildlife conflict frame. *P < 0.05, **P < 0.01, ***P < 0.001

598

599 **Figure captions:**

600

601 **Figure 1:** An example of two different versions of the same scenario which were presented to different participants, from two of eight different question
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608 ""HHC" = Human-human conflict, "High" = "Very highly developed nation", "Less" = "High, Medium or Less highly developed nation", "Illegal" = Behaviour
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611 **Figure 4**: Results from a multinomial logit regression model (Model 2), showing the estimated conditional effects of each predictor variable on likelihood of
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