Conservation conflicts: behavioural threats, frames, and intervention recommendations

Abstract

Conservation conflicts are widespread and are damaging for biodiversity, livelihoods and human well-being. Conflict management often occurs through interventions targeting human behaviour. Conservation interventions are thought to be made more effective if underpinned by evidence and a Theory of Change – a logical argument outlining the steps required to achieve goals. However, for conservation conflicts, the evidence and logic supporting different types of interventions has received little attention. Using conflict-related keywords, we reviewed trends in behavioural intervention recommendations across conflict contexts globally, as published in peer-reviewed literature. We developed typologies for conflict behaviours, intervention recommendations, and conflict frames and identified associations between them and other geographical variables using Pearson's Chi-squared tests of independence. Analysing 100 recent articles, we found that technical interventions (recommended in 38% of articles) are significantly associated with conflicts involving wildlife control and the human-wildlife conflict frame. Enforcement-based interventions (54% of articles) are significantly associated with conflicts over illegal resource use, while stakeholder-based interventions (37% of articles) are associated with the human-human conflict frame and very highly developed countries. Only 10% of articles offered 'strong' evidence from the published scientific literature justifying recommendations, and only 15% outlined Theories of Change. We suggest that intervention

recommendations are likely influenced by authors' perceptions of the social basis of conflicts, and possibly also by disciplinary silos.

Highlights: see Interventions highlights.doc

Keywords: human-wildlife; conflict; interventions; behavioural change; evidence

1. Introduction

Conservation conflicts are some of the most intractable problems facing conservation and are increasing in frequency and intensity globally (Young et al., 2010). These conflicts negatively impinge upon biodiversity, livelihoods and human well-being, and therefore considerable effort is put into their management (Redpath et al., 2015). Conflicts involve situations where multiple stakeholders with strongly held positions clash over conservation objectives, and when one party imposes their interests over another (Redpath et al., 2013). They are hard to define and are often interpreted differently by authors, managers, and stakeholders involved in the conflict. The language used to describe a given interpretation of a conflict can be considered as a 'frame' (Peterson et al., 2010), and in the conservation literature conflicts are framed in many different ways (Table 1). Commonly, authors frame conflicts as primarily occurring between wildlife and humans - 'human-wildlife conflict' – (Woodroffe et al., 2005). Others, however, posit that underpinning human-wildlife impacts such as crop-raiding are actually conflicts between different human interests, such as between conservation and agriculture

(Peterson et al., 2010; Young et al., 2010). Under this interpretation, the umbrella of conservation conflict extends far beyond wildlife impacts on humans and also involves other conflicts such as those over resource-use, land-use or even animal welfare (Redpath et al., 2015). For example, in many cases conservation rule-breaking, from illegal wildlife killing to resource use, has been identified as representing political protest or resistance to conservation (De Pourcq et al., 2017; Holmes, 2016).

The ultimate drivers of many conservation conflicts may be rooted in larger societal issues, such as poverty and inequality (Czech, 2008; Vedeld et al., 2012), imbalances of power (Raik et al., 2008) and inappropriate governance processes (Lute and Gore, 2014) (Table 1). However, the majority of interventions aimed at reducing conservation conflicts focus on the proximate human behaviours which impinge upon conservation interests (Schultz, 2011). These proximate behaviours are often referred to as behavioural 'threats' (Salafsky et al., 2008) and interventions commonly target their proximate drivers. For instance, the retaliatory killing of wildlife is often addressed by attempts to reduce wildlife impacts (Nyhus, 2016), deforestation by stronger enforcement (Duffy et al., 2014) and active opposition to conservation by efforts to improve stakeholder trust (Young et al., 2016) – though other social outcomes may also be targeted independently of conservation.

Following Heberlein (2012), human behavioural interventions can be categorised into 'technical', 'cognitive' and 'structural' fixes. Technical fixes attempt to change the external environment and commonly target wildlife impacts such as crop-raiding and livestock depredation. These may include the erection of fences, provision of deterrents, the encouragement of wildlife-friendly products or the diversionary feeding of wildlife (Nyhus, 2016; Sutherland et al., 2017). These interventions operate under the assumption that retaliatory killing of wildlife, or active opposition to conservation, is directly related to human-wildlife impacts (Pooley et al., 2016). Cognitive fixes instead attempt to change behaviour through information dissemination. Examples include conservation or livelihood education and conservation awareness campaigns (Baruch-Mordo et al., 2011; Holmes, 2003). Structural

66 interventions attempt to change the context itself. Examples include financial instruments (such as
67 incentives, insurance or compensation) or alternative livelihoods to reduce the physical or opportunity
68 costs incurred by wildlife or conservation-related resource restrictions, or to discourage certain resource
69 use (Kremen et al., 2000; Ravenelle and Nyhus, 2017). Likewise, structural fixes include the creation or
70 enforcement of new rules aiming to increase compliance or discourage certain behaviours such as illegal
71 resource use (Agrawal et al., 2014; Arias, 2015). Contrastingly, stakeholder engagement, mediation
72 programmes and conflict transformation efforts are structural fixes which target the social dimensions
73 of conflicts. These operate under a range of rationales, from engendering greater support for
74 conservation, to championing environmental justice (Madden and McQuinn, 2014; Redpath et al.,
75 2017).

76 Like other types of conservation, conflict interventions are expected to be more effective if they are
77 informed by evidence – from scientific evidence (Sutherland et al., 2017) to local ecological knowledge
78 (Sterling et al., 2017) – and underpinned by a valid Theory of Change (ToC) (Biggs et al., 2017; Margoluis
79 et al., 2013), which describes the logical and ordered sequence of interventions, actions, perturbations
80 and outcomes identified during the planning process (Qiu et al., 2018). However, the evidence
81 underpinning interventions is often lacking (Eklund et al., 2017; Treves et al., 2016), and the extent to
82 which recommended conflict interventions are supported by ToC has not been assessed. Nor has there
83 has been much consideration of the reasons underpinning different conflict interventions.

84 The purpose of this review is to contribute towards informed conservation conflict management by
85 exploring, across a range of conflict contexts globally, behavioural intervention recommendations as
86 presented in peer-reviewed academic journal articles. We aim to scrutinize how the types of
87 behavioural intervention recommendations differ across these contexts and to inform researchers and
88 decision-makers, particularly those acting at the local scale. To generate a sample of conservation
89 conflict case-studies and intervention recommendations for comparison, we conducted a sampled

literature review, and analysed 100 recent articles from the published conservation literature related to conflicts. To identify the prevailing intervention types, we first developed conflict typologies from directed content analysis and then highlighted the most common intervention types recommended by authors in different contexts. To further understand why certain types of intervention are recommended in certain contexts, we explored associations between the recommended interventions, different behavioural threats and conflict frames. We hypothesised that authors who frame conflicts as primarily occurring between humans, would be more likely to recommend stakeholder-based interventions. As some conflict interventions, such as compensation (Ravenelle and Nyhus, 2017) and militarised enforcement (Duffy et al., 2014), appear to vary regionally, we also considered whether different types of interventions correlate with other geographical factors, such as the development status of nations and the conservation status of species and areas. To identify any possible gaps in the intervention evidence-base, we assessed the extent to which intervention recommendations are supported by scientific evidence and ToC. Lastly, we also estimated the proportion of articles that focus on other forms of evidence (e.g. stakeholder knowledge), and explored whether intervention recommendations and framing could be analysed across academic disciplines.

2. Materials and methods

To generate a sample of conservation conflict case-studies we conducted a search of peer-reviewed conservation literature using ISI Web of Knowledge in October 2016. To facilitate reproducibility and transparency, we followed best-practise guidelines (Haddaway et al., 2015) and applied carefully designed keyword search-strings to capture a wide variety of conflict contexts, including those not necessarily identified in the conservation conflict literature (Table 1).

112 To focus on interventions, in our final search we included wildcard search terms for a series of active
113 verbs. Using the English language only, we searched for the following combination of terms in the titles,
114 abstracts or keywords of all articles in the ISI core collection: “conservation conflict*" OR
115 ("conservation" AND "illegal") OR ("conservation" AND "conflict" AND ("stakeholder*" OR "human-
116 wildlife")) AND either - "prevent*" OR "mitigat*" OR "reduc*" OR "resolv*" OR "resolution*" OR "solv*"
117 OR "solution*" OR "manag*" OR "interven*" OR "improv*". To avoid unconscious bias in the sample
118 selection (Haddaway et al., 2015), we decided the temporal and spatial boundaries before the final
119 search. We excluded publications before 2011 to focus on the most recent interventions. To aid
120 comparison, reviews and book chapters were excluded to focus on primary case-studies of roughly
121 similar length. The final search yielded 897 results.

122 To produce a representative sample for analysis, we used a random list generator to sort the sample
123 into a randomly ordered list, from which we analysed articles sequentially. We excluded any
124 publications (N=57) which did not describe contexts falling within the definition of conservation conflicts
125 provided by Redpath et al., (2013), those which we could not access, reviews, and those which did not
126 make any intervention recommendations (Appendix Table A12). We continued analysing articles,
127 following the random sequence until we had a total sample of 100 relevant articles. This total sample
128 size (N=100) and proportion of articles reviewed (157/897) was comparable to previous similar studies
129 (Estévez et al., 2015; Peterson et al., 2010; Redpath et al., 2015). Demonstrating representativeness,
130 there was no significance difference in the proportions of key search terms between the analysed
131 sample and non-analysed sample (Appendix Table A1).

132 To avoid selection bias (Haddaway et al., 2015) we developed our conflict and intervention typologies
133 (Table 2) and our coding system prior to collecting and analysing our final sample. We used directed
134 content analysis (Hsieh & Shannon 2005), whereby we first derived each typology from previous
135 reviews, before refining each typology through analysing a large sample of conflict case-studies. This

preliminary sample of case-studies (N=150) was drawn from the published literature using a similar search and sampling process described above (Appendix Search 1).

Following Heberlein (2012), we first categorised interventions into 'technical', 'cognitive' and 'structural' types. With reference to previous conservation conflict reviews (Dickman, 2010; Nyhus, 2016) and content analysis of the preliminary sample, we subdivided 'structural' further into 'economic', 'enforcement' and 'stakeholder' types. Our typology of human behavioural threats was derived from existing literature (Salafsky et al., 2008) and content analysis of the preliminary sample to include: 'wildlife control', 'resource-use', 'environment change', 'indirect damage' and 'active opposition'. Likewise, from existing reviews we identified two key frames –'human-wildlife conflict' (HWC) and 'human-human' conflict (HHC) (Peterson et al., 2010; Redpath et al., 2015). We then derived an additional frame – 'illegal resource use' (IRU) – from content analysis of the preliminary sample.

All data analysis was conducted by the lead author, but the typologies were created and refined in consultation with co-authors. In the final sample, each article was analysed at least twice to check for errors, with ambiguous articles marked and returned to. For all variables (besides framing), we used a binary coding system within larger non-mutually exclusive categories – e.g., articles could describe more than one threat or intervention type, but were categorised as one frame. The development status of nations (as designated by the Human Development Index) (UNDP, 2016), protected area presence, the conservation status of species (as designated by the IUCN Red List) (IUCN, 2017) was recorded, as was the identification of stakeholder groups, wildlife impacts and illegal activity.

After categorising each article in our final sample (N=100), we calculated intervention recommendation proportions across variables, and identified associations between interventions, behavioural threats and frames, using Pearson's Chi-Squared test for independence and a mosaic plot of Pearson's residual values (using the "vcd" package) in R 3.4.1 (R Development Core Team, 2014).

We recorded articles as demonstrating reasoning akin to a ToC if they identified the steps required for interventions to achieve a desired outcome. We assessed the level of published scientific evidence supporting recommendations using three categories. 'Strong' evidence included articles in which all, or nearly all, recommendations were supported either by reference to previous studies, and/or by experimental, correlative or comparative evidence from the study itself. 'Partial' evidence included articles in which over half of recommendations were supported by references or within-study evidence. 'Weak' evidence included articles in which less than half of recommendations were supported by references or within-study evidence. Following Estévez et al., (2015), we also explored author affiliations (region) and journal geographical scope, and attempted to categorise institution and journal types by disciplinary focus. However, during analysis we found that the interdisciplinary nature of many conservation-related journals and departments meant such a categorisation approach was ultimately unsatisfactory (Appendix 'Journals and Affiliations'). Lastly, following our initial analysis – in which we (unintentionally) overlooked non-scientific forms of knowledge – we later attempted to overcome this by estimating the proportion of articles in the whole sample which focused on stakeholder-based knowledge specifically. To do so, we conducted a keyword search (in article titles, abstracts and keywords) of the entire sample (N=897) for: "local knowledge", "traditional knowledge", "ecological knowledge", "stakeholder knowledge" or "indigenous knowledge".

3. Results

Across the final sample (N=100), we categorised 30 articles as using the frame 'human-wildlife conflict' (HWC), 41 as 'illegal resource use' (IRU), and 29 as 'human-human conflict' (HHC). Of these, we recorded 32 articles describing wildlife control, 59 resource use, 26 environment change, 34 indirect damage and

33 active opposition. 48 articles included IUCN Red Listed species, 40 articles focused on very high development countries, 20 high development, 31 medium development, and 9 low development. 61 articles described protected areas, and 66 reported illegal behaviours (Appendix Table A2). 88% of articles were published in journals with a global scope (Appendix Table A11) and both study locations and author affiliations were spread across the worlds regions (Appendix Figure A1).

Across the sample 'enforcement' was the most commonly recommended intervention type, appearing in 54% of articles. 'Economic', was the next most popularly recommended intervention type (suggested in 47% of articles), followed by 'cognitive' (40%), 'technical' (38%) and 'stakeholder' (37%) (Figure 1).

<Figure 1> < Figure 2>

Technical interventions (such as fences, diversionary feeding or guarding tools) were over 2.5 times more likely to be recommended (Odds ratio (OR) > 2.5) when authors reported behaviours related to wildlife control (such as retaliatory killing) (OR: 2.63, $P < 0.001$) (Figure 2) and when they used the HWC frame (OR: 2.59, $P < 0.001$) (Appendix Table A3).

Cognitive interventions – such as livelihood training and education awareness programmes – showed no clear associations with any conflict variables. Economic interventions – such as compensation payments or alternative livelihoods – did not associate with any threat, but were positively associated with high, mid and low development countries (OR, 1.94, $P = 0.005$), and were negatively associated with very high development countries (OR: 0.51, $P = 0.005$) (Appendix Table A3).

Enforcement interventions – such as anti-poaching patrols and new regulations – are positively associated with the threats of resource use (OR: 1.99 $P < 0.001$), and indirect damage (such as wildlife collisions or pollution) (OR: 1.67, $P = 0.005$), the illegal resource use frame (OR: 2.09, $P < 0.001$), and the reporting of illegal behaviours (OR: 2.96, $P < 0.001$). Enforcement is negatively associated with active opposition (OR: 0.35, $P < 0.001$) and the human-human conflict frame (OR: 0.56, $P = 0.012$).

Enforcement is also negatively positively associated with high, mid and low development countries (OR: 1.73, P = 0.006) and negatively associated with very high development countries (OR: 0.58, P = 0.006).

In contrast, stakeholder interventions – such as participatory decision-making or peace-building – are positively associated with the threats of active opposition (OR: 2.98, P < 0.001), environment change (OR: 2.17 P = 0.003), the human-human conflict frame (OR: 4.02 P < 0.001) and very high development countries (OR: 2.46, P <0.001). Stakeholder interventions are negatively associated with the resource use threat (OR: 0.53, P = 0.014), the illegal resource use frame (OR: 0.22, P < 0.001), IUCN Red-Listed species (OR: 0.29, P < 0.001) and high, mid and low development countries (OR: 0.41, P < 0.001).

Only 22% of articles recommended just one intervention type, and on average authors recommended 2.16 intervention types. No authors recommended interventions pertaining to all five of our intervention categories, and only enforcement and stakeholder types showed a significant (negative) association (P = 0.004) (Appendix Table A7).

Many of the conflict variables associated with different intervention types were also strongly associated with each other (Appendix Table A6). The HWC frame was positively associated with articles describing wildlife control, wildlife impacts and IUCN Red-Listed species. The IRU frame was positively associated with articles describing resource use, indirect damage, illegal activity and high, mid and low development countries. In contrast, the HHC frame was positively associated with articles describing active opposition, environment change, stakeholder groups and very high development countries.

15% of articles outlined the steps required for an intervention to reach a goal, but none of these were explicitly referred to as ToC. 10% of articles offered ‘strong’ scientific evidence to justify recommendations, 65% offered ‘partial’ scientific evidence and 25% offered ‘weak’ scientific evidence. Articles offering ‘weak’ evidence tended to recommended less interventions, but this relationship is not significant (Appendix Table A9). Economic recommendations were positively associated with ToC (OR:

1.94, P= 0.006) and strong evidence (OR: 2.13, P = 0.004) and enforcement was positively associated with weak evidence (OR: 1.58, 0.037). Only 16 (1.8%) articles out of the entire search sample (N=897) made explicit reference to stakeholder-based forms of knowledge in their titles, abstracts or keywords. 68% of first-author affiliations corresponded to same geographical region as the study conflict (Figure A1). Of those that studied a conflict in a different region, 88% of first-author affiliations were based in Europe or North America.

4. Discussion

Globally, many different actors, from scientists, to practitioners to governments, design and implement interventions to tackle conservation conflicts, and these conflicts take many forms. From reviewing the published academic literature, we compare together for the first time a wider range of conservation conflict contexts and show that conflict intervention recommendations vary with regards to the behaviours they target, the way conflicts are framed, and the evidence and reasoning underpinning them.

In contexts where there are human-wildlife impacts (e.g. crop or livestock loss) and often the subsequent retaliatory killing of wildlife, we find that authors tend to recommend technical interventions. Such technical interventions (including wildlife fences and diversionary feeding) aim to alter human behaviour by changing the external environment (Heberlein, 2012). Like others (e.g., Pooley et al., 2016), we find that that those who recommended these interventions typically reason that the retaliatory killing of wildlife will reduce as the damage exerted by wildlife reduces. In contexts where there is illegal natural resource use, or indirect environmental damage, and in countries with lower levels of human development, we find enforcement-based interventions are favoured. As elsewhere (Keane et al., 2008) we identify that enforcement-based interventions are often recommended under

the logic that the greater policing of natural resources and stricter regulations will reduce over-harvesting and illegal behaviour directly. Where there is undesirable environment change – such as agriculture or recreation expansion – or active opposition to conservation – such as protests, hostility or objections – and in more highly developed countries, we find that stakeholder-based interventions are favoured. These authors often perceive that social, sometimes non-material factors, sustain the conflict and hence stakeholder interventions commonly target emotions and aim to increase dialogue and trust, with the idea that shared, and agreed-upon problems and solutions can be met (Redpath et al., 2017; Young et al., 2016). However, as documented elsewhere (Peterson et al., 2005; Reed, 2008) in our sample, stakeholder-based interventions vary considerably in style and motivation. Some advocate for collaborative decision-making or more devolved governance (Dandy et al., 2014), whereas others focus on increasing decision-making transparency or on conducting stakeholder consultations (Elston et al., 2014).

In terms of behavioural threats, we find that economic interventions are recommended less selectively, but they are more common in less developed countries. This result contrasts with that found for wildlife impact compensation (Ravenelle and Nyhus, 2017), but this might be because we also considered other economic mechanisms (like alternative livelihoods), and other contexts such as natural resource where economic interventions are common (Agrawal et al., 2014). Economic interventions were generally best supported by evidence and reasoning, but no article considered whether it mattered which group or institution was conducting the recommended intervention, despite indications that perceptions of trust can play a key role in responses to conservation interventions (Stern and Coleman, 2015). Cognitive interventions associated with no variables, suggesting they may be deemed suitable across contexts. However, we found many cognitive interventions to be undeveloped in reasoning and unsupported by evidence. Given critiques of the information deficit model underpinning information-based interventions (Heberlein, 2012; Schultz, 2011), we suggest they would benefit from further testing.

Like similar reviews (Estévez et al., 2015; Peterson et al., 2010; Ravenelle and Nyhus, 2017), we were unable to include non-English-language articles or grey literature, which would likely have provided further insight. Our conclusions are also limited to recommendations about interventions which are unlikely to be accurate reflections of actually implemented interventions – as recommendations are likely less limited by resources or other constraints. Hence, comparing our findings with implemented interventions, including in regions such as South America which are underrepresented in our sample, would be useful future work. The rigour of the analysis could also have been improved by training multiple coders (e.g., Peterson et al., 2010), increasing the sample size and checking the quality of references used as evidence. Experiments could also be designed to test our findings; for example, a choice experiment with conflict mangers or researchers could test the effect of framing on intervention preferences.

Our finding that framing seems to influence whether socially-focused interventions are recommended is significant because all conservation conflicts are ultimately rooted in social conflicts (Redpath et al., 2013). For instance, beyond wildlife impacts, cultural factors such as religion, or levels of opposition to conservation can determine levels of the retaliatory killing of wildlife (Dickman and Hazzah, 2015; Mariki et al., 2015). Likewise, illegal activities such as poaching or protected area encroachment often reflect protest, opposition or resistance to conservation (Holmes, 2007; Stern, 2008). Reframing conflicts to better reflect their root cause is therefore crucial for successful conflict management (Peterson et al., 2010; Young et al., 2010). Our attempts at exploring the possible influence of disciplinary silos on both framing and intervention recommendations proved unfruitful. However, others have identified disciplinary silos in conservation (Margles et al., 2010), and that interventions recommended by conservation researchers may reflect their disciplinary training (Sandbrook et al., 2013). Hence, given these findings and the importance of framing identified here, we suggest it would be beneficial for

298 researchers to think more broadly about conflicts in conservation, and look beyond the literature
299 specifically related to their study context.

300 Future work should examine the extent to which authors' disciplinary background, beliefs, expertise or
301 the nature of the conflict itself influence their intervention recommendations. For instance, does
302 variation in ethical positions or rationales for conservation (Holmes et al., 2017) influence the types of
303 intervention recommended? Do those that perceive illegal behaviour as being more or less legitimate
304 (e.g., Sheil et al., 2016) differ in the extent to which they advocate enforcement over participatory
305 approaches? Likewise, the reasons why enforcement and stakeholder-based interventions appear to
306 differ depending upon the development status of countries needs to be explored. Does this trend just
307 reflect the increased presence of threatened species or protected areas, or does it represent
308 perceptions of the strength of governance, or more problematic biases revolving around top-down
309 conservation that prevail where conservationists have relatively more power (Duffy, 2014; Kashwan,
310 2017; Sandbrook, 2017)? Future work could also look at factors such as the broader socio-economic,
311 cultural or governance context, as well as the involvement of particularly marginalised or minority
312 communities in conflicts.

313 We find that few authors provide ToC, authors rarely justify all intervention recommendations with
314 published scientific evidence, and the adaptive approach was largely overlooked, despite the
315 effectiveness of decision-making frameworks and adaptive management having been regularly
316 advocated (e.g. Bunnefeld et al., 2017). The lack of causal-reasoning and scientific evidence is
317 problematic as it suggests conservation interventions often borne out of intuition, group-think or
318 convention rather than evidence (Eklund et al., 2017; Sutherland and Wordley, 2017), which might
319 prevent otherwise successful interventions from being considered. One reason for the lack of ToC might
320 be that only recently has a framework been developed to bridge different methodologies and guide
321 their development for conservation (Qiu et al., 2018). Step-wise reasoning (ideally underpinned by

behavioural theory) and the outlining of clear goals would also make it easier to assess the effectiveness of interventions (Agrawal et al., 2014), thus contributing to the possible evidence-gap that we have highlighted. However, other forms of knowledge, including local ecological knowledge (LEK), or expert/stakeholder experience can also inform interventions (Sterling et al., 2017). We identify that such knowledge forms may be underrepresented in the published literature, and argue that future work could explore this trend further, and identify how best to incorporate multiple knowledge forms in conflict management.

Conclusions

Individuals or groups who actively participate in conservation-related rule-breaking, such as protected area infringement, may as much be in conflict with conservation as those who poison livestock-raiding predators, or those who lobby against conservation regulations in parliament. Behavioural interventions recommended to tackle such conflicts vary with the types of behaviours targeted, the conflict frames adopted by authors, and by the evidence and reasoning underpinning them. Technical intervention recommendations are associated most with conflicts involving wildlife control (such as retaliatory killing) and those framed as 'human-wildlife conflict'. Enforcement-based recommendations are associated most with conflicts involving (often illegal) natural resource use, and those in less developed countries. In contrast, stakeholder-based intervention recommendations are associated most with conflicts framed as 'human-human conflicts' and more highly developed countries. We suggest that effective interventions should be informed by robust and appropriate evidence, and underpinned by carefully considered ToC. We highlight that other factors appear to influence intervention recommendations which might potentially lead to poor decisions being made. Lastly, we recommend that future studies

should make the theoretical and evidential basis of their recommendations clearer and research should study why certain conflict frames arise and their impact.

5. Recommendations

- Researchers should seek to recognise and transcend the arbitrary barriers which categorise different conflicts, so that any entrenched silos do not lead to potentially successful solutions being overlooked.
- Researchers should further explore how the framing of conservation conflicts is generated and how it influences intervention suggestions.
- Those recommending conflict interventions should more clearly outline the social and environmental goals targeted, and the steps required to reach these goals.
- Those recommending conflict interventions should justify recommendations with greater evidence, including scientific and stakeholder-based knowledge.
- Researchers should aim to contribute to this evidence-base by testing the assumptions underpinning how particular interventions are intended to influence behaviours.

6. Conflict of Interest

The authors have no competing interests to declare.

7. Policy and Ethics

All appropriate ethics and other approvals were obtained for the research.

8. Role of the funding source

<Insert after review> provided funding for this research, and played no role in study design, data collection, analysis or interpretation.

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587 Table 1. A non-exhaustive and non-mutually exclusive list of different conflict drivers and associated frames presented in the literature, based
588 upon our interpretation.

Conflict drivers	Otherwise framed as
Wildlife impacts including livestock depredation or crop-raiding and/or human injury, with associated retaliatory killing or persecution of wildlife and/or active opposition to conservation efforts trying to prevent this. Similar conflicts surround proposed reintroductions, or predator management on recreational hunting estates.	Human-wildlife conflict (HWC), (Woodroffe et al., 2005) coexistence (Rust and Marker, 2014), human-wildlife relations/interactions (Pooley et al., 2016) stakeholder conflict (Redpath et al., 2015) persecution (Whitfield et al., 2004), pest-control (Delibes-Mateos et al., 2013)
Resource-use and restrictions Including unsustainable or illegal harvest of fauna and flora and associated efforts to prevent/reduce such harvest. This includes commercial activities (e.g. logging, fisheries, wildlife trade, recreational hunting) and non-commercial activities (e.g. subsistence hunting or foraging).	Natural resource related conflict (NRRC) (De Pourcq et al., 2017), Illegal wildlife trade (Nijman, 2010), logging, poaching, unsustainable use, encroachment (Mackenzie et al., 2012) fisheries management (Marzano et al., 2013), common-pool resource conflict (Adams et al., 2003)
Land-use decisions including protected area establishment, land-use change, relocations and/or associated loss of livelihoods, traditions identity. Associated behaviours may include 'encroachment' and local (or international) opposition to conservation regulations and organisations	People-park conflict (Stern, 2008), environmental justice, indigenous rights, land-use conflict (West et al., 2006)
Conservation governance Lack of transparency in decision-making process, lack of trust, unequal power dynamics, ineffective governance	Stakeholder conflict (Young et al., 2016), conservation governance (Lute et al., 2018; Peterson et al., 2005; Stern and Coleman, 2015), natural-resource management (Raik et al., 2008)
Development and economics including conflicts between poverty and/or economic growth and conservation, commercial or state-sanctioned development in 'green' spaces or protected areas, and associated civic and organisational protest/opposition	Development conflict, Natural resource management, (Bockstael et al., 2016; Hopcraft et al., 2015), poverty traps (Vedeld et al., 2012), Environmental Kuznets Curve (Czech, 2008)
Clashing of values including animal-rights campaigns against lethal control, or trophy hunting. Also includes conflicts over different approaches, philosophies or ethics	Animal welfare (Crowley et al., 2017), human-human conflict (Redpath et al., 2015), conservation values (Holmes et al., 2017), conflict over stakeholder participation (López-Bao et al., 2017)

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591 Table 2. Our typology of conservation conflict intervention types, behavioural threats, and frames.

Variable	Examples	References
Intervention type		
Technical	Wildlife control lethal (traps, shooting, pesticides, poison), non-lethal (translocation, deterrents, diversionary feeding, fertility/disease management) Habitat manipulation buffer crops, alternative food, barriers (fences, nets, enclosures) Livelihoods livestock /crop protection, guarding , modify crops, rotations, immunization People control barriers, surveillance systems, modified gear, signposts	(Lute et al., 2018; Nyhus, 2016; Pooley et al., 2016; Sutherland et al., 2017)
Cognitive	Livelihood training husbandry techniques, crop cycles, sustainable yields Awareness wildlife attitudes and perceptions, conservation benefits Regulatory information species protection laws, quotas, access rights	(Baruch-Mordo et al., 2011; Holmes, 2003; Keane et al., 2011)
Economic	Remuneration compensation & insurance schemes (state, charitable, private) Incentives direct payments, payments for ecosystem services, tourism income, sustainable use/harvest Employment direct employment, alternative livelihoods Services education, healthcare, infrastructure	(Kremen et al., 2000; Ravenelle and Nyhus, 2017; Wünscher and Engel, 2012)
Enforcement	Regulation creation protective status, land-use zoning, land rights, quotas, trade-bans, equipment/practice ban (e.g., poisons) Regulation enforcement	(Agrawal et al., 2014; Arias, 2015; Challender et al., 2015; Donald et al., 2007)

	increased patrols, trials, punishments, reduced corruption, legal processes	
Stakeholder	Stakeholder engagement participatory planning, knowledge sharing, consultations, deliberations Conflict resolution trust building, transformation, third-parties Devolution community-based natural resource management, land rights, power sharing	(Madden and McQuinn, 2014; Peterson et al., 2005; Young et al., 2016)
Behavioural threat		
Wildlife control	Lethal retaliatory killing, persecution of wildlife Non lethal Harassment, scarring of wildlife	(Jensen et al., 2008; Marquez et al., 2013; Nyhus, 2016)
Resource use	Illegal poaching, bush-meat, wildlife trade, encroachment Non-illegal unsustainable harvest (e.g., logging, fisheries)	(Nijman, 2010; Watson et al., 2013)
Environment change	Land-use development, recreation, agriculture Ecosystem stewardship, management change	(Bockstael et al., 2016; Gross et al., 2013)
Indirect damage	Primary damage pollution, bycatch, collisions Secondary spread of disease or invasive-species, consumer demand	(Gilman, 2011; Lin et al., 2013)
Active opposition	Protest civic protest, lobbying, campaigns against conservation efforts Resistance sabotage, hostility, non-participation with conservation efforts	(Holmes, 2007; Stern, 2008)

Frame		
Human-wildlife conflict (HWC)	Authors describe conflict as primarily occurring between humans and other animals. Often involves crop/livestock loss and associated retaliatory killing of wildlife	(Nyhus, 2016; Woodroffe et al., 2005)
Illegal resource use (IRU)	Authors describe rule-breaking natural resource use (such as illegal wildlife trade, logging, bush meat, fisheries, encroachment), without reference to underlying relationships between different stakeholders. These behaviours are usually considered illegitimate	(Nijman, 2010; Solomon et al., 2015)
Human-human conflict (HHC)	Authors describe human disagreements between particular actors over conservation actions or decisions Conservation-related rule-breaking may be considered as acts of protest or resistance	(De Pourcq et al., 2017; Redpath et al., 2015)

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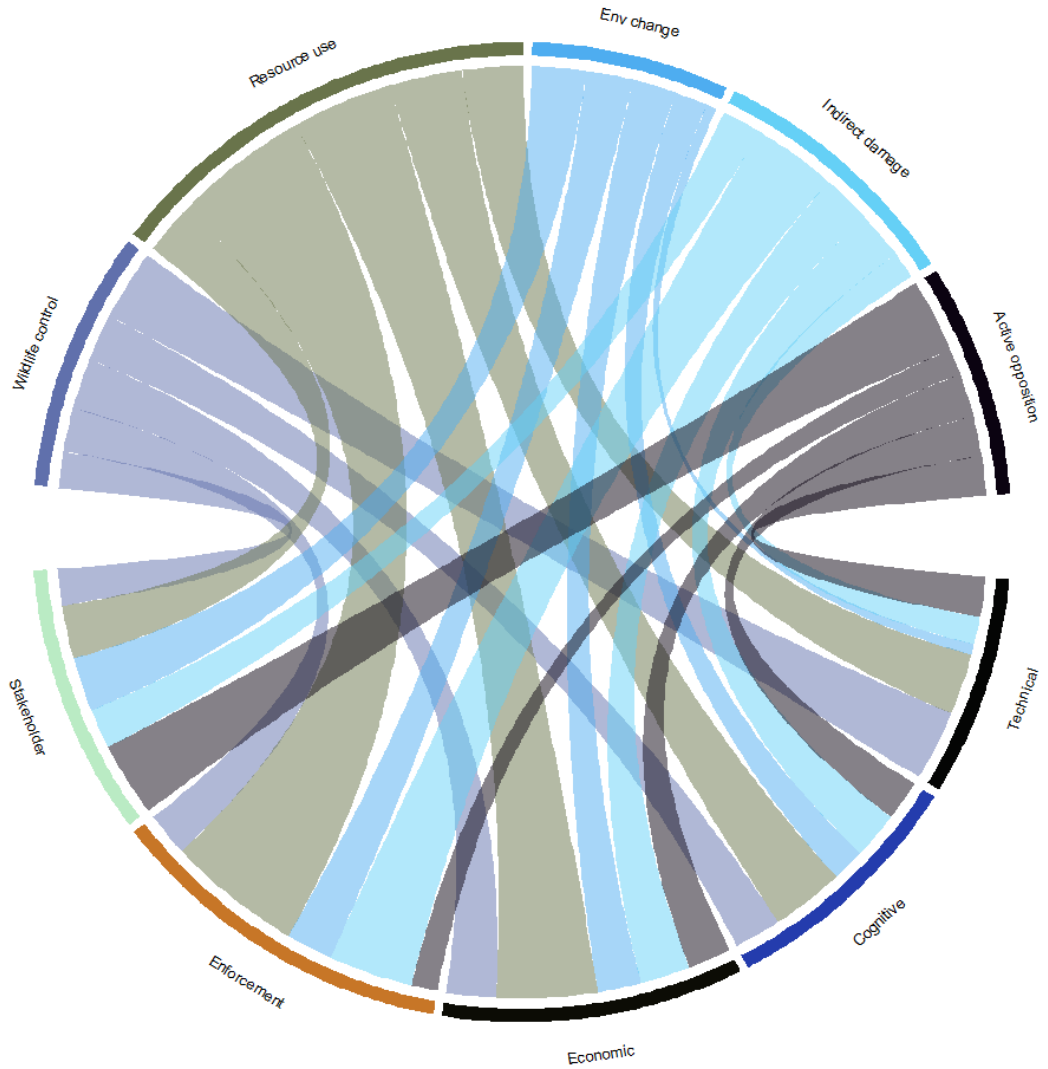
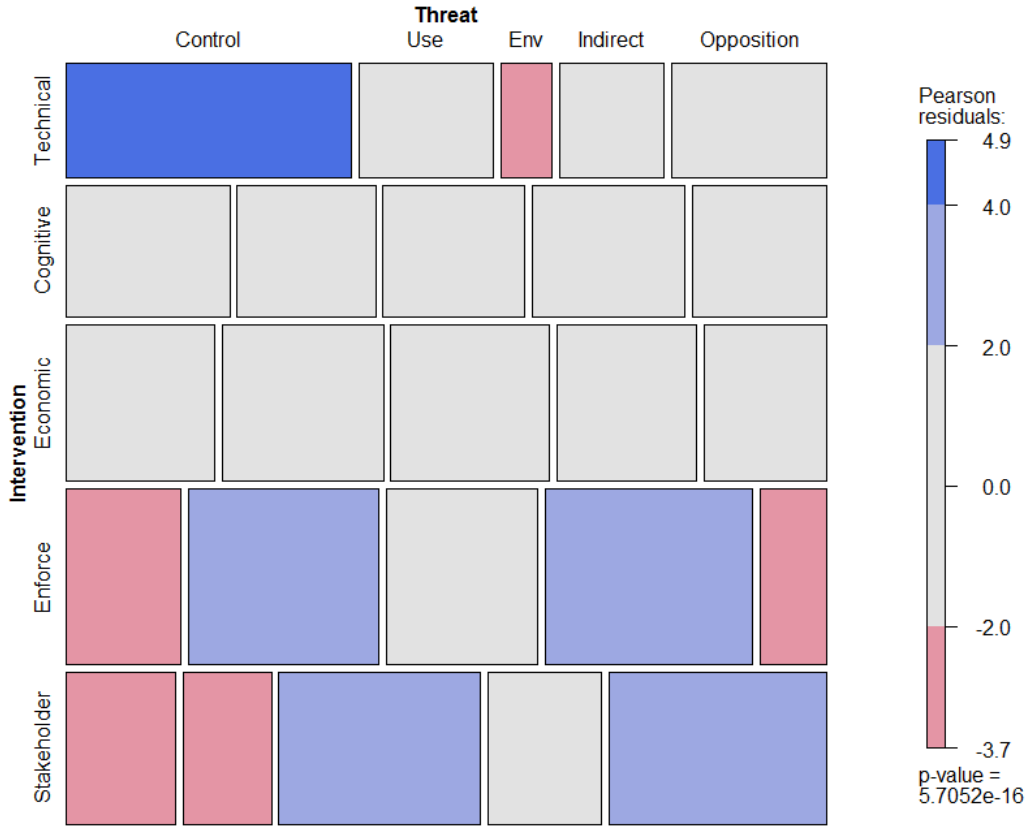


Figure 1. Chord diagram showing the relationship between behavioural threats (top) and recommended intervention types (bottom). The width of each outer rim depicts the proportion of total articles describing each threat and intervention type. The direction and width of inner flows show the proportion of articles within each behavioural threat category that recommend each intervention type. 'Env' = Environment. <colour required in print>



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598 Figure 2: A mosaic plot depicting the association between intervention recommendations and behavioural threats, colour-coded by Pearson's residual values,
599 with blue cells indicating significantly more observations than would be expected under independence (positive association), red cells indicating fewer
600 observations than would be expected (negative association). Box size is proportional to the observed frequencies of each cross-classification. 'Control = Wildlife
601 control, 'Use' = Resource Use, 'Env' = Environment change, 'Indirect' = Indirect damage, 'Opposition' = Active opposition, and 'Enforce' = Enforcement <colour
602 required in print>