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Review

Key factors driving attitudes towards large mammals in conflict with humans

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ABSTRACT

Biodiversity conflicts, and human–wildlife conflicts (HWC) in particular, are predicted to increase. Understanding drivers of these conflicts is a prerequisite for developing strategies to achieve conservation goals. People are a part of all HWC problems meaning social research methods are essential for finding solutions. We conducted a meta-analysis of the variables predicted to drive attitudes of people living in areas with damage causing carnivores, ungulates, elephants and primates so as to determine if common patterns of variables are present across a wide range of contexts. We categorized variables reported in publications into main and sub-categories and developed three indexes to describe relative frequency of category use, relative significance of categories and degree of accuracy between use and significance. From 45 suitable publications, 16 main categories and 17 sub-categories were identified. The majority of publications measured variables with a low likelihood of explaining drivers of HWC, or did not quantify variables of generally high utility. For example, only four categories (25%) were applied in over 50% of publications, and two thirds were mostly not significant in explaining attitudes. *Tangible costs* and *tangible benefits* thought to be the main drivers of attitudes were respectively, two and three times more non-significant than significant. *Intangible costs* however were the most important category to explain attitudes but was under represented in publications. *Intangible benefits* were mostly not important in explaining attitudes. *Costs* were more significant than *benefits* suggesting negative perceptions more strongly determine attitudes. Other important categories were exposure and experience with a species, stakeholder types and legal status of land. Socio-demographic variables commonly used in published studies such as gender, education and wealth, poorly explained attitudes. We conclude that greater conceptual clarity is urgently required to guide future attitude studies so that research can reliably inform the development of species management plans and policies.

Contents

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1. Introduction

Human–wildlife conflicts (HWC) are defined as occurring whenever an action by humans or wildlife has an adverse effect on the other (Conover, 2002). However since conflicts cannot occur between people and animals as animals cannot consciously engage in such conflicts (Peterson et al., 2010) suggestions have been made to define HWC more broadly and consisting of two components: (i) impacts that deal with direct interactions between humans and wildlife; and (ii) conflicts that centre on human interactions between those seeking to conserve species and those with other goals (i.e. biodiversity conflicts) (Redpath et al., 2013; Young et al., 2010).

Biodiversity conflicts and HWC are predicted to increase globally (Balmford et al., 2001; Henle et al., 2008; Pettigrew et al., 2012; Redpath et al., 2013) and pose a challenge for conservation managers, particularly in light of the rapid rate of biodiversity loss and the political consequences of failing to achieve Millennium Development Goals (Millennium Ecosystem Assessment, 2005) The drivers of these conflicts are well recognized (Balmford et al., 2001, 2012; Woodroffe et al., 2005; Young et al., 2010), however the solutions are less apparent and depend on disciplinary focus areas and the methods used within frameworks. For example ecologists and wildlife managers typically prioritize management of wildlife populations and their impacts using scientific knowledge and ecological principles rather than focusing on the human dimensions (Messmer, 2009; Young et al., 2010). They generally make three assumptions when managing HWC impacts: (i) the level of wildlife damage is directly related to the level of conflict, (ii) the level of conflict elicits a response proportional to the level of damage, (iii) mitigation activities appropriate to the level of conflict and damage will result in proportional support for conservation (Dickman, 2010). Under these assumptions, an obvious solution to HWC is to reduce the levels of damage through implementing technical mitigation measures, of which a wide variety exist (e.g. Breitenmoser et al., 2005; Lamarque et al., 2008; Linnell et al., 1996; Pettigrew et al., 2012). In contrast, a development paradigm that typically prioritizes human well-being highlights the costs associated with conserving biodiversity (Brockington, 2002; Neumann, 1998; Sundberg, 1998; West et al., 2006) and emphasizes solutions that primarily focus on increasing human well-being. More recently, inter-disciplinary and transdisciplinary approaches, which recognize the complexity of social–ecological systems (SES) (Berkes and Folke, 1998), have been proposed (Decker et al., 2012; Dickman, 2010; Messmer, 2009; Redpath et al., 2013; White et al., 2009). These approaches typically highlight the need to integrate ecological, economic and social perspectives using concepts and methods from a range of disciplines (e.g. conservation biology, anthropology, social psychology, economics and development studies). Within this approach effective solutions are not the preserve of any one discipline and focus equally on wildlife management as well as human dimensions.

Understanding the attitudes of stakeholders living in proximity to wildlife are recognized as essential for informing the design of wildlife management and HWC interventions (Decker et al., 2012; Manfredo et al., 2009). Attitudes can be defined as dispositions or tendencies to respond with some degree of favourableness, or not, to a psychological object, the psychological object being any discernable aspect of an individual's world, including an object, a person, an issue or a behaviour (Fishbein and Ajzen, 2010). The attitude construct is prominent in social psychology (Allport, 1935; Fiske and Taylor, 2013) as well as environmental psychology (Clayton, 2012; Heberlein, 2012), as the ability to evaluate one's environment is key to human existence. Without such evaluations we would be unable to make daily choices about how to behave (Fazio and Olson, 2012). Accordingly, the attitude concept has been at the centre of attempts to predict and explain human behaviour (Fishbein and Ajzen, 2010; Heberlein, 2012). Although attitudes do not always predict behaviour because an attitude seldom includes all the specific characteristics of a specific situation (Heberlein, 2012), positive attitudes towards an object or behaviour are necessary conditions for behaviour. For example, people who have a positive attitude towards hunting may not always partake in hunting but people with a negative attitude towards hunting will never hunt (Heberlein, 2012). In HWC attitude research provides insight on stakeholder preferences for diverse management options, indicate support for desired population sizes for a species, the extent of damage stakeholders are willing to tolerate and the desirability of different species on private or communal land (Kansky et al., 2014; Manfredo et al., 2009). With such information conservation managers can predict and design interventions more likely to be supported by stakeholders thereby preventing or reducing the emergence of potential conflicts. In addition, when the drivers of these preferences are understood, interventions can be more appropriately designed (Heberlein, 2012).

Although many HWC attitude studies have been conducted, most are site and species specific and no systematic quantitative reviews have been conducted which identify the drivers of attitudes across a broad range of species and societies (but see

Williams et al., 2002 for wolves). It is then difficult to see broader patterns across landscapes and upscale lessons learnt (Madden, 2004). For this reason, we conducted a meta-analysis (Glass, 1976) of publications investigating attitudes towards damage causing mammalian wildlife by people experiencing direct conflict with wildlife. Our first aim was to determine if common patterns of factors are present across a wide range of species, stakeholders and contexts. More specifically, we were interested in testing the hypothesis that the costs that stakeholders incur are the primary determinant of attitudes towards damage causing wildlife, as this is often considered to be the primary driver of negative attitudes towards a species and towards conservation in general (Dickman, 2010; Linnell et al., 2010; Madden, 2004). Another issue in research on attitudes towards damage causing wildlife is that currently no theories exist that are applied across a wide range of studies. This has resulted in a lack of a set of agreed variables or constructs to guide the selection of variables in attitude research, preventing cross species and cross-cultural comparisons. Therefore a second aim of our meta-analysis was to categorize, describe and critically evaluate variables used in HWC attitude research. This initiates a process of identifying variables and constructs to be included in a future theoretical framework. Our approach in the current study is inductive (Babbie and Mouton, 2007), meaning we do not pose a priori hypotheses of which variables are important. We identify which variables others have used and these form the basis for theory building. Designing a theoretical framework was beyond the scope of the current study however in a forthcoming publication we propose such a theoretical framework based on our findings in the current paper as well as drawing from theories and constructs from additional disciplines.

2. Methods

Meta-analysis is a statistical technique conducted on a large collection of results from individual studies that aims to integrate the findings (Glass, 1976). We conducted a meta-analysis of publications in English language peer-reviewed journals that surveyed stakeholders who had experienced direct conflict with medium- and large-sized carnivores, ungulates, elephants or primates. We focused on these groups since larger mammalian species primarily occur outside protected areas (Crooks et al., 2011; Grunblatt et al., 1996; IUCN, 2008); are generally more endangered (Inskip and Zimmermann, 2009; IUCN, 2008; Schipper et al., 2008), and are keystone species governing ecological processes (Estes et al., 2011). Publications detailing attitudes of individuals not having direct experience with HWC were excluded, as the general public can have more positive attitudes towards wildlife when not directly affected (Kaltenborn et al., 2006; Martín-López et al., 2008; Williams et al., 2002). The inclusion or exclusion of grey literature in a review depends on the relative importance of maintaining scientific rigor versus avoiding publication bias towards significant results (Calver and King, 1999; Rosenthal, 1979). We preferred scientific rigor that ensures that statistical analyses were peer reviewed thereby reducing the risk of sampling bias. Furthermore, we felt there was little risk of publication bias towards significant results because when using statistical models, as was the case in most of the publications in this review, the risk of publication bias was small.

We searched Web of Science for publications using terms described in Supplementary Material 1. Publications were also identified from the reference list of each publication. Publications were filtered to include only those that quantified attitudes as a scale or index and were published post-1990, as very few publications were identified before this date and typically applied outdated methods. Publications meeting these criteria were then examined in detail and six variables extracted and compiled in an Excel spreadsheet. The variables extracted were defined by their availability across all publications and their relevance to our research questions. The variables were; (1) species, (2) species group, (3) question type, (4) stakeholder group, (5) experience direct conflict and (6) country development status (see variable definitions in Table 1). Detailed analyses of these variables are reported in Kansky et al. (2014) where they were found to impact attitudes.

In addition to the above six variables, we extracted the variables that were examined by the authors in each publication for their effect on attitudes. We then recorded which variables were found to be statistically significant or non-significant when subject to statistical analyses by these authors. Each row in the dataset therefore represented a species, a species group, a question type, a stakeholder group, experience direct conflict, country development status and a variable that was either significant or non significant in explaining the attitude measure. These variables were then coded and grouped into main categories and sub-categories that emerged from the data through an iterative inductive assessment as per Babbie and Mouton (2007). We conservatively chose to split, rather than lump, categories in order to ensure all important categories were identified (Babbie and Mouton, 2007). In so doing, we note that each category potentially has increased likelihoods of having low frequencies of variables. The two-tier system of main and sub-categories may compensate for lower frequencies by lumping the sub-categories into main categories. These are defined in Table 2 together with the total number of publications that applied each category.

2.1. Data analysis

We constructed three indexes to describe category trends:

An *Application Index* (APP) measured the number of times each variable in a category was used in a publication expressed as a percentage. It is therefore a measure of the frequency that a category was examined in surveys because it was thought to be important by the author in explaining attitudes. This was computed according to the formula:

$$\mathrm{APP} = n{-}N \times 100$$

where n is the number of times each category was used in a study, N is the total number of publications in the meta-analysis (45).

A *Significance Index* (SIG) measured the relative frequency that variables included in a category were found to significantly explain attitudes and is therefore a measure of how important a category is in explaining attitudes. This was computed according to the formula;

$$\mathrm{SIG} = f\ (\mathrm{NS}) - f\ (\mathrm{S})$$

where f (NS) is the number of times variables in a category were not statistically significant, f (S) is the number of times variables in a category were statistically significant. Dividing these two frequencies allowed one to control for the fact that there were twice as many non-significant variables as there were significant variables. A value of 1 therefore indicates equal frequencies of non-significant and significant variables in a category. A value below zero indicates that the frequency of significant variables in a category is higher than non-significant variables and therefore is important in explaining attitudes. A value above 1 indicates that frequencies of non-significant variables in a category are higher than significant and therefore the category is of low importance in explaining attitudes.

An *Accuracy Index* (ACC) measured how often category variables were found to be significant in a publication (i.e. Significance Index-SIG) relative to the frequency it was applied in a publication

Table 1
The variables that were extracted from publications to form the database on which the current meta-analysis was performed. The primary variables are defined in the second column. Primary variables consist of secondary variables and these are listed and defined in the third column.

Primary variable	Definition	Secondary variables
Question type	The items (i.e. questions) used by individual publications to measure respondents attitudes, perceptions and tolerance	Questions were coded into seven themes that emerged from the data and were not based on any prior theoretical concepts. These were questions seeking responses: (i) Supporting an increase, decrease or stable future population of a species. (ii) As to whether a person has or would kill or remove a species from their property. (iii) Addressing the desirability of a species on a persons' property or the desirability to live near a species. (iv) Addressing support for removal or lethal control of a species as a management option, in the context of under-abundant species. (v) Addressing support for reduction of over-abundant species using non-lethal control. (vi) To questions consisting of single or multiple questions summarized into a single index that describes an affect or cognition about a species, such as the extent to which a species is liked or should be conserved. (vii) To the degree to which an individual will tolerate damage from a species
Species	Animals widely recognized as a biologically distinct group for which attitudes were reported	Each species was afforded a separate entry. Some publications reported on several species while others focused on a single species. The full species list is reported in Appendix S2
Species group	The order or grand order to which a species belonged	Species were categorized into four groups as carnivores, ungulates, elephants or primates using the order or grand order according to Kingdon (2003)
Country development status	The status of a country as categorized by criteria of wealth and human well being	Countries were categorized as either developed or developing according to the United Nations criteria of Developed or Developing regions. Developing countries were those from Africa, the Caribbean, Central America, South America, and Asia excluding Japan. Developed regions were North America, Europe and Japan. (http://unstats.un.org/unsd/methods/m49/m49regin.htm#least, accessed November 2011)
Experience direct conflict	Respondents who lived within the species range of the species under consideration	Publications were initially excluded if respondents attitudes were not recorded separately for respondents who lived within the species range of the species under consideration and those who did live in areas that included the species range of the species under consideration. However, the small number of publications identified using this criteria necessitated that we included those publications that consisted of both types of respondents. Ultimately, two categories of publications were identified: Live in Conflict Zone (LCZ) and Mixed Conflict and Non Conflict Zone (MZ)
Stakeholder group	The categories of respondents surveyed in the publications included in this meta-analysis	Five categories emerged from the publications surveyed: commercial farmers, communal farmers, urban residents, "other" and stakeholders who experienced no damage. Commercial farmers are people undertaking broad-scale crop and animal producers primarily for sale. Communal farmers are defined as small-scale crop and animal producers who primarily produce for subsistence and/or possibly for sale. "Other" category comprised: (1) some or all of these categories where a publication did not explicitly identify a stakeholder type, or (2) any other type of stakeholder that experienced direct conflict but were categorized differently by the researcher, for example rural, hunters, berry pickers. This last category was necessary because there were insufficient numbers of publications with these stakeholder categories to be statistically analyzed. "No damage" stakeholders were those who, although living in an area where a species occurred, did not have costs imposed by wildlife, for example tourists visiting a nature reserve

(i.e. the Application Index-APP) and is therefore a measure of how accurately categories are used relative to their importance in explaining attitudes. This was computed according to the formula;

$$ACC = \text{rank}\ (SIG) - \text{rank}\ (APP)$$

Rank (SIG) and rank (APP) are hierarchical rankings of these indexes and were computed by assigning each category (main category and sub-category) a rank according to their position in a hierarchy of importance. For the SIG index the lowest value received the highest rank of one, as it was the most important category that explained attitudes (Table 3, column 7). For the APP index the highest value received the highest rank of one, as it was the category that was applied most frequently in publications (Table 3, columns 8). Values of the ACC index close to zero mean that the SIG and APP ranks of a category were similar and therefore indicated that a category was applied in publications at a frequency similar to its significance in explaining attitudes. Extreme negative and extreme positive values indicate low accuracy. Extreme negative values indicate a category is highly under applied in publications relative to its significance in explaining attitudes. Extreme positive values indicate that the category is over applied in publications relative to its significance in explaining attitudes.

3. Results

We identified 45 suitable publications from 19 different countries that met the selection criteria (S2). Seven publications were from developed countries and 12 from developing countries (S2). Thirty-six species were assessed across all publications: 18 were carnivore species, 14 ungulates, 2 primates and 2 were elephant species (S2). On average, 8.7 variables (median = 8) were measured

per publication, ranging from 1 to 39 variables. There were almost twice as many non-significant (66%) as significant (34%) results. Sixteen main categories emerged from our coding of the variables (Table 2). Seven of these main categories could be sub-divided into 17 sub-categories (Table 2). Table S3 lists the publications that used each main and sub-category.

3.1. Application Index

The APP index ranged from 2 to 33 publications (4–73%) but most of the categories were rarely applied: eight (50%) main categories and five (29%) sub-categories were applied at frequencies of 13% or below (Table 3, Fig. 1). Only four (25%) of the main categories and three (17%) of sub-categories were applied in more than 50% of publications. The four main categories most widely applied were: *Cost* (73%), *Socio-demographic* (73%), *Landuse* (62%) and *Experience species* (56%). The three most widely applied sub-categories were: *Socio-demographic/age* (67%), *Cost tangible* (64%) and *Socio-demographic/gender* (53%) (Table 3, Fig. 1).

3.2. Significance Index

The SIG index ranged from 0.19 to 9 (Table 3, Fig. 1). Most categories were poor predictors of attitudes as only four main categories (25%) and five sub-categories (29%) had values below or equal to 1. The six best predictors of attitudes (those with values below 1) were: *Cost/intangible* (0.19), *Legal/tenure* (0.28), *Attitude* (0.4), *Legal* (0.44), *Socio-demographic/tribe* (0.88) and *Legal/conservancy* (0.92) (Table 3, Fig. 2). However they were all applied in few publications (2–10, 4–22%).

3.3. Accuracy Index

The ACC index ranged from −16 to 17 (Table 3). We divided this range into three groups corresponding to low (−11 to −16 and 11–16), moderate (−6 to −10 and 6–10) and high accuracy (−5 to 5) (Table 3, column 9). High accuracy means that the rank of a category in the APP was similar to its SIG rank indicating high agreement between the extent to which it was applied in publications and its importance in explaining attitudes. Only 50% of main categories and 35% of sub-categories occurred in the high accuracy group meaning that many categories that are important are not being applied while others that are not important are widely applied.

3.4. Costs and benefits

The *cost* category was commonly applied in surveys (73%) and was of high importance in explaining attitudes (SIG = 1.04) resulting in a high ACC of 5 (Table 3, Figs. 1 and 2). *Intangible costs* (22%) (indirect costs, such as psychological costs of danger or risk, Table 2) were the most important variable explaining attitudes (SIG = 0.19, Table 3) however *tangible costs* (direct monetary losses, e.g. number of livestock killed or proportion of crop lost, Table 2) were measured three times more often (64%). *Tangible costs* ranked 11th (out of 33) on the SIG index (SIG = 1.91) with almost twice as many non-significant as significant results, but since it was widely applied, resulted in a medium ACC of 8, meaning it was applied more often than it was important in explaining attitudes (Table 3, Fig. 2). *Intangible costs* resulted in a low negative ACC index (−11) since it was applied much less relative to its importance in explaining attitudes (Table 3).

The *benefit* category was applied less frequently than costs (in 27% of surveys). Benefits were also less important in explaining attitudes than costs (SIG = 2.66, Table 3). Contrary to costs, *tangible benefits* (direct monetary benefits; e.g. from tourism, trophy hunting, meat, Table 2) were applied at similar frequencies as *intangible benefits* (indirect costs, such as psychological costs of danger or risk, Table 2) (APP = 16%, Table 3). However, similarly to costs, *intangible benefits* were more important in explaining attitudes (SIG = 1.5, Table 3) than *tangible benefits* (SIG = 2.96, Table 3). This resulted in a negative ACC index for *intangible benefits* (ACC = −4), meaning it was applied less than it was important in explaining attitudes. The positive ACC index (ACC = 2) for *tangible benefits* meant it was applied more than it was important in explaining attitudes. Overall the ACC indices for benefits were high (Table 3).

3.5. Experience, exposure and interest in a species

Experience species was the third most common main category applied in surveys (APP = 56%, Table 3, Fig. 1), had a medium SIG index of 1.43 and a high positive ACC index of 4. The three sub-categories were all applied in relatively few surveys (Table 3, Fig. 1) but differed widely in the their importance in explaining attitudes. *Personal experience* of a species was the best predictor (SIG = 0.71) and was applied the most (APP = 27%, Table 3, Figs. 1 and 2). *Distance to species*, which typically was a measure of the proximity of a stakeholder to an area where a species occurred, predicted attitudes to a lesser extent (SIG = 1.83, Table 3, Figs. 1 and 2), while *Length lived in area*, which typically measured the duration of time a stakeholder resided in an area where a species occurred, was not a good predictor of attitudes as there were 9 times more non-significant results than significant results (SIG = 9, Table 3, Fig. 2).

Species characteristics typically comprising measures of perceptions of a species presence or absence, abundance, density, or the frequency with which it was observed (Table 2) had medium SIG index of 1.12, was applied in 12 (27%) publications and presented a relatively high ACC value of −3 (Table 3, Figs. 1 and 2).

3.6. Salience and knowledge

Salience was applied in 10 (22%) of publications and had a low SIG value (2.15) and therefore high ACC index (1) (Table 3, Figs. 1 and 2).

Knowledge was also applied in few publications (6, 13%) but had a medium SIG index (1.2) resulting in a low ACC index of −7 (Table 3, Figs. 1 and 2).

3.7. Sub-groups: socio-demographic, wealth and cohort

Socio-demographic variables (e.g. age, education and gender) were applied in the majority of publications (73%), but scored low on the SIG index, presenting a low ACC index (Table 3, Figs. 1 and 2), meaning they were applied more often than they were significant. The sub-category *tribe* was an exception with a high SIG index but low APP index (Table 3, Figs. 1 and 2). The main category *Wealth* was also over represented in surveys compared to its significance (Table 3, Figs. 1 and 2).

Half of all *cohorts* quantified were found to significantly predict attitudes (SIG = 1). This category was well applied (19, 42%) resulting in a high ACC index of −2 (Table 3, Figs. 1 and 2).

3.8. Institutions and Legal

Legal and *institutions* were rarely applied in publications occurring in five (11%) and two (4%) of studies respectively (Table 3, Fig. 1). *Legal* however was very important in explaining attitudes (SIG = 0.44) while institutions poorly explained attitudes (SIG = 6).

Table 2
The main and sub-categories resulting from the coding of variables that were examined by authors of each publication for their significance in explaining attitudes towards carnivores, ungulates, elephants and primates. Sixteen main categories resulted from the coding process and are listed in alphabetical order in the second column. The third column lists the number of publications that applied each category. The fourth column defines each category. The final column defines the sub-category (where present) and provides additional explanations and examples.

	Main category	No. of publications	Definition		Sub-categories (where present)
1	Attitude	6	A disposition to regard the species as favourable or unfavourable	1.1	These are cases where a publication provided data on correlations between two attitude measures. In such cases one attitude variable is a dependent variable and a second different attitude measure was an independent variable
2	Benefit	12	A perception of receiving positive outcomes from the species	2.1	Tangible benefits – those where the respondent receives direct monetary benefits due to the presence of the species on their land or in the area. For example from compensation programs, development projects, subsidies for implementing mitigation measure, hunting fees or tourism
				2.2	*Intangible benefits* – the indirect benefits as perceived by the respondent, such as existence value of the species, aesthetic value or use for cultural purposes
3	Context	2	A specific condition for which the attitude question is asked	3.1	For example when an animal is seen close to a village, if it has only threatened a person, injured a domestic animal, when it has killed a domestic animal or a person
4	Cost	33	A perception of negative outcomes due to a species	4.1	Tangible costs – those where the respondent receives direct monetary losses due to the presence of the species on their land or in the area. For example the number of livestock killed, whether any damage was incurred or the severity of damage
				4.2	*Intangible costs* - the indirect cost as perceived by the respondent, such as psychological costs of fear, danger or risk
5	Experience species	25	The extent to which a person was exposed or interacted with the species	5.1	Distance to the conflict – in cases where respondents were surveyed adjacent to a protected area or how far they were to a known territory of the species
				5.2	Length lived in area – for cases where the length a responded lived in the area was an indicator of how long they were exposed to living with the species
				5.3	Personal experience – for cases where a person actually saw the species or saw signs of it or had a particular interaction or the frequency of experience/interaction
6	Institutions	2	Attitudes or trust towards various government organizations	6.1	Examples of institutions include wildlife authorities, compensation programs, or community representatives
7	Knowledge	6	Information that a respondent has about a species	7.1	Knowledge could be about the natural history of a species, wildlife in general or conservation in general
8	Landscape characteristics	6	The features of the environment where the species occurs	8.1	Examples include density of properties for example rural or urban, size of community, or housing density
9	Land-use	28	The type of activities that were undertaken on the land where the species occurred	9.1	Cohort – was used to indicate how the respondent used the land in terms of their identity or occupation. For example, hunter, farmer, forester, livestock producer, lived on a farm, obtained income from farm, was dependent on income from land
				9.2	Activity-what types of activities took place on the land. For example livestock, game, mixed game and livestock
				9.3	Dependency – whether the respondent was dependent on the resource that is impacted by the species. For example livestock dependency (recorded as residuals of regression of livestock numbers against crop area, presence of livestock), purpose of keeping livestock (sale, subsistence, tradition), main source of income from farm or other
10	Legal	5	The judicial status of land on which the respondent lives	10.1	Conservancy – whether the land was managed as a conservancy or not
				10.2	Tenure - types of land ownership were private, communal private, communal government, Wildlife Management Area
11	Mitigation measures	4	The methods used to prevent or reduce damage from a species	11.1	Examples include whether mitigation measures were used, the number of mitigation measures used or the extent to which they were effective
12	Property characteristics	4	Features of the land on which a species occurs	12.1	Examples include the presence of ''play ''trees that attract cheetah to mark at, livestock density and livestock type
13	Salience	10	A measure of how important a species or wildlife in general or nature in general is to a respondent	13.1	Examples include attention to wildlife stories in press, general environmental concern, interest in walking in a forest, picking berries, fishing, member of a nature NGO
14	Socio-demographic	33	A variable that measures a combination of sociological (=related to sociology) and demographic (=relating to populations) characteristics	14.1	Age
				14.2	Gender
				14.3	Education
				14.4	Tribe
				14.5	Other – included rural or urban upbringing, number of children in school, religion, household size, age of children
15	Species characteristics	12	Features of a species as perceived by the respondent	15.1	Examples include measures of perception of presence of a species, its abundance, frequency it is seen or its density. This category is similar to *Experience species* but differs in that the variable is a measures of a species characteristic whereas *Experience species* measures a human characteristic
16	Wealth	15	Measures of the monetary value of the respondent	16.1	Examples include number of livestock, size of farm, size of field, income, perceived financial stress

Table 3
Values of the three indexes used to describe meta-analysis result. The calculation of these indexes and their interpretation is described in Section 2. Main categories are recorded as single words and sub-categories are recorded as two words, the first being the main category and the second the sub-category. We divided the range of values for each index into high, medium and low values. High values for all indexes are highlighted in dark cells, low values are highlighted in the lightest cells and medium values are highlighted in cells of shades intermediate between the darkest and lightest coloured cells.

Main category and sub-category	No. of publications	APP%	No. significant	No. non-significant	SIG	Rank SIG	Rank APP	ACC
Legal/tenure	3	7	36	10	0.28	2	18	−16
Legal/conservancy	2	4	12	11	0.92	5	19	−14
Legal	5	11	48	21	0.44	3	16	−13
Context	2	4	11	11	1.00	6	19	−13
Attitude	6	13	5	2	0.40	3	15	−12
Cost/intangible	10	22	36	7	0.19	1	12	−11
Socio-demographic/tribe	6	13	17	15	0.88	5	15	−10
Knowledge	6	13	5	6	1.20	8	15	−7
Mitigation measures	4	9	2	3	1.50	10	17	−7
Experience sp./personal	12	27	14	10	0.71	4	10	−6
Property characteristics	4	9	2	4	2.00	12	17	−5
Benefit/intangible	7	16	6	9	1.50	10	14	−4
Species characteristics	12	27	17	19	1.12	7	10	−3
Landscape characteristics	6	13	6	12	2.00	12	15	−3
Land-use/cohort	19	42	19	20	1.05	6	8	−2
Experience sp./distance to species	11	24	6	11	1.83	10	11	−1
Salience	10	22	13	28	2.15	13	12	1
Benefit/tangible	7	16	23	68	2.96	16	14	2
Institutions	2	4	0	6	6.00	22	19	3
Experience species	25	56	21	30	1.43	9	5	4
Land-use/dependence	7	16	2	7	3.50	18	14	4
Cost	33	73	71	74	1.04	6	1	5
Benefit	12	27	29	77	2.66	15	10	5
Socio-demographic/other	5	11	3	12	4.00	21	16	5
Socio-demographic/education	22	49	26	64	2.46	14	7	7
Land-use/activity	5	11	12	100	8.33	23	16	7
Cost/tangible	29	64	35	67	1.91	11	3	8
Wealth	15	33	12	44	3.67	19	9	10
Experience sp./length lived area	8	18	1	9	9.00	24	13	11
Socio-demographic/age	30	67	27	81	3.00	16	2	14
Socio-demographic/gender	24	53	20	76	3.80	20	6	14
Socio-demographic	33	73	93	318	3.42	17	1	16
Land-use	28	62	33	127	3.85	20	4	16

3.9. Mitigation measures

Mitigation measures were applied in few publications (4, 9%), were of medium importance (SIG = 1.5) resulting in low accuracy (ACC = −7) (Table 3, Figs. 1 and 2).

4. Discussion

4.1. Costs and benefits of living with damage causing wildlife

The costs and benefits associated with living with wildlife, notably for people adjacent to protected areas, have generally been considered the primary determinants of attitudes towards wildlife, and conservation initiatives more broadly (Chan et al., 2007; Linnell et al., 2010; Treves and Bruskotter, 2014). Interestingly, *intangible costs* were more important than *intangible benefits* and *tangible costs* were also more important than *tangible benefits*, suggesting that negative perceptions may more strongly determine attitudes than positive perceptions. The propensity for negativity bias is well documented in economic psychology (Kahneman, 2011). For example, individuals are only indifferent to a prospect involving a 50% chance of losing $50 if it also affords a 50% of winning $100. This bias increases with increased attachment to an object (Kahneman, 2011). Individuals may thus require at least twice as many benefits than costs in order to tolerate wildlife particularly if they have strong attachment to their livestock (Vitterso et al., 1998). The relative importance of costs versus benefits in determining attitudes to different wildlife species would therefore be an important future research imperative as this would usefully inform the ratio and types of benefits needed in order to counter the costs of living with wildlife.

4.1.1. Costs of living with damage causing wildlife

Not surprisingly, the perceived costs of living with a species were one of two categories most commonly applied in surveys, and were of high importance in explaining attitudes. However, separating *costs* into *tangible* and *non tangible*, the high significance is mostly due to *intangible costs* which were ten times more significant than *tangible costs*. This finding supports recent qualitative reviews emphasizing the importance of non-tangible cost variables (Barua et al., 2013; Dickman, 2010; Redpath et al., 2013). Caution however is required in concluding that *tangible costs* are not important due to methodological considerations. Of 29 publications quantifying *tangible costs*, 26 used a unique measure of damage meaning there was no overlap in how the damage was measured in each case. This could mean that for a particular study damage may have been significant if a different damage variable were used. Although 13 of these 26 unique measures were from one publication, one measure (experience damage or not) was used in the majority of publications (69%). Here equal numbers of significant and non-significant results were documented suggesting damage is not always important. Although this measure is simple to apply, it accounts neither for the extent nor frequency of damage. For example, a person may incur damage once a year or 10 times a year and these events are quantified equally. Similarly, two peoples experiences would be quantified as equal when a single damage event destroys 90% of one's crops and 1% of the others. Other cost measures used were costs over a specified time frame, total financial losses, total number of livestock lost or the percentage of holdings lost. These measures are possibly also inadequate as the value placed on objects by a person is determined by various cognitive biases (Kahneman, 2011).

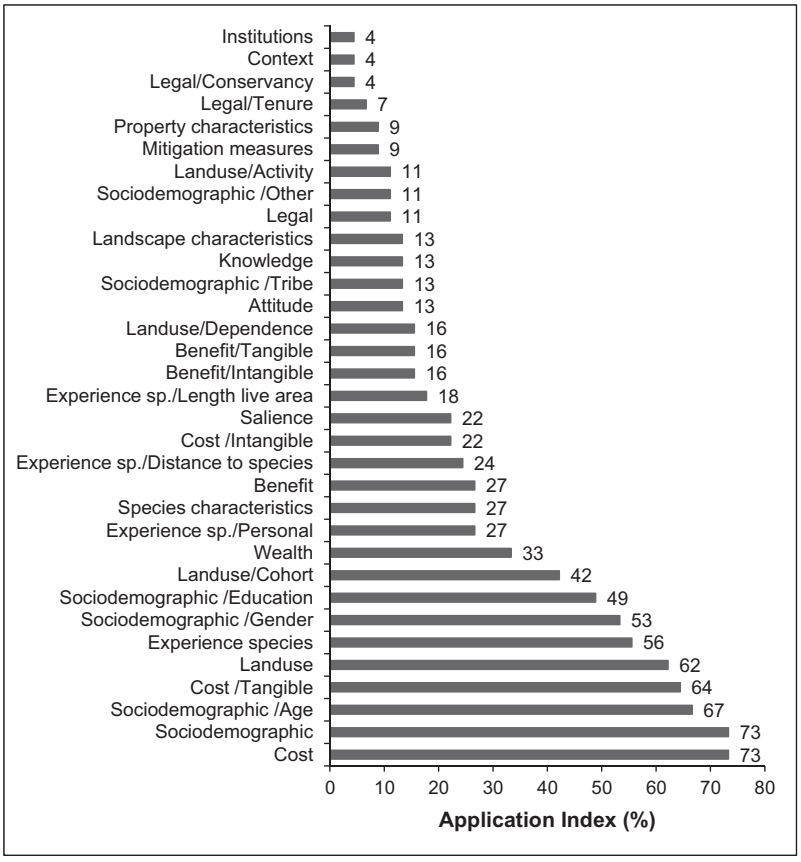

Fig. 1. Application Index (APP) for main and sub-categories according to increasing importance. Main categories are recorded as single words and sub-categories are recorded as two words, the first being the main category and the second the sub-category.

A more useful measure may be the amount or proportion of the most substantial income source that is lost relative to the total benefit (financial or otherwise). For example, Bagchi and Mishra (2006) recorded predation by Snow Leopard in the Kibber and Pin Valleys in Spiti, India. Despite suffering greater livestock losses than farmers in Pin valley, Kibber valley farmers had more positive attitudes, possibly because in the Pin valley horses being predated were more important in contributing to people's livelihoods compared to the cash crops grown in Kibber Valley. The sub-category *dependency* within the main category *land use* provides an example of how this concept could be operationalized. However since it was rarely applied in surveys its low importance in explaining attitudes in our study (Table 3, Figs. 1 and 2) must be treated with caution. It is also possible that its operationalization in surveys was inappropriate as each household may be unique. For example, in the same village one household may depend on livestock while another household may depend on alternative sources of income. If however *intangible costs* are more important than *tangible costs* the use of financial incentives such as compensation schemes for livestock or crop loss will need to be reconsidered as a strategy to increase tolerance.

4.1.2. Benefits of living with damage causing wildlife

Given the importance that benefits are considered to have for determining support for species conservation (notably through provision of ecosystem goods and services: Chan et al., 2007; Linnell et al., 2010; Nature, 2005; Treves and Bruskotter, 2014), it is surprising that measures of *benefits* appeared in relatively few publications both compared to *costs* and compared to other categories. Also surprising was the low importance of *benefits* in explaining attitudes. This suggests a mismatch between qualitative and quantitative researchers. Caution however is required in interpreting these results because as the number of surveys applying a category decreases, the accuracy of the SIG index decreases (see also Section 4.8). Therefore future attitude surveys should aim to apply benefit categories, particularly in light of the importance qualitative reviews ascribe to this category (Treves and Bruskotter, 2014). Further, methodological limitations in measuring *tangible benefits* are similar to those of measuring *tangible costs*, meaning caution is warranted when results suggest that benefits are not as important as costs. The low application of benefits in surveys may also be a consequence of a tendency to focus on the negative due to negative perceptions of the impacts of wildlife by both stakeholders and researchers and be due to the limitations in survey length and narrow focus of publications.

4.1.3. Intangible costs and benefits

For both *costs* and *benefits*, *intangible costs* and *intangible benefits* were more important in explaining attitudes than *tangible costs* and *tangible benefits*. The importance of *intangible costs* and *benefits* has also been recognized through recent research focused on the role of emotions in determining attitudes (Jacobs et al., 2011; Vaske et al., 2013) as well as the hidden health, opportunity and transactions costs of living with damage causing wildlife (Barua et al., 2013). Understanding *intangible costs* will greatly improve our identification of factors determining attitudes. *Intangible benefits* such as positive emotions, existence values aesthetic or cultural values as well as ecosystem services have been less applied and is an important future research imperative.

One of the aims of this study was to test the hypothesis that the costs and benefits that stakeholders incur are the primary determinant of attitudes towards damage causing wildlife. Our study

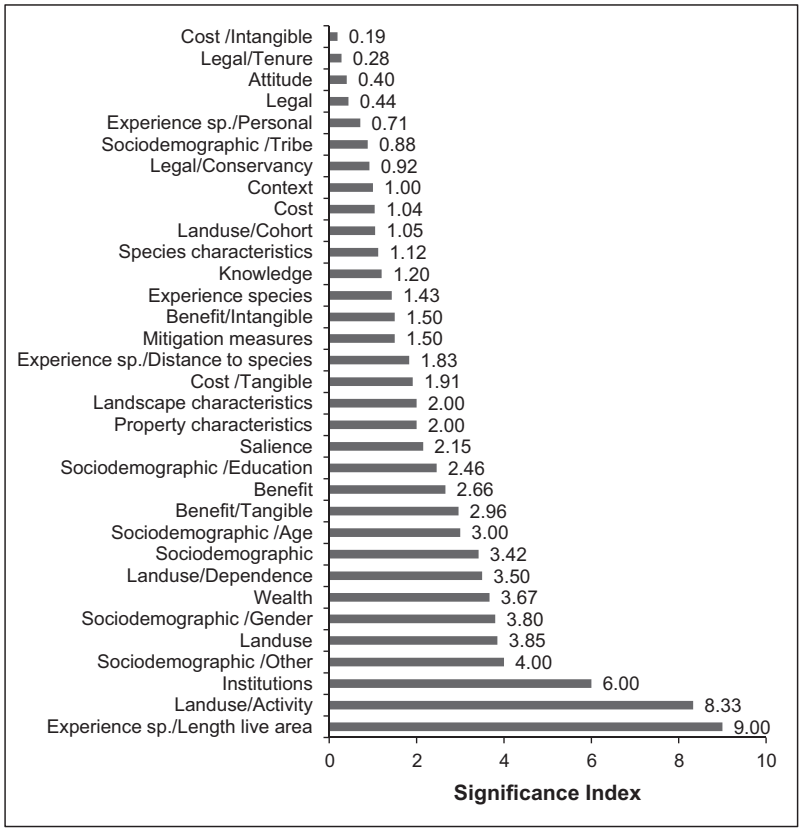

Fig. 2. Significance Index (SIG) for main and sub-categories according to decreasing importance (i.e. low values indicate high importance). Main categories are recorded as single words and sub-categories are recorded as two words, the first being the main category and the second the sub-category.

found that while *intangible costs* were highly important, *tangible costs* and both *tangible* and *intangible benefits* were of low importance in explaining attitudes. We cautioned however against concluding that costs and benefits are of less importance because of methodological issues. To overcome these, we recommend that at the start of a study qualitative research is conducted to determine types of costs and benefits operating at a site and the resources that are being impacted by different species of wildlife. Once this is understood these can be incorporated into a multi item construct (Worthington and Whittaker, 2006). These items can then be examined for their contribution to a cost construct, which in turn can be analyzed for explaining attitudes. This will allow conservation managers to target the most important costs to reduce and benefits to increase.

4.2. Experience and exposure to wildlife

Learning from experience is a fundamental concept of life. Failure to learn increases the risk of death and therefore should be highly adaptive. Learning is defined as "a change in behavior due to experience" (Chance, 2013). Stronger experiences are more likely to be retained in memory and more rapidly recalled, resulting in stronger attitudes and more congruence between attitudes and behaviour (Glasman and Albarrac'in, 2006; Heberlein, 2012). Therefore the extent to which a person is exposed to a species and the extent to which exposure results in interactions with a species are likely to be important predictors of attitudes towards a species. It is therefore not surprising that our category of *experience species* was the third most common main category applied in surveys suggesting that most researchers recognize the importance of experience in predicting attitudes. However, of the three sub-categories used *personal experience* was the best predictor but was only applied in a third of publications. It is also the most direct measure compared to *distance to species* and *length lived in area*. Given the significance of this sub-category, and of the power of negative experiences in explaining attitudes (Baumeister et al., 2001; Rozin and Royzman, 2001), adoption of direct measures of the nature, extent and frequency of *personal experience* of a species should be a priority in future surveys.

The main category *species characteristics*, typically comprising measures of perceptions of a species presence or absence, abundance, density, or the frequency with which it was observed can also be considered an indicator of experience of a species. This is because the greater its abundance, density or frequency it is seen the higher the probability of experiencing a species. This category however differs to the *experience species* category in that it measures attributes of a species whereas *experience species* measures attributes of people. *Species characteristics* could also be a separate measure of the extent to which a person is exposed to a species. In other words how often a species is present at a specific distance to a person is different to the type of experience a person has when in the presence of a species. Therefore we suggest application of two distinct measures; exposure and experience. It will then be more accurate to compare attitudes between stakeholders while controlling for exposure since higher exposure would increase the probability of incurring costs and therefore negative attitudes.

4.3. Salience and knowledge

The main category *salience* was generally measured by indicators such as attention to wildlife stories in the press, general environmental concern, interest in walking in a forest, picking berries, fishing or membership of an environmental group (Table 2). We assume the rationale of these indicators is that higher interest in

nature or wildlife motivates action on that interest and increases the probability of positive experiences resulting in positive attitudes. The low importance of *salience* in explaining attitudes however suggests that this assumption may not be valid. However, we caution against this conclusion, due to the low application of this category in studies (see Section 4.8) as well as the possibility that measures used may not be sufficiently specific. The Theory of Planned Behaviour (TPB) specifies that general attitudes towards an object or issue may result in poor prediction of specific attitudes or behaviours (Fishbein and Ajzen, 2010). We hypothesize that specific interest in animals and wildlife would be an important predictor of attitudes towards damage causing wildlife and suggest future surveys test this using more specific indicators rather than general interest in nature or the outdoors.

The main category *knowledge* may be suitably categorized with *salience* as it could indicate the level of interest in a species, the assumption being that people will be more knowledgeable on objects or topics they are interested in. The higher importance of *knowledge* over *salience* suggests that *knowledge* questions may be better predictors of interest in a species than the behaviours' measured under *salience*. If, however, people's level of knowledge is tested under the assumption that knowledge per se about wildlife or conservation translates into positive attitudes, i.e. that there is a causal relationship between knowledge and positive attitudes, this assumption is more tenuous as knowledge of accurate facts does not necessarily translate into positive attitudes or behaviour (Ajzen et al., 2011; Heberlein, 2012). For instance, knowledge about saiga antelope (*Saiga tatarica*) ecology and population decline was high but individuals with accurate knowledge were not less likely to poach (Kuhl et al., 2009). A pertinent future research question is what type of knowledge is important in the context of HWC, if at all? In the TPB subjectively held knowledge (i.e. beliefs) are the only type of relevant knowledge that predicts behaviour (Fishbein and Ajzen, 2010). In theories of pro-environmental behaviour (Klöckner, 2013) knowledge of the environmental problem is an important mediator of pro environmental behaviour. For instance perceived severity of water shortage during a drought predicts households' efforts to conserve water (Van Vugt and Samuelson, 1999). In HWC lack of problem awareness is unlikely. Working knowledge, defined as the information a person has at their disposal when evaluating or processing information about an object or issue (Wood et al., 1995) may be relevant for HWC. For example knowledge of different types of prevention methods to reduce or prevent damage may determine whether they are implemented or attitudes towards implementing them. We therefore recommend that future surveys refrain from using general knowledge type questions and focus on questions of working knowledge when relevant to the context of the study.

4.4. Sub-groups as useful targets for conservation interventions

Exposure of sub-groups within a population to diverse learning experiences may produce different attitudes or behaviours. Understanding these differences allows for specific interventions to be designed and targeted for different sub-groups (Carpenter et al., 2000; Fishbein and Ajzen, 2010). *Socio-demographic* variables such as age, education, gender and wealth were generally poor predictors of attitudes despite being widely applied. Overall they are therefore not useful target subgroups for mitigation interventions. However, they may be useful for describing populations, for example to ensure equal representation of gender, age, education and wealth in a sample. The sub-category *tribe* was an exception showing high importance in explaining attitudes. Since different tribes are likely differ culturally, this finding is unsurprising. However since it was applied in few surveys, it should be investigated in future surveys.

Wealth was also over represented in surveys compared to its significance. When framed in the traditional HWC perspective where costs are considered the primary driver of attitudes, this seems counter intuitive. A wealthy person could be expected to have more positive attitudes as their wealth could provide resilience to damage. Alternatively they could be expected to have negative attitudes as they are more able to manipulate their context (i.e. environment) to be as they want it, meaning they are less used to costs when they unexpectedly occur. A possible explanation for the low significance of *wealth* may be that the measures used do not incorporate the total wealth of a person. For example, each household may have a different primary income sources so measuring only number of livestock when the household has income from outside work or other assets would underestimate the wealth and therefore resilience of a household. Therefore, we suggest using multiple indicators of wealth such as those often used in national population censuses to create a wealth index rather than relying on one indicator. Choice of indicators that are comparable across wide ranges of wealth such as those occurring between developed and developing countries would be useful for cross-cultural studies.

The *cohort* sub-category was useful in defining sub-groups as half of all *cohorts* quantified were found to significantly predict attitudes. This suggests studies have targeted meaningful groups. Contexts where sub-groups are not significant may usefully indicate that interventions are not required for these groups. *Salience* and *cohort* are similar, but different, measures of an individual's activities. *Cohort* proved twice as important as *salience*, which may be a result of higher relevance of these groups to activities on the land and therefore more closer experience of the impacts of a species compared to the more indirect experiences by individuals in the *salience* grouping.

4.5. Institutions

Institutions are defined as durable systems of established and embedded social rules (convention, norms and legal rules) that structure social interaction (Hodgson, 2006). The definition of HWC as consisting of two components; (i) impacts that deal with direct interactions between humans and wildlife species; and (ii) conflicts that centre on human interactions, indicates four key stakeholder groups: wildlife, people who are impacted by wildlife, stakeholders not directly impacted by wildlife (e.g. Non Governmental Organizations) and authorities. It follows that institutions and relationships between stakeholder groups and institutions are critical. However, the two categories in our meta-analysis *legal* and *institutions* were rarely applied in publications. There is a strong indication from managing common pool resources that institutions and their relationships with stakeholders are important factors in sustainable resource management (Brooks et al., 2013; National Research Council, 2002; Ostrom, 2009). There is also a high level of institutional failure in resource management (Acheson, 2006; Anthony et al., 2010). Therefore incorporation of institutional issues into future HWC attitude research is an urgent future research imperative (Decker et al., 2013; White et al., 2009). This could be incorporated into surveys by evaluation of support for relevant organizations and laws related to wildlife and natural resource management in an area. Communities or individuals who have low trust and support for a particular organization or legislation are less likely to support interventions or laws promulgated by them. Further, when there is a mismatch between the attitudes of stakeholders and organizations, mitigation strategies or policies they are not likely to be up taken by stakeholders therefore increasing conflict (Heberlein, 2012).

4.6. Mitigation measures

Documenting and understanding stakeholder use of and reasons for implementing mitigation measures (or not) is important as mitigation measures have the potential to prevent or reduce the costs of living with wildlife. However, *mitigation measures* were applied in few publications in our study. They are also often not used by stakeholders (Frank et al., 2006; Maclennan et al., 2009). The reasons for their lack of use has rarely been investigated. Understanding the relationship between attitudes and the types of mitigation measures used is also important since positive attitudes although in some cases may be associated with less lethal and more integrated pest management (Canavelli et al., 2013), is not always a good measure of sustainable management practices (Heberlein, 2012). For example in a meta-analysis (Kansky et al., 2014) commercial farmers tended to hold more positive attitudes to damage causing wildlife than communal farmers however one could not assume that these farmers engaged in more sustainable management practices as commercial farmers may have relatively more resources to manage and extirpate wildlife. The TPB (Fishbein and Ajzen, 2010) could be used to investigate use of mitigation measures as well as factors that enable or constrain their use.

4.7. Context

Although applied in only two publications context is generally considered an important aspect in attitude surveys as slight changes in context can result in different interpretation of a question and therefore different results (Heberlein, 2012; Zinn et al., 2000). For example in the TPB (Fishbein and Ajzen, 2010) four elements must be part of an attitude question; the action performed, the target at which the action is directed, the context in which it is performed and the time at which it is performed. Compare for example, the difference between a general question such as: Do you support elephant conservation, compared to: Do you think an elephant should be culled when it is seen 100 m from your house two times a week? Not surprisingly significant differences in attitudes towards different wildlife species and willingness to pay for their conservation have been reported in studies where questions were categorized into different types (Kansky et al., 2014; Martín-López et al., 2007). We recommend future attitude questions be operationalized as constructs rather than single item questions (Worthington and Whittaker, 2006). This will allow incorporation of a diversity of contexts.

4.8. Limitations of study

This study has some limitations that should be noted. Firstly, the majority of publications involved carnivores. Ungulates were moderately represented but very few studies involved elephants and primates, meaning caution is required when generalizing results. We do not think this would affect the list of variables and categories examined because we surmise that the categories of drivers in these conflicts would be similar for all wildlife species. Where differences most likely occur are in relative importance of categories for different animal species. For example *tangible costs* may be more important for species that particularly target important income generating crops while *intangible costs* may be more important for particularly dangerous species. Similarly *tangible benefits* may be more important for species that generate larger contributions to livelihoods, while *intangible benefits* may be more important for species that are particularly attractive or have high symbolic importance. This in turn may impact the relative importance of other categories. For example where *tangible benefits* are important, the role of *institutions* may become more important as the presence of laws, policies and relations with authorities could enable or limit the ability of stakeholders to capitalize on these benefits.

A second limitation is the low coverage of species, stakeholders, question type and sites for each category and sub-category since these variables have been shown to affect attitudes (Kansky et al., 2014). Controlling for these variables would require an extensive number of publications that were not available in this study.

A third limitation was the low application of many categories in publications, which was also a major finding. This impacts on the accuracy of the SIG and ACC indices because the less a category is applied the higher the chance that the number of times it was found to be significant or not will be random. For this reason the indexes are not the sole basis of our evaluation of categories; we also use concepts and theories from other disciplines and qualitative reviews.

5. Conclusions

Increasing pressures on biodiversity will increase the frequency and magnitude of HWC events. An understanding of the causes of these conflicts is a prerequisite for developing effective and cost-efficient management strategies to ensure achievement of conservation goals. People are a part of all HWC problems meaning social research methods are essential for understanding what solutions are more likely to be effective because congruence between attitudes and policies are essential (Heberlein, 2012). Surveys and interviews can provide quantitative assessments of the attitudes of stakeholders and this information can guide management strategies (Decker et al., 2012; Heberlein, 2012; Manfredo et al., 2009). Quantitative surveys are particularly useful to identify the extent and magnitude of a problem because without such surveys powerful individuals or groups can distort reality. However, for research to usefully contribute to providing solutions to HWC problems, research must be targeted on the most soluble dimensions of these problems.

Despite the limitations of this study it is valuable in several ways. Firstly, it is the first attempt to consolidate the large body of research on this topic. Secondly, we have initiated a process of evaluating potential drivers of attitudes and how they may contribute towards building a comprehensive theory of factors that determine attitudes towards damage causing wildlife. Thirdly, a combination of our indices together with critical evaluation of categories based on available theory allowed us to identify a relatively small subset of specific variables of significance for explaining attitudes across a range of mammal species and contexts. The review also identified a large sub set of categories with low importance in explaining attitudes. This is useful because it allows for research to be more effectively targeted and creates opportunities to critically examine the theory behind their use.

Our intention was to find broad patterns of factors that explain attitudes so as to determine if these can be applied across a wide range of species and contexts therefore our indices were designed for this purpose. However, variables that were not found to be important with our indices should not necessarily be discarded in future surveys because they may be relevant in a particular context.

Ultimately management strategies need to be designed on a case-by-case basis but application of broader strategies and policies should be the aim in order to reduce costs and increase efficiency. This could also avoid conflicts between organizations responsible for different species (McCracken, 2009) by promoting more effective coordination across the different jurisdictions of management and policy-making organizations. For this to be achieved, a broad conceptual framework for understanding and managing HWC is necessary.

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Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.biocon.2014.09.008.

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