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Abstract

Tolerance may lessen when wildlife adversely impacts people. Models from

psychology can help elucidate how people make judgements, why they act

accordingly, and whether beliefs and norms influence support for policy and

intervention. Working in a globally important region for tigers, we estimated hunting

prevalence for this endangered species and three sympatric taxa using methods for

asking sensitive questions. We also investigated the relative strength of ethnicity and

social-psychological predictors in influencing intention to hunt. Men's behavioural

intention and perceptions differed by species: pro-conservation values were most prevalent for tiger, weakest for wild boar. Perceived behavioural control was the strongest predictor of hunting-intention; affect and injunctive norms were also important. The prominence of affect in determining intention suggests increasing environmental knowledge is unlikely to curb hunting. However, existing norms could be leveraged to incentivise behaviour-change. Integrating behaviour-change models into conservation science is crucial where strategies require changes in people's actions.

Introduction

As rural populations grow, people can come into greater contact with wildlife. Where wildlife adversely impacts people, tolerance may be lessened (Redpath et al. 2013). Tolerance can be attitudinal, such as beliefs and values, and behavioural, such as killing or political lobbying (Bruskotter & Wilson 2013). Viewed on a continuum (Fig.1), intolerance and stewardship are expressed through actions including killing animals or political lobbying for/or against a species, whilst acceptance/tolerance is a passive concept requiring no action (Bruskotter & Fulton 2012). This conceptualisation permits the application of models and hypotheses from psychology to better our understanding of how people formulate judgements, and ultimately why they act as they do.

Observed behaviour and behavioural intention are considered the best indicators of species tolerance, and antecedents of both have been studied extensively

(Bruskotter & Fulton 2012; Bruskotter & Wilson 2013). For example, the theory of planned behaviour (TPB) posits that behavioural intention, the immediate precursor to behaviour, is shaped by attitude towards the behaviour, perceived societal expectations (subjective norms) and the perceived behavioural control (PBC) people believe they have (Fishbein & Ajzen 1975).

The relative importance of TPB constructs varies across behaviours. For example, attitude best predicted ranchers' intention to kill jaguar in Amazonia (Marchini & Macdonald 2012), whilst PBC was the strongest predictor of intention to hunt deer in the USA (Shrestha et al. 2012). Factors including affect and norms are also important predictors of behaviour, as are the perceived probability of capture and punishment when examining rule-breaking (Nagin 1998). Slagle et al. (2012) showed how affect, the instant feeling of goodness or badness people have to stimuli (Slovic et al. 2007; Wilson 2008), influenced people's beliefs about wolf recovery. Positive emotions were associated with positive beliefs about wolf recovery, and had a greater influence on people's intention to engage in politically-relevant behaviour with respect to recovery, than knowledge of wolf biology (Slagle et al. 2012). Descriptive norms are one's perception of what most people do and they motivate individuals to act accordingly (Cialdini et al. 1991). In contrast, injunctive norms are perceptions of what most people approve/disapprove of, defining how individuals act according to group rules (Cialdini et al. 1991). Both types of norm can trigger behavioural changes (Cialdini 2003) and there is evidence they relate to conservation-compliance. For example, in Taiwan people reporting little awareness

(descriptive) and familial disapproval (injunctive) of killing leopard cats were less likely to have killed them (St. John et al. 2015).

There is clear evidence that factors such as beliefs and affect, through their role in judgement and decision making, influence support for policy and management actions (Finucane et al. 2000; Slagle et al. 2012) and that studies investigating the relative importance of behavioural predictors can usefully inform the design of conservation interventions (Marchini & Macdonald 2012; Slagle et al. 2012). Building on such studies we investigate hunting prevalence of tigers and three sympatric species (boar, *Sus scrofa*; sambar, *Rusa unicolor*; pangolin, *Manis javanica*) in Sumatra, Indonesia. Further, we measure the relative strength of ethnicity and social-psychological factors in influencing men's intention to hunt these species, which vary in protection status and perceived value to people.

Sumatran people are renowned for their diverse cultural and spiritual beliefs, which are thought to permeate their interactions with wildlife (Bakels 2013). Whilst Christianity may attribute souls exclusively to people, such spiritual elitism is incomprehensible to many Asians (McNeeley & Sochaczewski 1988). Minangkabau and Kerincinese reportedly believe ancestral souls transfer to tigers, which then protect people, only attacking someone who breaks customary law (McNeeley & Sochaczewski 1988; Bakels 2013). We expected negative attitudes and affective responses, pro-killing norms, low perceived probability of enforcement and high PBC to be indicative of intention to kill; ethnicity was expected to be related to intention,

particularly for tiger. Understanding people's relationship with different species can help develop a more complete picture of their ability to coexist with wildlife.

Methods

Identified as a global priority for tiger survival (Dinerstein et al. 2007), Kerinci Seblat National Park (KSNP) supports ~145 tigers, ~30% of the Sumatran population (Linkie et al. 2006, 2015), which exist despite encounters with people. Unlike other areas in Sumatra where forest has been converted to large-scale plantations, smallholder farming communities of different ethnicities border KSNP. Tigers occasionally attack livestock and people (Linkie et al. 2007), and key prey species, boar and sambar, crop raid. Whilst sambar are hunted for meat (Bakels 2013), Islam prohibits consumption of boar so hunting for this purpose is unlikely. However, snares found in KSNP where all hunting is prohibited, are indiscriminate (Linkie et al. 2015). Regionally, increases in wildlife trade, particularly in tiger and pangolin, may be encouraging poaching of these species which, together with sambar, is prohibited throughout Indonesia (boar may be hunted outside of PAs).

Sampling was stratified across the landscape using information on 228 human-tiger incidents reported by local people (unpublished, Martyr). Each location was georeferenced and an observed incident density surface computed to identify low, medium or high incident study areas (Fig 2).

Following questionnaire piloting and revisions, data were gathered from a systematic sample of male and female heads-of-households between Nov-2014 and Jul-2016 by Indonesian enumerators. Sex of respondents was chosen at random and biased towards men because they are more likely than women to hunt (Wadley & Colfer 2004) (see SI).

Because hunting within KSNP is illegal, we used two forms of the randomised response technique, in addition to direct questions (DQ) to measure past hunting behaviour. The proportion of people hunting was estimated using the forced response randomised response technique (RRT) (Warner 1965). Equipment comprised ten cards, eight orange, one displaying, in Indonesian, 'Yes' and another, 'No'. Respondents selected one card prior to each sensitive question (Table 1). The 'Yes' card demanded the prescribed answer 'Yes'; the 'No' card, 'No'. The orange card required an honest answer, 'Yes', or 'No'. The chosen card was never revealed to enumerators and was replaced after each question.

We estimated the prevalence of hunting using the partial additive randomised response technique (aRRT) (Robinson et al. 2015). Forty eight cards were held in a stack, 12.5% were marked 'zero' and required respondents to answer honestly by reporting the frequency of the behaviour defined in the question (Table 1). All other answers were randomised by the numbers 1, 2, 3 and 4 displayed on the cards with the corresponding frequencies 22, 6, 8 and 6. If a numbered card was selected, respondents were asked to add their answer to the number displayed on the card. The frequency distribution of the cards had a mean of 1.95 and a variance of 1.28.

Respondents were randomly assigned to RRT or aRRT and completed an example prior to study questions. Hunting pressure was also estimated by asking respondents to report their yes/no (for RRT participants) or numeric response (for aRRT respondents) to the hunting questions directly at the end of the questionnaire. Acceptability of RRT and aRRT was measured using two statements (Table S1).

The questionnaire also included nine sections (Table S2) designed to examine factors underlying men's intention to hunt specific species in the future, measured using a five-point ordinal scale (Very weak=1 to Very strong=5). Questions were asked separately for each species. To understand how people's emotional response influences intention to hunt, respondents identified their position on two five-point semantic scales (Good-Bad; Harmless-Dangerous) after being shown an image of each animal. Many tools exist for measuring affect (Jacobs 2012); to minimise cognitive burden we used semantic scales which have proven proficient (Slagle et al. 2012). Answers to remaining questions were given on five-point Likert scales (Strongly agree to Strongly disagree). Attitudes towards the existence of each species were captured using two target, action, context and time-specific (Conner & Sparks 2008) statements for example, 'These days I think that [animal] in the village, on the farm land around the village and in the forest should be caught'. To investigate the relationship of descriptive and injunctive norms on people's intention to hunt, respondents were asked to indicate if they felt that most people try to hunt each animal, and if they felt social pressure to catch each animal. Respondents indicated how much perceived behavioural control they had over hunting by stating

how much they agreed/disagreed to the following statement 'If the opportunity arose, I am confident I could catch [animal] around here if I wanted to'. Two statements were used to capture the core elements of enforcement, the perceived probability of capture and perceived probability of penalty once captured. Crop and livestock loss to study species occurring in the preceding 12 months was also recorded.

Data analysis

Data were analysed using SPSS v22 (IBM Corp. 2013) and Rv.3.4.0 (R Development Core Team 2012). The proportion of people admitting to hunting via RRT was calculated following St. John et al. (2012); aRRT data were estimated following Robinson et al. (2015) (Supporting Information). For RRT, aRRT and DQ, 95% confidence intervals were estimated from 1000 bootstrapped samples. We considered there to be significant differences between estimates when confidence intervals did not overlap.

To examine relationships between men's intention to kill and beliefs and perceptions we fitted cumulative logit mixed models using the R package Ordinal (Christensen 2015) defined *a priori* drawing upon work of others (e.g. Marchini & Macdonald 2012; Slagle et al. 2012; Fairbrass et al. 2015). Affect, attitudes towards killing or conserving, injunctive and descriptive norms, PBC and perceived probability of capture and punishment were all considered as potential fixed effects. Prior to modelling, these variables were scaled so that the higher the value, the less inclined people were to hunt in the future. Pearson's correlation coefficients were calculated for each pair of variables to avoid issues of multi-collinearity. Men with missing data

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were excluded from models. Since estimates from RRT, aRRT and DQ were consistently low and hence unsuitable for modelling, past hunting behaviour was omitted from models.

Results

The questionnaire was completed by 2386 people, missing data were $\leq$1.7% for model variables; exceptions were probability of capture or punishment ($\leq$3.5%). Mean age was 44 (SE±0.26), most had completed elementary (53.2%) or junior (23.0%) school and 73.9% were male. The majority were Minangkabau (45.4%) or Melayu (32.4%), 2.9% were Kerincinese (Table S3). Most people growing crops reported losses to boar (85.1%), but few to sambar (13.3%); 0.6% lost livestock to tigers. Amongst men, all direct question (DQ) estimates significantly exceeded those of the randomised response technique (RRT) (Fig 3A). However, the additive RRT (aRRT) estimated significantly higher frequencies of sambar and tiger hunting than DQ; whilst higher, women's aRRT estimates of tiger hunting did not always differ significantly to DQ (Fig 3B). Men's DQ reports of tiger capture by outsiders and villagers did not differ significantly to women's (Table S4). RRT was considered significantly easier (U=338,736.5, z=-12.85, p=<0.001) and more private (U=433,021.0, z=-4.94, p=<0.001) than aRRT, but perceived ease and privacy was limited (Table S5).

Men's perceptions towards wildlife differed by species, with pro-conservation values most prevalent for tigers and weakest for boar (Fig 4). The perceived probability of capture, and punishment if captured, were significantly correlated for all species

(Pearson's R; P< 0.05; boar=0.67, sambar=0.78, tiger=0.73, pangolin=0.76), so probability of punishment was omitted from models. Across all species, PBC was the strongest predictor of intention to hunt in the future. As PBC declined, so did intention (Table 2). The relative importance of other variables differed by species. Injunctive norm was particularly important for tigers (β=-0.83, *p*=<0.001). By contrast, whilst a significant predictor for all other species, descriptive norm was weakly and not significantly related to men's intention to kill tigers (β=-0.10, *p*=0.30). The affective measure of danger was negatively and significantly related to intention to kill (except sambar), implying greater perceived danger equates to greater intention. Contrary to expectations, affect for tiger and pangolin measured via 'Bad-good' was positively related to intention, indicating that intention to kill increased with perceived goodness. Attitudes towards killing significantly predicted intention across all species; the probability of capture was not significantly related to intention for tiger or pangolin (Table 2).

Discussion

Most respondents reported experiencing crop loss to boar, which 13% of men admitting to trying to catch on average seven times in the preceding year. Coupled with 2% of men admitting to hunting sambar once during the same period, this equates to a substantial number of indiscriminate snares within or around KSNP. Indeed, 4433 snares were removed by rangers from 2000-2010 (Linkie et al. 2015). Few men admitted (via DQ) to trying to catch tigers (1%) or pangolins (2%) since 2010. Whilst 1% seems low, as >184,500 men live within 5km of KSNP (Badan Pusat Statistik 2010), 1% represents considerable poaching pressure. Indeed, 231

tiger snares were removed from KSNP between 2005 and 2014 (Risdianto et al. 2016). Whilst recall is vulnerable to biases (Golden et al. 2013), we measured common events across short timeframes and where event rarity required longer periods (tiger hunting), actions were deemed memorable and thus accessible for recall.

As Indonesia modernises and strong religious views permeate, worldviews held by groups such as the Minangkabau and Kerincinese, including that spirit tigers embody the souls of ancestors, are vulnerable. Incorporation into the market economy has increased the importance of money, which has encouraged some to sell tiger parts (Bakels 2013; Bakels et al. 2016). However, our models suggest that this may not be the result of beliefs attributed to particular ethnic groups. Ethnicity was incorporated into our models due to the prevalence of human-wildlife narratives in local ethnographic work. However, given evidence that sociodemographic characteristics generally fail to reveal underlying differences in how people relate to wildlife (Teel & Manfredo 2010), we did not include other such variables.

Ethnicity was not related to men's intention to kill boar, tiger or pangolin. However, intention to kill sambar was higher amongst Melayu. Hunting for sambar is known to peak prior to Idul Fitri (Risdianto et al. 2016), yet all ethnicities surrounding KSNP follow Islam so the link between Melayu and sambar hunting warrants further exploration. Men's perceived behavioural control (PBC) over hunting was the strongest predictor of intention across all species; when PBC was weak, so too was intention. PBC was low for all species (Fig 4), but particularly tiger. Species-specific

injunctive norms and attitudes towards hunting were also important predictors of behavioural intention; those not feeling social pressure to hunt did not intend to, nor did those reporting pro-conservation attitudes towards killing. Few men (<7%) perceive that others were killing tigers which may explain why descriptive norms, whilst related to intention to kill other study-species, were unimportant regarding behaviour towards tigers. Contrary to expectations, for sambar, tiger and pangolin, affect measured via 'Bad-Good' was weakly and positively related to intention, implying that the greater the level of goodness associated with the animal, the greater the intention to kill one. Given the desirability of sambar meat and commercial value of tiger and pangolin, the possibility that men equated 'goodness' to dietary or financial gains cannot be ruled out. However, affective perceptions of tigers as dangerous was a stronger driver of intention to kill than perceived goodness. As perceived dangerousness increased, so too did intention to kill. Initial responses to stimuli are frequently affective; they occur automatically but then guide information processing and judgement (Slovic et al. 2007). Whilst conservation agencies may want stakeholders to rationally deliberate facts (e.g. the probability of tiger-attack) divorced from emotion, evidence abounds to the contrary (Wilson 2008; Slagle et al. 2012).

Observed behaviour and behavioural intention are considered the best indicators of tolerance for a species (Bruskotter & Wilson 2013). When studying illegal acts, behavioural observation is challenging, so we used the randomised response technique (RRT) and the additive RRT (aRRT) while also asking people to directly report their rule-breaking behaviour. Whilst there is substantial evidence that RRT

returns higher estimates of rule-breaking under varied conservation contexts (Razafimanahaka et al. 2012; St. John et al. 2015), it was of limited use surrounding KSNP. However, despite being perceived by respondents as more difficult and less private than RRT, compared to asking men directly, aRRT estimated significantly higher hunting frequencies for four of six questions. An exception was boar, but since this species can be hunted beyond KSNP boundaries, this question is of limited sensitivity. Nevertheless, proximity to protected areas can impact the likelihood of people reporting rule-breaking behaviour (Razafimanahaka et al. 2012).

Integrating behaviour-change models into conservation science is crucial as emerging conservation strategies increasingly require widespread changes in people's actions (Reddy et al. 2017). Many studies, including ours, measure predictors of behaviour directly. Whilst using value or belief-based measures, such as wildlife value orientations (Teel & Manfredo 2010), provide advantageous insights into cognitive foundations of behaviour, these values are less-easily influenced by interventions; hence our focus on higher-order antecedents of behaviour. We provide estimates of hunting and identify determining factors in a globally important tiger landscape. We conclude that awareness raising activities aimed at increasing knowledge of our study species may be of limited use in curbing men's intention to hunt given the prominence of affect in determining intention (Slagle et al. 2012). However, existing personal values could be leveraged to incentivise behaviour-change in a similar manner to that which has been operationalised to reduce energy consumption (Allcott & Rogers 2014). Such an approach would appeal to people's affective intuitive, and rational thinking simultaneously (Reddy et al. 2017). Applied in

a standardised manner, our assessment of tolerance and behavioural intention could be up-scaled to monitor threats to tigers or other conflict species. Doing so would enable pre-emptive or responsive interventions targeting the strongest predictor(s) and thus actors engaged in specific behaviours, which likely vary by site. Further, where intervention design is informed by socio-psychological investigation, these data double as a monitoring and evaluation baseline.

Societal goals of conserving nature will unlikely be achieved with a blanket approach to enforcement. We recommend further interrogation of psychological components underpinning decision making including in the area of audience segmentation which strives to design optimal interventions for groups sharing common psychographic attributes (Kurtz 2012). Our study provides evidence that behaviour-change models provide informative material for practitioners seeking to encourage compliance and coexistence with wildlife.

Acknowledgements

Table 1 Questions presented to RRT and aRRT respondents. Men answered

questions 1-7; women, questions 5-7.

	RRT	aRRT
1	In the last 12 months, have you tried to catch wild boar?	In the last 12 months, how many times have you tried to catch wild boar?
2	In the last 12 months, have you tried to catch sambar?	In the last 12 months, how many times have you tried to catch sambar?
3	Since the Mentawai earthquake and tsunami in 2010, have you tried to catch tiger?	Since the Mentawai earthquake and tsunami in 2010, how many times have you tried to catch tiger?
4	Since 2010, have you tried to catch pangolin?	Since 2010, how many times have you tried to catch pangolin?
5	Since 2010, have people from outside the village hunted tiger around here?	Since 2010, how many people from outside the village have hunted tiger around here?
6	Since 2010, have people in the village hunted tiger around here?	Since 2010, how many people in the village have hunted tiger around here?

Table 2 Maximum likelihood estimates and their standard errors derived from species-specific cumulative logit mixed models (study area as random effect) fitted to respondents' intention to kill a particular species. The first rows represent intercepts (cut-points between categories), whilst the remainder are predictor coefficients.
[a]Reference category Melayu. Bold indicates significant variables at P< 0.001, italics P <0.01, underlined P<0.5, italic underlined P<0.1.

Intercepts	Boar β	Boar S.E.	Sambar β	Sambar S.E.	Tiger β	Tiger S.E.	Pangolin β	Pangolin S.E.
Very strong | Strong intention	-3.29	0.29	-2.77	0.41	-5.33	0.58	-4.04	0.43
Strong intention | Neutral	-5.35	0.31	-5.15	0.41	-6.81	0.55	-6.60	0.44
Neutral | Weak intention	-6.20	0.31	-6.30	0.42	-7.87	0.56	-8.03	0.46
Weak intention | very weak intention	-8.28	0.34	-9.07	0.44	-10.93	0.59	-11.16	0.50
Affect: Bad-Good	**-0.34**	0.07	_0.10_	0.06	*0.17*	0.06	*0.22*	0.07
Affect: Dangerous-Harmless	**-0.23**	0.06	0.05	0.06	**-0.39**	0.06	*-0.17*	0.06
Attitude towards killing	**-0.37**	0.07	**-0.47**	0.06	**-0.29**	0.08	**-0.81**	0.07
Attitude towards conserving	0.08	0.08	-0.09	0.06	-0.06	0.08	*-0.21*	0.07
Descriptive norm	*-0.15*	0.05	_-0.12_	0.06	-0.10	0.09	*-0.23*	0.07
Injunctive norm	**-0.39**	0.05	**-0.37**	0.07	**-0.83**	0.11	**-0.40**	0.07
Perceived behavioural control	**-0.73**	0.05	**-0.81**	0.06	**-1.18**	0.10	**-0.85**	0.06
Perceived probability of capture	_0.18_	0.08	_-0.15_	0.06	-0.00	0.07	0.00	0.06
Age	**-0.02**	0.00	**-0.02**	0.00	*-0.01*	0.00	**-0.01**	0.00
Ethnicity: Minangkabau[a]	-0.23	0.14	_-0.21_	0.12	-0.06	0.17	-0.03	0.15
Ethnicity: Other	-0.19	0.14	_-0.32_	0.14	-0.15	0.18	-0.16	0.16

Figure 1 A conceptual model of wildlife conservation behaviour adapted from Bruskotter and Fulton (2012). Intolerance and stewardship, expressed through actions, may be viewed as sitting at opposite ends of a spectrum of conservation-related behaviours. Acceptance/Tolerance sits in the middle and is not necessarily expressed through tangible acts.
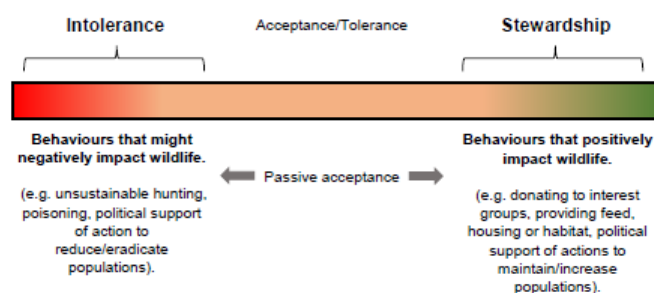

Figure 2 Map of Kerinci Seblat landscape showing the density of human-tiger encounters and study areas sampled. Forest within and adjoining the Kerinci Seblat National Park is shown in dark shading.
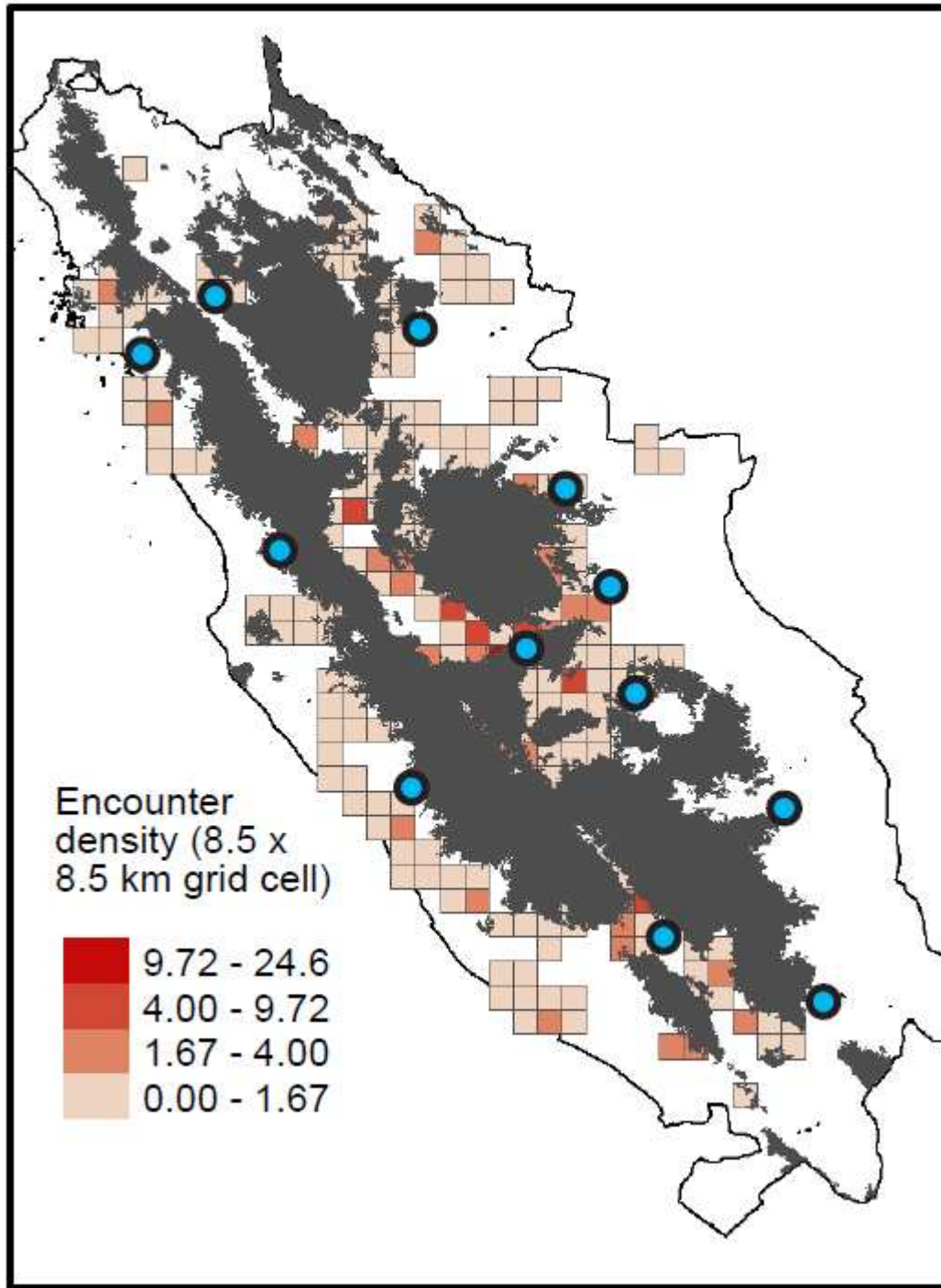
Encounter density (8.5 x 8.5 km grid cell)

- 9.72 - 24.6
- 4.00 - 9.72
- 1.67 - 4.00
- 0.00 - 1.67

Figure 3A Proportion of respondents reporting hunting behaviour estimated using RRT and DQ (men *n*=778, women *n*=282). B Frequency of hunting behaviour reported via aRRT and DQ (men *n*=697, women *n*=238). Grey shading identifies data from men only, black bars indicate the mean and bar length represent the 95% confidence interval. Tiger hunting conducted by people from outside the village (outsider) or from within the village (village) are reported by men and women.
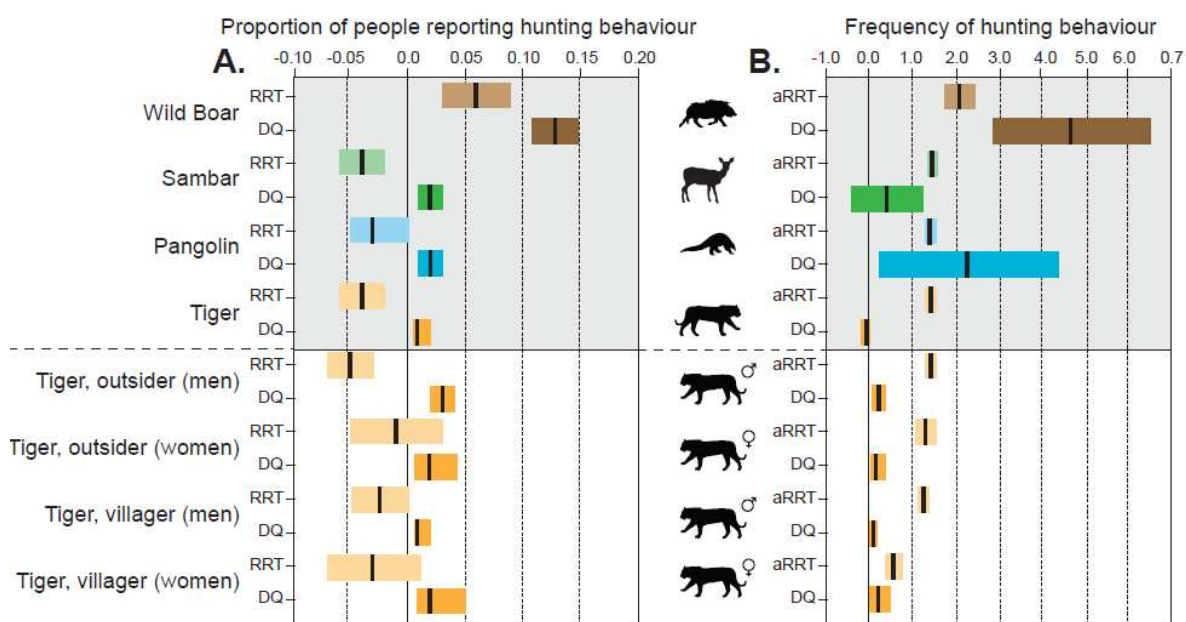
Figure 4 Distribution of social variables reported by men and described with mean and 95% confidence interval (wild boar *n*=1739, pangolin *n*=1686, tiger *n*=1687, sambar *n*=1713). With the exception of intention, variables are scaled such that the higher the value, the less inclined people were to hunt in the future. For example, an attitude towards killing or PBC score of five reflects disagreement with hunting and weak perceived control over performance of the behaviour.
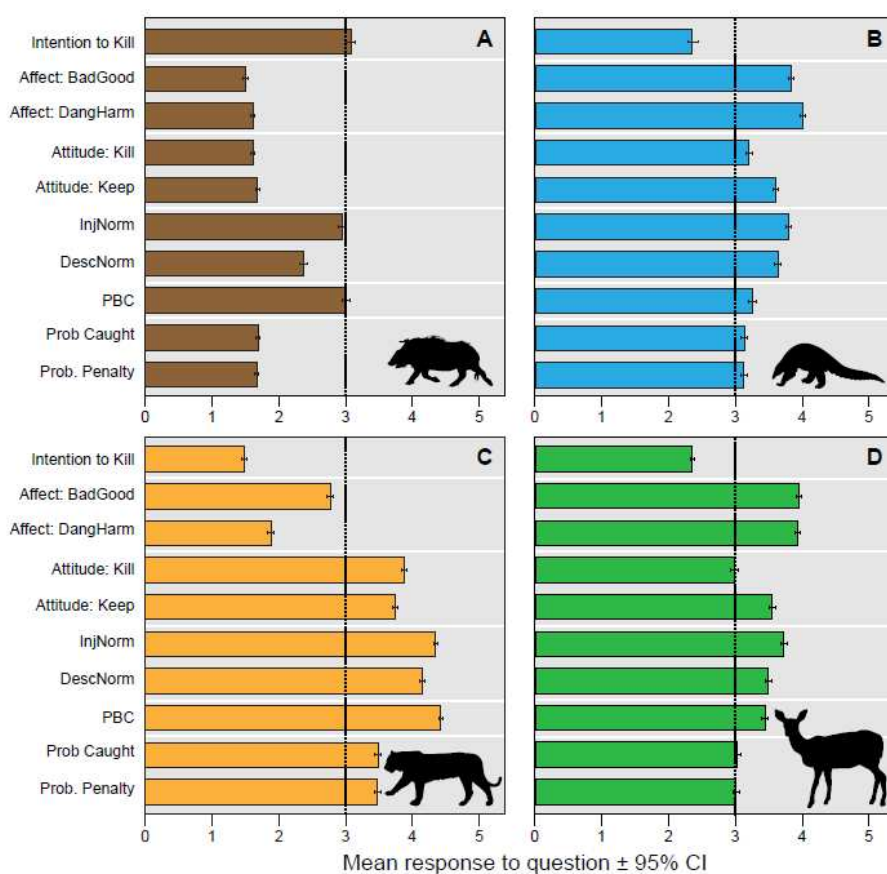
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