Predicting intention to hunt protected wildlife: a case study of Bewick's swan in the European Russian Arctic

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Abstract Illegal killing of wildlife is a major conservation issue that, to be addressed effectively, requires insight into the drivers of human behaviour. Here we adapt an established socio-psychological model, the theory of planned behaviour, to explore reasons for hunting the Endangered Bewick's swan *Cygnus columbianus bewickii* in the European Russian Arctic, using responses from hunters to a questionnaire survey. Wider ecological, legal, recreational and economic motivations were also explored. Of 236 hunters who participated overall, 14% harboured intentions to hunt Bewick's swan. Behavioural intention was predicted by all components of the theory of planned behaviour, specifically: hunters' attitude towards the behaviour, perceived behavioural control (i.e. perceived capability of being able to perform the behaviour) and their subjective norms (perception of social expectations). The inclusion of attitude towards protective laws and descriptive norm (perception of whether other people perform the behaviour) increased the model's predictive power. Understanding attitudes towards protective laws can help guide the design of conservation measures that reduce non-compliance. We conclude that conservation interventions should target the socio-psychological conditions that influence hunters' attitudes, social norms and perceived behavioural control. These may include activities that build trust, encourage support for conservation, generate social pressure against poaching, use motivations to prompt change and strengthen peoples' confidence to act. This approach could be applied to inform the effective design, prioritization and targeting of interventions that improve compliance and reduce the illegal killing of wildlife.

Keywords Behavioural intention, conservation interventions, *Cygnus columbianus bewickii*, hunting, illegal killing, Russia, theory of planned behaviour

Supplementary material for this article is available at doi.org/10.1017/S0030605320000435

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Received 7 May 2019. Revision requested 13 September 2019.
Accepted 19 May 2020. First published online 30 November 2021.

Introduction

The ability to predict human behaviour is vital for addressing some of the most pressing conservation issues such as habitat fragmentation, climate change and overexploitation (Lande, 1998; Thomas et al., 2004; Nuno & St John, 2015). Recognition of this has led to increasing calls for frameworks that develop understanding of human behaviours that detrimentally affect the conservation of species and habitats (Nuno & St John, 2015; Redpath et al., 2018). However, understanding the complex processes that characterize these behaviours presents challenges, particularly where they encompass illicit activities.

Conservation is often undermined by illegal behaviours (Solomon et al., 2015) such as illegal logging in protected areas (Lee et al., 2015) and the illegal killing of wildlife (Keane et al., 2008), and such acts can have wide-ranging impacts on socio-ecological systems (Solomon et al., 2015). Illegal killing of wildlife threatens biodiversity globally and affects the conservation of threatened species (Gavin et al., 2010; Brochet et al., 2016). The ecological consequences of such killing include population declines and extinctions, and reduced genetic diversity, species richness and ecosystem function (Gavin et al., 2010). Ramifications for human societies of illegal killing of wildlife range from the degradation and loss of ecosystem services (e.g. Ripple et al., 2016) to exploitation and criminalization of vulnerable, poverty-stricken communities (Duffy et al., 2016), and escalations in conservation conflicts (e.g. Carter et al., 2017; St John et al., 2019). Overexploitation is a key cause of bird

extinctions worldwide (BirdLife International, 2013), with illegal killing posing a significant threat for migratory birds that is second only in importance to habitat loss and degradation (Bairlein, 2016; Brochet et al., 2016). Growing recognition of the illegal killing of birds as a conservation issue has prompted the adoption of numerous international species action plans (Nagy et al., 2012), conservation interventions (Jones et al., 2017) and policy instruments (e.g. European Commission, 2012; Council of Europe, 2013; UNEP-CMS, 2014, 2017).

The effective targeting of conservation interventions to discourage illegal killing and other environmentally harmful behaviours relies upon their drivers being identified (Vlek & Steg, 2007; St John et al., 2010). Illegal killing is often driven by a complex range of motivations that may be influenced by diverse social, economic and ecological conditions across varying social and spatio-temporal scales (von Essen et al., 2014; Carter et al., 2017). Rather than simply being a way to harvest game, hunting may provide opportunities to realize a number of social, psychological, emotional, physical and other benefits (Hrubes et al., 2001). However, identifying drivers for sensitive issues relating to illicit or socially taboo behaviours presents challenges, not least the lack of willingness of individuals participating to identify themselves or reveal information through fear of retribution (Keane et al., 2008; Gavin et al., 2010; St John et al., 2011). Illegal behaviour is therefore frequently subject to high uncertainty (Nuno et al., 2013), and baseline information about prevalence, those participating and underlying drivers is often difficult to obtain. Under these circumstances, use of indicators that predict behaviour reliably can be of great value (St John et al., 2011). Several tools and frameworks have been employed to measure and predict sensitive behaviours (e.g. Stern, 2000; Nuno & St John, 2015). A number of specialized questioning techniques such as the unmatched-count technique were considered for this study but were not used because of several limitations (as outlined in Nuno & St John, 2015), including the requirement for higher sample sizes, which was unachievable given practical constraints such as resource limitations and inaccessibility of participants. In recognition that humans are not purely rational beings making considered and informed decisions within static economic frameworks (St John et al., 2010; Fairbrass et al., 2016), social-psychological models have increasingly been applied to predict behaviour and environmental rule-breaking (St John et al., 2011).

One such framework and a widely used social-psychological model, is the theory of planned behaviour (Ajzen, 1985; Fig. 1) within which the most important determinant of a behaviour is the intention to engage in that behaviour (Armitage & Conner, 2001). Behavioural intentions are influenced by: (1) attitude towards the behaviour, (2) perception of social expectations (termed the subjective norm), and (3) perceived capability to perform the behaviour (perceived behavioural control; Fig. 1; Ajzen & Cote, 2008). The efficacy of this model in predicting intention and behaviour is supported by several meta-analyses and reviews (e.g. Armitage & Conner, 2001; Miller, 2017). A review of case studies that used this theory found that two-thirds had recorded a degree of desired behaviour change following intervention (Hardeman et al., 2002). Conservationists and natural resource managers have applied the theory to predict intentions to hunt (Hrubes et al., 2001) and kill wildlife illegally (Rossi & Armstrong, 1999; Marchini & Macdonald, 2012; Steinmetz et al., 2014; Fairbrass et al., 2016; Castilho et al., 2018).

Although there is broad empirical support for the theory of planned behaviour (Ajzen & Cote, 2008), for some behaviours and circumstances the inclusion of additional elements may increase its predictive power (e.g. Marchini & Macdonald, 2012; Fairbrass et al., 2016). For example, assessment of descriptive norms, which reflect a perception of whether other people perform the behaviour (Cialdini et al., 1990), increased the predictive utility of the theory in a study examining the intention to hunt jaguars in Amazonia and the Pantanal (Marchini & Macdonald, 2012). Although contextual factors such as laws and government regulations can also influence environmental behaviour (Stern, 2000), little is known about the role of attitude towards rules in predicting the intention to violate them and the route by which this may occur (e.g. directly or through elements of the theory). Effectiveness of environmental regulations is partly dependent upon people's willingness to comply (Winter et al., 2001), which in turn is probably influenced by attitude towards the regulations (Keane et al., 2008). Trust of those obliged to adhere to rules in the people and authorities associated with and supportive of regulations, and their perceived legitimacy and fairness, have been identified as key factors associated with compliance (Stern, 2008; Young et al., 2016). Perceptions of fairness may in turn be shaped by the cultural context within which measures are implemented; for example, how they are accepted according to local customs and cultural norms (Aiyadurai, 2011). Demographic variables (e.g. ethnicity and age) may also indirectly influence behavioural intention (Marchini & Macdonald, 2012).

In this study, we use an extended version of the theory of planned behaviour model to explore potential predictors of the intention of individuals to hunt the Endangered north-west European Bewick's swan *Cygnus columbianus bewickii* in the European Russian Arctic (Fig. 2; BirdLife International, 2015). Despite being protected under legislation throughout its migratory range (Rees, 2006), the Bewick's swan population in the European Russian Arctic is nevertheless subject to exploitation and killing (Newth et al., 2011; Nagy et al., 2012; Mineyev & Mineyev, 2014). Circa 31% of live Bewick's swans x-rayed between the 1970s and early 2000s carried embedded gunshot in their bodies (Newth et al., 2011). Illegal shooting is potentially a major threat for this population (Nagy et al., 2012) and

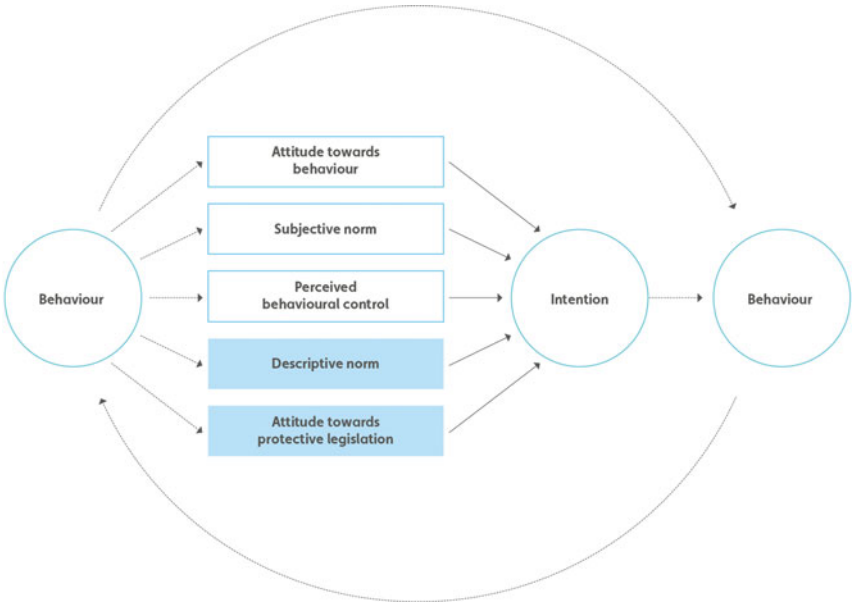

FIG. 1 Adapted model of the theory of planned behaviour, which includes attitude towards protective laws and descriptive norm as predictors of behaviour. Clear boxes indicate variables in Ajzen's (1985) original model of the theory. Shading indicates additional variables investigated. Solid lines indicate relationships that were examined in this study. Age and ethnicity of respondents were also included in the global model as demographic information has been found to influence behavioural intention indirectly (Marchini & Macdonald, 2012). In this study, past behaviour is used as a proxy for behaviour. Past behaviour may also influence variables that drive behavioural intention.

may impact survival significantly (Wood et al., 2018). Newth et al. (2019) found there was a risk of Bewick's swans being accidentally shot on their breeding grounds in the European Russian Arctic, partly because they were mistakenly taken for the morphologically similar whooper swan *Cygnus cygnus* or mute swan *Cygnus olor*, which have weaker legal protection in this region, and also because some hunters were unaware of protective legislation. Overall, 15% of hunters claimed they had accidentally hunted a Bewick's swan and 12% admitted to non-accidental hunting (Newth et al., 2019).

In accordance with the theory of planned behaviour, we hypothesized that those who harbour intentions to hunt Bewick's swan: (1) are more likely to have positive attitudes towards this behaviour, (2) believe there is social support for this behaviour (subjective norm), and (3) perceive there are no, or few, barriers to undertaking this activity (perceived behavioural control). We expect the predictive utility of the model to improve with the inclusion of (4) attitude towards protective laws (where those with hunting intentions are more likely to hold negative attitudes towards such laws), and (5) descriptive norm (with those intending to hunt being more likely to believe that this behaviour is a norm in their locality). We predict that those intending to hunt swans are more likely to have hunted them previously. We also explore and discuss perceived motivations for hunting in relation to typologies that aim to deconstruct, understand and predict illegal hunting (von Essen et al., 2014). These include recreational satisfaction, gamesmanship, commercial gain, household consumption, poaching as a traditional right, poaching as a political protest (Holmes, 2016), disagreement with wildlife regulations and conflict with people or institutions supportive of them (Muth & Bowe, 1998; Holmes, 2016), lack of enforcement of regulations (Muth & Bowe, 1998), and ignorance of either conservation law or ecology (von Essen et al., 2014). An understanding of the determinants for hunting behaviours can help identify and prioritize effective interventions to encourage that contribute to species conservation (e.g. Steinmetz et al., 2014), and these are also discussed.

Methods

Study area and participants

A total of 256 people were approached, of whom 20 (8%) declined to participate in the survey (Supplementary Material 1). Those regarding themselves as hunters were asked to participate in the survey. Overall, 236 hunters from seven settlements in the European Russian Arctic, six in the Nenets Autonomous Okrug and one in Arkhangelsk Oblast, were surveyed during 27 June–16 July 2016. The Nenets Autonomous Okrug has an area of 176,700 km² and a low level of human occupation, with 43,392 inhabitants recorded in the 2015 census (Russian Federal State Statistics Service, 2015). The region is ethnically diverse, comprising Russians (66.1%), Indigenous Nenets (18.6%), Komi (9.0%) and other nationalities (6.3%; Russian Federal State Statistics Service, 2010). The Nenets traditionally engage in nomadic reindeer herding and other subsistence land uses across the seasonally changing landscapes (NAO Administration, 2015). The urban population predominates; more than half of the inhabitants reside in Nar'Yan-Mar, the administrative centre of the region. Arkhangelsk Oblast borders the Nenets Autonomous Okrug and extends over 587,400 km² with 1,140,109 inhabitants (Russian Federal State Statistics Service, 2015). The population

FIG. 2 The locations of Nenets Autonomous Okrug and Arkhangelsk Oblast in the Russian Arctic, where we interviewed 236 hunters to explore reasons for hunting Bewick's swan *Cygnus columbianus bewickii*.

is predominantly Russian (95.6%; Russian Federal State Statistics Service, 2010).

To ensure anonymity, the identity of participants and exact locations of settlements are not reported. Settlements were selected for their proximity to areas used by Bewick's swan (Mineyev, 1991; Rees, 2006), ease of access, and the ethnic heterogeneity of the population across the settlements (ensuring all main ethnicities were sampled across the settlements; Supplementary Material 2). Interviews were conducted in Russian by three trained facilitators, with participants choosing a time and place of their convenience. For each settlement, 2.5% of the total population (based on population numbers in 2015; range 10–88 participants per settlement) were included in the survey. Sampling methods were partly guided by survey resource limitations, the remoteness and size of settlements, and intentions to capture information from multiple settlements. Given the sensitive nature of illicit behaviours, snowball sampling was used to recruit participants (Newing et al., 2011), with recruitment continuing until a sufficient number of individuals had been identified to meet the desired sample size for each settlement. Although it is not possible to make statistical inferences from the sample to the population using snowball sampling, information can be gathered from groups that are ordinarily less easily accessed, and influential factors may be identified. Research to identify and arrange interviews with participants was undertaken prior to fieldwork, with the help of known contacts in each settlement. These contacts also helped build trust between the facilitators and participants, enabling the facilitators to conduct interviews soon after their arrival in each settlement. The facilitators were Russian and had experience working in the study regions. All participants were aged 18 years or over.

Survey design

Methods, including the wording of questions presented to participants, were refined following a pilot survey of 50 inhabitants from one settlement in the Nenets Autonomous Okrug during 24 June–1 July 2015. The pilot survey, which was administered in Russian by two trained interview practitioners, explored the feasibility of several social survey methods including semi-structured interviews, questionnaires completed without assistance and focus groups, and obtained a preliminary assessment of attitudes, knowledge and beliefs about Bewick's swans, their conservation and illegal persecution. Focus groups and open-ended questions allowed participants to talk freely, enabling the interviewers to identify salient beliefs and perceptions. Only information obtained from interviews held in 2016 are used in this analysis (Supplementary Material 1). Participants were asked about their intention to hunt Bewick's swans over the next 3 years (Table 1). Questions relating to all three components of the theory of planned behaviour predicted to influence hunting intention were included in the survey (Fig. 1, Table 1). Additionally, participants were asked whether the hunting of Bewick's swans is typical or normal in their locality (i.e. descriptive norm; White et al., 2009), and about their attitude towards legislation protecting Bewick's swan (indicated by views on whether local people should be authorized to hunt them under some circumstances; Table 1). Information on the age group and ethnicity of respondents was also obtained as demographic variables have been found to influence behavioural intention indirectly (Marchini & Macdonald, 2012). Responses were analysed in an adapted model of the theory of planned behaviour (Table 1, Fig. 1). Those who agreed or strongly agreed that local people should be authorized to hunt Bewick's swans in their area were asked under which circumstances this would be permissible (Supplementary Material 1, Q9a). Hunters were also given the opportunity to describe any perceived barriers to hunting Bewick's swans (Supplementary Material 1, Q12a). According to the theory of planned behaviour, behavioural intention predicts behaviour. Because of practical barriers (i.e. the substantial time and cost of accessing participants living in remote settlements), we were not able to return to measure directly the hunting behaviour of individuals, or indirectly using specialized questioning techniques (Nuno & St John, 2015), after they were surveyed and had declared their hunting intentions. Past behaviour was therefore used as a proxy for behaviour (Marchini & Macdonald, 2012); each hunter was asked directly whether they had hunted Bewick's swans in the region in the previous 3 years (Supplementary Material 1, Q16; Newth et al., 2019).

TABLE 1 Responses by 201 hunters in the European Russian Arctic to a survey in 2016 on the illegal hunting of Bewick's swan *Cygnus columbianus bewickii*.

Variable[1]	Statement	Response[2]	% (no. of respondents)
Behavioural intention	I intend to hunt Bewick's swans in the [area] in the next 3 years	Disagree	83.6 (168)
		Agree	16.4 (33)
Attitude towards hunting	For me the hunting of Bewick's swans in this area would be:	Bad	29.4 (59)
		Neutral	6.2 (133)
		Good	4.5 (9)
Perceived behavioural control	There is nothing stopping me from using guns & ammunition to hunt Bewick's swans in this area	Disagree	56.7 (114)
		Neutral	5.5 (11)
		Agree	37.8 (76)
Subjective norm	People who are important to me think that it is OK to hunt Bewick's swans in this area	Disagree	35.8 (72)
		Neutral	30.3 (61)
		Agree	33.8 (68)
Descriptive norm	Bewick's swans are hunted near my village	No	37.8 (76)
		Yes	36.3 (73)
		I don't know	25.9 (52)
Attitude towards protective legislation	Local people should be authorized to hunt Bewick's swans in the [region] under some circumstances	Disagree	22.4 (45)
		Neutral	19.4 (39)
		Agree	58.2 (117)

[1]The theory of planned behaviour (Ajzen, 1985) was used as a framework to predict hunting intention. Statements related to the following elements of the theory: attitude towards the behaviour, subjective norm and perceived behavioural control. The framework was extended to include attitude towards protective laws, descriptive norm (which reflects an individual's perception of whether other people perform the behaviour in question; Cialdini et al., 1990), and the age group and ethnicity of participants, all of which are also expected to influence hunting intention.
[2]The following categories were collapsed: agree/strongly agree (agree); disagree/strongly disagree (disagree); very good/good (good); very bad/bad (bad).

This may have potentially been a limitation, as views on wildlife can change over time (Dickman et al., 2013) and thus behaviours performed in the previous 3 years may not reflect current intentions or behaviours. We therefore examined the relationship between past hunting behaviour and intention to hunt in the future (Fig. 1). In turn, past hunting behaviour may also have a direct influence on variables that determine hunting intention and this relationship is indicated in Fig. 1. For example, past hunting experience may shape perceptions on barriers to hunting (i.e. perceived behavioural control).

Given the sensitive nature of illegal killing, indirect questions explored perceived motivations for hunting swans to give participants an opportunity to reveal information without the risk of incriminating themselves. Participants were asked to use a 5-level Likert scale (from very likely to very unlikely) to indicate their views on the likelihood of people in their area hunting Bewick's swans for legal, ecological, recreational and subsistence reasons (Supplementary Material 1, Q13), drawing on and developing drivers for illegal killing identified by Muth & Bowe (1998). This facilitated the identification of general as well as socio-psychological causal factors (Muth & Bowe, 1998; von Essen et al., 2014). An open-ended response question asked participants to suggest 'other reasons for hunting Bewick's swans in this area' (Supplementary Material 1, Q14), to capture additional motivations. In addition to age group and ethnicity, participants were also asked about their gender, place of residence, and occupation (Supplementary Material 1, Qs1–6). Following each interview, the facilitators completed an evaluation form that assessed the respondents' perceived understanding of the questions and the degree of comfort with answering questions (Forder et al., 2020). All respondents were deemed to have understood the meaning of the questions posed and were able to answer the questions without apparent difficulty. Respondents were also given the opportunity to comment on the hunting behaviour of others and provide information on motivations in a way that did not incriminate themselves.

Treatment of data

Participants were divided into those who agreed they intended to hunt Bewick's swans, and those who disagreed. When responding to questions, few people selected categories on the extreme ends of the Likert scale (i.e. categories 1 and 5; Supplementary Material 1) and therefore the following response categories were collapsed: strongly agree/agree (= agree); strongly disagree/disagree (= disagree); very good/good (= good); very bad/bad (= bad).

Statistical analysis

All analyses were conducted in *R 3.1.1* (R Development Core Team, 2016). A generalized linear model (GLM) with a binomial error distribution and a logit link function was used to assess the effects of the explanatory variables on

hunters' intention to hunt Bewick's swans within the next 3 years (0 = disagree, 1 = agree; Table 1). Generalized variance inflation factors were used to check for multi-collinearity between explanatory variables. All variables were within acceptable norms (i.e. generalized variance inflation factors < 3; Thomas et al., 2013) and were therefore retained in the global model. An information theoretic approach (Burnham et al., 2011) was applied to select the most parsimonious models using the *MuMIn* package in *R* (Barton, 2018). Models were ranked according to the value of Akaike's information criterion, corrected for small sample sizes (AICc). The relative likelihood, Akaike weight, and evidence ratio were also used to assess support. R^2 values (Tjur, 2009) assessed the percentage of the variance in hunters' intention to hunt Bewick's swans explained by each model. We undertook model averaging across our best supported models (i.e. those where ΔAICc ≤ 3.0) using the *MuMIn* package to estimate the effect sizes associated with each variable. A Fisher's test examined the association between past hunting behaviour and intention to hunt in the future. Responses to open-ended questions that examined additional motivations for hunting, barriers to hunting and circumstances under which hunting would be acceptable, were explored using inductive thematic analyses, in which themes that emerged from the data were identified upon reading each response (Braun & Clarke, 2006).

Results

The 236 participants surveyed belonged to eight ethnic groups, with two being substantially represented (Russian: 65%; Nenets: 25%; Supplementary Material 2). Overall, 14% (33/236) of participants agreed they intended to hunt Bewick's swans in the next 3 years. Those who were neutral regarding their intention to hunt Bewick's swans (n = 33) were omitted from the theory of planned behaviour model; their inclusion in an ordinal logistic regression (where disagree = −1, neutral = 0 and agree = + 1) resulted in multi-collinearity between the explanatory variables and thus the predictors hypothesized to influence hunting intention (Fig. 1) could not be tested within the same model. Two hunters did not provide answers to certain questions and were thus also removed from the theory of planned behaviour analysis. In total responses from 201 hunters were therefore included in this model.

Predicting intention to hunt and hunting behaviour

Intention to hunt Bewick's swans was best explained by a model that included all three predictors from the theory and two additional predictors (descriptive norm and attitude towards protective laws) that, as hypothesized, increased the model's predictive power (Tables 2 & 3). Attitude towards protective legislation was a significant predictor of intention to hunt, and those holding a negative attitude (i.e. favouring a relaxation of the law under certain circumstances) were more likely to harbour hunting intentions (Tables 1 & 3). Circumstances deemed acceptable for hunting Bewick's swans were identified by 115 hunters, and included: if limited quotas for hunted swans were in place (with suggested quotas of 1–15 swans per individual per hunting season; n = 69), when the swan population needed to be regulated (i.e. when they were perceived to be too numerous; n = 19), if there were licenses and rules in place for swan hunting (n = 13), and for subsistence (n = 9; Fig. 3). Attitude towards hunting Bewick's swans and perceived behavioural control also emerged as significant predictors of hunting intention; those holding positive or neutral attitudes towards hunting were more likely to intend to hunt, as were those who agreed or felt neutral about the concept that there was nothing stopping them from exploiting the species. Nevertheless, most hunters (57%) agreed there were barriers to shooting Bewick's swans, including law (n = 68) and law enforcement (n = 14), absence of desire (n = 8) and one's own conscience (associated with pity for the swans, liking the Bewick's swan, regarding the swan as beautiful, and as one participant described, 'inner moral conviction', n = 16; Fig. 4). The subjective norm influenced intentions to hunt Bewick's swans; those perceiving that people important to them condoned such behaviour were more likely to harbour hunting intentions. Hunting intention was also predicted by descriptive norm; hunters were less likely to harbour hunting intentions when

Table 2 A comparison of the relative support and explanatory power of our best-supported models for predicting the intention to hunt Bewick's swan in the European Russian Arctic, based on a survey of 201 hunters. Model averaging of parameter estimates was undertaken for the first three models (Table 3).

Model[1]	K^2	AICc	ΔAICc	Relative likelihood	Akaike weights	Evidence ratio	R^2
i + *AH* + *PBC* + *SN* + *AL* + *DN*	6	133.3	0.0	1.00	0.54	1.00	0.43
i + *PBC* + *SN* + *AL* + *DN*	5	135.4	2.1	0.36	0.19	2.80	0.38
i + *AH* + *PBC* + *SN* + *DN*	5	135.5	2.2	0.34	0.18	2.95	0.38
i + *AH* + *PBC* + *SN* + *AL*	5	138.3	5.0	0.08	0.05	11.89	0.36
i + *AH* + *SN* + *AL* + *DN*	5	138.8	5.4	0.07	0.04	15.11	0.35

[1]*i*, intercept; *AH*, attitude towards hunting Bewick's swan; *PBC*, perceived behavioural control; *SN*, subjective norm; *AL*, attitude towards protective legislation; *DN*, descriptive norm.
[2]Number of parameters in the model.

TABLE 3 Predicting the intention of 201 hunters to hunt Bewick's swan in the Russian Arctic using the theory of planned behaviour, with a summary of model-averaged effects associated with our three best-supported models (i.e. all models where ΔAICc ≤ 3.0). A GLM with a binomial error distribution and logit link functions was used to assess the effects of the explanatory variables on the intention of hunters to hunt Bewick's swan in the next 3 years (intention to hunt: 0 = disagree, 1 = agree).

Variable[1]	Parameter	Estimate	SE	*Z*	P
	Intercept	3.564	1.172	3.022	0.003
Attitude towards behaviour (hunting)	For me the hunting of Bewick's swans in this area would be: (good)	2.164	1.542	1.399	0.162
	For me the hunting of Bewick's swans in this area would be: (neutral)	0.398	0.635	0.622	0.534
Perceived behavioural control	There is nothing stopping me from using guns & ammunition to hunt Bewick's swans in this area (agree)	0.646	0.525	1.224	0.221
	There is nothing stopping me from using guns & ammunition to hunt Bewick's swans in this area (neutral)	2.860	0.912	3.115	0.002
Subjective norm	People who are important to me think it is OK to hunt Bewick's swans in this area (agree)	1.676	0.676	2.462	0.014
	People who are important to me think it is OK to hunt Bewick's swans in this area (neutral)	−1.295	0.973	1.322	0.186
Attitude towards protective legislation	Local people should be authorized to hunt Bewick's swans in the [region] under some circumstances (agree)	1.216	1.156	1.048	0.295
	Local people should be authorized to hunt Bewick's swans in the [region] under some circumstances (neutral)	−0.440	1.366	0.320	0.749
Descriptive norm	Bewick's swans are hunted near my village (no)	−2.011	0.783	2.552	0.011
	Bewick's swans are hunted near my village (yes)	−0.232	0.603	0.382	0.703

[1]The reference levels are: attitude towards behaviour (bad); perceived behavioural control (disagree); subjective norm (disagree); attitude towards protective legislation, hunting should be authorized (disagree); descriptive norm (I don't know).

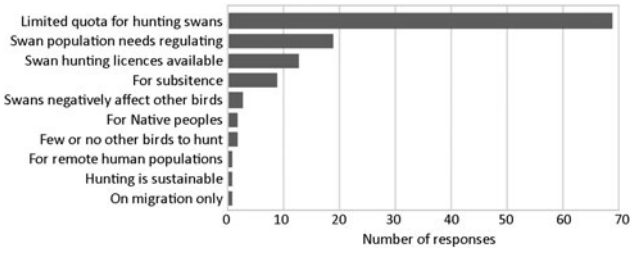

FIG. 3 Circumstances under which hunting of Bewick's swans is acceptable, according to 112 of 149 hunters surveyed in the European Russian Arctic (Fig. 2) who agreed or strongly agreed that hunting should be authorized for local people under certain circumstances. Eight respondents identified more than one circumstance. Themes emerged from an inductive thematic analysis of open-ended responses (Braun & Clarke, 2006).

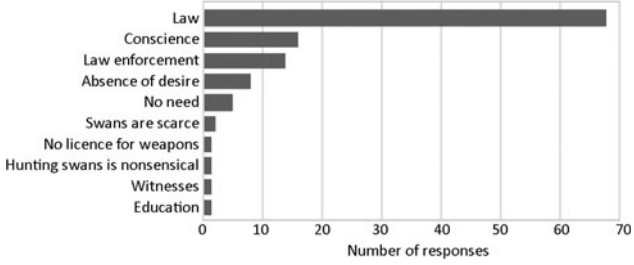

FIG. 4 Perceived barriers to hunting Bewick's swans according to 105 hunters surveyed in the European Russian Arctic (Fig. 2). Twelve respondents identified more than one barrier. Categories emerged during an inductive thematic analysis of responses (Braun & Clarke, 2006). 'Law' refers to the regulations prohibiting the hunting of Bewick's swans and 'law enforcement' refers to the enforcement of these laws.

they believed this behaviour was not a social norm in the locality (Tables 1 & 3). Of 27 individuals who admitted to hunting Bewick's swans previously, 11 (41%) harboured intentions to hunt them in the future. Conversely, of those stating they had not hunted Bewick's swans before (n = 171), only 7% (n = 12) had intentions to hunt them in the future. The difference between these two groups was significant (odds ratio = 0.1, 95% CI 0.03–0.31; Fishers Exact $P < 0.001$).

Perceived motivations for hunting Bewick's swans

Respondents perceived that people in their area were motivated to hunt Bewick's swans for ecological, recreational, subsistence and legal reasons (Fig. 5; Supplementary Material 1, Q13). The following were believed to be the most likely motivations: the number of Bewick's swans is increasing/high (72% of respondents, n = 170, regarded this as a likely motivation), no enforcement of protective legislation (56%, n = 132), Bewick's swans arriving during the hunting season (54%, n = 128) and Bewick's swans having negative impacts on breeding waterbirds on the tundra (51%, n = 120). In total, 26 hunters identified additional motivations, including: swans being present in the absence of other birds to hunt, swans being easier to shoot as they fly slowly, swan skins for clothes, curiosity (related to the meat or the sporting experience), lack of awareness that the swans are protected and misidentification of Bewick's swans for other swan species (Supplementary Material 3).

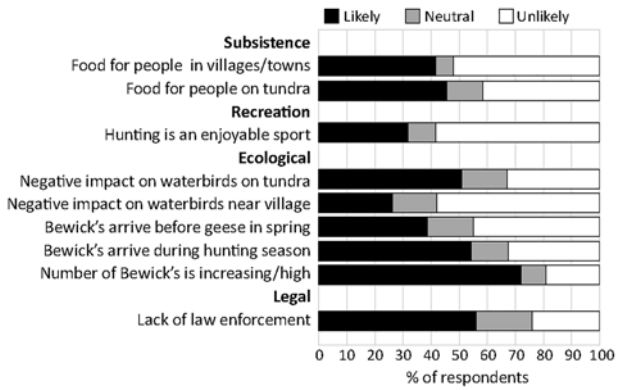

FIG. 5 The views of 236 hunters in the European Russian Arctic (Fig. 2) on the likelihood of people in their area hunting Bewick's swans for subsistence, recreation, ecological and legal reasons. One respondent provided no answer when asked for their view on 'food for people on tundra' as a motivation for hunting Bewick's swans, and therefore the per cent for this view is of 235 participants.

Discussion

Biodiversity loss is largely driven by human behaviours and thus identifying predictors of behaviour is critical for informing effective conservation measures (Vlek & Steg, 2007; St John et al., 2010). Here, we examined the utility of an adapted socio-psychological model (the theory of planned behaviour; Ajzen, 1985) for predicting the deliberate illegal hunting of Bewick's swans in the European Russian Arctic. Behavioural intention was predicted by all components of the theory; attitude towards the behaviour (i.e. illegal hunting), perceived behavioural control and subjective norm. This study supports our hypotheses and presents evidence that inclusion of attitude towards protective laws and descriptive norm increases the predictive power of this model, suggesting that both should be considered when exploring drivers of non-compliance.

The theory of planned behaviour has also been used to predict intentions to hunt and kill wildlife illegally in other cases (e.g. Rossi & Armstrong, 1999; Marchini & Macdonald, 2012; Steinmetz et al., 2014; Fairbrass et al., 2016; Castilho et al., 2018). In one study of 169 rural residents in the Atlantic Forest in Brazil, attitudes and descriptive norms were good predictors of hunting behaviour. For example, those who disagreed with hunting protected wildlife for consumption hunted less than those that agreed. Furthermore, those who perceived a reduction in hunting activities in the vicinity (i.e. the descriptive norm) were less likely to hunt and vice versa (Castilho et al., 2018). Although overexploitation is one of the main drivers of bird extinctions globally (Brochet et al., 2016), socio-psychological models such as the theory of planned behaviour have rarely been applied to examine determinants of illegal hunting of birds. However, one recent study by Fairbrass et al. (2016) found that social norms, social approval and individual attitudes of 146 bird hunters in Portugal were positively related to admittance to trapping passerines for consumption. Those with a positive attitude towards poisoning birds were also much more likely to admit to engaging in this behaviour (Fairbrass et al., 2016).

Factors predicting hunting intention and behaviour

Hunters were more likely to harbour hunting intentions if they held a negative attitude towards protective laws. The perceived legitimacy and acceptability of rules affect their acceptance by resource users (Keane et al., 2008). Those with a positive or neutral attitude towards hunting Bewick's swans were also more likely to intend to hunt them. Attitude towards hunting has been found in previous studies to be the strongest predictor of hunting intention (Rossi & Armstrong, 1999). Social pressure was also influential and those intending to hunt Bewick's swans were more inclined to believe the behaviour was socially acceptable. Humans have a natural tendency to respond to social norms or shared understandings about what is regarded as appropriate behaviour (Steinmetz et al., 2014) and are consequently reluctant to deviate from the norm (Schultz, 2011). Those who agreed there were no practical barriers preventing them from hunting were also more likely to intend to hunt, as were those who felt ambivalent about the existence of such barriers. Although Bewick's swans are protected by law (Mineyev & Kondratiev, 2001; Gurtovaya & Litvin, 2006; Novoselov, 2008), the study region is a geographically vast and isolated area, making law enforcement challenging.

Measuring illegal hunting behaviour of hunters following their participation in the survey was not possible and therefore the validity of the model predicting future hunting behaviour could not be verified. However, we present evidence that suggests our indicator of intention to hunt Bewick's swans is related to self-reported past hunting behaviour. Firstly, relationships between intention and the predictors aligned with those expected based on the theory of planned behaviour (Marchini & Macdonald, 2012). Secondly, there was a significant relationship between intention to hunt and past hunting behaviour, suggesting that hunting intention may also be a valid proxy for future hunting behaviour (Marchini & Macdonald, 2012), as proposed by the theory (Ajzen, 1985). Furthermore, this relationship may indicate that the hunting of Bewick's swans is habitual for some hunters, and this warrants further investigation. Behavioural decision-making models such as these rely on self-reporting, which may be subject to social desirability bias (Armitage & Conner, 2001). Given the sensitive nature of killing Bewick's swans, it is likely this illegal behaviour was under-reported; for example, some respondents may have answered questions in a manner that they perceived would be viewed favourably by the interviewer. On designing the study, a

number of approaches were therefore applied to discern truthful answers. Anonymity was guaranteed for each participant and interviewers subjectively measured the degree of comfort with answering questions (Forder et al., 2020). Respondents were deemed comfortable answering sensitive, direct questions relating to their own hunting behaviours. Respondents were also given the opportunity to comment on the hunting behaviour of others and provide information on motivations in a way that did not incriminate them.

Snowball sampling is likely to have led to selection bias as the sample was determined by the subjective choices of the respondents first accessed (Atkinson & Flint, 2001). Furthermore, such sampling will be biased towards the inclusion of individuals with inter-relationships and may therefore omit those not connected to the networks accessed and include those with similar characteristics such as attitudes and experience. However, although it is not possible to make statistical inferences from the sample to the population using this method, it enabled information to be gathered from groups that are ordinarily less easily accessed (i.e. individuals participating in illegal behaviours).

The model explained 43% of variation in hunting intention, which, although consistent with previous research aiming to predict hunting intentions (e.g. 38%; Rossi & Armstrong, 1999), indicates significant unexplained variance. Unexplained variance may partly reflect the complex nature of human behaviour (Schultz, 2011). The theory of planned behaviour assumes that behaviour is the product of rational, elaborative thought (Manfredo, 2008; Miller, 2017). It cannot therefore fully account for human complexity as it omits the role of emotions, identity and other variables that influence behaviour (Manfredo, 2008; Jacobs et al., 2014) such as moral considerations (Kaiser, 2006; Miller, 2017). Additionally, poaching often operates within systems that have complex historical and contemporary political, economic and social contexts, and these components need to be understood to help explain model variation and inform effective interventions (Duffy et al., 2016). The influence and interplay of these wider contextual considerations was demonstrated by Steinmetz et al. (2014) in a national park in Thailand where effectiveness of outreach in reducing poaching of wildlife was believed to be linked to the fact that the poachers were small in number and had land. This meant that social pressure against poaching came from the majority of the community and poachers were able to use agriculture to support themselves in the absence of poaching (Steinmetz et al., 2014). Although wider legal, ecological, subsistence and recreational motivations for hunting swans were explored in our study, further examination is required to connect theories explaining individual motivations for hunting with those focusing on broad social, economic and political drivers. This may include investigating linkages between participants and relevant actors, networks and structures such as those responsible for regulating hunting, protecting swans and facilitating hunting tourism. Further exploration of suitable alternatives to hunting swans for both social and economic motivations would also be valuable.

Wider motivations

Legal (lack of enforcement) and ecological factors were perceived to be the most likely motivations for illegal hunting. Lack of knowledge of protective laws was also noted as a likely motivation and has previously been identified as an important factor underlying illegal hunting (e.g. von Essen et al., 2014). In a complementary study 42 of 232 hunters (18%) in this study region believed it was permissible to hunt Bewick's swans or did not know whether or not they were protected (Newth et al., 2019). Perceived ecological drivers included increasing Bewick's swan numbers/numbers being too high and the swans having a negative impact on other waterbirds. Swans are perceived by some to disrupt the breeding success of waterbird species that can be legally hunted (Gurtovaya, 2000). The misidentification of Bewick's swans as other swan species, probably implying accidental shooting, was also noted by Newth et al. (2019). The perception that Bewick's swans are numerous may reflect the current status of swans in this region, but may also arise when Bewick's swans are mistaken for other swan species (i.e. the whooper and mute swan) that reside there. There may be several reasons that explain why increasing or apparently high numbers of Bewick's swans is perceived as a driver for shooting, and these should be explored further. For example, reasons may include damage to surrounding wildlife and the environment and perceptions that the natural environment is unbalanced. Thirty-two participants agreed that the law and enforcement of the law presented barriers to shooting Bewick's swans and also believed a lack of law enforcement was a likely or very likely motivation for shooting them.

Attitudes to wildlife may change over time as they are influenced by a dynamic combination of individual, societal and cultural factors (Dickman et al., 2013), and events such as conservation interventions (e.g. Treves et al., 2013). It is also possible that attitudes towards a species alter when it is present and therefore recently encountered, which in the case of the swans in northern Russia, is during May–October. We therefore recommend a longitudinal study of attitudes in this region, within and across years, to capture any shifting viewpoints.

Implications for conservation

Our findings suggest that conservation interventions should target social and psychological conditions that influence

hunters' attitudes, social norms and behavioural control. This requires activities that build trust (Stern, 2008), encourage support for Bewick's swan conservation (Yaffee & Wondolleck, 2000), promote the benefits of conservation to motivate change (Schultz, 2011), consider reasons surrounding dislike of protective laws (Tyler, 1990), and strengthen perceived confidence and power to act (Kaplan, 2000). Activities that build trust, motivate, raise awareness and offer opportunities for action, increase perceived behavioural control and generate social pressure against poaching (Steinmetz et al., 2014). In addition, attitudes interact with social norms to determine behavioural intention (McCleery et al., 2006). For example, the availability of new knowledge and incentives may make community members less tolerant of poaching and increase their interactions with conservation workers. A new level of trust and understanding between parties may develop, leading to increased support for conservation efforts (Steinmetz et al., 2014). As a consequence, a poacher may be reluctant to act as new social norms expect them to comply with the expectation of others (Steinmetz et al., 2014). Using the theory of planned behaviour to identify predictors of wildlife poaching, Steinmetz et al. (2014) designed a community outreach programme encompassing these elements, and poaching of five ungulate and one rodent species in a reserve in Thailand declined by 76% within 3 years of targeted interventions. According to local community leaders, poaching declined because of increased access to information about the issue, more pressure and increased consideration of national park staff. Therefore, existing and potential poachers responded to new attitudes and expectations of their leaders, park staff and community members (Steinmetz et al., 2014). Persuasive communication campaigns involving respected community leaders and institutions may help to redefine the social norm and increase social pressure against hunting Bewick's swans while reducing pressure to hunt them. Past studies have shown that when behaviours become socially unacceptable they become less common (e.g. Cialdini et al., 2006). Conversely, widespread support for environmental protection and conservation has been found to culminate in positive behavioural change (Schultz, 2011). Ultimately, engaging with local communities that are best placed to conserve wildlife is essential to prevent poaching and conserve threatened wildlife (Challender & MacMillan, 2014). Attitude towards protective laws was an important additional predictor of intention to violate those same laws. Such knowledge may be useful for informing the design of agreeable conservation measures that reduce non-compliance and avoid conflict between stakeholders.

Targeting ecological and legal (lack of enforcement) motivations through community engagement and law enforcement, respectively, may be beneficial. For example, perceptions about the negative impact of swans on other waterbirds could be countered through interventions that increase tolerance towards wildlife (Liu et al., 2011). However, increasing knowledge through such communication alone (as in the information deficit model; Kahan et al., 2012) rarely results in behaviour change (McKenzie-Mohr et al., 2012). Efforts to educate and raise awareness should include motivational elements, such as self-interest, values and social responsibility (Stern, 2000; Schultz, 2011). However, given many hunters lacked knowledge of protective laws (Newth et al., 2019), and ignorance of the law was perceived as a likely motivation for hunting, increasing knowledge about the law may in this case yield benefits. Law enforcement (e.g. through patrolling) may reduce poaching (e.g. Hilborn et al., 2006), although without changes in underlying social norms people often revert to past habits when enforcement stops or fails (Steinmetz et al., 2014). Conversely, outreach aims to alter the social conditions around the poacher and thus seeks changes that are internally motivated (Steinmetz et al., 2014) and that are consequently more stable (de Young, 2000). In conclusion, the approach used here, which examines socio-psychological drivers of individual hunting behaviour while also assessing the wider motivations for poaching, can be applied to inform the effective design, prioritization and targeting of interventions that could improve compliance with regulations and species protection.

Acknowledgements We thank all participants for their contribution to this study and Charlie Liggett for his translation services. Our research was funded by The Peter Smith Charitable Trust for Nature and the Olive Herbert Charitable Trust.

Author contributions Study design: JLN, AN, IS; fieldwork: AC, GM; data analysis, writing: JLN; revision: AN, RAM, KAW, ECR, IS, SB, RLC, PG, AB.

Conflicts of interest None.

Ethical standards Survey methods were approved by the College of Life and Environmental Sciences (Penryn) Ethical Review Committee at the University of Exeter (reference 2016/1496), and each respondent gave their informed consent prior to participation. The research otherwise abided by the *Oryx* guidelines on ethical standards.

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