



Trust in large carnivore science in Norway

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Abstract

Large carnivores are controversial species, and associated conflicts between stakeholders with opposing views on large carnivores are observed across the globe. Social trust, the public's willingness to rely on those responsible for developing policies, has gained much attention regarding the acceptance of large carnivores and large carnivore management. However, trust in large carnivore science has not received as much consideration. In Norway, administrative management authorities are responsible to execute the political framework decided by the Norwegian Parliament while basing their decisions on recommendations from large carnivore science. As large carnivore science is the main knowledge provider for monitoring and measures implemented in management decisions to achieve viable carnivore populations, trust in science is crucial. Yet, scientific information is often challenged. As attitude studies show a tendency for the wider general public to be more positive towards large carnivores than people most adversely affected, we wanted to examine whether the trust in large carnivore science follows the same pattern. We used a geographically stratified sample of 2110 respondents, five respondents from each municipality in Norway, to model how trust varies across the sample. Our results indicate that elderly men, people with lower education, those who have experienced loss of livestock to carnivores associate with lower trust in large carnivore science. Lower trust was also found among big game hunters and people who fear large carnivores. This knowledge could help to guide targeted science communication and contribute to a more comprehensive understanding of cognitions important for management of conflicts involving large carnivores.

Keywords Large carnivores conflict · Wildlife management · Human dimensions · Trust in science · Science communication

Introduction

Large carnivores are controversial species (Dickman 2008; Lewis et al. 2017), and associated conflicts between stakeholders with opposing views on large carnivores are observed across the globe (Chapron et al. 2014; Lozano et al. 2019; Treves and Karanth 2003). Emotional responses to large carnivores range from admiration to hate (Johansson et al. 2012; Sjölander-Lindqvist et al. 2015). As general attitudes towards

an object are a relevant predictor of broad behavioral patterns (Fishbein and Ajzen 1977; Fiske and Taylor 1991), knowledge about the public's attitudes towards large carnivore has been used to predict the social foundation for future conservation (Vaske and Manfredi 2012). Negative attitudes at an individual level can, for instance, lead to poaching, a frequently observed problem for the conservation of several threatened carnivore species (Gangaas et al. 2013; Liberg et al. 2012; Woodroffe and Ginsberg 1998). At a societal level, negative attitudes can induce public resistance to conservation plans and policies (Bruskotter and Fulton 2012; Sandström et al. 2015). Social-psychological theories have contributed to an understanding of behavior based partly on concepts involving general cognitions, such as attitudes, beliefs, norms, and trust (Schwartz 1992; Siegrist et al. 2000; Stern et al. 1999). Such theories are used extensively to guide research in human dimensions of wildlife, and the importance of attitudes has, for example, been highlighted as the basis for people's assessment of environmental management (Bright and Manfredi

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1996; Teel and Manfredo 2010; Vaske and Manfredo 2012). The cognitive hierarchy theory (Fulton et al. 1996; Homer and Kahle 1988; Vaske and Donnelly 1999) states that behavior can be predicted, to some extent, by lower levels of cognition, but more specific levels of cognition such as attitudes and norms have proved to be better predictors (Ajzen and Fishbein 2005; Whittaker et al. 2006). Attitudes are considered rather stable positive or negative evaluations of an object, and the more specific they are in terms of the object in question, the better the attitude becomes as a predictor (Heberlein 2012). Moreover, it has been suggested that people's attitudes towards objects such as policies are influenced by the trust they have in the management agency (Vaske et al. 2007).

Trust has been claimed to have a fundamental role in conservation conflicts (Stern and Coleman 2015; Young et al. 2010, 2016). It has been suggested that a willingness to rely on those responsible for developing policies, called *social trust* (Cvetkovich and Winter 2003), is essential for establishing cooperation between an agency and the public (Beierle and Konisky 2000; Cvetkovich and Winter 2004). Ultimately, the public may not support management options because they lack trust in the management agencies (Borrie and Liljeblad 2006; Cvetkovich and Winter 2004; Nyaupane et al. 2009). It has been proposed that social trust mediates the relationship between shared values and attitudes towards environmental management such as wildland fire management strategies (Vaske et al. 2007), sharpshooting programs to reduce the spread of chronic wasting disease (CWD) (Harper et al. 2015), and large carnivore management (Sponarski et al. 2014).

In addition to management agencies, scientists have been argued to play an important role in conservation conflict management (Pullin et al. 2004; Sutherland et al. 2004), for example, by providing a better understanding of the root causes of conflicts, helping to discover and test mitigation techniques, and exploring trade-offs (Bennett et al. 2017a, b; Redpath et al. 2013). Yet, scientific inquiry is constantly at risk of being politicized in environmental controversies (Sarewitz 2004), challenging the trust people hold in scientific knowledge. Scientists can be perceived as biased if they advocate positions fitting with only some of the stakeholders (Sutherland et al. 2004) or frame questions and interpret results supporting one side rather than the other (Treves et al. 2006). Furthermore, stakeholders may focus solely on findings that support their own position, contributing to an impression of science being politicalized (Thirgood and Redpath 2005). The Norwegian large carnivore management is based on a national policy defined by the Norwegian Parliament, where the government prepares specific management goals for the large carnivore species. The administrative management authorities are responsible for ensuring that the political framework is followed at both local (Municipality) and regional (County) levels. This makes the

large carnivore management a mixture of centralized and decentralized processes (de Boon et al. 2020). The county governor is responsible for implementing state directives together with local carnivore committees (rovviltnefder), and local politicians will work for local democratic influence that is not necessarily in line with national administrative goals. In the midst of this complexity between local and national governance and influence, large carnivore science works as a knowledge provider giving professional recommendations.

Norwegian studies report that large carnivore science is regularly being challenged (Skogen et al. 2018) and cherry-picked by stakeholders to benefit their own interests (Skogen and Thrane 2007). This may cause people to lose trust in carnivore science. We believe it is important to include trust in carnivore science when trying to understand the cognitions important for management of conflicts involving large carnivores. People holding more negative attitudes towards large carnivores often claim that local knowledge is ignored by those in power, e.g., politicians, managers, biologists, and conservationists (Skogen and Krangle 2003). Judgments on trust relies on heuristics (Cvetkovich and Winter 2007), including similarity between oneself and the person or organization to be trusted (Balliet and Van Lange 2013), and positive affect towards that person/organization (Schoorman et al. 2007). People tend to trust those they perceive to hold the same values as themselves (Johansson et al. 2017; Stern and Coleman 2015). We consider it urgent to better understand which variables underlie the lower trust of some people in both carnivore scientists and the management agency. This would strengthening trust.

Direct experience with wolves (*Canis lupus*) have been observed to associate with negative attitudes towards the species (Eriksson et al. 2015; Williams et al. 2002). People living in large carnivore areas are potentially negatively affected by large carnivores (Krangle et al. 2017b), for example, by experiencing losses of domestic animals (Røskaft et al. 2007), being a hunter and thus experiencing competition for big game species (Naughton-Treves et al. 2003; Treves and Martin 2011), and/or fear of meeting these animals in the wild (Krangle et al. 2017a). In addition, as the influence from what friends, peers, and enemies think can strongly affect a person's attitude (Boninger et al. 1995; Petty et al. 1997), indirect experiences (e.g., relying on other people's experiences rather than personally being exposed to carnivores or seeing tracks or signs; Eriksson et al. 2015) can be important influencing attitudes (Karlsson and Sjöström 2007). People living in areas with big game hunting traditions and high sheep densities have earlier reported more negative attitudes towards large carnivores (Gangaas et al. 2013). Further, sociodemographic variables have also been included in attitude surveys. While the association between gender and attitudes toward large carnivores

have been observed to vary, with both males and females being most negative (Kleiven et al. 2004; Røskaft et al. 2007; Williams et al. 2002), higher age (Bjerke et al. 2002; Dressel et al. 2015; Røskaft et al. 2007) and lower education (Dressel et al. 2015; Williams et al. 2002) have been associated with more negative attitudes towards large carnivores.

Large carnivore presence varies geographically in Norway, with some regions having all four large carnivore species, brown bear (*Ursus arctos*), wolf, Eurasian lynx (*Lynx lynx*), and wolverine (*Gulo gulo*) present, while others have none. To meet the two-folded objective of large carnivore management in Norway, both ensuring viable populations of large carnivores and securing a sustainable grazing industry, the Norwegian parliament have established a zonal management system (Hansen et al. 2019; Strand et al. 2019). Carnivore management zones prioritized for large carnivore species are thus separated from areas prioritized for grazing livestock. The uneven distribution of large carnivores and consequently the variation in experiencing negative consequences associated with living close to these species are therefore expected to vary geographically. To capture skepticism and negative perceptions at smaller spatial scales, without losing those voices in proportional surveys, non-proportional sampling methods are useful (Ericsson et al. 2006). Considering the important influence of geographical variation in carnivore presence and any associated negative experiences, on people's attitudes towards these animals, we wonder whether this spatial variation also influences trust in large carnivore science.

Here we wanted to examine whether variables known to influence peoples' attitudes towards large carnivores associate with trust in large carnivore science, as this could contribute to improve future science communication. In order to build trust among the public, a better understanding of the characteristics that describe people with low trust in carnivore science is important, potentially helping communicators to identify needs leading to more efficient science communication. This study aims to contribute to that understanding by exploring the association between trust in large carnivore science and variables related to carnivore presence and consequently how people perceive them. We examine whether the level of trust in carnivore science can simply be described by sociodemographic patterns and local presence of carnivores, or whether it follows a more complex pattern based on multiple factors. Therefore, we hypothesize that respondents living in areas with large carnivores show lower trust in large carnivore science, as they are more directly affected compared to respondents living far away from large carnivore species. We hypothesize that variables within the variable-group of rural context associate with lower trust in large carnivore science. Last, we hypothesize that trust in carnivore

science will differ with age, gender, and education level among our respondents, and that respondents with higher levels of self-reported fear will have lower trust in large carnivore science. Ultimately, we hope that by improving the knowledge of trust in carnivore science, we can facilitate a better understanding of the cognitions important for management of conflicts involving large carnivores.

Method

Respondents and data collection

The study included 2110 respondents (43% female, 57% male), aged between 15 and 92 years (mean age = 45.63, SD = 17.72 years), representing five respondents from each of Norway's 422 municipalities. The sampling was done by a data collection agency (www.norstat.no), and the data frame was based on existing registers that are publicly available, and respondents were sampled randomly within a municipality until five persons from that municipality had completed the survey. This geographically stratified sampling procedure allowed for the inclusion of people from all over the country, and with a mixture of different backgrounds, carnivore presence and experiences with large carnivores. The data collection agency is not required to seek permission for this kind of data collection from the Norwegian Social Science Data Service (NSD; www.nsd.no). NSD is the institution reviewing research proposals for data collection, but an ethics review and a permit are only required in cases where the researchers and/or the data collection agency retain a register of respondents for purposes such as reminders or follow up surveys. This was not the case for our study, and we have no register or any other kind of information that can be used for linking individuals to the data set.

Survey

The questionnaire used for the survey included items on trust, rural context, and sociodemographic variables. Trust in large carnivore science was measured based on how the respondent rated the statement "I trust large carnivore science produced in Norway," and this was used as the response variable in the statistical analysis. Respondents were also asked to rate statements about their trust in science in general, in climate science, and in medical science in the same format. Respondents were asked to respond to these statements using a five-point Likert scale from 1 = "strongly disagree" to 5 = "strongly agree" with 3 = "neutral".

Predictor variables

The predictor variables were collected both through the survey and from official available databases, and were divided into four groups with different themes before the analysis (Table 1). The first group included sociodemographic variables such as age, gender, and education. Age was included as a continuous variable to explore if there is a general trend of changes in trust with increasing age. The second included variables for whether carnivores in general or wolves in particular were present or not in the respondents' residential municipality. Data on large carnivore presence were obtained from Rovdata (<https://rovdata.no/>), while hunter ration and sheep density were obtained from Statistics Norway (<https://www.ssb.no/en>). Given that people may be more aware of carnivore management zones than carnivore distribution, a variable about whether the municipality of the respondent was covered by a management zone of at least one of the four carnivore species was included. In addition, a variable on whether the municipality is within the national wolf zone was also included. Lastly, this group included a question in which respondents were asked which of the four large carnivores they thought were present within their municipality, to examine whether their awareness of carnivore presence was more important than data on carnivore presence regarding their reported trust in carnivore science. The third group was named rural context and focused on respondent's experience of losses of livestock, density of free ranging sheep in the municipality, and big game hunting traditions, which according to previous research are important characteristics defining this context (Gangaas et al. 2013). In addition, we asked whether respondents were big game hunters themselves. In Norway, hunting traditions are deeply established in the country's history and culture, with big game hunting including the hunting of moose (*Alces alces*), roe deer (*Capreolus capreolus*), wild reindeer (*Rangifer tarandus*), and red deer (*Cervus elaphus*). Generally, local hunters have good access to hunting through informal connections with landowners or through organized hunting teams. The final group of factors consisted of a self-reported level of fear towards each of the four large carnivore species present in Norway (see full variable description in Table 1).

Statistical analyses

Trust in carnivore science was a 5-level categorical response variable. We analyzed how it varied in response to different combinations of the explanatory variables (Table 1) using multiple ordinal linear regression models. We also wanted to understand which of the variables in the different group best described the variation in the level of trust in large carnivore science. For example, within the group "carnivore presence, was it the presence of

carnivores in general, the presence of wolves in particular or whether, or not a respondent lived within a defined carnivore zone that best described the variation in trust? The candidate models constructed and the model selection procedure reflect these considerations. Although it might be expected that some of the variables would interact, we only considered additive effects and no interaction effects due to data restrictions. The models were constructed using the MASS-library (Venables and Ripley 2013) in the statistical environment (R Core Team 2019), and we used an information theoretic approach based on AIC-values (Burnham and Anderson 2002) to objectively select the most supported model for variation in trust.

Results

Trust in science in general and specific scientific disciplines

We found lower levels of trust in large carnivore science and climate science compared to medical science (Table 2). While approximately four out of five either agreed or highly disagreed with the statements on having trust in medical science, only 58% did so for carnivore science. Almost one out of five respondents disagreed or highly disagreed in having trust in large carnivore science.

Models of trust in carnivore science

The most supported model describing the variation in trust in large carnivore science included variables from all groups and were gender, age, education, wolf presence, big game hunter, experienced loss, and fear of wolves (Table 3). The specific effects within each variable group are described in more detail below.

Sociodemographic variables

The probability of agreeing with the statement concerning trust in large carnivore science decreased as a function of age (Fig. 1a). Gender differences were less obvious, but females showed a slightly higher probability of highly agreeing to trust in carnivore science compared to males (Fig. 1b). People who completed high school as their highest education level agreed less with the statement concerning trust in large carnivore science compared to other types of education levels. Besides that, the probability of highly agreeing with the statement concerning trust in carnivore science generally increased with education level (Fig. 1c).

Table 1 Predictor variables included in the model selection. The column named source state whether information about the variable were collected from the survey or are official statistics, named official data, achieved from open data sources

Variable	Description	Numerical summary (total=2110)	Source
(i) Sociodemographic			
Age	Continuous variable representing the individual specific age of the respondents	Mean (yr) = 45.63 (SD = 17.72), range (yr) = 15–92	Survey
Gender	Categorized into “male” or “female”	Female = 906, Male = 1204	Survey
Education	Highest level of education for the respondent. Categorized as primary education, high school, lower degree university (bachelor), or higher degree (master or PhD)	Elementary = 191 High school = 907 Bachelor = 651 Master or higher = 361	Survey
(ii) Carnivore presence			
Presence of carnivores	Officially registered observations or signs (tracks, fur), within the last 5 years of either lynx, bear, wolf or wolverine in the municipality, categorized as “present” or “not present”	Present = 1545 Not present = 565	Official data
Presence of wolves	Officially registered observations or signs (tracks, fur), within the last five years of wolves, categorized as “present” or “not present”	Present = 775 Not present = 1335	Official data
Carnivore zone	Presence of a management zone of at least one of the species wolverine, brown bear, and lynx within the municipality of the respondent. Categorized as “within” or “outside” management zone	Within zone = 1250 Outside zone = 860	Official data
Wolf zone	Municipality being within the national wolf zone. Norway has one established wolf zone, consisting of land in the East bordering Sweden, in which wolves are to be prioritized over other human interests, e.g. livestock farming. Categorized as “within” or “outside” management zone for wolves	Within zone = 265 Outside zone = 1845	Official
Perception of carnivore presence	The respondent’s statement about which of the four large carnivores they think are present in their municipality, categorized as “present” or “not present”	Present = 1480 Not present = 630	Survey
(iii) Rural context			
Big game hunter	Whether the respondent hunts big games (moose, roe deer, wild reindeer, and red deer)	Yes = 410 No = 1700	Survey
Big game traditions in area	To what degree do respondents agree with the statement: “There are strong traditions for big game hunting in your municipality”	Highly agree = 310 Agree = 179 Neutral = 229 Disagree = 432 Highly disagree = 959 No answer = 1	Survey
Hunter ratio	The number of registered big game hunters divided on the total number of inhabitants in municipality of the respondent	Mean = 0.15 (SD = 0.08), range = 0.03–0.43	Official data
Sheep density	The density of free ranging sheep in the municipality	Mean = 178.27 (SD = 222.50)/km ² , range = 0.00–2206.70 / km ²	Official data
Experienced loss	Experience of personal loss of pets or livestock to large carnivores, categorized as “no” or “yes”	Yes = 194 No = 1916	Survey
(iv) Fear			
Fear	Self-perceived fear of each large carnivore species, categorized into “not scared,” “little scared,” “pretty scared,” and “very scared” given for bears/wolves/lynx/wolverine	Not scared = 302/416/507/429 Little scared = 812/648/877/947 Pretty scared = 438/781/339/292 Very scared = 558/265/387/442	Survey

Table 2 The number of respondents reporting different levels of agreement with statements about different science disciplines with the percentages (%) shown in brackets. Total number respondents for each science discipline $n=2210$

Type of science	Level of trust				
	Highly disagree	Disagree	Neither	Agree	Highly agree
Science in general	72 (3.41)	112 (5.31)	349 (16.54)	662 (31.37)	915 (43.36)
Medical science	54 (2.56)	69 (3.27)	241 (11.42)	740 (35.07)	1006 (47.68)
Climate science	170 (8.06)	197 (9.34)	424 (20.09)	591 (28.01)	728 (34.50)
Large carnivore science	186 (8.82)	193 (9.15)	508 (24.08)	669 (31.71)	554 (26.26)

Carnivore presence

All variables included in the section of carnivore presence improved the model compared to a model setup containing only sociodemographic variables (Table 3). However, the most supported model included wolf presence, where respondents living in municipalities with wolves showed lower agreement with the statement concerning trust in large carnivore science, on average (Fig. 2).

Rural context

Including some of the variables describing a rural context improved the model fit (Table 3). Respondents that reported to be a big game hunter themselves were more likely to report lower levels of agreement in the statement concerning trust in carnivore science (Fig. 3a). The likelihood of responding agree or highly agree were higher for non-hunters than for hunters. Relatively few had experienced loss ($n=194$), but they agreed less with the statement concerning

Table 3 The candidate models used in the model selection, with $\Delta AICc$ and degrees of freedom. The candidate model in bold was the most supported model as judged from AICc values

Candidate models	$\Delta AICc$	Degrees of freedom
<u>(i) Sociodemographics</u>		
Gender	205.9	5
Age	203.5	5
Education	163.4	7
Age + education	152.7	8
Gender + age + education	150.5	9
<u>(ii) Sociodemographics + carnivore presence</u>		
Gender + age + education + wolf zone	149.8	10
Gender + age + education + Carnivore presence	141.1	10
Gender + age + education + carnivore zone	139.1	10
Gender + age + education + perception carnivore presence	137.6	10
Gender + age + education + wolf presence	131.2	10
<u>(iii) Sociodemographics + carnivore presence + rural context</u>		
Gender + Age + education + wolf presence + hunter ratio	115.4	11
Gender + age + education + wolf presence + sheep density	132.4	11
Gender + age + education + wolf presence + big game hunting traditions	115.1	11
Gender + age + education + wolf presence + big game hunter + Sheep density	76.6	12
Gender + age + education + wolf presence + big game hunter	75.7	11
Gender + age + education + wolf presence + experienced loss	75.3	11
Gender + age + education + wolf presence + big game hunter + Experienced loss	33.6	12
<u>(iv) Sociodemographics + carnivore presence + rural context + fear</u>		
Gender + age + education + wolf presence + big game hunter + experienced loss + fear of bears	34.7	15
Gender + age + education + wolf presence + big game hunter + experienced loss + fear of lynx	25.1	15
Gender + age + education + wolf presence + big game hunter + experienced loss + fear of wolverines	22.3	15
Gender + age + education + wolf presence + big game hunter + experienced loss + fear of wolves	0.0	15

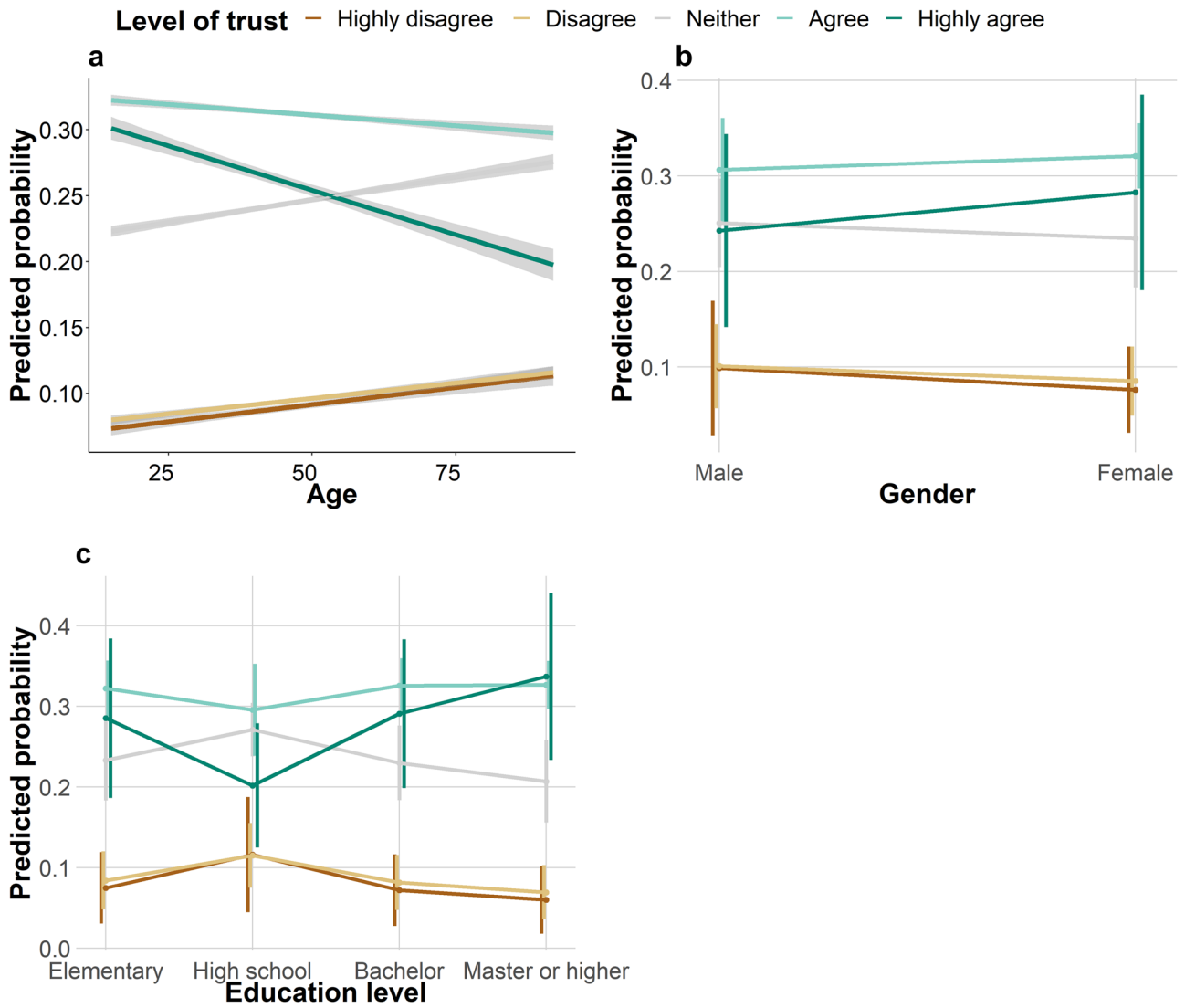
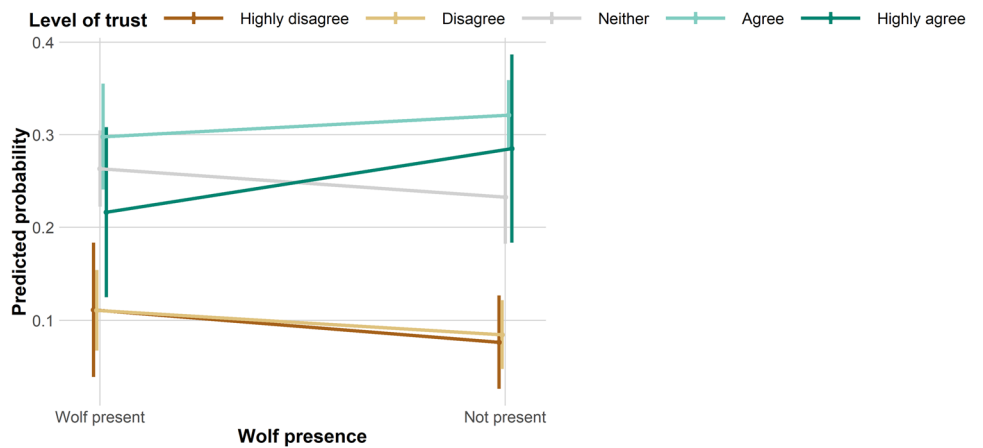


Fig. 1 The predicted probability of each of the five levels of agreement to the statement of trust in large carnivore science as a function of age (a), gender (b), and education level (c). The vertical lines depict the SD for each category

Fig. 2 The predicted probability of each of the five levels of agreement to the statement concerning trust in large carnivore science as a function of whether the respondent lives in a municipality where wolves were present. The vertical lines depict the SD for each category



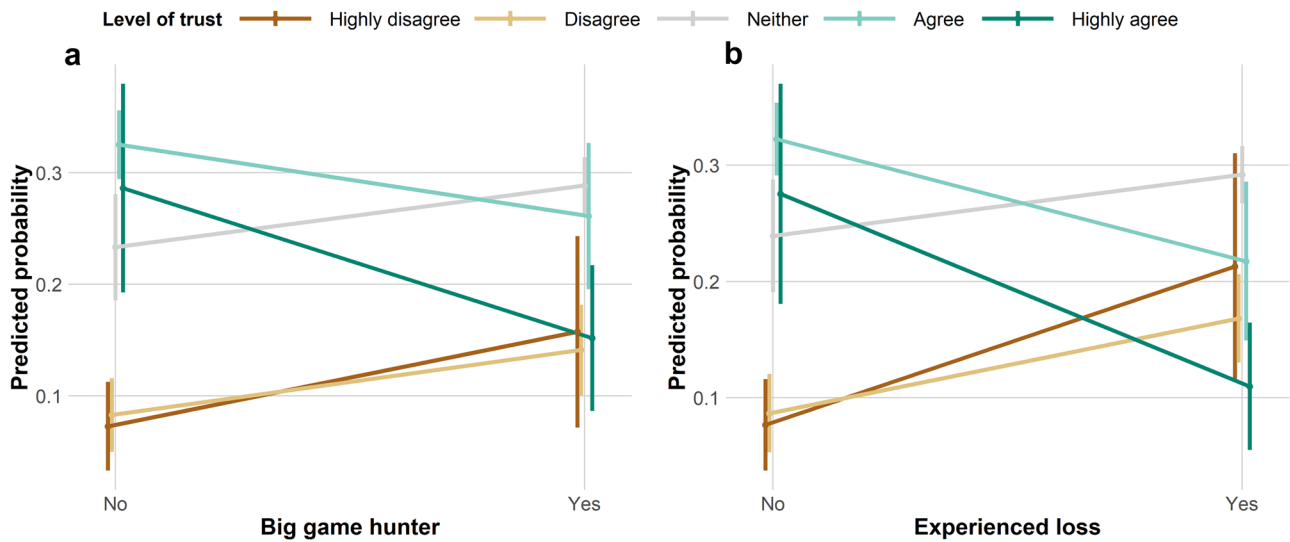
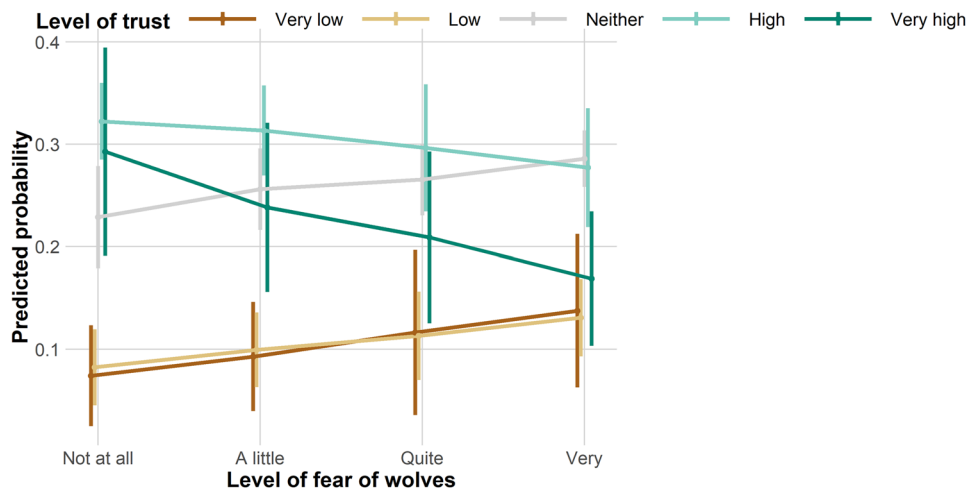


Fig. 3 The predicted probability of each of the five levels of agreement to the statement concerning trust in large carnivore science as a function of being a big game hunter or not (a) and having experi-

enced loss to large carnivores or not (b). The vertical lines depict the SD for each category

Fig. 4 The predicted probability of each of the five levels of agreement with the statement concerning trust in large carnivore science as a function respondents' self-reported level of fear of wolves. The vertical lines depict the SD for each fear level



trust in large carnivore science than people who had not experienced any loss (Fig. 3b).

Fear

The results suggest that trust in large carnivore science is negatively associated with a fear of wolves, with the probability of responding agree or highly agree to the statement concerning trust in large carnivore science declining with every increase in level of fear, from not scared, little scared, pretty scared, and very scared of wolves (Fig. 4). The probability of responding disagree and highly disagree increased the most with increased fear of wolves. Fear towards the

other species (e.g., wolverine, lynx, and brown bear) were also associated with mistrust in carnivore science, but to a lesser extent.

Discussion

Lower trust in large carnivore science associated with the variables wolf presence, being a big game hunter, having experienced loss of livestock to carnivores, older age, less education, being a male, and self-reported higher levels of fear of wolves. Essentially, the results show that there is no single variable alone that predicts a lower trust in carnivore

science, but rather a combination of variables, many of which vary spatially. Compared to the other categories of science, carnivore science and climate science experience lower levels of trust than medical science. The observed lower trust in climate science, and perhaps carnivore science, may be partly explained by the different nature of the science categories included in the survey. Previous studies have suggested a trend towards lower levels of trust in what may be called impact science, e.g., science that identifies environmental and public health impacts of economic production, than in production science, e.g., science that provides new inventions for economic production (McCright et al. 2013). Denying evidence that does not conform to one's ideological worldview, values or ideology, is not uncommon, exemplified by the denial of climate change by many political conservatives in the USA (Dunlap and McCright 2015; McCright and Dunlap 2011). The presence of carnivores varies greatly between different parts of Norway, and consequently so do the potential negative consequences of living with these animals. We observed that respondents who lived in municipalities with large carnivores generally had a lower trust in carnivore science than respondents living elsewhere, with the strongest effect being found for the presence of wolves. This result is consistent with previous studies showing that people who reported personal experience of signs of wolves in the area where they lived had relatively lower social trust in the managing authorities (Johansson et al., 2012).

Wolf presence has been associated with negative attitudes towards carnivores in several previous studies (Karlsson and Sjöström 2007; Krange et al. 2017a; Skogen and Krange 2003). Direct experience with wolves has been observed to correlate with negative attitudes towards both the animals and wolf policy goals (Ericsson et al. 2006; Eriksson et al. 2015). As zoning has become an important management strategy in Norway, uneven costs of coexistence will continue to be the reality. Based on our results, this will exacerbate regional variation in levels of trust. A person's experience of large carnivores may be perceived differently depending on their attitudes towards the animal. For example, some people living in carnivore areas report their experience of wolves as being unwanted, agonizing, assertive, or unnatural (Skogen et al. 2018). If scientific knowledge presented by large carnivore scientists is not in line with people's personal experience, for example communicating that wolves tend to be shy, people may lose trust in large carnivore scientists.

Both wolf presence and fear of wolves are included in the top model, indicating the importance of wolves in influencing people's level of trust in large carnivore science. Wolves are perceived as a flagship species, and may thus be more frequently associated with social conflicts than other large carnivore species (Douglas and Verissimo 2013).

Researchers have sought to explain the underlying socio-cultural causes of the observed controversies accompanying wolf presence (Kaltenborn and Bjerke 2002; Skogen and Thrane 2007). Among other observations, wolves can symbolize urban dominance over rural areas, contributing to a divide between urban and rural inhabitants (Enck and Brown 2002; Skogen and Krange 2003). Attitudes towards wolves seem in general to be more negative than those towards other large carnivores species in Norway (Dressel et al. 2015; Krange et al. 2017b), and seem to have a special position in people's awareness (Figari 2008; Figari and Skogen 2011). Krange and Skogen (2018) observed an association between lower trust in environmental institutions and negative attitudes towards wolves in Norway. Consequently, it may not be surprising that we observed wolf presence and fear of wolves to be included in the top model rather than variables relating to other species.

Negative experience, such as loss of livestock, was associated with a mistrust of carnivore science and has previously been shown to associate with negative attitudes towards carnivores (Kleiven et al. 2004; Røskaft et al. 2007). Social scientists have argued that personal importance of an issue is a key feature in studies of attitude-behavior relationships (Ajzen and Fishbein 2005; Bright and Manfredi 1996). Farmers owning free ranging sheep and big game hunters wanting to maximize big game abundance will have an interest in reducing the population sizes of large carnivores. Previous research has suggested that vested interests in a topic may motivate people to reject science communicated to them that is not compatible with their interests (Hornsey and Fielding 2017; Kunda 1987). Stakeholders that perceive carnivore science as being unbeneficial may thus be more likely to repudiate information communicated to them. Also, new relevant information that stand against currently held experiences and views may result in cognitive dissonance, making people rejecting it (Festinger 1957). Further, discomfort about the notion of the potential influence of policy preferences of scientists has been discussed in previous research (Lackey 2007). It should be noted that people tend to trust agencies that they perceive to hold similar values as themselves (Siegrist et al. 2000). On the other hand, distrust happens if the management agency is thought to have other values, or if it operates in a perceived inconsistent way with shared values for non-legitimate reasons (Cvetkovich and Winter 2003). Lack of power, e.g., if the management agency is not being perceived to control the situation, can lead to lower trust, as observed in management of threatened and endangered species (Cvetkovich and Winter 2003). While carnivore scientists are not directly responsible for management decisions, people may still have expectations to scientific knowledge being implemented into the management principles. Distinguishing between the distribution

of roles and responsibilities between decision makers, managers, and scientists in relation to the complexity of the large carnivore issues may be difficult for people in general. If people fail to recognize the contributions of large carnivore scientists, they might lose trust in them and their role as knowledge providers.

Social trust plays an important part in achieving efficient nature management (Cvetkovich and Lofstedt 2013; Sponarski et al. 2014). The existence of trust allows agencies to work without the need to continuously ensure that stakeholders will act acceptably. Zajac et al. (2012) argues that raising an individual's social trust in the management agency can indirectly lead to increased stakeholders' acceptance of large carnivores. Trusted organizations do not need to continuously argue for their decisions and defend their policies and actions. We found that trust in large carnivore science is associated with very much the same variables as attitudes to large carnivores. Consequently, provision of science-based information to the public, while simultaneously building trust in information, is an approach that may reduce extreme attitudes and increase acceptance of large carnivores (Arbieu et al. 2019). This may further influence support in management decisions (Heberlein 2012; Sponarski et al. 2014).

Altogether, our results show that distrust in large carnivore science is associated with a distinct suite of characteristics. The variables describing these are available to and could be used by managers and science communicators. Our approach, while not being proportionally representative of the population, show patterns that will be useful for detecting distrust. This can in turn help guide science communication and the use of resources spent on interventions aimed at providing prerequisites for local people to lower their level of fear or increasing their trust in large carnivore science. Large carnivore scientists need to better understand how different factors, processes, and dynamics play in building mistrust in general, and we also think that both large carnivore scientists and management authorities need to clarify roles they fulfill. Closer cooperation between scientists and managers has been suggested to improve management success, but this may make it more challenging for the public to distinguish between them, and may make people doubt scientists' motivation in management recommendations. If this is true, building trust in carnivore science will rely on simultaneously building trust in carnivore management agencies. Wildlife professionals could help in reducing controversy around large carnivores by clearly delineating policy decisions from the scientific contributions used to reach to those decisions (Bruskotter 2013). Science communicators should be aware of their role, and specific local experts could be appointed to engage with media and verify information accuracy of large carnivore science. Further, ensuring the communication of science-based information on both costs and benefits of large carnivores is crucial to gain trust in large carnivore science over time.

To reduce the risk of local communities feeling neglected, citizen science, e.g., involving citizens in data collection such as monitoring, and encourage participation in management strategy development, may help to develop a trustful relationship with science (Anhalt-Depies et al. 2019; Ostermann-Miyashita et al. 2021). In groups with low levels of trust in carnivore science, e.g., hunters, citizen science could aid to make results more likely accepted as unbiased and reliable as basis for management decisions. Increased effort in including these groups in the research projects, or being invited in different discussions, may help bridging the perceived gap between scientists and hunters, as well as other stakeholder groups. Acknowledgment of different types of knowledge and knowledge sources, including local knowledge, such as personal experiences, tradition, and cultural, in addition to science, can help to improve legitimacy in management decisions (Sandström et al. 2015). Co-creation of knowledge including both scientists and stakeholders may improve perceived legitimacy of the knowledge used to inform management decisions and consequently increase support for large carnivore management policies.

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Availability of data and material We will make all data available upon request. The data set will be archived for at least 10 years.

Code availability Open access.

Declarations

Ethics approval and consent to participate The survey was conducted by a data collection agency (NORSTAT; www.norstat.no) between April and June 2019. The interviews follow a strict protocol as dictated by standard research ethics. Neither the research agency nor the data collection agency are required to seek permission for this kind of data collection from the Norwegian Social Science Data Service (Ross et al. 2016). NSD is the institution reviewing research proposals for data collection, but an ethics review and a permit are only required in cases where the researchers and/or the data collection agency retain a register of respondents for purposes such as reminders or follow up surveys. This was not the case for our study, and we have no register or any other kind of information that can be used for linking individuals to the data set.

Consent for publication All authors have been contributing to this work, and all authors agree to the publication of this research.

Conflict of interest The authors declare no competing interests.

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References

- Ajzen I, Fishbein M (2005) The Influence of Attitudes on Behavior. In: Albarracín D, Johnson BT, Zanna MP (eds) *The handbook of attitudes*. Lawrence Erlbaum Associates Publishers, Mahwah, pp 173–221
- Anhalt-Depies C, Stenglein JL, Zuckerberg B, Townsend PA, Rissman AR (2019) Tradeoffs and tools for data quality privacy transparency and trust in citizen science. *Biol Conserv* 238:108195. <https://doi.org/10.1016/j.biocon.2019.108195>
- Arbieu U et al (2019) Attitudes towards returning wolves (*Canis lupus*) in Germany: exposure, information sources and trust matter. *Biol Conserv* 234:202–210. <https://doi.org/10.1016/j.biocon.2019.03.027>
- Balliet D, Van Lange PAM (2013) Trust conflict and cooperation: a meta-analysis. *Psychol Bull* 139:1090
- Beierle TC, Konisky DM (2000) Values conflict and trust in participatory environmental planning. *J Policy Anal Manag* 19:587–602
- Bennett NJ et al (2017a) Conservation social science: Understanding and integrating human dimensions to improve conservation. *Biol Conserv* 205:93–108
- Bennett NJ et al (2017b) Mainstreaming the social sciences in conservation. *Conserv Biol* 31:56–66
- Bjerke T, Skogen K, Kaltenborn B (2002) Nordmenns holdninger til store rovpattedyr Resultater fra en spørreskjemaundersøkelse [Attitudes toward large carnivores in Norway. Results from a national survey]. NINA Oppdragsmelding 768:1–42
- Boninger DS, Krosnick JA, Berent MK (1995) Origins of attitude importance: self-interest social identification and value relevance. *J Pers Soc Psychol* 68:61–80. <https://doi.org/10.1037/0022-3514.68.1.61>
- Borrie WT, Liljeblad A (2006) Trust in wildland fire and fuel management decisions. *Int J Wilderness* 12:39
- Bright AD, Manfredo M (1996) A conceptual model of attitudes toward natural resource issues: a case study of wolf reintroduction. *Hum Dimens Wildl* 1:1–21
- Bruskotter JT (2013) The predator pendulum revisited: social conflict over wolves and their management in the western United States. *Wildl Soc Bull* 37:674–679
- Bruskotter JT, Fulton DC (2012) Will hunters steward wolves? A comment on Treves and Martin. *Soc Nat Resour* 25:97–102
- Burnham KP, Anderson DR (2002) *Model selection and multimodel inference: a practical information-theoretic approach*, 2nd edn. Springer, New York
- Chapron G et al (2014) Recovery of large carnivores in Europe's modern human-dominated landscapes. *Science* 346:1517–1519. <https://doi.org/10.1126/science.1257553>
- Cvetkovich G, Lofstedt RE (2013) *Social trust and the management of risk*. Taylor and Francis Group, Oxfordshire. <https://doi.org/10.4324/9781315071350>
- Cvetkovich G, Winter PL (2003) Trust and social representations of the management of threatened and endangered species. *Environ Behav* 35:286–307
- Cvetkovich G, Winter PL (2007) The what how and when of social reliance and cooperative risk management. In: Siegrist M, Earle TC, Gutscher H (eds) *Trust in Risk Management: Uncertainty and Scepticism in the Public Mind*. Taylor & Francis Group, Oxfordshire, pp 200–222. <https://doi.org/10.4324/9781849776592-17>
- Cvetkovich GT, Winter PL (2004) Seeing eye-to-eye on natural resource management: trust value similarity and action consistency/justification. In: *Proceedings of the Fourth Social Aspects and Recreation Research Symposium*, San Francisco State University, San Francisco, California, p 47–50, 4–6 February 2004
- de Boon A et al (2020) Governing dual objectives within single policy mixes: an empirical analysis of large carnivore policies in six European countries. *J Environ Policy Plan* 23:399–413. <https://doi.org/10.1080/1523908X.2020.1841614>
- Dickman AJ (2008) Key determinants of conflict between people and wildlife particularly large carnivores around Ruaha National Park Tanzania. University College London, London
- Douglas LR, Veríssimo D (2013) Flagships or battleships: deconstructing the relationship between social conflict and conservation flagship species. *Environ Soc Adv Res* 4:98–116
- Dressel S, Sandström C, Ericsson G (2015) A meta-analysis of studies on attitudes toward bears and wolves across Europe 1976–2012. *Conserv Biol* 29:565–574
- Dunlap RE, McCright AM (2015) Challenging climate change. *Clim Change Soc Sociol Perspect* 300
- Enck JW, Brown TL (2002) New Yorkers' attitudes toward restoring wolves to the Adirondack Park. *Wildl Soc Bull* 30:16–28
- Ericsson G, Sandström C, Bostedt G (2006) The problem of spatial scale when studying the human dimensions of a natural resource conflict: humans and wolves in Sweden. *Int J Biodivers Sci Manag* 2:343–349
- Eriksson M, Sandström C, Ericsson G (2015) Direct experience and attitude change towards bears and wolves. *Wildlife Biol* 21:131–137
- Festinger L (1957) *A theory of cognitive dissonance*. Stanford University Press, Evanston
- Figari H (2008) *Konsensus i konflikt: Sosiale representasjoner av ulv [Social representations of wolves]*. University of Oslo, Oslo (In Norwegian)
- Figari H, Skogen K (2011) Social representations of the wolf. *Acta Sociol* 54:317–332
- Fishbein M, Ajzen I (1977) *Belief attitude intention and behavior: An introduction to theory and research*. Philos Rhetor 10
- Fiske ST, Taylor SE (1991) *Social cognition*. McGraw-Hill Book Company, New York
- Fulton DC, Manfredo MJ, Lipscomb J (1996) *Wildlife value orientations: a conceptual and measurement approach*. *Hum Dimens Wildl* 1:24–47
- Gangaas KE, Kaltenborn BP, Andreassen HP (2013) Geo-spatial aspects of acceptance of illegal hunting of large carnivores in Scandinavia. *PLoS ONE* 8:9. <https://doi.org/10.1371/journal.pone.0068849>
- Hansen I, Strand G-H, de Boon A, Sandström C (2019) Impacts of Norwegian large carnivore management strategy on national grazing sector. *J Mt Sci* 16:2470–2483
- Harper EE, Miller CA, Vaske JJ (2015) Hunter perceptions of risk social trust and management of chronic wasting disease in Illinois. *Hum Dimens Wildl* 20:394–407
- Heberlein TA (2012) *Navigating environmental attitudes*. Oxford University Press, New York

- Homer PM, Kahle LR (1988) A structural equation test of the value-attitude-behavior hierarchy. *J Pers Soc Psychol* 54:638
- Hornsey MJ, Fielding KS (2017) Attitude roots and Jiu Jitsu persuasion: understanding and overcoming the motivated rejection of science. *Am Psychol* 72:459–473. <https://doi.org/10.1037/a0040437>
- Johansson M, Frank J, Støen O-G, Flykt A (2017) An evaluation of information meetings as a tool for addressing fear of large carnivores. *Soc Nat Resour* 30:281–298
- Johansson M, Karlsson J, Pedersen E, Flykt A (2012) Factors governing human fear of brown bear and wolf. *Hum Dimens Wildl* 17:58–74
- Kaltenborn BP, Bjerke T (2002) The relationship of general life values to attitudes toward large carnivores. *Hum Ecol Review* 9:55–61
- Karlsson J, Sjöström M (2007) Human attitudes towards wolves a matter of distance. *Biol Conserv* 137:610–616. <https://doi.org/10.1016/j.biocon.2007.03.023>
- Kleiven J, Bjerke T, Kaltenborn BP (2004) Factors influencing the social acceptability of large carnivore behaviours. *Biodivers Conserv* 13:1647–1658
- Krange O, Sandstrom C, Tangeland T, Ericsson G (2017a) Approval of wolves in Scandinavia: a comparison between Norway and Sweden. *Soc Nat Resour* 30:1127–1140. <https://doi.org/10.1080/08941920.2017.1315652>
- Krange O, Skogen K (2018) Nordmenns holdninger til ulv - 2018 [Norwegians' attitudes toward wolves - 2018]. NINA Rapport 1570:58 (In Norwegian)
- Krange O, Skogen K, Helland H (2017) Nordmenns holdninger til store rovdyr — endringer fra 2010 til 2017 [Norwegians' attitudes toward large carnivores - changes from 2010 to 2017]. NINA Rapport 1836:28 (In Norwegian)
- Kunda Z (1987) Motivated inference: self-serving generation and evaluation of causal theories. *J Pers Soc Psychol* 53:636–647. <https://doi.org/10.1037/0022-3514.53.4.636>
- Lackey RT (2007) Science scientists and policy advocacy. *Conserv Biol* 21:12–17
- Lewis P-M, Burns GL, Jones D (2017) Response and responsibility: humans as apex predators and ethical actors in a changing societal environment. *Food Webs* 12:49–55. <https://doi.org/10.1016/j.fooweb.2016.09.001>
- Liberg O, Chapron G, Wabakken P, Pedersen HC, Hobbs NT, Sand H (2012) Shoot shovel and shut up: cryptic poaching slows restoration of a large carnivore in Europe. *Proc R Soc B Biol Sci* 279:910–915
- Lozano J et al (2019) Human-carnivore relations: a systematic review. *Biol Conserv* 237:480–492. <https://doi.org/10.1016/j.biocon.2019.07.002>
- McCright AM, Dentzman K, Charters M, Dietz T (2013) The influence of political ideology on trust in science. *Environ Res Lett* 8:044029
- McCright AM, Dunlap RE (2011) The politicization of climate change and polarization in the American public's views of global warming 2001–2010. *Sociol Q* 52:155–194
- Naughton-Treves L, Grossberg R, Treves A (2003) Paying for tolerance: rural citizens' attitudes toward wolf depredation and compensation. *Conserv Biol* 17:1500–1511. <https://doi.org/10.1111/j.1523-1739.2003.00060.x>
- Nyaupane GP, Graefe AR, Burns RC (2009) The role of equity, trust and information on user fee acceptance in protected areas and other public lands: a structural model. *J Sustain Tour* 17:501–517
- Ostermann-Miyashita E-F, Pernat N, König HJ (2021) Citizen science as a bottom-up approach to address human-wildlife conflicts: from theories and methods to practical implications. *Conserv Sci Pract* 3:e385. <https://doi.org/10.1111/csp2.385>
- Petty RE, Wegener DT, Fabrigar LR (1997) Attitudes and attitude change. *Annu Rev Psychol* 48:609–647. <https://doi.org/10.1146/annurev.psych.48.1.609>
- Pullin AS, Knight TM, Stone DA, Charman K (2004) Do conservation managers use scientific evidence to support their decision-making? *Biol Conserv* 119:245–252
- Redpath SM et al (2013) Understanding and managing conservation conflicts. *Trends Ecol Evol* 28:100–109. <https://doi.org/10.1016/j.tree.2012.08.021>
- Ross LC et al (2016) Sheep grazing in the North Atlantic region: a long-term perspective on environmental sustainability. *Ambio* 45:551–566. <https://doi.org/10.1007/s13280-016-0771-z>
- Røskaft E, Händel B, Bjerke T, Kaltenborn BP (2007) Human attitudes towards large carnivores in Norway. *Wildl Biol* 13:172–185
- Sandström C, Johansson M, Sjölander-Lindqvist A (2015) The management of large carnivores in Sweden—challenges and opportunities. *Wildl Biol* 21:120–121
- Sarewitz D (2004) How science makes environmental controversies worse. *Environ Sci Policy* 7:385–403. <https://doi.org/10.1016/j.envsci.2004.06.001>
- Schoorman FD, Mayer RC, Davis JH (2007) An integrative model of organizational trust: past present and future. *Acad Manag Rev* 32:344–354. <https://doi.org/10.5465/AMR.2007.24348410>
- Schwartz SH (1992) Universals in the content and structure of values: theoretical advances and empirical tests in 20 countries. *Adv Exp Soc Psychol* 25:1–65
- Siegrist M, Cvetkovich G, Roth C (2000) Salient value similarity social trust and risk/benefit perception. *Risk Anal* 20:353–362
- Sjölander-Lindqvist A, Johansson M, Sandström C (2015) Individual and collective responses to large carnivore management: the roles of trust representation knowledge spheres communication and leadership. *Wildl Biol* 21:175–185
- Skogen K, Johansson M, Figari H, Flykt A, Krange O (2018) Erfaringer med ulv [Experiences with wolves]. NINA Rapport 1567:128 (In Norwegian)
- Skogen K, Krange O (2003) A wolf at the gate: the anti-carnivore alliance and the symbolic construction of community. *Sociol Rural* 43:309–325
- Skogen K, Thrane C (2007) Wolves in context: using survey data to situate attitudes within a wider cultural framework. *Soc Nat Resour* 21:17–33
- Sponarski CC, Vaske JJ, Bath AJ, Musiani MM (2014) Salient values social trust and attitudes toward wolf management in south-western Alberta Canada. *Environ Conserv* 41:303–310
- Stern MJ, Coleman KJ (2015) The Multidimensionality of Trust: Applications in Collaborative Natural Resource Management. *Soc Nat Resour* 28:117–132. <https://doi.org/10.1080/08941920.2014.945062>
- Stern PC, Dietz T, Abel T, Guagnano GA, Kalof L (1999) A value-belief-norm theory of support for social movements: The case of environmentalism. *Hum Ecol Rev* 6:81–97
- Strand G-H, Hansen I, de Boon A, Sandström C (2019) Carnivore management zones and their impact on sheep farming in Norway. *Environ Manag* 64:537–552. <https://doi.org/10.1007/s00267-019-01212-4>
- Sutherland WJ, Pullin AS, Dolman PM, Knight TM (2004) The need for evidence-based conservation. *Trends Ecol Evol* 19:305–308. <https://doi.org/10.1016/j.tree.2004.03.018>
- R Core Team (2019) R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna
- Teel TL, Manfredo MJ (2010) Understanding the diversity of public interests in wildlife conservation. *Conserv Biol* 24:128–139
- Thirgood S, Redpath S (2005) Hen harriers and red grouse: the ecology of a conflict. *Conserv Biol* 9:192

- Treves A, Karanth KU (2003) Human-carnivore conflict and perspectives on carnivore management worldwide. *Conserv Biol* 17:1491–1499. <https://doi.org/10.1111/j.1523-1739.2003.00059.x>
- Treves A, Martin KA (2011) Hunters as stewards of wolves in Wisconsin and the Northern Rocky Mountains USA. *Soc Nat Resour* 24:984–994
- Treves A, Wallace RB, Naughton-Treves L, Morales A (2006) Co-managing human-wildlife conflicts: a review. *Hum Dimens Wildl* 11:383–396. <https://doi.org/10.1080/10871200600984265>
- Vaske J, Manfredo M (2012) Social psychological considerations in wildlife management. In: Decker DJ, Riley SJ, Siemer WF (eds) *Human dimensions of wildlife management*, 2nd edn. The John Hopkins University Press, Baltimore, pp 43–57
- Vaske JJ, Absher JD, Bright AD (2007) Salient value similarity social trust and attitudes toward wildland fire management strategies. *Hum Ecol Rev* 14:223–232
- Vaske JJ, Donnelly MP (1999) A value-attitude-behavior model predicting wildland preservation voting intentions. *Soc Nat Resour* 12:523–537
- Venables WN, Ripley BD (2013) *Modern applied statistics with S-PLUS*. Springer Science & Business Media, New York
- Whittaker D, Vaske JJ, Manfredo MJ (2006) Specificity and the cognitive hierarchy: Value orientations and the acceptability of urban wildlife management actions. *Soc Nat Resour* 19:515–530
- Williams CK, Ericsson G, Heberlein TA (2002) A quantitative summary of attitudes toward wolves and their reintroduction (1972–2000). *Wildl Soc Bull* 30:575–584
- Woodroffe R, Ginsberg J (1998) Edge Effects and the Extinction of Populations Inside Protected Areas. *Science* 280:2126–2128. <https://doi.org/10.1126/science.280.5372.2126>
- Young JC et al (2010) The emergence of biodiversity conflicts from biodiversity impacts: characteristics and management strategies. *Biodivers Conserv* 19:3973–3990
- Young JC, Searle K, Butler A, Simmons P, Watt AD, Jordan A (2016) The role of trust in the resolution of conservation conflicts. *Biol Conserv* 195:196–202. <https://doi.org/10.1016/j.biocon.2015.12.030>
- Zajac RM, Bruskotter JT, Wilson RS, Prange S (2012) Learning to live with black bears: a psychological model of acceptance. *J Wildl Manag* 76:1331–1340

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