Conservation professionals agree on challenges to coexisting with large carnivores but not on solutions

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ABSTRACT

Although many studies explore characteristics of stakeholders or publics “for” or “against” large carnivores, disagreements among conservation professionals advocating different conservation strategies also occur, but are not well recognized. Differing viewpoints on whether and how humans can share landscapes with large carnivores can influence conservation policies. To characterize current viewpoints about terrestrial large carnivore conservation, we conducted an online survey assessing a wide range of viewpoints about large carnivore conservation among international professionals (n=505). We explored how variation in viewpoints was related to expertise, background, and broader institutional contexts in which one lives and works. The majority of participants agreed people and large carnivores can share the same landscapes (86%). Human adaptation to carnivores (95% agreement) and acceptance of some conflict (93%) were the highest ranked requirements for human-carnivore coexistence. We found broad consensus regarding intrinsic value of carnivores, reasons carnivores are imperilled, conflict drivers, and importance of proactive solutions, such as adopting preventative livestock husbandry methods or avoiding situations that put people at risk. The greatest polarization was observed in issues related to lethal control, where we only found broad consensus for killing carnivores in situations where humans are in immediate risk. Participants opposed the killing of large carnivores when objectives were to decrease population sizes or increase human tolerance, profits, livelihoods, or fear of humans. Results point to considerable diversity, perhaps driven by local context, concerning how to proceed with large carnivore conservation in the increasingly human-influenced landscapes of the Anthropocene. The different observed viewpoints represent both different strategies about how to best conserve, but also different moral platforms about what, how, where, and for whom conservation should occur. Our study underlines that challenges to adopting and implementing long-lasting carnivore conservation strategies may well occur as much within the conservation community as outside it.

INTRODUCTION

Large carnivores (hereafter carnivores) are among the most controversial species in conservation. Their predatory behavior, including killing domestic animals or game species, comes into conflict with human interests (Quigley and Herrero, 2005) and may represent the main factor hindering human-carnivore coexistence. Social conflicts between human stakeholder groups with different values, emotions and interests also complicate carnivore conservation (Dietsch et al., 2016; Lute et al., 2016; Redpath et al., 2015). Economic, social and political issues (Chapron & López-Bao, 2014; Newsome et al., 2016), and the multifaceted symbolic nature of large carnivores add further challenges to carnivore conservation (López-Bao et al., 2017; Skogen et al., 2017).

Although much research has focused on public stakeholder positions “for” or “against” carnivores (e.g., Dressel et al., 2015; Slagle et al., 2017), many heated conflicts between conservation professionals (e.g., wildlife biologists, employees of non-governmental organizations [NGOs], social and biological researchers) advocating and justifying

different conservation strategies also exist. At the heart of this controversy are questions of whether humans and carnivores can and should share space, and how to manage this relationship (Carter and Linnell, 2016; Chapron et al., 2014; López-Bao et al., 2017; Packer et al., 2013). Answering these questions involves insights from behavioral, psychological and ecological sciences, as well as philosophy. Synthesizing distinct disciplines is the difficult task of conservation professionals who inform and take part in the decision-making processes and public discourses about large carnivores.

In response to multiple conservation challenges, two fundamental perspectives have been proposed: land sparing for carnivores or land sharing between humans and carnivores (López-Bao et al., 2017). The tension between these two perspectives is evidenced by the lively debates, for example, regarding fencing to protect humans and African lions (*Panthera leo*), coexisting tigers (*P. tigris*) and people in Nepal or recovering gray wolves (*Canis lupus*) in developed nations (Carter et al., 2013, 2012; Chapron et al., 2014; Lopez-Bao et al., 2015; Packer et al., 2013). Fundamentally, current debate is over the often-stated goal of coexistence and its location along a spectrum of land sparing to sharing (Carter and Linnell, 2016).

Controversy over carnivores within and outside professional conservation communities also often focuses on two approaches to management policies and practices: strict protection versus sustainable use of carnivores. As some populations recover, debate shifts to whether and under what circumstances lethal take (often recreational hunting) will be allowed. The ever-changing legal status of wolves in North America−from U.S. Endangered Species Act (ESA) listing to game species listing in each state when ESA protections are removed−displays the potentially strong differences of opinion among conservation professionals (Bruskotter et al., 2014). Debate over whether it is appropriate policy to allow trophy hunting of African carnivores to raise conservation funding is another example, especially in light of the recent controversy over Cecil the lion (Nelson et al., 2016).

Because of the role conservation professionals play in decision-making, interacting with other stakeholders, media and general publics, their contributions are integral to conservation policy and practice. Therefore, their knowledge, experience, values, and perceptions regarding carnivore conservation can have a strong influence on public discourses, policies and conservation outcomes (Heeren et al., 2017). Although deliberation and controversy are healthy and can contribute to important progress in philosophy and policy, too much discord in conservation approaches may stymy decision-making or contribute to the 'predator pendulum' observed so clearly in wolf management throughout the Northern Hemisphere and Iberian lynx *(Lynx pardinus)* in Spain (Bruskotter, 2013; Garrote et al., 2013).

A deeper understanding of motivations, justifications, and preferences among conservation professionals can identify areas of consensus and spark new ideas. By identifying areas of consensus, conservation professionals can spend less time in polarizing debate and more time in articulating and advancing “a bolder and more honest vision of biodiversity conservation” to stakeholders and policymakers (Noss et al., 2012).

If areas of disagreement are identified, it will be possible to focus research efforts or formal analysis (e.g., using ethics) to explore the nature of these differences. Having such a vision, some argue, is needed to achieve long-term conservation goals rather than short-term political gains (Noss et al., 2012). Consensus is not always appropriate or possible, and can result in longer processes and less effective decisions that cater to the lowest common denominator (Peterson et al., 2005). But where possible and appropriate, building areas of consensus and understanding divergent viewpoints might also foster greater trust in the scientific and policy process among the public, on whom conservation success largely depends.

Given the variety of backgrounds, local contexts, knowledge systems and experiences of conservation professionals, we might expect divergent viewpoints about carnivore conservation among international communities. If this diversity is due to local contexts, homogeneity may exist within regional or national communities. Alternatively, if differences reflect individual values and moral judgements, we would expect to find great variation in viewpoints within regions.

Despite the need, little research has evaluated conservation professionals' viewpoints (Addison et al., 2016; Chapman et al., 2016; Holmes et al., 2016), and very few have focused on international carnivore conservation (e.g., sharks as discussed in Shiffman & Hammerschlag, 2016). To help fill this gap, our objectives were to characterize viewpoints about terrestrial carnivore conservation among international conservation professionals and explore how these viewpoints relate to disciplinary expertise, background, and broader institutional contexts in which one lives and works. Specifically, we examined participants' support for competing conservation strategies, focusing on the following main gradients: utilitarian vs intrinsic value justifications, land sharing vs land sparing locations, and protection vs sustainable use policies (Mattson et al., 2006; Rastogi et al., 2013; Mace, 2014; Redpath et al., 2017). We thus aimed to get a broad sense of participants' viewpoints about **why** and **where** to conserve carnivores, and **how** to manage them and mitigate human-carnivore conflicts. A novel aspect of the survey was to explore how ascription of intrinsic value, or the inherent right of an entity to exist beyond its use to anyone or anything else, is an important factor in determining when protection is emphasized over instrumental uses or lethal control (Vucetich et al., 2015). This study also explores the extent to which local context vs individual characteristics matters in framing global discourse on human-carnivore coexistence in the Anthropocene.

METHODS

2.1. Participant recruitment

In December 2015, we recruited 727 participants 18 years or older via email and listserv announcements to complete a web-based survey hosted on Qualtrics (qualtrics.com). Because we wanted to target conservation professionals from diverse fields, we emailed colleagues, posted on our social media accounts, and sent invitations to participate in the survey through five regional groups of the Society for Conservation Biology (Africa,

Asia, Europe, Latin America and Caribbean, and North America), The Wildlife Society, Ecolog (a listserv maintained by the Ecological Society of America), the Society for Restoration Ecology and the Large Carnivore Initiative for Europe IUCN/SSC Specialist Group. We asked participants to pass the survey along to their colleagues. Convenience sampling such as this is a common and appropriate approach when conducting exploratory research (Creswell, 2009; Salant and Dillman, 1994).

2.2. The survey instrument

The survey instrument was developed through an iterative process whereby all coauthors, whose interdisciplinary experiences in carnivore conservation ranges from 6-22 years and covers North and South America, Europe, Asia and Africa, synthesized relevant topics in relation to carnivore conservation strategies. Selected topics included: ideal goals for carnivore conservation, human-carnivore shared spaces, appropriate areas for conservation, conflict drivers, strategy efficacy, lethal justifications, conservation considerations, coexistence factors, and carnivores' intrinsic value and associated reasons for attributing intrinsic value (defined in Table 1). The survey was pretested by asking colleagues working in diverse sectors of carnivore conservation to complete the survey and provide feedback including coverage of topics, clarity of wording, and time to completion. The survey was then modified and sent to additional colleagues for additional rounds of pretesting.

Boise State University's Internal Review Board approved this research (090-SB15-182). Informed consent was received from all participants; respondents had to first read the informed consent statement and continuing on to the survey was viewed as consent to participate in the study. Participants were then asked a series of close-ended questions within pre-established topics (Table 1), alternating between 5-point Likert scales and multiple-choice statements. Specific phrasing for items in each topic are italicised through the Results section.

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Topic	Question	Specific items	Response Options
Ideal goals	Which of the following situations represents the ideal goal of large carnivore conservation?	Maintaining minimum viable populations Managing populations that sustainably support multiple benefits to people Recovering populations to significant parts of their historical ranges Re-establishing self-regulating populations Re-establishing populations to the point they can fulfill their ecological functions Other, please specify:	0= not selected 1= selected
Sharing space	To what extent do you agree or disagree that humans and large carnivores can share the same landscapes?		1=Strongly Disagree - 5=Strongly Agree
Appropriate areas	Which of the following areas are appropriate for large carnivores to inhabit? Please select all that apply.	Protected areas Remote wilderness Multi-use public lands (e.g., recreation, grazing activities) Private lands WITH domestic animals present Private lands WITHOUT domestic animals present	0= not selected 1= selected
Conflict drivers	What drives conflict over large carnivore conservation? Select all that apply.	Fear of carnivores Lack of transparency in decision processes Mistrust between decision-makers and locals Misunderstanding attitudes of others Unequal power among stakeholders Risks posed by carnivores to human safety Depredation on domestic livestock Competition with hunters for wild prey Other, please specify:	0= not selected 1= selected
Strategy efficacy	How effective are each of the following strategies for reducing human-carnivore conflicts?	Adopting livestock husbandry that prevents depredation Avoiding situations that put people at risk Community-based management Deterring carnivores with non-lethal methods Reducing large carnivore costs with financial tools (e.g., subsidized fencing) Establishing wilderness protected areas	1= Not Effective 2=Somewhat Effective 3=Very Effective 99=Not Sure

		Involving stakeholders in decision-making Legal hunting of large carnivores Relocation of people out of large carnivore habitat Restoration of wild prey populations Spatial separation of humans and large carnivores Targeted removal of problem large carnivores	
Lethal justifications	To what extent do you agree or disagree that the following interests are appropriate reasons to kill a large carnivore?	Increase carnivores' fear of humans Increase human tolerance of carnivores Maximize economic benefits Protect domestic animals from immediate risk Prevent large carnivores from colonizing areas of potentially high conflict Recreationally hunt large carnivores Protect humans from immediate risk Protect humans from perceived risk Protect rural livelihoods Regulate the size of large carnivore populations Protect an endangered species affected by large carnivores	1=Strongly Disagree - 5=Strongly Agree
Conservation considerations	How important are the following considerations for large carnivore conservation?	Promoting sustainable use (e.g., hunting) of carnivores by humans Promoting intrinsic value (i.e., value beyond use) of carnivores Reducing negative impacts of humans on carnivores Reducing negative impacts of carnivores on people	1=Not at all important - 5=Very Important
Coexistence factors	To what extent do you agree or disagree that the following factors are necessary for coexistence between people and large carnivores?	Acceptance of some human-carnivore conflict Carnivore adaptation to humans Enforcement and monitoring of the rule of law Human adaptation to carnivores Locals' acceptance of management authority Permitting regulated hunting of carnivores Prohibiting any killing of carnivores	1=Strongly Disagree - 5=Strongly Agree
Intrinsic value	To what extent do you agree or disagree with each of the following statements?	Only humans have intrinsic value. Large carnivores have intrinsic value. All living things have intrinsic value. Ecosystems have intrinsic value as a whole, beyond that of their component species.	1=Strongly Disagree - 5=Strongly Agree

Intrinsic value reasons	I intrinsically value large carnivores because…? Please select all that apply.	All life has intrinsic value. They are sentient and conscious. They are part of interconnected ecosystems. Other, please specify:	0= not selected 1= selected

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The survey concluded with general socio-demographic questions, such as age, gender, education, country of residence, but also specific questions regarding professional characteristics: region of field work, work sector (i.e., government, NGO, private sector [e.g., for-profit, industry], research institute, university), job role (i.e., conservation biologist, conservationist, conservation social scientist, ecologist, naturalist, veterinarian, wildlife biologist, wildlife manager, zoologist), and years of experience. The complete survey and dataset can be found in Supporting information.

2.3. Statistical methods and analysis

We removed surveys where respondents did not answer all questions; the majority of incomplete surveys (n=128) answered no more than one question. After incomplete surveys were removed, we calculated basic descriptive statistics and ran normality tests for all variables using STATA 13.1 (StataCorp, TX). A mean composite variable was created for lethal justifications averaging all eleven potential reasons to lethally remove carnivores and scale reliability was sufficiently high (Cronbach's α=0.85). We tested for differences in continuous responses associated with coexistence factors, conservation considerations, and the lethal justification scale, in relation to region of fieldwork and work sector by means of non-parametric Kruskal-Wallis tests, which were used because Doornik-Hansen tests for bivariate normality revealed that pairings between variables (i.e., coexistence factors, conservation considerations, and the lethal justification scale) were not normally distributed. Cramer's V is reported to indicate effect sizes of Kruskal-Wallis tests. Cramer's V ranges 0-1 with 0.3 considered a medium magnitude of effect size and 0.1 a small magnitude (Cohen, 1988). Spearman partial correlations were used to explore whether experience was correlated, controlling for age, with viewpoints on coexistence factors, conservation considerations, and the lethal justification scale. Fisher's exact tests (some expected frequencies fell below 5) were used to test differences in categorical responses associated with ideal goals for carnivore conservation (each of the five goals were treated separated) among different work sectors, region of field work, and experience (i.e., ranked ordinal variable). We did not explore differences in other responses due to a lack of sufficient variation. For brevity, non-significant tests are not reported.

Lastly, for the following topics: conservation considerations, lethal justifications, strategy efficacy, and coexistence factors, we also calculated the Potential for Conflict Index$_2$ (PCI_2; Vaske et al., 2010) to examine differences in consensus among viewpoints. The PCI_2 assesses the degree of consensus (vs disagreement) within the sample based on a response scale and is therefore not appropriate for the binary questions used in the other topics (Table 1). The PCI_2 ranges from 0 to 1, with complete consensus ($PCI_2 = 0$) occurring when all respondents provide the exact same response on a response scale (e.g., 100% strongly agree) and the least amount of consensus ($PCI_2 = 1$) occurring when responses are equally divided between two extreme values on a response scale (e.g., 50% strongly disagree, 50% strongly agree). We calculated PCI_2 among all respondents as well as evaluated whether PCI_2 significantly differed (Engel et al., 2017) between different sampled groups, including: those who indicated working or studying primarily in North America or Europe (regions with large enough sample size to meaningfully test), that identified as being conservation biologists or wildlife biologists/managers (job role),

and that indicated working in government, NGOs, or research institutions/universities (work sector).

RESULTS

3.1 Participants

Excluding incomplete surveys, our final sample contained 505 participants. Participants hailed from 71 different countries and 7 continents, ranged from 20-79 years in age (median age = 41 years), and the majority were male (61%, Table S1). These trends may indicate some selection or response bias; like many online surveys, participants tended to be male (Ansolabehere and Schaffner, 2014; Bell et al., 2011). But this may also simply reflect gender bias in disciplines related to large carnivores and conservation.

Across continents, most participants had their fieldwork in North America (50%), followed by Europe (22%). Most participants self-identified as wildlife biologists or conservation biologists (27%, 22% respectively) and the most common work sectors were universities (39%), NGOs (22%) and governments (20%). Median level of education was a master's level/professional degree and the most common length of conservation experience was 11-20 years.

3.2 Ideal conservation goals

Re-establishing populations to the point they can fulfill their ecological functions was by far the most agreed upon goal of large carnivore conservation (60%; Fig. 1). The only goal varying across fieldwork regions was the goal of *maintaining minimum viable populations* (Fisher's exact test p=0.014; Cramer's V=0.23). Agreement was low across most groups, with 3% of those working in North America, 11% in India, 14% in South America, and 17% in Central America agreeing. We caution against interpreting this result as practically significant (Vaske, 2002).

Among work sectors, we observed differences in viewpoints in relation to *re-establishing self-regulating populations* (Fisher's exact tests p=0.005; Cramer's V=0.19) and *re-establishing populations to the point they can fulfill their ecological functions* (Fisher's exact tests p=0.023; Cramer's V=0.16). In the first case, the private sector participants showed the lowest agreement (7%) and NGO participants agreed most (22%); whereas in the second case, NGO participants showed the lowest agreement (49%) and private sector participants agreed most (70%).

3.3 Appropriate areas for large carnivores

The majority of participants agreed that *humans and large carnivores can share the same landscapes* (86%), and that carnivores belong in protected areas (98%), remote wilderness (97%), private land without livestock (83%), and multi-use public lands (78%). However, participants were deeply split on private land with livestock (57% agreed, 43% disagree; Fig. 1).

3.4 Drivers of human-carnivore conflict and strategy efficacy

The most agreed upon drivers of conflict were depredation on domestic livestock (87%), fear of carnivores (83%), and mistrust between decision-makers and locals (73%; Fig. 1). According to their efficacy, the highest-rated conflict mitigation actions were the implementation of preventative measures: 91% of participants agreed with avoiding situations that put people at risk, 90% with adopting livestock husbandry that prevents depredation and 87% with restoration of wild prey populations; whereas relocating people out of carnivore habitats and legal hunting were the lowest-rated interventions (Fig. 2). Twenty-seven per cent of participants indicated that spatial separation of humans and carnivores was a very effective solution to conflicts, 19% indicated it was not, and 40% of participants indicated spatial separation was somewhat effective.

3.5 Lethal justifications

We only found broad consensus for killing carnivores in situations where humans are in immediate risk (80%; mean=3.97; Fig. 3). Participants were split on killing carnivores to regulate their population sizes (43% agreed, 40% disagreed). Majorities disagreed that responding to perceived risk (71%), increasing carnivores' fear of humans (67%), economic benefits (62%), recreational hunting (54%) or human tolerance of carnivores (51%) were appropriate reasons to kill a carnivore.

Placement on the lethal justifications scale differed based on work sector (Kruskal-Wallis test=29.0, $p \leq 0.0001$; Cramer's V=0.29). Government participants showed the highest scale agreement (mean=3), meaning that they agreed with lethal removal for more reasons, and participants from the private sector showed the lowest agreement (mean=2.30). Years of experience positively related to support of lethal justifications (Spearman correlation analysis, $r_s=0.17$, $p \leq 0.001$). No significant differences were found across fieldwork regions.

3.6 Conservation considerations

Considerations found to be important for carnivore conservation included *reducing negative impacts of humans on carnivores* (98% agreement, mean=4.80), *promoting intrinsic value of carnivores* (92%, mean=4.58) and *reducing negative impacts of carnivores on people* (88%, mean=4.40; Fig. 4). Less important but still supported by a slight majority was *promoting the sustainable use of carnivores* (54% agreed, 30% disagreed but overall mean agreement was low at 3.3; Fig. 4).

Viewpoints in relation to promoting sustainable use of carnivores significantly differed across work sectors (Kruskal-Wallis test =12.02, $p<0.05$; Cramer's V=0.13) and fieldwork regions (Kruskal-Wallis test =39.70, $p \leq 0.0001$; Cramer's V=0.20). NGOs and private sector participants showed the highest disagreement (41% and 33%, respectively) followed by government (30%), research institute (26%) and university participants (24%). Among the fieldwork category, participants who work in India disagreed the most (53%) followed by Southeast Asia (45%), Russia (43%) and Central Asia (40%). In the middle were respondents working in the Middle East (33% disagreed), Central America (32%), Europe (30%), North and South America (23% each), Oceania (23%) and Sub-Saharan Africa (22%). Respondents working in North Africa (14%) disagreed the least.

3.7 Coexistence factors

Among our sample, *human adaptation to large carnivores* (95% agreement, mean=4.46) and *acceptance of some conflict* (93%, mean=4.37) were the highest ranked requirements for coexistence between people and carnivores, followed by *enforcement and monitoring of the rule of law* (87%, mean=4.28) and *locals' acceptance of management authority* (87%, mean=4.12; Fig. 4). Sixty percent of participants disagreed with *prohibiting any killing of carnivores* while 20% agreed (mean=2.46). Participants were split on the other two coexistence factors: 30% disagreed and 43% agreed that *carnivores must adapt to humans* for coexistence to occur (mean=3.10); 36% disagreed and 40% agree that *permitting regulated hunting of carnivores* was necessary for coexistence (mean=2.95; Fig. 4).

The two coexistence factors related to lethal control, *prohibiting any killing of* and *permitting regulated hunting of carnivores*, showed significant differences based on region of fieldwork, work sector, and experience. Participants who work in North Africa showed the lowest agreement (7%) with *prohibiting any killing of carnivores* as necessary for coexistence (Kruskal-Wallis test =45.8, $p \leq 0.0001$; Cramer's V=0.22) and the highest agreement (57%) with *permitting regulated hunting of carnivores* (Kruskal-Wallis test =38.2, p=0.0001; Cramer's V=0.22). Participants working in the Middle East also showed low agreement (8%) with *prohibiting any killing of carnivores.* Participants working in India (38%), Central America (32%), Oceania (31%) and Southeast Asia (26%) showed the highest agreement with *prohibiting any killing of carnivores*. Participants working in India and Oceania generally disagreed (58% and 62%, respectively) with *permitting regulated hunting of carnivores*. In terms of work sector, participants differed significantly in their viewpoints related to *prohibiting any killing of carnivores* (Kruskal-Wallis test =13.9, $p \leq 0.01$; Cramer's V=0.11), with government participants showing the lowest agreement (14%), and private sector participants showing the highest agreement (27%). Government participants showed the highest agreement with *permitting regulated hunting of carnivores* (51%) and NGO and private sector participants generally disagreed (51% and 63%, respectively; Kruskal-Wallis test =26.3, $p \leq 0.0001$; Cramer's V=0.15). Experience was positively correlated to agreeing with the *permitting regulated hunting of carnivores* (Spearman correlation analysis, $r_s=0.12$, $p \leq 0.01$) and *enforcement and monitoring of the rule of law* (Spearman correlation analysis, $r_s=0.13$, $p \leq 0.01$), and negatively correlated to agreeing that *prohibiting any killing of carnivores* is necessary for coexistence (Spearman correlation analysis, $r_s=-0.1$, $p<0.05$).

3.8 Differences in consensus among viewpoints

The highest values for PCI_2 (least consensus) were observed for lethal justifications and strategy efficacy (Figs 2, 3). In particular, for lethal justifications, there was least consensus over whether it was justified to use lethal methods to *regulate the size of large carnivore populations, increase human tolerance of carnivores,* or *recreationally hunt large carnivores*. In contrast, we observed an overall consensus that to *protect humans from perceived risk* was not a justifiable reason for lethal removal of carnivores but to *protect humans from immediate risk* was a justifiable reason (Fig. 3). On the other hand, in the case of strategy efficacy, there was least consensus on whether *relocation of people out of large carnivore habitat* and the *spatial separation of humans and*

large carnivores were effective strategies for reducing human-carnivore conflicts. However, there was greater consensus on *adopting livestock husbandry methods that prevent depredation* and *avoiding situations that put people at risk* as effective strategies for reducing human-carnivore conflict (Fig. 2).

Consensus was lowest for conservation considerations and coexistence factors related to lethal control, including *promoting sustainable use of carnivores by humans* and *permitting regulated hunting of carnivores* (Fig. 4). Consensus was highest for the considerations *reducing negative impacts of humans on carnivores* and vice versa and *promoting the intrinsic value of carnivores*; and the coexistence factors regarding *human adaptation to carnivores, acceptance of some human-carnivore conflict, enforcement and monitoring of the rule of law* and *locals' acceptance of management authority* (Fig. 4). In all these items, excepting *reducing negative impacts of carnivores on people* ($PCI_2 = 0.13$), PCI_2 values were always <0.10, the items with the highest levels of consensus in this study.

In general, those who work in Europe expressed greater internal differences of viewpoints than those who work in North America over a range of topics (Fig. S1, S2). There was significantly lower consensus among those who work in Europe than in North America toward *prohibiting any killing of large carnivores* to facilitate coexistence, lethally removing carnivores to *increase carnivores' fear of humans* (Fig. S1), as well as the efficacy of various strategies for reducing human-carnivore conflicts, such as *reducing large carnivore costs with financial tools, establishing wilderness protected areas,* and *avoiding situations that put people at risk* (Fig. S2). Those that work in North America, however, showed lower consensus about whether *recreationally hunting large carnivores* was a justifiable reason to lethally remove them (Fig. S1), and the effectiveness of *adopting livestock husbandry than prevents depredations* for reducing human-carnivore conflict (Fig. S2).

Those working in NGOs tended to have greater internal consensus around responses than those working in governments or in research to a range of topics; such as in relation to the efficacy of *community-based management* (Fig. S3). Likewise, those working in governments had greater difference of opinion than those in NGOs that *increasing carnivores' fear of humans* was a justifiable reason for lethally removing carnivores (Table S3). On the other hand, those working in research had a greater difference of opinion than those working in NGOs about the efficacy of *spatial separation of humans and large carnivores* to reduce human-carnivore conflict (Fig. S3). Those who define themselves as wildlife biologists, managers, and conservation biologists did not have different levels of consensus around most topics. However, wildlife biologists and managers had lower consensus than conservation biologists about the efficacy of *community-based management* for reducing human-carnivore conflict (Table S4).

3.9 Intrinsic Value

Ninety-seven percent of participants attributed intrinsic value to carnivores for biocentric (because all life has intrinsic value; 62%) and ecocentric reasons (because they are part of interconnected ecosystems; 84%). Only two percent of participants were anthropocentric, attributing intrinsic value to humans only, while 95% could be classified as ecocentric,

attributing intrinsic value to whole ecosystems beyond that of their component species (Table S2).

DISCUSSION

We sought to explore viewpoints about specific strategies associated with carnivore conservation, and the challenges of coexisting with them, among the global community of conservation professionals. Greatest polarization was observed in issues related to lethal control. For example, our results highlight low consensus about lethal control as a conflict reducing mechanism. Our results suggest existence of broad consensus about carnivores' intrinsic value, why carnivores are imperilled, conflict drivers, and the importance of proactive solutions (i.e., preventative livestock husbandry methods, risky situation avoidance). Conservation professionals showed, however, a broad disagreement about killing large carnivores for the purposes of decreasing population sizes or increasing human tolerance, profits, livelihoods, or fear of humans.

The majority of participants agreed people and carnivores can share space (Carter & Linnell, 2016; López-Bao et al., 2017) and that carnivores belong in multi-use public lands, but disagreed about whether private lands with livestock present are appropriate areas for carnivores (Fig. 1). Differences in support for land-sparing versus -sharing approaches, may be influenced by local contexts or other social-ecological circumstances (Chapron et al., 2014; Carter & Linnell, 2016; Chapron & López-Bao, 2016). Although participants agreed spatial separation of humans and carnivores was at least somewhat effective in addressing conflict, this item had the second lowest consensus in this study (PCI_2: 0.78). This discrepancy may indicate a hope for shared landscapes constrained by perceived drivers of conflict: attacks on domestic animals, game species, and humans, human fear of carnivores, and locals' mistrust of decision-makers. If land sharing is to be a conservation target for carnivores, best practices may be agreed-upon proactive actions preventing carnivore attacks. Preventing depredation may also alleviate other conflict drivers related to fear and mistrust. Conservation policies and practices can aim to combine biological insights regarding effective nonlethal methods (e.g., livestock guarding animals, fencing; Eklund et al., 2017) with best practices from the behavioral sciences to address perceived risk and increase institutional trust (Bergstrom, 2017; López-Bao et al., 2017).

We believe it is fundamental to assess the appropriate justifications for large carnivores' conservation strategies if we are to make morally-sound, practical and effective decisions that match objectives (Lute et al., 2016). Part of such an assessment includes quantifying expert opinions. For example, conservation professionals in our sample clearly agreed on one justification for lethal control of large carnivores, that is, when humans are in immediate risk (PCI_2: 0.27), which supports current policies in many countries that allow people to protect themselves. This finding coupled with low agreement regarding other justifications for lethal control, such as psychological, economic or recreational interests, suggest conservation professionals may not consider broader hunting policies as morally justified or appropriate to address human-carnivore conflicts. Interestingly, experience positively related to lethal justifications. This result could be explained by evolving views among younger professionals that mirror broader cultural shifts away from utilitarian uses of wildlife and toward more

inclusive moral communities (Inglehart, 1990; Lute and Attari, 2016), or a drift towards more flexible and pragmatic approaches with increasing experience, or both.

From variation detected among work sectors and fieldwork regions, local context seems to matter in framing discourse on human-carnivore coexistence in the Anthropocene. Despite common goals of broadly-defined conservation, we see low consensus regarding fundamental ideas about human-carnivore relationships (e.g., should humans adapt to, be feared by, and/or allowed to hunt carnivores). Even wildlife biologists and managers with presumably similar educational backgrounds (e.g., degrees in life sciences) did not show high consensus while participants from NGOs, who could be coming from diverse backgrounds (e.g., law degrees, no degrees, political organizers, scientists), showed high consensus. Because conservation is a value-laden endeavour variably influenced by science (Dietsch et al., 2016; Manfredo et al., 2016; Wilson, 2008), greater understanding about other influences on conservation are needed. For example, religion might at least partially explain why India and Southeast Asia are in consensus about not hunting carnivores. Greater understanding of the myriad influences on conservation goals, preferred strategies, and other perceptions will not only aid decision-making about carnivores but can also inform broader debates about land sparing or sharing and fundamental conservation motivations, such as whether conservation is of species, biodiversity, ecosystems, or biosphere and whether goals should aim to restore historical assemblages or manage novel ecologies.

Differing perspectives between North America and Europe, the regions most represented in our sample, may be a product of contrasting legacies regarding Europe's land sharing versus North America's land sparing (Chapron et al., 2014; López-Bao et al., 2015; López-Bao et al., 2017). In North America, larger available wilderness, remote spaces, and agricultural intensification, have resulted in larger protected areas, which may explain American dualistic ideals about wilderness and other protected areas as refuges for large carnivores (Linnell et al., 2015). But European viewpoints may be shifting (Linnell et al., 2015), which is corroborated by our findings of low consensus, particularly about lethal control and strategies for reducing conflict like establishing protected areas.

Our results also suggest support for the importance of co-adaptation (Carter and Linnell, 2016), first and foremost with humans adjusting to and accepting some level of conflict with carnivores (Chapron & López-Bao, 2016). Asking humans to adapt to, and accept, carnivores may be a bold approach for many conservation professionals. Traditionally, conflict mitigation strategies emphasize risks from carnivores to humans, not the other way around. An emphasis on risks from carnivores may be an underlying driver of disagreement over lethal control, whereas considering risks to and from carnivores may lead to greater agreement on preventing depredation. Clearly these novel ideas are increasingly on the minds of conservation professionals, particularly among younger respondents. More research on multiple human dimensions interacting with carnivore conservation is needed to identify how best to encourage human behaviour change and make decisions that respect valid interests of both people and carnivores (Bruskotter et al., 2013; Bennett et al., 2017). Additionally, more open and transparent dialogue regarding what contexts are appropriate for co-adapting and land sharing among people and carnivores may inform future biological and social science and improve conservation policies and practices.

Controversy over large carnivore conservation will not likely be resolved soon. But with greater understanding of where we stand as a global conservation community, we are more likely to advance debate, provide new insights into better delineation of coexistence goals, and identify appropriate, effective, and publicly-supported strategies for addressing conflicts. A major conclusion of this study is that the early 21st century seems to be a time of considerable diversity of opinion concerning how to proceed with wildlife management in general, and large carnivore conservation in particular (Rastogi et al., 2013; Sandbrook et al., 2011). There is an ever-expanding range of approaches to conservation (Mace, 2014) and rather than new ones replacing older ones it appears that they are increasingly competing for attention. These different approaches represent both different strategies about how to best conserve wildlife, but also different moral platforms about what, how, where, and for whom conservation should be done (Redpath et al., 2017). The divergence in views revealed by our study merely reflects this diversity of existing discourses, but we could not determine if this was based on respondents' professional views on strategy or their personal moral judgements. Progress in addressing these outstanding questions requires an admission that "conservation biology" is far from being a monolithic and unified enterprise.

While it has been long recognized that conservation is a value-led discipline (Barry and Oelschlaeger, 1996; Decker et al., 1991), we need to explore the extent to which it is now being led by ever-evolving and diversifying values, some of which may be incompatible, or at least difficult to reconcile (e.g., intrinsic value and recreational hunting of carnivores). The coexistence model presented by Carter & Linnell (2016) builds on new understandings of conflicts (Redpath et al., 2013) to underline the need for human-human coexistence (learning to live with value-plurality) as well as human- wildlife coexistence. Our study underlines that challenges of human-human coexistence may well occur as much within conservation communities as with our external relationships with stakeholders and the public.

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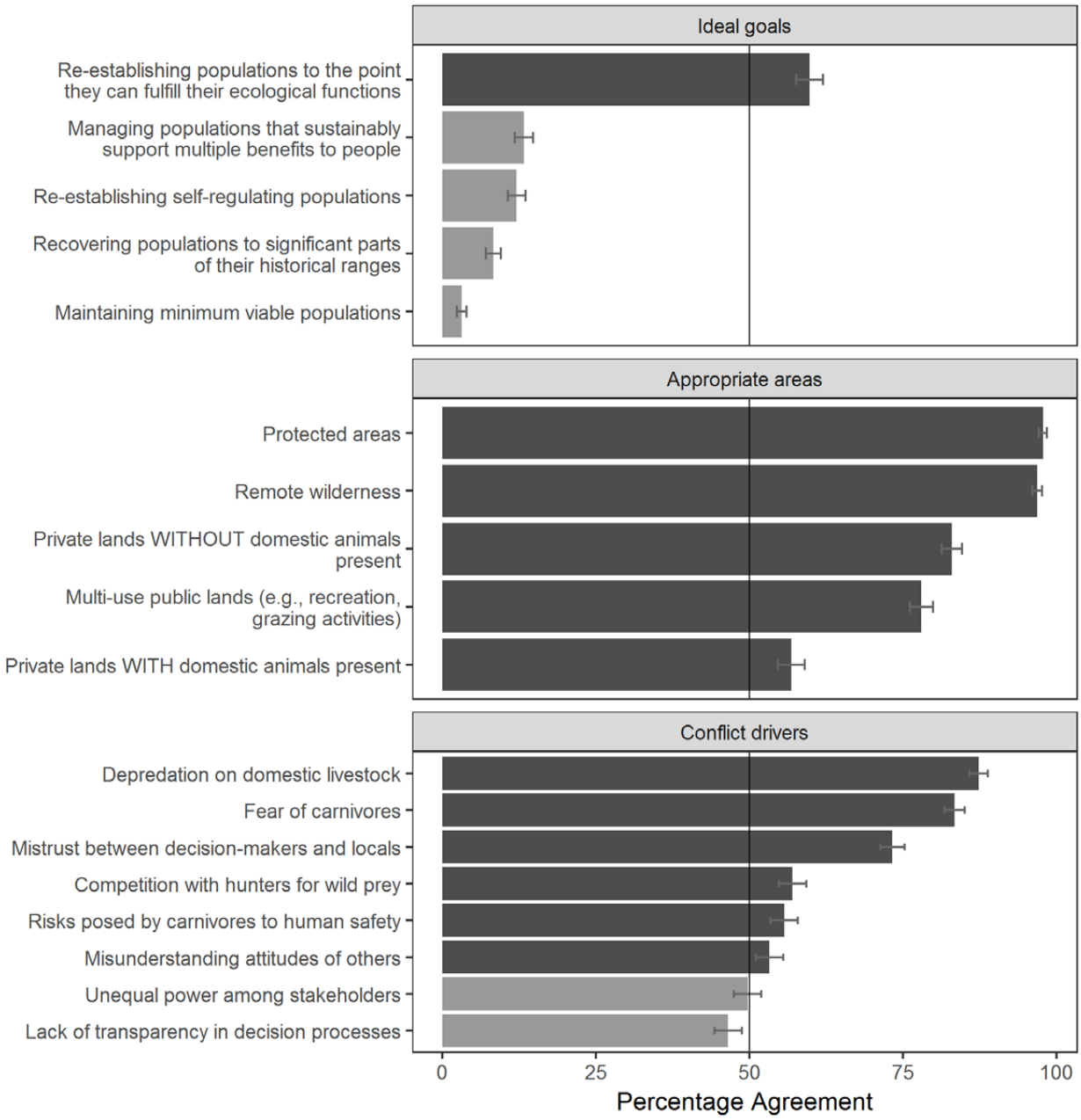
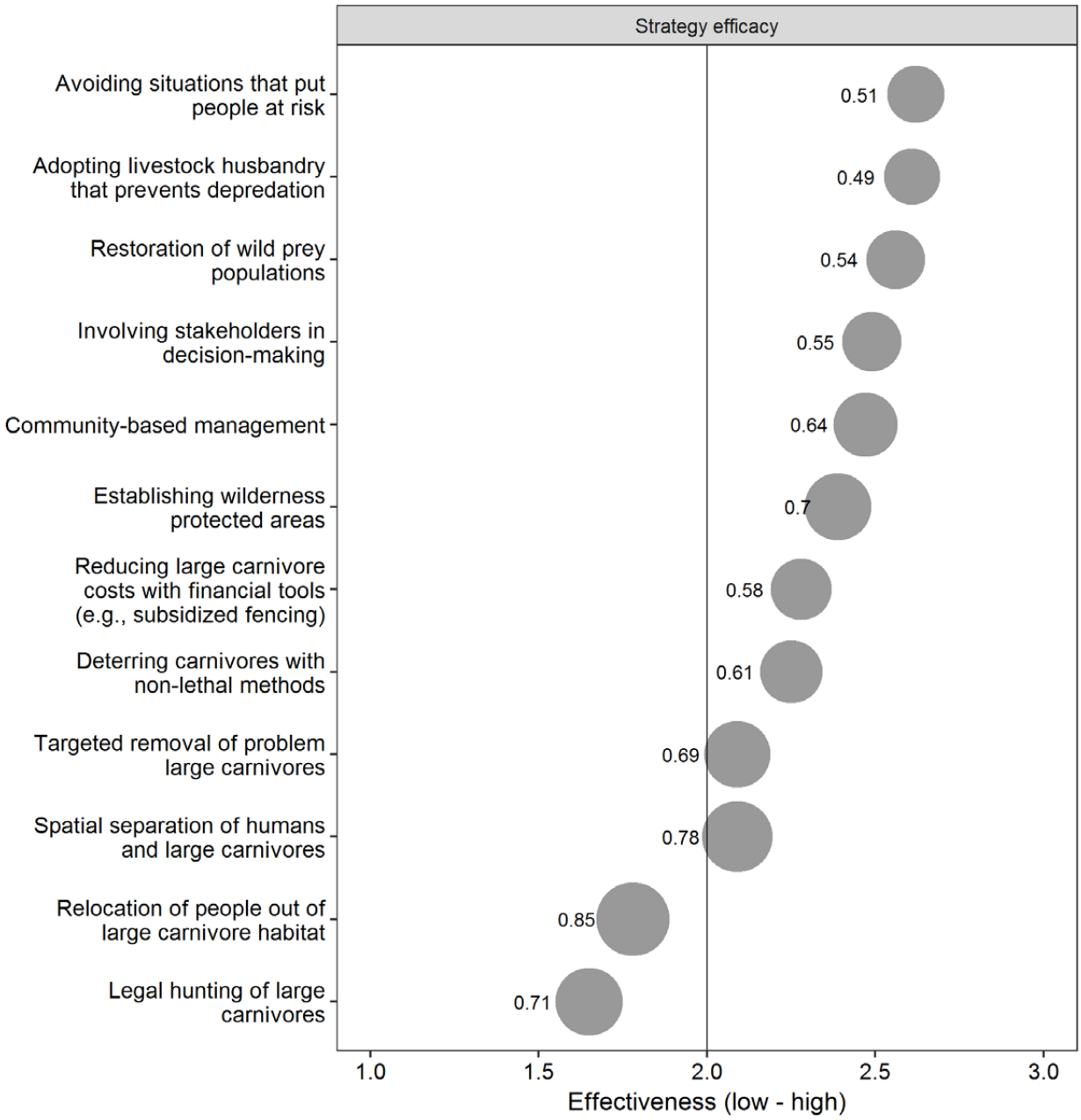
Figure 1: Percentage of 505 participants that agreed with the questions for three topics: ideal goals, appropriate areas, and conflict drivers. Percentages above 50% (bars colored dark grey) indicate overall agreement whereas values below 50% (bars colored light grey) indicate overall disagreement. Because responses were binary, standard errors are shown to illustrate variation in responses rather than the potential for conflict index (PCI_2) which was calculated for items with three or more choices.

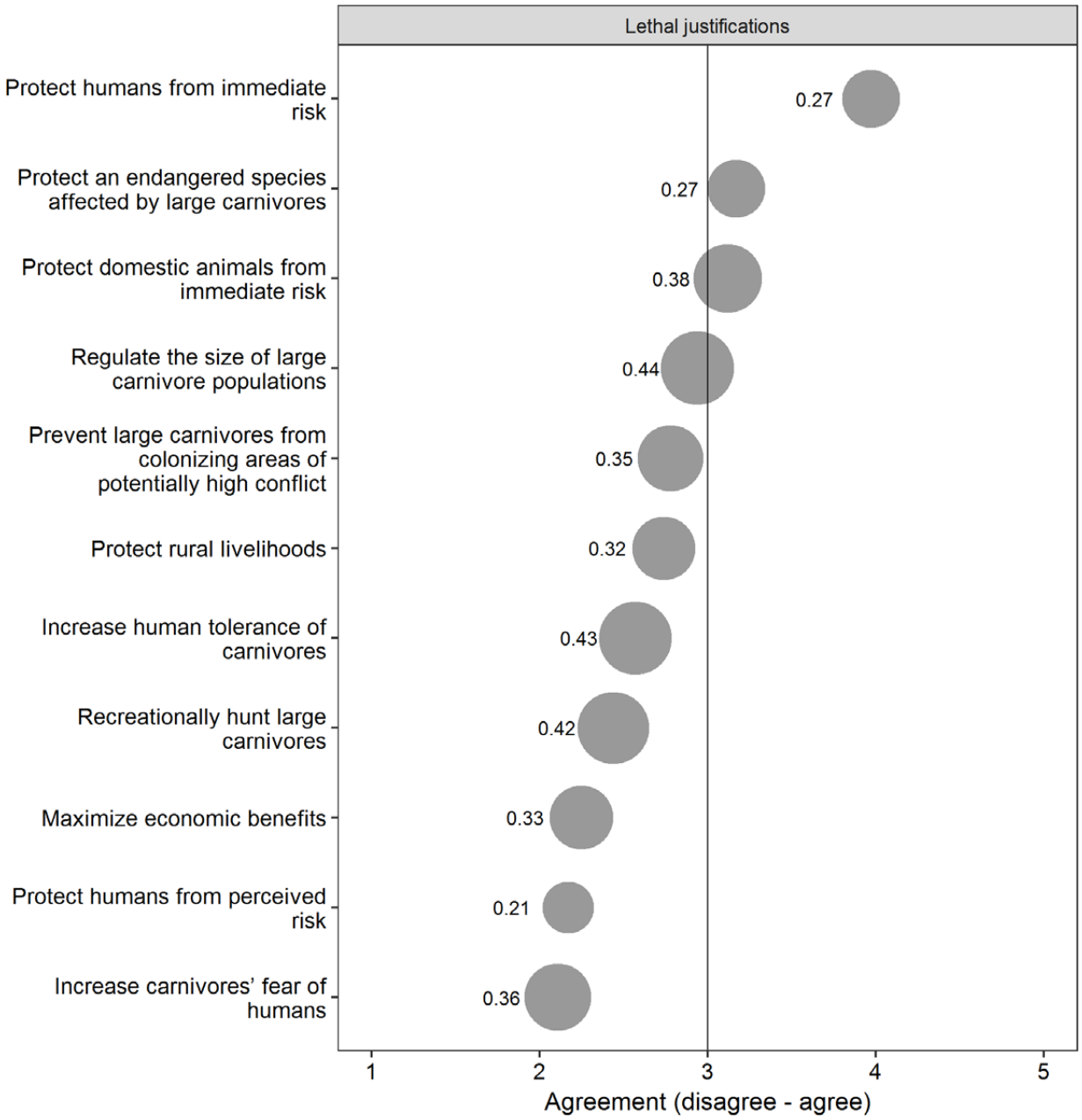
Figure 2: Effectiveness values among 505 participants for various strategies. Responses to these questions were not effective (1), somewhat effective (2), or very effective (3). The response 'not sure' was omitted from the analysis. Effectiveness values over 2 indicate that participants overall believed a strategy to be effective whereas values below 2 indicate an overall belief that a strategy is not effective. Bubble size illustrates the relative magnitude in PCI_2 values, ranging from 0 (complete consensus) to 1 (no consensus), among the survey items of this block. Larger bubble size indicates less consensus.

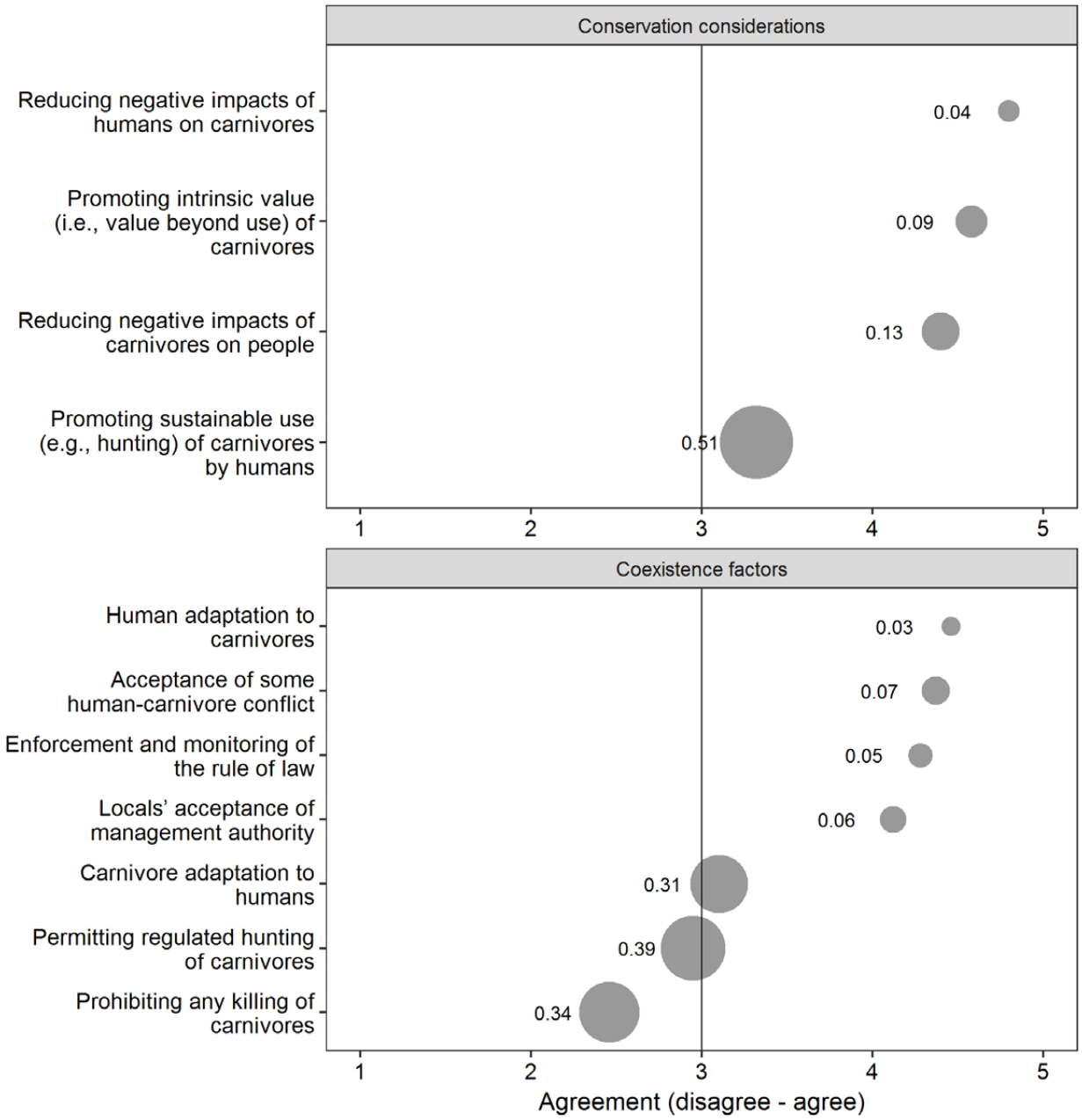
Figure 3: Agreement values among 505 participants for the topic, lethal justifications. Responses to these questions were on a 5-point Likert scale and range between 1 (strongly disagree) to 5 (strongly agree). Agreement values over 3 indicate overall agreement whereas values below 3 indicate overall disagreement. Bubble size illustrates the relative magnitude in PCI_2 values, ranging from 0 (complete consensus) to 1 (no consensus), among items in each block. Larger bubble size indicates less consensus.

Figure 4: Agreement values among 505 participants for two topics, conservation considerations and coexistence factors. Responses to these questions were on a 5-point Likert scale and range between 1 (strongly disagree) to 5 (strongly agree). Agreement values over 3 indicate overall agreement whereas values below 3 indicate overall disagreement. Bubble size illustrates the relative magnitude in PCI_2 values, ranging from 0 (complete consensus) to 1 (no consensus), among items in each block. Larger bubble size indicates less consensus.


Ideal goals
Re-establishing populations to the point they can fulfill their ecological functions
Managing populations that sustainably support multiple benefits to people
Re-establishing self-regulating populations
Recovering populations to significant parts of their historical ranges
Maintaining minimum viable populations
Appropriate areas
Protected areas
Remote wilderness
Private lands WITHOUT domestic animals present
Multi-use public lands (e.g., recreation, grazing activities)
Private lands WITH domestic animals present
Conflict drivers
Depredation on domestic livestock
Fear of carnivores
Mistrust between decision-makers and locals
Competition with hunters for wild prey
Risks posed by carnivores to human safety
Misunderstanding attitudes of others
Unequal power among stakeholders
Lack of transparency in decision processes
0
25
50
75
100
Percentage Agreement


Strategy efficacy
Avoiding situations that put people at risk
Adopting livestock husbandry that prevents depredation
Restoration of wild prey populations
Involving stakeholders in decision-making
Community-based management
Establishing wilderness protected areas
Reducing large carnivore costs with financial tools (e.g., subsidized fencing)
Deterring carnivores with non-lethal methods
Targeted removal of problem large carnivores
Spatial separation of humans and large carnivores
Relocation of people out of large carnivore habitat
Legal hunting of large carnivores
0.51
0.49
0.54
0.55
0.64
0.7
0.58
0.61
0.69
0.78
0.85
0.71
1.0
1.5
2.0
2.5
3.0
Effectiveness (low - high)


Lethal justifications
Protect humans from immediate risk
Protect an endangered species affected by large carnivores
Protect domestic animals from immediate risk
Regulate the size of large carnivore populations
Prevent large carnivores from colonizing areas of potentially high conflict
Protect rural livelihoods
Increase human tolerance of carnivores
Recreationally hunt large carnivores
Maximize economic benefits
Protect humans from perceived risk
Increase carnivores' fear of humans
0.27
0.27
0.38
0.44
0.35
0.32
0.43
0.42
0.33
0.21
0.36
1
2
3
4
5
Agreement (disagree - agree)


Conservation considerations
Reducing negative impacts of humans on carnivores
Promoting intrinsic value (i.e., value beyond use) of carnivores
Reducing negative impacts of carnivores on people
Promoting sustainable use (e.g., hunting) of carnivores by humans
0.04
0.09
0.13
0.51
1
2
3
4
5
Coexistence factors
Human adaptation to carnivores
Acceptance of some human-carnivore conflict
Enforcement and monitoring of the rule of law
Locals' acceptance of management authority
Carnivore adaptation to humans
Permitting regulated hunting of carnivores
Prohibiting any killing of carnivores
0.03
0.07
0.05
0.06
0.31
0.39
0.34
1
2
3
4
5
Agreement (disagree - agree)

Supporting Information

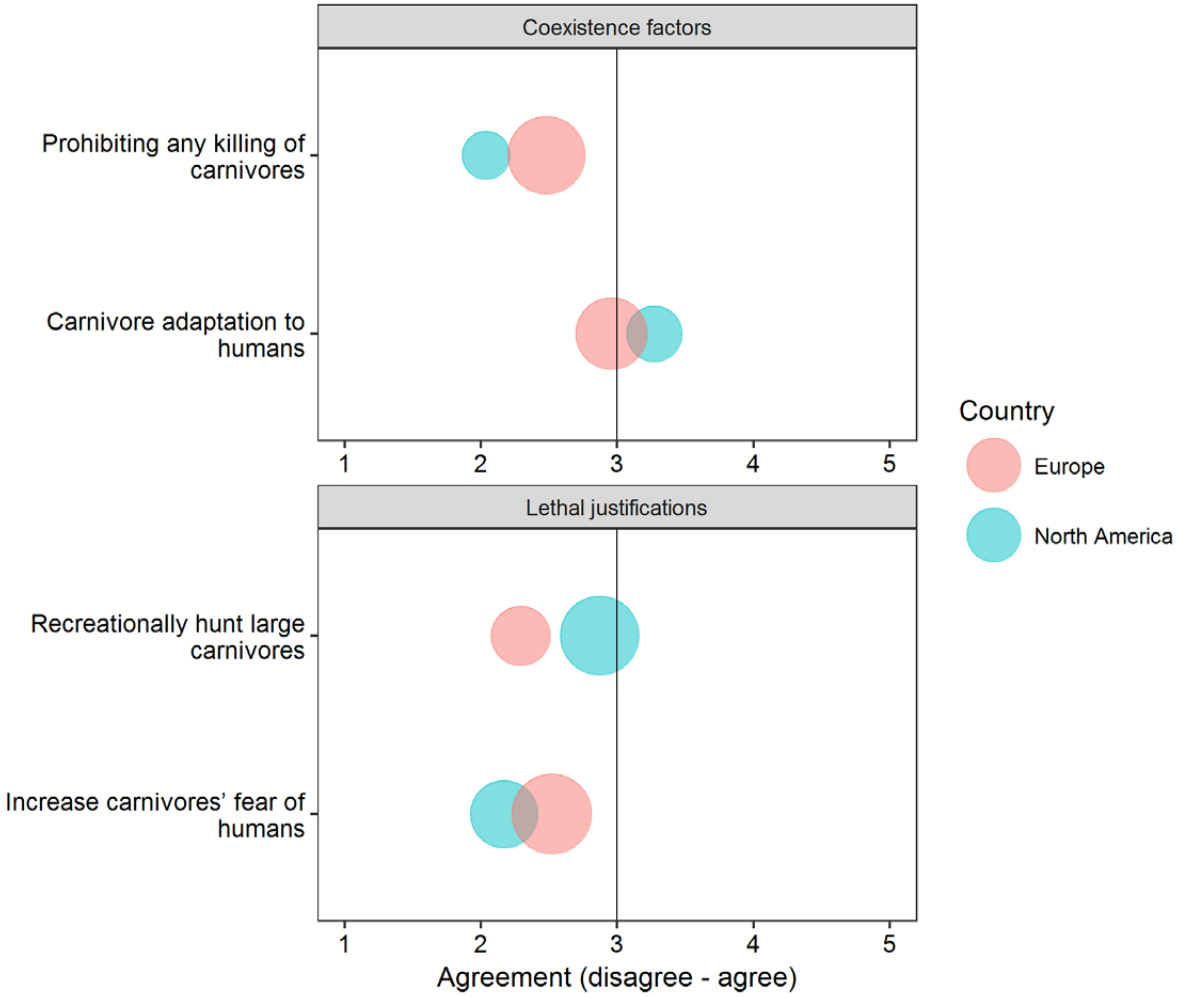


Figure S1: Significant differences in consensus between participants from Europe (n=77) and North America (n=181) for questions in the topics, coexistence factors and lethal justifications. Responses to these questions were on a 5-point Likert scale and range between 1 (strongly disagree) to 5 (strongly agree). Agreement values over 3 indicate overall agreement whereas mean values below 3 indicate overall disagreement. Bubble size illustrates the relative magnitude in PCI_2 values with larger bubble size indicating less consensus around the mean.

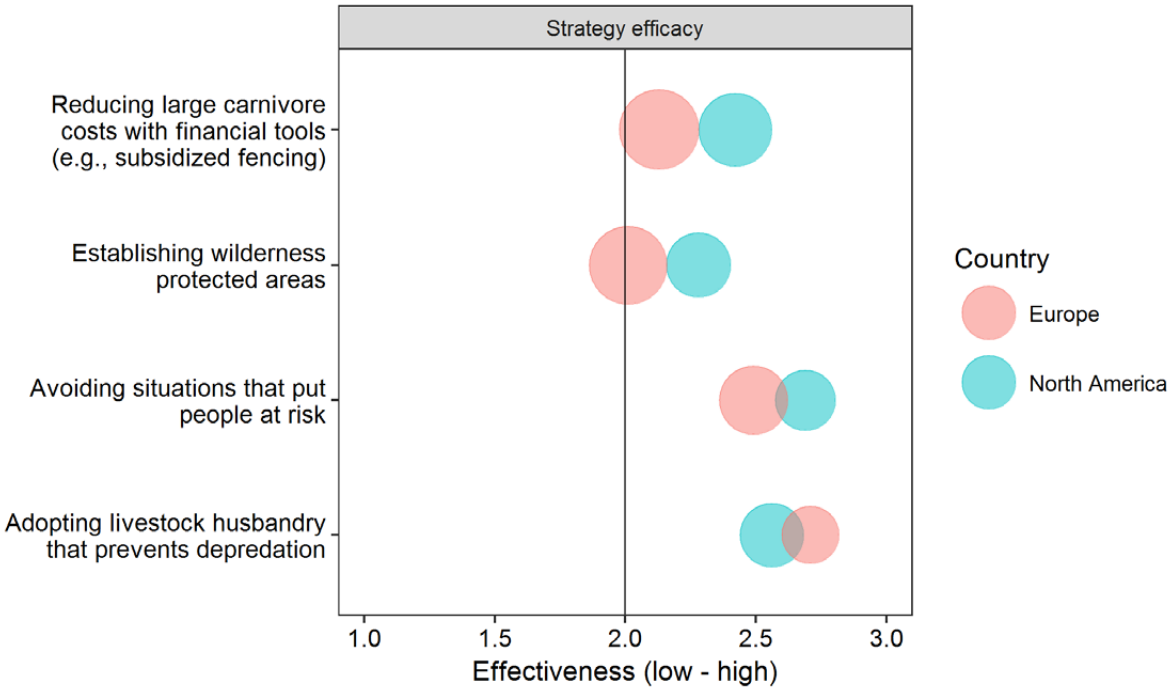


Figure S2: Significant differences in consensus between participants from Europe (n=77) and North America (n=181) for questions in the topic, strategy efficacy. Responses to these questions were not effective (1), somewhat effective (2), or very effective (3). The response 'not sure' was omitted from the analysis. Effectiveness values over 2 indicate that participants overall believed a strategy to be effective whereas values below 2 indicate an overall belief that a strategy is not effective. Bubble size illustrates the relative magnitude in PCI_2 values with larger bubble size indicating less consensus around the mean.

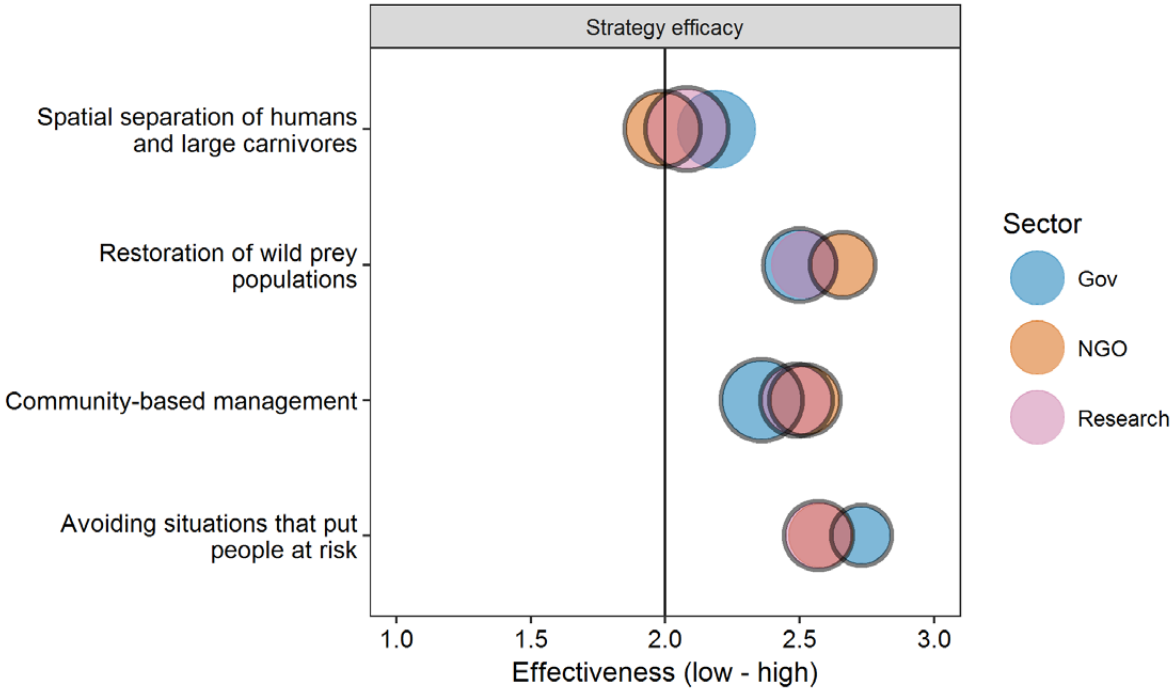


Figure S3: Significant differences in consensus between participants working in governments (n=102), non-government organizations (n=111), and research institutions (n=233) for questions in the topic, strategy efficacy. Responses to these questions were not effective (1), somewhat effective (2), or very effective (3). The response 'not sure' was omitted from the analysis. Effectiveness values over 2 indicate that participants overall believed a strategy to be effective whereas values below 2 indicate an overall belief that a strategy is not effective. Bubble size illustrates the relative magnitude in PCI_2 values with larger bubble size indicating less consensus around the mean. Bubbles with bold outlines for each survey item specify which work sectors significantly differ in PCI_2 from each other.

Table S1: Sociodemographic Summary.

Variable	Response Option	n	Percentage	Range	Mean	SD
Age				20-79	41.03	12.89
Sex	Male	306	61%			
	Female	198	39%			
	Other	1	0%			
Education	Elementary / Middle school	0	0%			
	High school diploma or equivalent	6	1%			
	Some college, but no degree + Two-year degree / certificate + Technical degree / college	9	2%			
	Bachelor's degree	65	13%			
	Some graduate / professional school but no degree	30	6%			
	M.A. / Professional degree	186	37%			
	Ph.D. / M.D. / D.V.M.	209	41%			

Table S2: Summary Descriptive Statistics.

Topic	Variable	%Disagree	% Agree	Mean	SD
Ideal goals	Maintaining minimum viable populations	0	3	0.03	0.18

	Managing populations that sustainably support multiple benefits to people	0	13	0.13	0.34
	Recovering populations to significant parts of their historical ranges	0	8	0.08	0.28
	Re-establishing self-regulating populations	0	12	0.12	0.33
	Re-establishing populations to the point they can fulfill their ecological functions	0	60	0.60	0.49
	Other	0	3		
Appropriate areas	Protected areas	2	98	0.98	0.15
	Remote wilderness	3	97	0.97	0.18
	Multi-use public lands (e.g., recreation, grazing activities)	22	78	0.78	0.41
	Private lands WITH domestic animals present	17	83	0.83	0.38
	Private lands WITHOUT domestic animals present	43	57	0.57	0.50
Conflict drivers	Fear of carnivores	17	83	0.83	0.37
	Lack of transparency in decision processes	53	47	0.47	0.50
	Mistrust between decision-makers and locals	27	73	0.73	0.44
	Misunderstanding attitudes of others	47	53	0.53	0.50
	Unequal power among stakeholders	50	50	0.50	0.50
	Risks posed by carnivores to human safety	44	56	0.56	0.50
	Depredation on domestic livestock	13	87	0.87	0.33
	Competition with hunters for wild prey	43	57	0.57	0.50
	Fear of carnivores	86	14	0.14	0.35
Strategy efficacy	Adopting livestock husbandry that prevents depredation	1	57	2.61	0.51
	Avoiding situations that put people at risk	2	60	2.62	0.54
	Community-based management	6	43	2.47	0.63
	Deterring carnivores with non-lethal methods	6	30	2.28	0.58
	Reducing large carnivore costs with financial tools	10	46	2.39	0.68
	Establishing wilderness protected areas	8	30	2.25	0.60
	Involving stakeholders in decision-making	2	47	2.49	0.55
	Legal hunting of large carnivores	39	10	1.65	0.68
	Relocation of people out of large carnivore habitat	36	19	1.78	0.80
	Restoration of wild prey populations	3	53	2.56	0.56
	Spatial separation of humans and large carnivores	19	27	2.09	0.73
	Targeted removal of problem large carnivores	16	24	2.09	0.67

Lethal justifications	Increase carnivores' fear of humans	69	19	2.11	1.19
	Increase human tolerance of carnivores	51	31	2.57	1.26
	Maximize economic benefits	62	19	2.25	1.90
	Protect domestic animals from immediate risk	33	47	3.12	1.13
	Prevent large carnivores from colonizing areas of potentially high conflict	46	32	2.78	1.10
	Recreationally hunt large carnivores	54	28	2.44	1.30
	Protect humans from immediate risk	12	80	3.97	1.06
	Protect humans from perceived risk	71	12	2.17	0.97
	Protect rural livelihoods	46	30	2.74	1.08
	Regulate the size of large carnivore populations	40	43	2.94	1.24
	Protect an endangered species affected by large carnivores	27	42	3.17	1.05
Conservation consideration	Promoting sustainable use (e.g., hunting) of carnivores by humans	30	54	3.32	1.45
	Promoting intrinsic value (i.e., value beyond use) of carnivores	3	92	4.58	0.78
	Reducing negative impacts of humans on carnivores	1	98	4.80	0.54
	Reducing negative impacts of carnivores on people	5	88	4.40	0.88
Coexistence factors	Acceptance of some human-carnivore conflict	2	93	4.37	0.73
	Carnivore adaptation to humans	30	43	3.10	1.05
	Enforcement and monitoring of the rule of law	2	87	4.28	0.75
	Human adaptation to carnivores	1	95	4.46	0.66
	Locals' acceptance of management authority	3	87	4.12	0.71
	Permitting regulated hunting of carnivores	36	40	2.95	1.25
	Prohibiting any killing of carnivores	60	20	2.46	1.20
Sharing space	To what extent do you agree or disagree that humans and large carnivores can share the same landscapes?	9	86	4.13	0.98
Intrinsic value	Only humans have intrinsic value.	67	30	1.26	0.67
	Large carnivores have intrinsic value.	1	81	4.74	0.58
	All living things have intrinsic value.	2	8	4.58	0.75
	Ecosystems have intrinsic value as a whole, beyond that of their component species.	1	95	4.75	0.60
Intrinsic reasons	All life has intrinsic value.	37	61	0.62	0.48
	They are sentient and conscious.	67	30	0.31	0.46

	They are part of interconnected ecosystems.	16	81	0.84	0.37
	Only humans have intrinsic value.	90	8	0.08	0.27

Table S3: Difference in consensus (potential for conflict index [PCI_2]) between participants working in governments (Gov., n=102), non-government organizations (NGO, n=111), and research institutions (Research, n=233) for a single survey item in the topic, lethal justifications. Values in bold specify which work sectors significantly differ in PCI_2 from each other.

Item	PCI_2	Mean	Sector
Increase carnivores' fear of humans	**0.40**	-0.65	Gov.
Increase carnivores' fear of humans	**0.24**	-1.11	NGO
Increase carnivores' fear of humans	0.37	-0.87	Research

Table S4: Difference in consensus (potential for conflict index [PCI_2]) between participants who identified as a conservation biologist (Con_Bio, n= 109) and those who identified as a wildlife biologist or wildlife manager (Wild_bio_man, n=170) for a single survey item in the topic, strategy efficacy. This was the only survey item for which there was a significant difference in PCI_2 between these two roles.

Item	PCI_2	Mean	Role
Community-based management	0.56	1.52	Con_Bio
Community-based management	0.74	1.37	Wild_bio_man