Resolving Human-Bear Conflict: A Global Survey of Countries, Experts, and Key Factors

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Abstract

Human-bear conflicts cause annoyance, financial losses, injuries, and even death to people. In poorer parts of the world, conflicts with bears can affect local economies. Retaliation against bears may threaten the future of small, isolated populations. Our survey of the world's bear experts revealed that the problem is worsening in terms of severity of conflicts and their impact on bear conservation on all four continents inhabited by bears. However, the main drivers of conflict, and its manifestations, differ among bear species. We reviewed human-bear conflict management plans from which we identified 10 categories of mitigating interventions that together comprise a ubiquitous bear conflict management toolbox. Within this toolbox, the peer-reviewed literature indicates heavy reliance on education and physical barriers for conflict mitigation. In customizing these general approaches to local circumstances, it is important to be mindful of starkly varying geopolitical and social circumstances. There is a pressing need to improve transfer of knowledge from places with active empirical research on mitigation (especially North America), and adapting methodologies to other parts of the world. We saw little evidence of evaluation and adaptive management in the conflict plans. Failure to mitigate conflicts may reduce society's tolerance of bears and diminish conservation efforts.

Introduction

Conflicts between humans and carnivores have occurred since prehistory (Zedrosser *et al.* 2011; Elfström *et al.* 2012). Carnivores are persecuted, sometimes to local extinction, in response to threats that may be real or perceived (Ginsberg 2001; Bergstrom *et al.* 2013). The intentional killing of carnivores in retaliation for such conflicts is a major and escalating threat to their conservation (Treves & Karanth 2003; Northrup *et al.* 2012).

Worldwide, conflicts between humans and bears seems to have drawn less attention than conflicts with other large carnivores, such as felids (Macdonald *et al.* 2011) and canids (Macdonald & Sillero-Zubiri, 2004). Millions of people live alongside bears on four continents, some happily but others having to endure serious conflicts.

Conflicts that occur for globally or locally threatened species raise conservation concerns. We define human-bear conflict as "any situation where wild bears use (undesirably) or damage human property; where wild bears harm people; or where people perceive bears to be a direct threat to their property or safety" (WSPA, 2009).

Conflict situations and conservation needs vary among the eight species of bears, and also vary geographically across these species' ranges. In most of Europe, brown bear (*Ursus arctos*) numbers are increasing, due to protection from persecution and high reproductive rates (Zedrosser *et al.* 2011). However, conflicts occur as a result of agricultural damage and livestock depredation, diminishing public tolerance of bears (Can & Togan 2004; Karamanlidis *et al.* 2011; Rigg *et al.* 2011). In North America, human-brown bear (grizzly bear) conflicts

are increasing in areas where bears are expanding into private lands bordering national parks, posing a threat to livestock and people. Bear mortality arising from these conflicts may limit their range (Northrup *et al.* 2012). Likewise, conflicts with American black bears (*Ursus americanus*) are associated with their increasing numbers (Garshelis & Hristienko 2006; Spencer *et al.* 2007) and their attraction to human-related foods such as garbage, apiaries, orchards, and crops; management agencies make concerted efforts to reduce conflicts by attempting to alter both human behavior (Gore *et al.* 2006; Baruch-Mordo *et al.* 2011) and bear behavior (Spencer *et al.* 2007), and through increased legal hunting of bears (Hristienko & McDonald 2007; Treves *et al.* 2010). In Asia, Asiatic black bears (*Ursus thibetanus*) and, to a lesser extent, sun bears (*Helarctos malayanus*) damage crops and livestock (Chauhan 2003; Fredriksson 2005; Japan Bear Network 2006; Liu *et al.* 2011); Asiatic black bears and sloth bears (*Melursus ursinus*) also pose a threat to people, causing injuries or death (Chauhan 2003; Bargali *et al.* 2005). In South America, Andean bears (*Tremarctos ornatus*) damage crops and kill livestock (Peyton 1994; Goldstein *et al.* 2006). In native villages in the Arctic, polar bears (*Ursus maritimus*) pose a threat to human safety when they are attracted to anthropogenic food sources or humans as potential prey (Towns *et al.* 2009). When any of these species of bears cause conflicts with people, the suspected culprit may be killed in an attempt to prevent further losses, thereby compounding a precarious conservation situation in areas where bear numbers are already low or declining (Servheen *et al.* 1999).

In the face of growing numbers of people, with a deepening footprint, inhabiting ever more remote areas, it is not surprising that human-bear conflicts appear to be on the rise in many areas (Gore *et al.* 2006; Hristienko & McDonald 2007; Worthy & Foggin 2008; Baruch-Mordo *et al.* 2011; Charoo *et al.* 2011). However, it is difficult to quantify actual trends because gathering data on conflicts with bears is labor-intensive, time-consuming, and expensive particularly in remote areas; in many countries there is not a perceived need for this information. Thus, no attempt has been made to document conflicts throughout large areas of bear range, including the entirety of South America (Goldstein *et al.* 2006). Much of the information that exists is fragmentary. Nonetheless, research on human-bear conflict, and efforts to resolve it, have increased. Human-bear conflict management plans, which were first developed in North America, present operational solutions to conflict and are becoming popular on other continents as a first step toward reducing losses for humans and deaths to bears. However, formulating useful plans is still a work in progress, as is overcoming the challenges of transferring knowledge between very

different regions of the world and customizing suggestions to local circumstances.

Here, we take a global snapshot of human-bear conflict and conflict management for all seven terrestrial bear species (i.e., excluding only the polar bear, *U. maritimus*). We provide a global overview of attempts to mitigate human-bear conflict, and we summarize what people involved in bear research and conservation currently understand about human-bear conflicts in terms of type, severity, cause, and trends. We then examine various management plans to develop a toolbox for human-bear conflict management. On that basis, we make suggestions to help ameliorate conflicts and promote long-term coexistence between people and bears.

Methods

Studies on human-bear conflict and initiatives on conflict management

We contacted bear experts in the IUCN Bear Specialist Group (SG) by e-mail during October-December 2011 to investigate which countries engaged in national level efforts to manage human-bear conflicts. The IUCN Bear SG comprised 180 members representing 59 of 65 countries with resident bear populations. All members of Bear SG regularly communicate in English by e-mail therefore there was not any need to involve translation corresponding with experts. We asked whether there are current national efforts/initiatives or future plans to deal with human-bear conflicts in their countries and to direct us to human-bear conflict management plans. We also conducted a search in Web of Knowledge database using the keywords "human bear conflict" to identify peer-reviewed studies specifically on this subject.

Expert survey about human-bear conflict

We conducted a questionnaire survey of people involved in bear research, conservation, or management throughout the world between May 2010 and January 2011. We distributed the self-administered questionnaire to the attendees of 19th International Conference on Bear Research and Management in Tbilisi, Georgia in May 2010, and then sent the questionnaire to the members of the Bear SG, and to the employees of North American wildlife management agencies who deal with bear conflicts (one per state or province) by e-mail. The self-administered questionnaire and all communication were in English and no translation was involved in the survey. The questionnaire consisted of 27 questions, nine of which are considered in this study. Six questions offered multiple-choice answers, eliciting knowledge and

opinions of respondents pertaining to: (1) trends in, and severity of, human-bear conflicts; (2) major causes of conflict; (3) conflict-related research efforts; and (4) impacts of conflicts on bear conservation (Supporting Information). Completed questionnaires were checked and when necessary further correspondence was carried out with respondents to clarify the markings and handwritings.

Human-bear conflict management: developing a toolbox

We used the Google search engine to find official strategy documents relevant to human-bear conflict management; such plans tend not to be listed in scientific databases. From the first 2,000 potential links, we identified 50 plans from 25 countries (many were individual U.S. states). We categorized each plan by its scope (species and region), author affiliation, content, and format. We also developed a list of mitigating tools proposed in the plan, and collapsed these into general categories. We then examined the peer-reviewed publications identified through our internet search, and tallied the number of times each type of tool was mentioned as a mitigation strategy.

Results

Studies on human-bear conflict and initiatives on conflict management

We obtained responses from bear experts in 54 of 59 countries (92% response rate; no responses from Finland, Macedonia, Peru, Serbia, and Uzbekistan). Representatives from two countries (Andorra and Lithuania) indicated that they had no permanent bear populations. From the remaining 52 countries (Table 1), 17 (33%) had a plan to deal with human-bear conflicts. In 11 countries (22%), such plans were in preparation. In the remaining 46% of countries, no current or anticipated conflict plans existed. Initiatives to deal with human-bear conflict management are more common in North America, South America, and Europe than in Asia (Figure 1).

The Web of Knowledge Database search yielded 172 scientific papers from 24 countries concerning human-bear conflict. We do not claim that our list of papers is exhaustive, but it should be reflective of the current body of literature regarding human-bear conflicts. About one-third (34%, $n = 59$) of the published studies were about American black bears, 28% ($n = 48$) were on brown bears in North America, 13% ($n = 23$) on brown bears in Europe, and 12% ($n = 21$) on Asiatic black bears. Ten papers concerned two species. Far fewer published stud-

ies on human-bear conflict involved sloth bears (7%, $n = 12$), brown bears of Asia (6%, $n = 11$), Andean bears (3%, $n = 6$), and sun bears (1%, $n = 2$). The vast majority (82%, $n = 141$) of these papers described conflicts in a certain site, whereas only 18% ($n = 31$) were about conflict resolution. Studies on North American bears not only dominated the human-bear conflict literature, but these tended to be more data-driven, comprehensive, and potentially useful for policy makers. However, these authors rarely discussed the potential transfer of management solutions outside of their local area.

Expert opinion about human-bear conflict

We obtained 130 completed questionnaires from 104 bear experts on six species of bears from 34 countries (some experts provided information on more than one bear species). No conflicts were reported for giant pandas (*Ailuropoda melanoleuca*) so this species was dropped from further analysis. Responses by continent (41% North America, 20% Europe, 32% Asia, and 7% South America) were more heavily weighted toward Europe, Asia, and South America than the published literature because the Bear SG membership is weighted toward areas with conservation concerns. In addition, it appears that North American studies of bear conflicts are more likely to be published in the peer-reviewed literature.

Most (89%) respondents reported high levels of human-bear conflicts: 7% ($n = 9$) judged the level as extreme, 40% ($n = 52$) as generally high, and 42% ($n = 54$) as high in some years. Conflicts were judged to be increasing in more than half the areas (56%, $n = 73$) from which survey respondents reported (29% stable, 6% declining, and 9% unknown).

Survey respondents thought that human-bear conflicts had a negative impact on conservation of bears to an extreme extent (4%, $n = 5$), to a high extent in some years (41%, $n = 53$), or to a generally high extent (31%, $n = 28$). Only 21% of the respondents judged that bear numbers were minimally affected by conflict (i.e., small proportion killed) (3% had no opinion). We found no differences among continents in opinions of the trends or the severity of conflicts, or their impact on bear conservation.

Drivers and types of human-bear conflict

Expert perceptions of the main drivers of conflict differed for the six species (Figure 2). Availability of anthropogenic food sources combined with periodic natural food failures are paramount issues for black bears and brown (grizzly) bears in North America. Brown bear expansion and anthropogenic foods are primary drivers of conflict in Europe. Expansion of people into bear

Table 1 Bear range countries, of which 52 provided data on human-bear conflicts

Species	IUCN Red List category	Range countries	Number of countries
American black bear	LC	Canada, Mexico, United States	3
Asiatic black bear	VU	Afghanistan, Bangladesh, Bhutan, Cambodia, China, India, Islamic Republic of Iran, Japan, Democratic People's Republic of Korea, Republic of Korea, Lao People's Democratic Republic, Myanmar, Nepal, Pakistan, Russian Federation, Taiwan, Thailand, Vietnam	18
Andean bear	VU	Bolivia, Columbia, Ecuador, Peru, Venezuela	5
Brown bear	LC	Afghanistan, Albania, Armenia, Azerbaijan, Belarus, Bhutan, Bosnia Herzegovina, Bulgaria, Canada, China, Croatia, Estonia, Finland, France, Georgia, Greece, India, Islamic Republic of Iran, Iraq, Italy, Japan, Kazakhstan, Democratic People's Republic of Korea, Kyrgyzstan, Latvia, the former Yugoslav Republic of Macedonia, Mongolia, Montenegro, Nepal, Norway, Pakistan, Poland, Romania, Russian Federation, Serbia, Slovakia, Slovenia, Spain, Sweden, Tajikistan, Turkey, Turkmenistan, Ukraine, USA, Uzbekistan	46
Giant panda	EN	China	1
Sloth bear	VU	Bhutan (?), India, Nepal, Sri Lanka	3—4
Sun bear	VU	Bangladesh (?), Brunei Darussalam, Cambodia, China (?), India, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Thailand, Vietnam	9—11

Note: IUCN Red List Categories are as follows: LC, least concern; VU, vulnerable; EN, endangered (? = questionable presence).

habitat is a primary source for conflicts with brown bears in Asia, Asiatic black bears, Andean bears, and sloth bears. Habitat loss and reduced human tolerance are also especially pertinent aspects of conflicts concerning sloth bears. Tolerance was low for sloth bears because attacks on people were much more common than for the other species (Figure 3). At the opposite extreme, Andean bears rarely attacked people, but are known for depredating livestock. The South American and Asian species (Andean bears, sun bears, sloth bears, and Asiatic black bears) were especially noted for raiding crops and orchards. Conflicts associated with garbage and property damage were most commonly reported for bears in North America, whereas beehive raiding was a primary concern for brown bears in Europe.

Considering human-wildlife conflicts in general, Macdonald & Sillero-Zubiri (2004) argued that whereas every situation is likely to be importantly different and demand tailored solutions, there are nonetheless rather few drivers of wildlife conflict, and correspondingly few categories of solutions. Developing this observation, Macdonald *et al.* (2012) observed that there are many cases where several species face the same problem in the same place, and might all benefit from the same intervention— a proposition which they illustrated for threatened felids and primates with a view toward extracting the greatest

benefit from each conservation dollar spent. Hence, actions to mitigate conflicts between people and one species of bear may not only be transferable to other species of bears, but may also efficiently deliver benefits to other wildlife in a similar way to the umbrella species concept.

Research efforts for understanding human-bear conflict

Most survey respondents felt that research on human-bear conflicts was failing to provide adequate solutions. Research on conflicts has been undertaken mainly in North America, yet 79% of North American respondents judged this research to be inadequate. In Europe, there are still many areas lacking bear conflict-related research. Research was considered particularly deficient for sloth bears (India) and Andean bears.

The toolbox of human-bear conflict management

We reviewed 50 official management-related plans either directly focused on human-bear conflict management or including information about approaches to conflict management. Most documents concerned brown bears (38%, *n* = 19) and American black bears (32%, *n* = 16). In

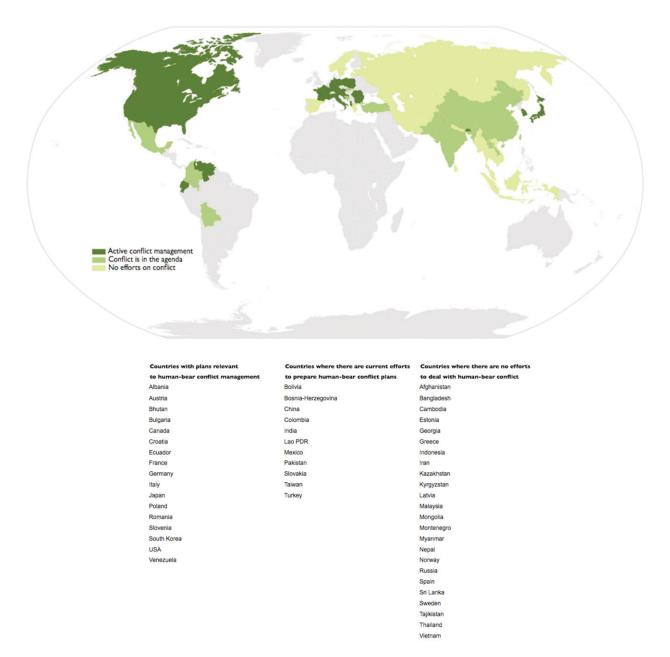| Countries with plans relevant to human-bear conflict management	Countries where there are current efforts to prepare human-bear conflict plans	Countries where there are no efforts to deal with human-bear conflict
Albania	Bolivia	Afghanistan
Austria	Bosnia-Herzegovina	Bangladesh
Bhutan	China	Cambodia
Bulgaria	Colombia	Estonia
Canada	India	Georgia
Croatia	Lao PDR	Greece
Ecuador	Mexico	Indonesia
France	Pakistan	Iran
Germany	Slovakia	Kazakhstan
Italy	Taiwan	Kyrgyzstan
Japan	Turkey	Latvia
Poland		Malaysia
Romania		Mongolia
Slovenia		Montenegro
South Korea		Myanmar
USA		Nepal
Venezuela		Norway
		Russia
		Spain
		Sri Lanka
		Sweden
		Tajikistan
		Thailand
		Vietnam

Figure 1 Status of national scale efforts (in the form of management or action plans) on management of human-bear conflict throughout bear range across the globe.

the United States and Canada, human-bear conflict management plans are mostly stand-alone documents. Elsewhere, if conflict is on the national agenda of wildlife agencies it is generally included within existing management and conservation plans. We distilled the recommended approaches to human-bear conflict management into 10 major actions that together constitute a toolbox for conflict management (Figure 4). None of the documents included all 10 components.

Most management plans were exclusively text documents, and lacked details for implementation of mitigation actions; only 8% ($n = 4$) provided decision trees for selecting mitigation measures. In 84% ($n = 42$) of the plans, no time frame for action or delivery was specified. Monitoring subsequent conflict, and evaluating the effectiveness of the proposed measures, were mentioned (but without further elaboration) in 72% ($n = 36$) and 66% ($n = 3$) of the plans, respectively. Sixty two percent
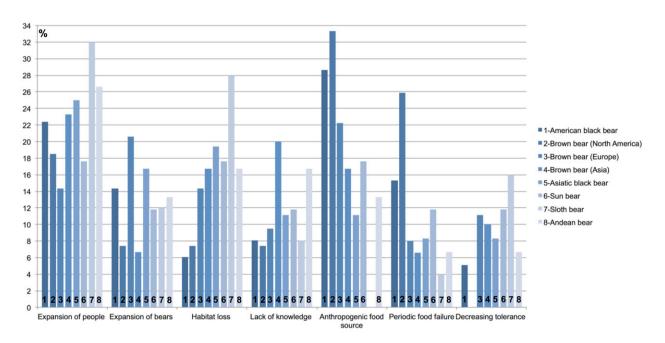
Figure 2 Main drivers of human-bear conflict reported by field biologists and managers (percentages of the factors as selected by experts for question six in the expert opinion survey).
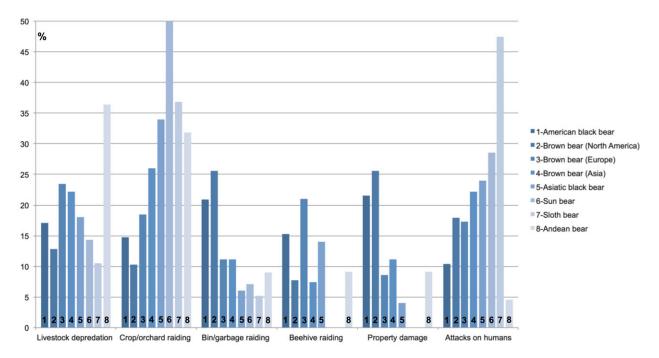

Figure 3 Types of human-bear conflict reported by field biologists and managers (percentages of the factors as selected by experts for question seven in the expert opinion survey).

($n = 31$) of the plans did not indicate the current (baseline) level or extent of bear conflict. Only 4 (8%) of the 50 plans mentioned animal welfare concerns in human-bear conflict management.

Of 172 papers on human-bear conflict that we found in our search of the Web of Knowledge, 31 mentioned tools to aid in human-bear conflict management. The most emphasized tools were education and awareness (36%,
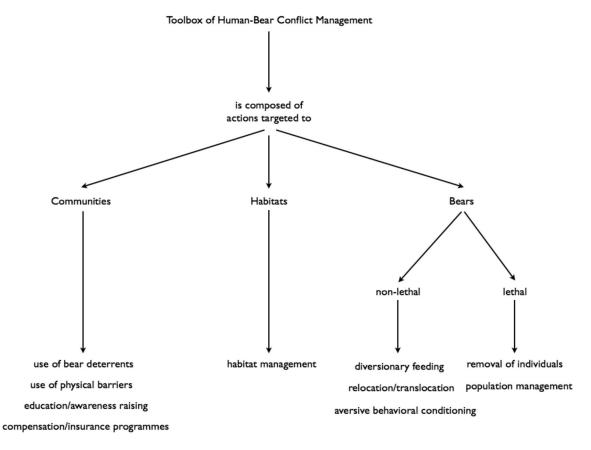
Figure 4 Toolbox of human-bear conflict management derived from management plans.

n = 19), physical barriers (23%, *n* = 12), aversive behavioral conditioning (13%, *n* = 7), and deterrents (12%, *n* = 6). Fewer studies regarded removal (6%, *n* = 3) or relocation of individuals (4%, *n* = 2), and fewer yet (each 2%, *n* = 2) concerned compensation and insurance programs, habitat management, and diversionary feeding (we are aware of more papers on these topics, but they did not come up with the keywords we used). Lethal approaches (other than legal hunting) were often mentioned as being the least acceptable to the general public, prompting studies of alternative methods.

Discussion

Conflicts in North America do not currently pose a threat to the viability of either American black or brown bears (Matt 2012). Illegal killing of brown bears due to either real or perceived conflicts is the principal cause of mortality for recovering European brown bear populations (Ciucci & Boitani 2008; Kaczensky *et al.* 2011). In Asia and South America, conflicts cause hardship for people, affect the rural economy, and hinder the acceptance

of conservation initiatives (Chauhan 2003; Charoo *et al.* 2011). Killing bears in the hope of reducing damage is a threat to the viability of Asiatic black bears and Andean bears in some parts of their range (Yokoyama *et al.* 2002; Goldstein *et al.* 2006; Liu *et al.* 2011).

The need for innovation: the toolbox for conflict management in South America and Asia is limited

There is a need for studies to investigate carefully the effectiveness of each of the tools of the conflict management toolbox. In parallel with evaluating and refining the effectiveness of these tools, it is essential to consider the capacity of the wildlife agencies to use the tools to deliver effective outcomes. There are great differences in the technical capacities of wildlife agencies in different parts of the world. Consider capacity to investigate the most serious of all conflicts, human deaths caused by bears. The investigation of four human fatalities from grizzly bear attacks in Yellowstone National Park (USA) in 2010 and 2011 included a large staff of professional people and

highly technical analyses involving forensics and genetics laboratories working on a greatly expedited schedule entailing enormous expense (Matt 2012). Investigations are likely to be much less rigorous or earnest in poorer countries, where fatal bear attacks are more common (e.g., Chauhan 2003; Bargali *et al.* 2005).

In North America, wildlife agencies receive over 40,000 complaints annually related to American black bears, and most are well equipped to handle these with a variety of approaches and well-defined protocols (Spencer *et al.* 2007). Outside North America, excepting a few European countries, wildlife agencies have much more limited capacity and resources. Given these limitations, these countries need innovative, cost-effective, thoughtful solutions; we argue that it is incumbent on the wider conservation community to help develop these. Initiatives for conflict reduction should be concentrated in places where conflict is likely to occur and where conflict mitigation strategies have the greatest potential to be effective (Honda *et al.* 2009; Northrup *et al.* 2012).

Action plans could have a role in documenting traditional ways of alleviating bear damage, based on the wisdom of generations, and splicing this with modern thinking and appropriate technology. Consider the effort in Rize, a province in northern Turkey, where people had traditionally placed beehives in the cracks of cliff-faces or on multishelved wooden platforms suspended on rock walls or in trees above the reach of bears (Figure 5). Inspired by this idea, one of us (ÖEC) designed a safer and more practical elevated bear-proof beehive platform (Can *et al.* 2007), supported on poles (Figure 5); this has become widely adopted in a local area, and is under consideration for wider deployment throughout Turkey (Can *et al.* 2010). Such low-tech, cheaply implemented, but resourceful approaches lend themselves to community development and microfinance schemes, and have the potential to mitigate conflict and encourage coexistence. The use of high-tech solutions such as virtual fences is mostly suited for group-living species (Jachowski *et al.* 2013) but might be refined for use with bears where resources are available.

Factors to be considered in future human-bear conflict management initiatives

A review of conflict management plans revealed that the toolbox of conflict mitigation is composed of actions targeted to communities (deterrents, physical barriers, education/awareness, and compensation/insurance programs), habitats (habitat management), and bears (diversionary feeding, relocation/translocation, aversive behavioral conditioning, removal of select individuals, and population management). In addition, through our

critical review, we identified the following five factors that should be considered in future conflict management initiatives.

(1) Economic instruments and human-bear conflict: In areas where killing bears poses a threat to their viability, incentives need to be created to foster tolerance among local communities (Peyton 1994). The biodiversity impacts compensation scheme (BICS), matching conservation problems and solutions (Macdonald 2001; Macdonald & Sillero-Zubiri 2004) applies well to bears, highlighting a hierarchy of options for mitigation, ranging from removal of the problem animal to compensating the affected stakeholder (Nyhus *et al.* 2003). Providing payments to people negatively affected by carnivores is a strategy for encouraging coexistence (see Dickman *et al.* 2011 for a critical review). Financial incentives should be tailored to individual situations, aligning the economic and cultural needs of people while delivering the desired conservation outcomes (Dickman 2010). Payments for environmental services (see Barrett *et al.* 2013 for a critical review) can be adapted within conflict management initiatives. For example, in South America and Asia, in areas with high levels of human-bear conflict, there is potential to integrate poverty alleviation strategies together with human-bear conflict management to foster reconciliation between bears and people.

(2) Community involvement in conflict management: It is essential for conservation that the public trusts that bear managers are acting to protect public safety (Herrero *et al.* 2011), and that affected local stakeholders engage in the conflict management process by adequately protecting their property. Sharing of responsibilities in conflict management is considered to be a key element for success in North America (Treves *et al.* 2006; Matt 2012). Establishing partnership between managers, locals, and conservationists is a priority in South America and Asia where rural people might otherwise perceive conservation actions as punitive restrictions on their land use, imposed by government or foreigners (Goldstein *et al.* 2006).

(3) Welfare aspect of conflict and its management: The human-bear conflict management plans had little to say about welfare, although this is relevant to any proposed action that might impact bears. In contrast with other academic fields (such as medicine), the ethical dimensions of conservation science have tended to be neglected (Paquet & Darimont 2010), yet they are an important component of conservation biology (Macdonald 2001). Conservation is

Photographs: Özgün Emre Can

Figure 5 Traditional wooden beehive platforms placed on cracks of cliff-faces to prevent bear damage to beehives (top two photographs) and the newly designed beehive platforms (Photographs by Ö.E. Can).

centrally concerned with populations, but these populations are emergent properties of individuals and their welfare is not just pertinent, but also more intuitively understood by a wider public than are abstract populations (Macdonald & Service 2007). Although quantifying the welfare implications of conflict is not an easy task, it should not be neglected. Many of the behavioral processes that are of interest to welfare science are also pertinent to conservation (Swaisgood 2007). Behavioral research can provide insights into ways of modifying animal behavior (Baker *et al.* 2007) or developing deterrents using knowledge of animal sensory susceptibilities (Schulte *et al.* 2007). Especially in North America, the public expects agencies to attempt to resolve human-bear conflicts with nonlethal methods (Spencer *et al.* 2007; Baruch-Mordo *et al.* 2014). Accordingly, attention to the welfare of wild bears is

likely to garner more public support for management initiatives.

(4) Effectiveness of educational initiatives: Education is the most mentioned approach to dealing with human-bear conflict worldwide. Public education should seek to increase awareness (Gore *et al.* 2006; Slagle *et al.* 2013) and help prevent encounters, damage, and injuries (Townes & Laughlin 2000). However, not all education programs produce the desired behavioral change; making conservation education effective is a topic meriting more research (Gore *et al.* 2006; Gore *et al.* 2008; Baruch-Mordo *et al.* 2011). Education should be a dynamic and interactive process, and new tools must be developed and their effectiveness evaluated (Spencer *et al.* 2007; Baruch-Mordo *et al.* 2011). Wildlife agencies should target specific segments of society by assessing and addressing their values and tailoring education
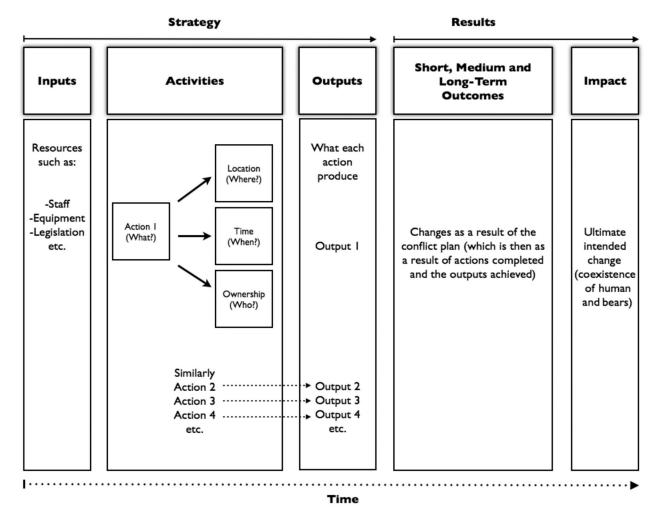
Strategy

Results

Figure 6 A logic model thinking for human-bear conflict management plans. Any process of conflict management takes place in time (the horizontal axis) and at a particular physical location, such as site, region, or country. Inputs are resources available (such as information on bears, staff, equipment, and legislation at the beginning of conflict management efforts) and when specific activities (such as activities 1, 2, 3, etc.) are completed, the associated outputs are achieved. They in turn lead us to short (less than 5 years), medium (5–10 years), or long-term (beyond 10 years) outcomes. Then the combined effect of those outputs result in outcomes and as a result of those outcomes, the impact of the conflict management plan is achieved.

initiatives accordingly (Slagle *et al.* 2013), and then monitoring outcomes by documenting failures as well as successes within the framework of adaptive management (Treves *et al.* 2006; Spencer *et al.* 2007).

(5) Improving human-bear conflict management plans: There are no established standards for conflict management plans. The 50 plans that we reviewed tended toward impenetrably dense text, designed more for life on a shelf (with the well-known risks of dust-gathering) than for action on the ground in the hands of practical decision makers. Greater use of graphic designs and logical schemata would enhance organizational clarity. Human-bear management plans could be considered logic models

(Kellogg-Foundation 2004), which are tools for organizing information in an if-then sequence of interactive relationships (Knowlton & Philips 2009). A logic model identifies a list of actions to be taken, specifying achievable outputs, and ensuring that these outputs secure the intended outcome (Knowlton & Philips 2009). We provide a template for expressing this in terms of human-bear conflict management plans (Figure 6). Within this template, it is important that plans are explicit about where, when, and under whose responsibility each action will be enacted. A human-bear conflict management plan within this framework should make clear the vision, goals, objectives, actions, outcomes, and outputs, and clearly

specify the structures for institutional and personal responsibility.

Policy implications

The fact that retaliations against bears is the principal cause for mortality in recovering bear populations in Europe signals the need for a critical look at management and conservation initiatives on bears there. Despite all available resources (technical experience, funds, and institutional capacity) and countless conservation initiatives, if coexistence of humans and bears cannot be established in areas of recovering populations in Europe, it is evident that much effort will be needed to achieve effective conservation in less developed areas of the world. Conflicts, either perceived or real, will continue as long as humans and bears live in proximity (Hristienko & McDonald 2007). Conflict is a conservation issue in Asia, South America, and in areas of recovering bear populations in Europe. As this study revealed, the top priorities for future conflict initiatives are Asiatic black bears and Andean bears, since conflict is a threat to those species in some parts of their range. By 2050, 87% of world's population will be living in the developing world (United Nations 2004). Many will find themselves near populations of bears, making conflicts increasingly likely. Policy objectives of human-bear conflict management might differ from one locality to another depending on the species, the needs of people, priorities of wildlife agencies, and availability of various elements of the toolbox of conflict management. Whatever the policy objectives are, the reduction in bear conflicts, and indeed human-wildlife conflict more generally (Peyton 1994), will hinge on a holistic approach that is as sensitive to the needs of people as it is to those of bears. In areas where conflict is a threat to the viability of bears, there is a need for international conservation groups and institutions to promote and aid in conflict management, and for international institutions such as IUCN, United Nations Development Programme, World Bank, and United States Agency for International Development to support governments and rural communities in conflict management. Particularly in South America and Asia, it is incumbent upon wildlife agencies with responsibility for bear conservation to engage fully with local stakeholders in ways that foster tolerance for bears and other wildlife in the vicinity. It is equally incumbent on those working in parts of the world with greater infrastructural and technological capacity to engage with colleagues in the developing world to adapt the best knowledge wisely, realistically, sensitively and, above all, practically, to the very different circumstances in which they work. We

share in the goal of encouraging the coexistence of bears and people worldwide, and similar principles may foster this aspiration globally, but to be useful their delivery must be ingeniously nuanced to local realities.

Acknowledgments

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web site:

Questions considered for expert survey.

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