Chapter 15

Human–Bear Conflicts at the Beginning of the Twenty-First Century: Patterns, Determinants, and Mitigation Measures

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Introduction

Conflicts between humans and bears have occurred since prehistory (Zedrosser et al. 2011). Through time, the catalogue of human–bear conflicts (HBC) has been changing depending on the values and needs of human societies and their interactions with bears. Even today, conflict situations vary among the eight species of bears and geographically across these species' ranges (Can et al. 2014). It therefore comes as no surprise that there is no single global definition of HBC accepted among world practitioners and researchers. For the purposes of this book, HBCs were defined as any interaction between humans and bears that result in negative impacts on human livelihood in terms of health, economy, and sociocultural aspects.

We do, however, recognize that HBCs also importantly affect bear populations and represent a major threat to bear conservation worldwide. Conflicts may reduce human tolerance to bears, increase poaching, undermine conservation efforts, and increase demands for legal management removals. Successful conflict mitigation is therefore not only important for people's well-being, but also represents a crucial part of the modern conservation management of bears on a global scale.

Most bear species are opportunistic omnivores, they are all large-bodied and potentially dangerous to humans. They live in diverse biomes and come in contact with various human societies. This results in a broad range of interactions between bears and humans that may be considered as conflicts, including: (1) predation of domestic or semi-wild animals, including bees, hunting dogs, and pet animals; (2) damage due to foraging on cultivated berries, fruits, agricultural products, and tree bark in forest plantations; (3) economic loss due to destruction of beehives, fences, silos, houses, and other human property; (4) bear attacks on humans causing mild or fatal trauma; (5) bluff charges, bear intrusions into residential areas and direct proximity of humans or other forms of bear behavior that provoke strong unease, fear, and/or defensive reaction by humans; and (6) vehicle collisions with bears and traffic accidents indirectly provoked by bears during "bear jams" (Can et al. 2014; Bautista et al. 2017).

In this chapter we aim to outline the principal types of HBC and geographical differences in the occurrence of conflicts, show direct and indirect causes of conflicts, illuminate the human dimensions of HBC, and review methods that are used to mitigate HBC with several successful examples that resulted in improved coexistence between people and bears.

Overview of Types of Human–Bear Conflicts

Bear conflict literature, reviewed from 1970 to 2018, showed that: (1) HBCs have never been reported for giant pandas; (2) brown and black bears are the species involved in most types of conflicts; whereas (3) Andean, sun, sloth, and polar bears are involved in few, specific types of HBC (Figure 15.1). Some bear species can also represent a threat to human safety, but a specific chapter (Chapter 17) on bear attacks on humans is included in this volume and therefore they are not discussed here. In this section, we present an overview of the different types of conflicts grouped by the bear species for which conflicts have been recorded.

Andean Bear

Although Andean bear diet is mostly based on plants, this species will attack domestic animals if available in their habitat (Zukowski & Ormsby 2016; Borbón-García et al. 2017). Cattle and sheep are the most common livestock animals in the Andean bear distribution range and are also most often attacked, although also attacks on goats and horses have been reported (Goldstein 1991; Jorgenson & Sandoval 2005; Zapata-Ríos & Branch 2018). In recent years, the number of damages to livestock has increased as the best grazing lands coincide with the best bear habitats and an increasing number of locals are changing from growing crops to breeding cattle, especially for dairy (Jampel 2016; Zukowski & Ormsby 2016). Occasionally Andean bears raid crops (especially corn), mainly when fields are close to forest cover and away from human settlements (Jorgenson & Sandoval 2005; Espinosa & Jacobson 2012; Jampel 2016).

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Sun Bear

Although little information is available on conflicts with sun bears, this species has been reported causing damage to crops and, more rarely, chickens and goats (Fredriksson 2005; Scotson et al. 2014; Wong et al. 2015). In Indonesian Borneo, sun bears have been reported damaging palm oil plantations and coconut trees by eating the fruits and new growth shoots (Fredriksson 2005). Sun bears are also known to feed on a variety of other fruits and horticultural products in mixed orchards such as corn, snakefruit, jackfruit, sugarcane, banana, pineapple, pumpkin, papaya, and oil palm fruits (Normua et al. 2004; Fredriksson 2005; Sethy & Chauhan 2013; Guharajan et al. 2017), as well as causing damage to farmhouses in search of household products such as rice, sugar, and palm oil (Wong et al. 2015; Figure 15.1).

Sloth Bear

Research on HBCs involving sloth bears is scarce and focuses mainly on bear attacks on humans (Can et al. 2014; Debata et al. 2017), which is the most frequently reported type of conflict (further addressed in Chapter 17). Although these bears rarely approach human areas, they can cause damage to agricultural fields when seeking crops (such as corn, sweet potatoes, potatoes, onions, or groundnuts; Rajpurohit & Krausman 2000; Bargali et al. 2005; Garcia et al. 2016).

Asiatic Black Bear

Conflicts between humans and Asiatic black bears have been reported across the whole species' range in Asia, including China (Liu et al. 2011; Huang et al. 2018), Japan (Saito et al. 2008), Pakistan (Ahmad et al. 2016; Ali et al. 2018), Iran (Ghadirian et al. 2017), India (Chauhan 2003), and Bhutan (Sangay & Vernes 2008; Jamtsho & Wangchuk 2016). The most frequently reported type of conflict is crop-raiding, especially of corn, potatoes, and various fruit trees (Figure 15.1). This kind of damage is concentrated during the summer (Charoo et al. 2011; Scotson et al. 2014), whereas attacks on livestock have been mostly documented during the autumn (Li et al. 2013; Mir et al. 2015; Jamtsho & Wangchuk 2016). Rarely, Asiatic black bears also raid beehives and fish farms (Liu et al. 2011; Jamtsho & Wangchuk 2016). Bark stripping has been reported in Japan, where bears are considered to be one of the greatest sources of conflict with forestry due to damage to tree trunks and consequent reduction of their value (Kobashikawa & Koike 2016).

American Black Bear

American black bears frequently raid crops, which represent an easy and calorically rich foraging opportunity (Mazur & Seher 2008; Merkle et al. 2013; Ditmer et al. 2015). Most frequently reported crop damage refers to cereals (Shivik et al. 2011; Ditmer et al. 2015), silage, corn, orchards, and various horticultures (Jonker et al. 1998; Baruch-Mordo et al. 2008; Treves et al. 2010; Shivik et al. 2011; Ditmer et al. 2015). Despite being less adapted to predation on large mammals compared to other large carnivores, American black bears also attack and kill livestock (Garshelis 2009). Most common victims are domestic sheep, goats, pigs, cattle, horses, and other smaller mammals and birds (Baruch-Mordo et al. 2008; Linnell et al. 2013). Apiaries are another strong attractant for black bears, which may cause considerable damage to beehives (Clark et al. 2005; McKinley et al. 2014) to obtain a high-energy food source (Beckmann & Berger 2003). American black bears can also cause considerable losses to forest landowners due to feeding or tree marking (rubbing). For example, bears strip bark from coniferous trees during spring to feed on newly forming vascular tissues for their relatively high content of free-floating sugars. This may result in significant damage (Kimball et al. 1998) and is mainly concentrated on younger stands (Stewart et al. 1999; Ziegltrum & Nolte 2001). They regularly seek out garbage, pet food, bird feeders, and other anthropogenic food and damage human property in the process, for example by breaking into houses, barns, vehicles, and other facilities (Miller & Tutterrow 1999; Breck et al. 2008, 2009; Treves et al. 2010). Other types of damage include bear–vehicle collisions and attacks on pets (Baruch-Mordo et al. 2008; Lowery et al. 2012; Wynn-Grant et al. 2018).

Brown Bear

Conflicts between people and brown bears are very diverse and are mainly related to the bears' opportunistic foraging and consumption of food. Across its range, the brown bear is the species most often reported to cause damage to livestock (Figure 15.1), which ranges from rabbits and chickens to cattle. Usually livestock damage is highest when brown bears occur in areas with sheep farming (Kaczensky 1999; Gunther et al. 2004). Besides livestock, brown bears have been reported killing pets, captive game animals, and fish (Molinari et al. 2016). When searching for insect larvae, brown bears also frequently destroy beehives (Figure 15.2), which represent the major HBC in some parts of the species' range (e.g. Groff et al. 2010; Karamanlidis et al. 2011; Naves et al. 2018). Damage in agriculture includes crop fields (especially corn), gardens, orchards, grass silage, and vineyards (Krofel & Jerina 2012). In some parts of the range, brown bears cause damage to forestry, which seems to be concentrated on mature conifer trees (Zyśk-Gorczyńska et al. 2016). Due to their large size, brown bears can also cause considerable damage to buildings, vehicles, wildlife feeders, and other human property while searching for human foods or during vehicle collisions (Krofel & Jerina 2012). Searching for anthropogenic food sources can also bring bears close to human settlements, which increases people's concern for human safety and often results in lethal removal of the intruding bear (Gunther et al. 2004).

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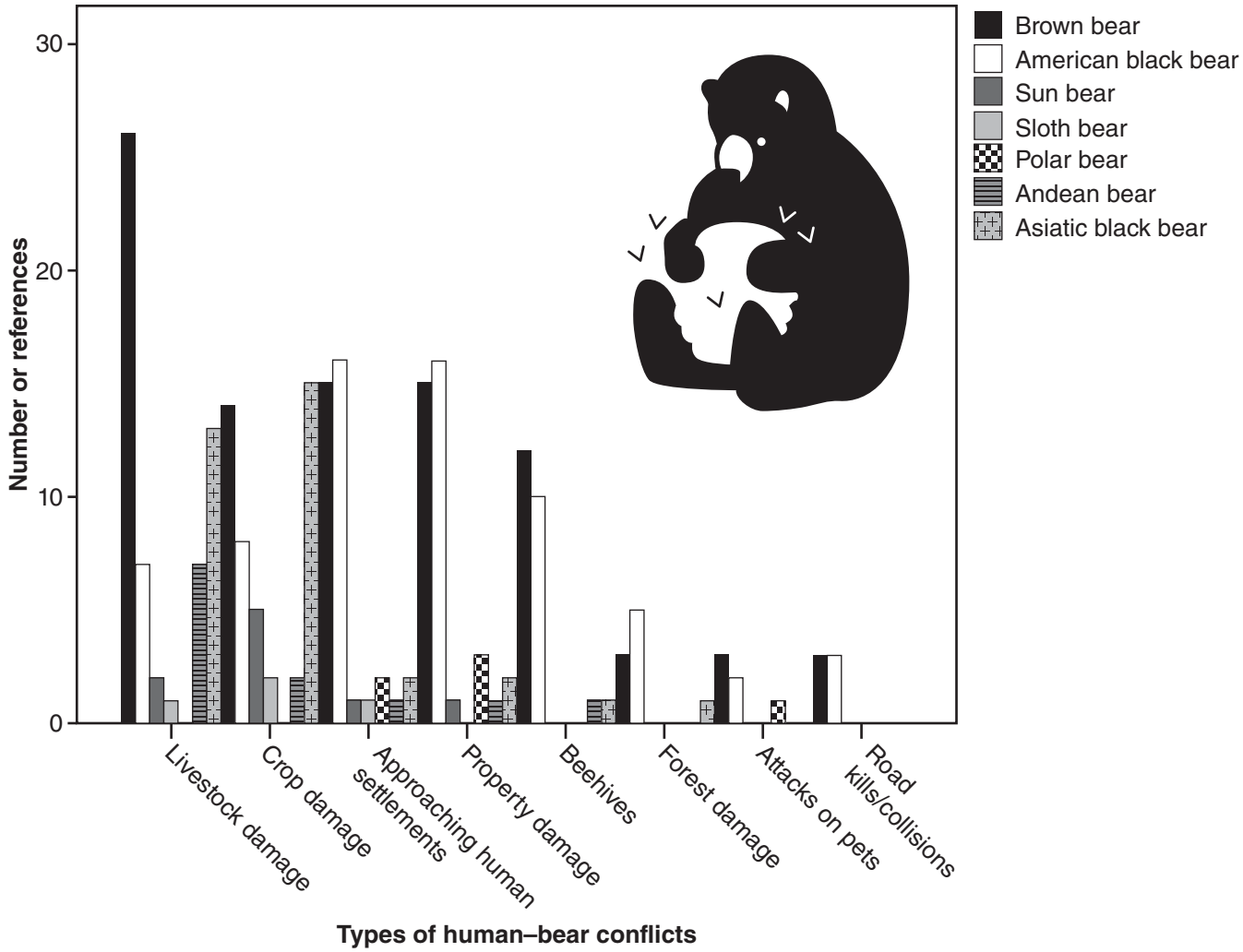

Figure 15.1 Types of human–bear conflicts reported in the scientific literature between 1970 and 2018. For each type of human–bear conflict, the number of related publications is shown. (Bear image credits: the image was downloaded from www.123rf.com, Image ID 107801431, copyright: vastard.)

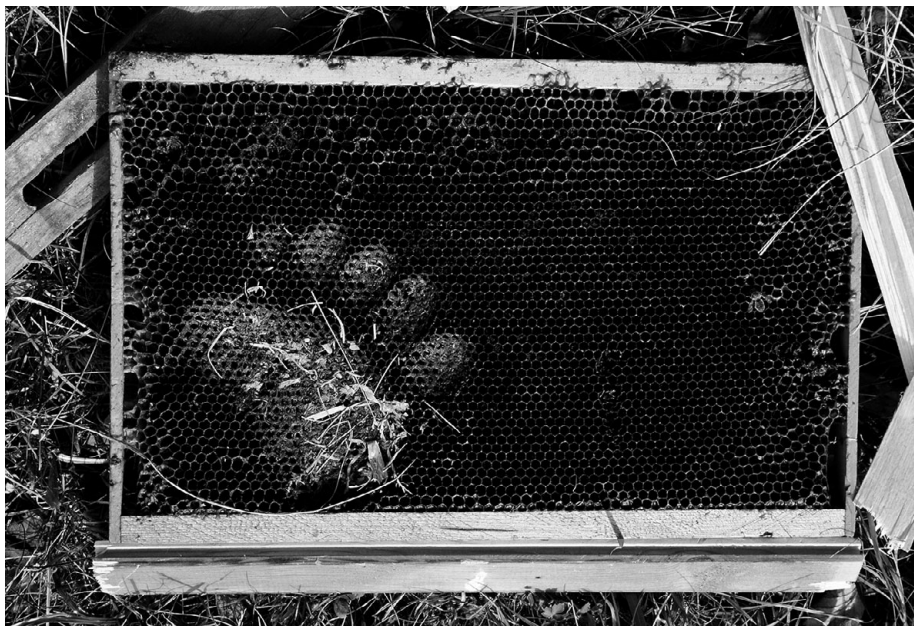

Figure 15.2 Human–bear conflicts are very diverse, but mostly associated with bear foraging behavior, such as raiding beehives to obtain protein-rich bee larvae. (Photo by Miha Krofel.)

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Polar Bear

Damage caused by polar bears is mainly related to human food stores, vehicles, attacks on domestic dogs, and entry into human settlements (Stenhouse et al. 1988; Dyck 2006). This damage derives from the bears' search for food, and is typically concentrated in August–November, when bears are on land due to melting sea ice (Stenhouse et al. 1988; Dyck 2006; Towns et al. 2009) and do not have access to the seals, their main prey (DeMaster & Stirling 1981).

Main Drivers and Factors That Influence Conflict Occurrence

Intrinsic Drivers

Large carnivores often avoid human activity and settlements. However, when large carnivores do occur close to people and settlements, it is often interpreted as a behavioral response, such as tolerance to human presence, and/or an association between humans and attractive foods.

The waning of a response to a stimulus (e.g. human presence) can explain the increased tolerance toward humans in animals with increasing non-threatening encounters with people, and is hereafter called *human habituation*. Food resources are unconditioned stimuli, i.e. not related with other stimuli, which usually results in the response of foraging. However, feeding can become conditioned upon an unrelated stimulus, such as human presence or settlements, after repeated association between human activity and food resources (Immelmann & Beer 1989); this process is hereafter called *food conditioning*. These learning processes can explain why some animals (habituated ones) are not wary of humans or often occur near settlements, while other conspecifics (non-habituated) still avoid them. However, human habituation and food conditioning do not predict that exposures to stimuli will vary among conspecifics (e.g. sex/age or reproductive categories). Bears can also transmit human tolerance by observational learning from mother to offspring, i.e. by social or cultural transmission (Morehouse et al. 2016). Similarly, young bears may become food-conditioned through their mother's behavior. However, regardless of the influence of cultural transmission, the development of positive associations between bears and human-derived foods requires some earlier experience with, or cues from, people, human activity, or settlements. In contrast to habituation and conditioning, if animals occur near people because they lack cumulative experience of them (Bejder et al. 2009), i.e. are naïve, this would predict a higher frequency of younger individuals near human activity and settlements. Thus, subadult bears may approach people or settlements due to their naïvety.

Human habituation and food conditioning are common responses by bears due to frequent exposure to people and human-derived foods (McCullough 1982; Herrero et al. 2005). However, human activity or settlements may also provide a refuge (sometimes termed *human shield*) for young bears and females with young against dominant conspecifics (Wielgus & Bunnell 1994; Mueller et al. 2004; Steyaert et al. 2013). Actually, predation and aggression towards conspecific young (especially cubs-of-the-year and yearlings) by older individuals, especially males, constitute a common pattern in brown bears (Swenson et al. 1997, 2001; McLellan 2005).

A common pattern across Europe, North America, and Japan is that brown bears, polar bears, and American and Asiatic black bears occurring near human activity and settlements are typically younger, and females accompanied by their offspring are more often near settlements or humans than adult males or lone adult females (Elfström et al. 2014c). The pattern of dominant bears displacing subordinate conspecifics from areas with higher habitat quality in terms of food and cover is referred to as a *despotic distribution* (Elfström et al. 2014c). In some areas, these displaced bears occurring near settlements often become human-habituated or food-conditioned (Mattson et al. 1992; Schwartz et al. 2006). In other areas, in particular among Scandinavian brown bears, food-conditioning seems to be uncommon (Elfström et al. 2014a, 2014b). Thus, the despotic distribution explains why certain bears more often occur near settlements, which may or may not result in human habituation or food conditioning. The availability of food resources and their distribution in relation to human settlements can differ considerably across the bears' range and this could explain why sometimes bears near settlements become food-conditioned, but not always.

Extrinsic Drivers

Based on a literature review we identified six main extrinsic drivers of HBC: availability of anthropogenic food, natural food failures, impacts of human activities on the landscape, climatic and meteorological events, differences in conflict management, and reduced human tolerance. Below, we give an overview of the mechanisms underlying these drivers, except for the reduced tolerance that is explained further in this chapter.

At a local scale, the availability of anthropogenic food (Figure 15.3) is a source of conflict and an ecological trap for bears in many parts of the world, for example: brown bears roaming in agriculture fields or garbage dumps in Japan, Europe, the Middle East, and North America (Narita et al. 2011; Northrup et al. 2012; Cozzi et al. 2016; Penteriani et al. 2018a); American black bears raiding mango plantations in Northern Mexico (Lira Torres et al. 2015); sun and Asiatic black bears raiding corn plantations in south-east Asia (Scotson et al. 2014); and Andean bears predating free-ranging cattle in pastures of the Ecuadorian Andes (Jampel 2016). Additionally, artificial feeding of bears, both intentionally and unintentionally, may increase the risk of HBC, which is why intentional bear feeding is generally discouraged or prohibited across North America (Garshelis et al. 2017). Artificial feeding can also shorten the hibernation period and thus

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Figure 15.3 Anthropogenic food, such as garbage, is one of the most important extrinsic drivers of human–bear conflicts. (Photo by Andrej Sila, Slovenia Forest Service.)

Figure 15.4 Delay in ocean freezing due to global warming is an important extrinsic factor promoting conflicts between people and polar bears. (Photo by Marcus Elfström.) (A black and white version of this figure will appear in some formats. For the color version, please refer to the plate section.)

prolong the period when human–bear interactions occur (Krofel et al. 2017).

The frequency of bears using or searching for anthropogenic foods and consequent HBC seems to increase when natural bear food sources become scarce. For instance, human–grizzly bear conflicts increased in British Columbia, Canada in years of low availability of salmon biomass (Artelle et al. 2016) and similar patterns of increased HBC in periods of natural food failures were described for European brown bears (e.g. Molinari et al. 2016), American black bears (e.g. Baruch-Mordo et al. 2008), Asiatic black bears (e.g. Oka et al. 2004), and sun bears (Wong et al. 2015). On the other hand, years of high mast production can increase bear reproductive rates (Costello et al. 2003), which in turn can lead to increased levels of conflicts in subsequent years, due to a larger number of mothers with cubs and young individuals that look for shelter and food near humans (Elfström et al. 2014c; Obbard et al. 2014). However, an occurrence of problem bears that is unrelated with seasonal food availability has also been reported (Elfström et al. 2014b).

Human population size and the impact of human activities on the landscape also influence the occurrence of HBC. Habitat degradation due to agricultural expansion increases the rates of HBC globally (Can et al. 2014). Additionally, the use of bear habitats by humans can increase the risk of human–bear interaction. For example, direct competition for fruits led to higher rates of sloth bear attacks on humans in India (Dutta et al. 2015). Also, recreational activities, such as bear viewing and nature tourism, are increasingly demanded and without proper regulation can be a cause for more human–bear interactions which may end in HBC (Penteriani et al. 2017). On the other hand, socioeconomic changes may lead to modifications in land use and to land abandonment in rural areas, which, in turn, can facilitate the expansion of bears and thus promote conflicts. For example, in the Ecuadorian Andes shifts from crops to cattle, and from a mostly subsistence-oriented economy to a more market-oriented and capital-intensive approach, have led to higher rates of cattle predation by Andean bears (Jampel 2016). Also, decrease and aging of the local human population may enhance leaving unattended fruit trees and unharvested crops, which attract bears to villages (Kishimoto 2009; Yamazaki et al. 2009).

Various climatic and meteorological events have been associated with the increasing trend of HBC. The most outstanding example is the considerable loss of sea ice and delay in ocean freezing due to global warming, which is forcing polar bears (Figure 15.4) to increasingly use terrestrial habitats and consequently promotes encounters with people (Wilson et al. 2017) and damage caused by polar bears (Towns et al. 2009; see also Chapter 14). At lower latitudes, an increase in the frequency of crop raiding and approaches to people by sun bears in Indonesia and American black bears in New Mexico (USA) was reported during drought periods associated with the El Niño–Southern Oscillation (Zack et al. 2003; Fredriksson 2012). Climate change is predicted to increase the severity of meteorological events, such as late-spring frosts that are associated with natural food failures in temperate regions and higher use of urban areas by American and Asiatic black bears (Honda 2013; Laufenberg et al. 2018). Additionally, climate change can reduce the duration of bear hibernation and consequently prolong the period when human–bear interactions occur (Johnson et al. 2018), as well as altering the geographic range of natural food resources. As a consequence, bears might be displaced from mountainous areas toward lower, more humanized ones, where an increase in conflicts is expected (Penteriani et al. 2019).

Finally, bear-damage management greatly influences the occurrence of HBC (Bautista et al. 2017) and good husbandry practices have been the most effective and widespread technique to prevent conflict with bears and other large carnivores (van Eeden et al. 2018).

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Human Dimensions of Human–Bear Conflicts

At a pragmatic level, it is vital to recognize that effectively addressing and solving HBCs requires working with people, communities, and a variety of stakeholders within a given social and ecological context (see also Chapter 20). Understanding the associated values, perceptions, social and cultural norms, and decision-making of people within a given context is important for illuminating the human dimensions of HBC. While regulatory approaches to mitigating undesirable human behaviors (e.g. poor sanitation practices, lack of use of prevention tools, or illegal poaching) are critically important to addressing HBC, collaborative approaches to decision-making offer additional means to build support and improve human behaviors and practices that address HBC.

Values Among Stakeholders are Important

Addressing HBC must have scaled levels of support, built upon effective stakeholder decision-making forums, well-designed management plans, effective public communication strategies, and institutionally backed political, legal, and financial support at national and international governmental levels. In many respects, resolving HBC rests upon *the support and acceptance of bears by communities of place and communities of interest* – where local and broad public values converge (Wilson 2016). This requires attention to be paid to the values and perspectives of people who actually live with bears and those who have strong interests in bears, often urban dwellers whose values may be different from local stakeholders.

Finding areas of convergence in values is no easy task considering that strong differences exist in terms of how groups of people or stakeholders believe bears should be managed and conserved. Moreover, in some contexts, there may be deep-rooted social issues, power inequities, historical events, or ethnic and cultural divides that cause social conflicts, resulting in a refusal by people to work collaboratively to address ways to live with bears. Failure to address these underlying sources of conflict may hinder well-intended efforts and may require facilitated processes that can expose, explore, and transform existing relationships so that meaningful HBC management can occur (Madden & McQuinn 2014). Social conflicts and the actual material damage from bears that impact individuals should therefore be understood within unique social and ecological contexts that reflect a keen understanding of political, cultural, historic, and economic conditions.

Problem Definitions Matter

Additionally, how different people orient to and define "the problem" of living with bears is an essential aspect of the human dimensions related to addressing HBC. For example, it is common for stakeholders to define the issue of HBC as one of having "too many bears" (Wilson et al. 2013). The perception that bears are too numerous can be complicated – for example, in certain European contexts, younger bears and females with cubs use human settlements as human shields from older male bears (Elfström et al. 2014c; Steyaert et al. 2016). This can make females and younger bears more regularly visible to people. Subsequently, this can cause the perception that the perceived problem is about an increase in the population of bears, when this may not be the case. If these types of perception are not addressed or corrected, then solutions to the perceived problem may be misguided – in this example, a call to reduce the bear population as a solution to HBC. This is just one example of the importance of paying attention to how local people define "the problem." In many cases, collaborative forums or decision-making processes that bring local people together with bear managers, scientists, and other stakeholders are essential for generating a shared understanding of the problem so that shared solutions are generated for effectively addressing HBC (Botetzagias & Kotilda 2018).

Community Responses to Biological Scale

The question of whether individuals and groups of people can work collaboratively to understand the problem and find solutions becomes even more imperative due to the large spatial scale of habitat that bears require. In most European landscapes, brown bear home ranges encompass human activities within a mixed mosaic of modified forest, mountain, and agricultural lands. In this context, the use of prevention tools by multiple individuals is necessary to match the biological scale at which bears live. Failure to match community-level responses to the scale of carnivore life history needs will inevitably fall short of resolving conflicts for both people and bears (Wilson et al. 2013). These challenges are further magnified in areas where large carnivore populations encompass multiple countries and where transboundary movements of bears cross multiple management jurisdictions (Bartoń et al. 2019). In these contexts, well-developed institutional partnerships and transboundary-level management agreements are central for addressing HBC across jurisdictional boundaries (Penteriani et al. 2018b; Proctor et al. 2018).

Effectiveness of Conflict Mitigation Measures

During thousands of years of coexistence with bears, humans have developed both proactive and reactive methods to prevent or mitigate HBC. While none of them is 100% effective, there are patterns of success and failure that transcend species. First and foremost, proactive methods that prevent conflict are almost always cheaper and more successful over time than reactive measures. Second, as the levels of food conditioning and human habituation increase, the effectiveness of mitigation decreases. Mast failures and water shortages also influence the effectiveness of mitigation efforts, as well as sex, age, and maternal status of individuals, and competition for resources among individuals (Majić Skrbinšek & Krofel 2015).

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Preventing Access to Anthropogenic Food and Human Property

As highlighted before, anthropogenic food is a well-known primary cause of HBC; therefore, denying bears access to human food resources is perhaps the most effective and proactive way of preventing HBC. In this way, bears are not rewarded for approaching humans or developed areas, thus habituation to human presence and food conditioning are less likely to occur (Majić Skrbinšek & Krofel 2015). There are numerous approaches to effectively prevent bears from accessing anthropogenic food sources, including livestock, although reliable evidence for effectiveness of many of these methods is still lacking (van Eeden et al. 2018). Exclusion by means of bear-proof bins and electric fences prevents access to unprotected resources such as garbage and livestock, respectively (Sowka 2009). Properly installed and maintained electric fences (Figure 15.5) can have near 100% effectiveness rate and the use of guarding dogs as protection, particularly for livestock, is also a highly effective technique (Belant et al. 2011; Proctor et al. 2018; van Eeden et al. 2018). Removal of attractants such as bird feeders, pet foods, and carcasses is essential, especially in spring or during mast failures, when natural foods are not widely available. Strict legislation and its enforcement, accompanied with public education, are also crucial elements in reducing the availability of anthropogenic foods (Majić Skrbinšek & Krofel 2015).

Aversive Conditioning

Aversive conditioning is a learning process in which deterrents are continually and consistently administered to change an undesirable behavior. Negative stimuli, such as shooting with rubber bullets, are applied while an animal is engaged in undesirable behavior in order to elicit an avoidance of such behavior in the future (Gillin et al. 1994). Other methods of aversive conditioning include: taste aversion, cracker shells, propane cannons, bear dogs, shooting with bean bag rounds, and capture and release of conflictual individuals. Most of these methods have produced mixed results and depend on multiple factors, including the context in which a learning process took place, the immediacy of a consequence to a given behavioral response, and the consistency and magnitude of these consequences and rewarding of alternative behavior (Majić Skrbinšek & Krofel 2015). Pain stimuli and the use of bear dogs have proven to be the most successful in the long term. However, effectiveness is lower when an undesired behavior is already strongly established, and it is important to remember that bears may also habituate to some of the aversion techniques (Mazur 2010). A monitoring and response system that quickly detects undesired behaviors is crucial for successful application of this tool.

Lethal Removal

Lethal removal of bears has been a widespread measure used in response to bear incidents in the past (Schwartz et al. 2005). This method includes shooting, trapping, and poisoning. It can refer to management removals of specific "problem" individuals or a general culling of the population with the aim to reduce bear density. In many regions of the world, however, lethal controls are losing public approval, and for endangered populations even limited removal can have strong negative effects (Treves & Karanth 2003; Schwartz et al. 2005). Poisoning and some types of trapping are in general ill-advised due to risk of non-target kills, including endangered wildlife and domestic animals. Lethal methods are most effective when known "problem" bears are removed (Gunther et al. 2004), for which permits may be obtained from a regulatory agency. Culling as a tool for conflict mitigation is not likely an acceptable solution near settlements; however, it may be considered for rural locations with agricultural conflicts, but must also consider population and damage characteristics (Belant et al. 2011).

Non-Lethal Removal

This method includes capturing an individual and moving it to another place. Translocations of problem bears are generally more acceptable for the public than lethal removals, but agencies are increasingly reluctant to use this method (Creachbaum et al. 1998). Translocations are costly and labor-intensive with high mortality rates, as bears often return to the capture site even from several hundreds of kilometers away, present road hazards, or cause problems in the new area (Linnell et al. 1997). Noteworthy successes from translocation have considered the age and sex of the individual in addition to significant translocation distance, impassable geographical barriers, and perhaps the quality of the new habitat (Taylor & Phillips 2019). Translocating young males that are not highly food-conditioned has seen the greatest success (Belant et al. 2011; Taylor & Phillips 2019).

Diversionary Feeding of Bears

By providing food in remote areas, managers attempt to divert bears from approaching settlements and/or reduce damage to human property. Effectiveness of diversionary feeding lacks rigorous studies and existing examples from brown bears and American black bears have been met with mixed results (Steyaert et al. 2014; Garshelis et al. 2017). Diversionary feeding with carcasses to reduce livestock depredation was not effective (Kavčič et al. 2013; Morehouse & Boyce 2017). There is also an increasing list of side effects, many of which are unwanted, associated with the artificial feeding of bears (Penteriani et al. 2018a). If diversionary feeding is to be used in HBC mitigation, a comprehensive review of the literature suggests that the highest efficacy with minimal side effects is through temporary, seasonal, and as-needed placement of natural foods (Taylor & Phillips 2019). Employing this strategy encourages exploitation of natural food sources first and discourages dependence on anthropogenic supplementary foods.

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Land-Use Practices

There are several potential mechanisms by which land-use practices can affect probability for occurrence of HBC. For example, limiting human access to the most crucial bear habitats in certain time periods gave positive results in American national parks (Coleman et al. 2013). Because cover is an important parameter affecting space use by bears, some authors recommended removing dense vegetation near human settlements (Elfström et al. 2014c) and crops (Sato et al. 2005). Water courses are popular travel routes for bears; therefore, removing livestock and apiaries from these areas can also be effective (Clark et al. 2005). Transition from sheep to cattle or horse breeding, from livestock breeding to other land use (e.g. agriculture, forestry), or selection of crops less attractive to bears can also reduce probability of bear damage (Gunther et al. 2004; Swenson & Andrén 2005; Wilson et al. 2006; Majić Skrbinšek & Krofel 2015). However, generating a will for such changes among stakeholders can be a considerable challenge (Linnell et al. 2013).

Figure 15.5 Electric fences and electric nets, when used properly, are a very effective way to prevent damage caused by bears to livestock, beehives, crops, or other human property. (Photo by Miha Krofel.)

Compensation

Economic compensation for claimed damage caused by bears started in the 1950s and is nowadays widespread in Europe and North America (Ravenelle & Nyhus 2017). Compensation programs differ from one country to another and can effectively reduce the economic impact of the HBC on certain stakeholders (Figure 15.6). However, they should be treated with care, as they can also decrease efforts to prevent damage and exacerbate conflicts (Bulte & Rondeau 2005). For example, in the Scandinavian brown bear population the level of conflict is considerably higher in Norway compared to Sweden, which is connected with sheep in Norway being mostly free-ranging and unprotected. In Norway, compensation is given in all cases, even if the incident is not verified and if no protection of sheep was used, whereas in Sweden compensation is conditional on the proper protection of livestock, and wildlife agencies strongly focus on subsidizing preventive measures (Swenson & Andrén 2005; Widman & Elofsson 2018). It should also be understood that compensation does not directly affect the occurrence of HBC, but only mitigates their economic impact.

Public Awareness and Education

Increasing public awareness about drivers of the HBC, demonstrating the preventive measures and their proper use, can considerably improve the effectiveness of HBC prevention programs. People also tend to follow prescribed rules more when they understand the reasons behind them (Majić Skrbinšek & Krofel 2015). Education of adults and children can also be effective to improve their attitude towards bears (Ambarlı 2016).

Figure 15.6 Economic compensation for claimed damages can effectively reduce economic impact of human–bear conflicts, as in the case of damage to fruit trees. Here is shown a brown bear scat full of domestic cherry stones. (Photo by Vincenzo Penteriani.)

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Successful Examples of Conflict Prevention

North American National Parks

The first systematic measures targeting availability of human food sources were applied in the 1970s and 1980s in North American national parks following high rates of HBCs, including several human casualties (Herrero 1994). Strict garbage management, regulations on human food storage, prohibition of artificial bear feeding, and intensive public education about proper behavior in bear habitat proved very successful. After application of these measures, HBC throughout national parks decreased considerably. For example, in the Yellowstone National Park, attacks on people decreased by almost 90% and at the same time there was less need for management removals of bears (Meagher & Phillips 1983; Gunther & Hoekstra 1998). In the Denali National park, cases of bears feeding on anthropogenic food decreased by 96%, which was followed by a 77% decrease in reported HBC and 77% lower number of management removals (Schirokauer & Boyd 1998). Similarly, after the change of focus from bear management to management of people and anthropogenic food, the number of problem bears removed decreased by 94% for black and 86% for brown bears in the Jasper National Park (Ralf 1995), and by 75% for black and 70% for brown bears in the Glacier National Park (Gniadek & Kendall 1998), respectively. In the Yosemite National Park, after management was changed from reactive (lethal removals, translocations, aversive conditioning) to proactive (limiting access to anthropogenic food, education, law enforcement), the proportion of anthropogenic food and garbage in the black bear diet was considerably reduced, which was followed by a 31% decrease in the number of bear incidents and a 63% decrease in the amount of damage caused by bears (Madison 2008; Hopkins et al. 2014).

Residential Areas in North America

Limiting the availability of anthropogenic food for bears is generally more difficult in residential areas compared to national parks. However, also here considerable improvements can be achieved with public education and implementation of methods preventing access to anthropogenic food. In Blackfoot Valley (Montana, USA), a proactive, community-based project was launched to provide cost-free removal of livestock carcasses for ranchers; introduce bear-proof garbage bins, provide electric fences for beehives, cattle calving areas, and garbage dumps in parallel with intensive public education. During the three-year project the number of conflicts with brown bears decreased by 91% without the need to remove a single bear (Wilson et al. 2006; Wilson 2007). Substantial decrease in HBC and management removals of brown bears was noted also in Kennecott Valley (Alaska, USA) after local residents were provided with bear-proof garbage containers, electric fences, and targeted public education (Wilder et al. 2007). Similar successes (40–80% reduction) in reducing HBC by preventing bears feeding on human food sources were reported for the American black bears in residential areas across the USA (Tavss 2005; Leigh & Chamberlain 2008).

South America

To reduce the impact of cattle depredation and damage to corn and avocado plantations caused by Andean bears, a pilot program was developed in Ecuador to improve livestock management by providing water channels, electric fences, fertilizers, grass seeds, artificial insemination, and permanent veterinary care. This resulted in the prevention of further cattle losses and improved farmers' attitude toward bears and their conservation in the project areas (Laguna 2018). In parallel, bear-watching ecotourism is promoted, which provides additional local employment.

Middle East

Electric fencing for preventing brown bear damage to beehives and orchards in Turkey was first implemented at six locations in 2007 and 2008 (Ambarlı & Bilgin 2008). After successful prevention of damage in this pilot EU Kaçkar Mountains Conservation Project and adoption by the government authorities, electric fencing became widespread throughout the country. Today, it is locally manufactured and used at more than 5000 locations, which caused a decrease in bear-caused damage, as well as a 10-fold reduction in the price of the electric fencing equipment compared to imported fences.

Arctic

In order to prevent conflicts due to polar bears approaching human settlements, a polar bear alert program has been established in Churchill, Manitoba (Canada), since 1980. Polar bears (with the exception of family groups) that approach residential or working areas of Churchill are captured and after a minimum of 30 days released outside of the town (Hedman 2009). Recaptured individuals are translocated about 70 km north to the Hudson Bay. If translocated bears are recaptured, they may be kept in the holding facility until the ice comes in. The program relies on maintaining a high alert on bear occurrence around the urban area, as well as on educating people to reduce bear accessibility to human-derived foods and restricting human activity outside of the city to avoid disturbing bears. The ice cover is the main driver behind polar bear occurrence ashore and beyond the reach of bear management. However, the bear alert management program results in saving lives of bears and people.

Conclusions

Human–bear conflicts are complex and diverse. Consequently, there is no single one-for-all solution to effectively prevent all types of problems. Because often only few problem bears cause the majority of all bear incidents, special attention needs to be given to preventing the development of repetitive conflict behavior, especially preventing bears' access to anthropogenic food. However, when this fails and bears develop high levels of

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human habituation or food conditioning, conflict behavior is difficult to change. In such cases, the removal of problem bears is often the only effective solution and will therefore likely remain an important part of bear management in the foreseeable future. Nevertheless, the main focus in bear management should be prevention, as successful proactive management is considerably more acceptable to the public than reactive responses once the conflicts have already occurred. Experience from several regions suggests that this approach gives the best results when local inhabitants are actively involved and well-informed about bear biology, occurrence, and prevention of HBC. At the same time, such non-lethal management is in line with recent trends of a decrease in the public's tolerance of lethal bear removals.

The science of HBC has enabled the development of several highly successful conflict-prevention programs throughout the world and has enabled the persistence of numerous bear populations in coexistence with people. Building upon this knowledge and best-practice examples is probably the safest way to ensure the future survival of these iconic animals.

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