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Education is not a panacea for reducing human–black bear conflicts

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Letter to the Editor

Education is not a panacea for reducing human–black bear conflicts

The long-term survival of carnivores is greatly challenged by conflict with humans. Such conflicts can bolster risk perceptions, lower tolerance, and lead to support of lethal control of carnivores. To address this ubiquitous challenge and improve conservation outcomes specifically for American black bears (*Ursus americanus*), Marley et al. (2017) used an agent based model to explore how management strategies could alter the use of the urban environment by bears, and subsequently reduce the occurrence of human-bear conflicts. Management strategies entailed education only, where people were taught to remove food attractants, apply aversive conditioning, or both, and the authors considered different spatial configurations of implementation (border, clustered, and random). Education resulting in food removals led to a reduction in the food values of urban cells. Education resulting in aversive conditioning led to increased vigilance by humans and increased probability of a bear being deterred, which in turn, resulted in the bear moving a significant distance away from the urban cell as well as a reduced memory value for those cells. Food and memory cell values determined the movement choices of the bears in the next time step, and cell visits along with the occurrence of deterrence events determined the habituation and food conditioning status of bears. When bears reached thresholds determined by the authors, they changed their status from 'graduated' to 'survival' and eventually 'conflict' status, which was modeled as a function of independent variables including initialization conditions (e.g., percent urbanization; Table 5 of Marley et al., 2017) and management strategies (e.g., clustered vigilance; Fig. 5 of Marley et al., 2017). The authors concluded that, compared to a 'no teaching' scenario, education works to reduce 'conflict' bears in urban areas, and that teaching people to apply aversive conditioning was the most effective strategy.

The authors' modeling approach is interesting and has some utility in helping define and understand the complex issues associated with human-bear conflict. However, we are concerned that readers might be captivated by the simplistic idea that "all education methods reduce the number of human–bear conflicts" (Marley et al., 2017), an idea which was reinforced in the title of an article published by a major professional organization dedicated to wildlife management: "How to deter problem black bears? Educate people" (Kobilinsky, 2017). Instead, the approach taken by Marley et al. (2017) explores what happens to bears when residents perform desired behaviors (i.e., removing food attractants and initiating aversive conditioning) and urban planners design appropriate spatial configurations. Thus, we outline concerns with the assumption of that education results in *change in human behavior*, which can lead to reduced human-bear conflicts. We then address why we believe it is inappropriate to educate residents to apply aversive conditioning as a management strategy. We end with a call to the research and modeling community to investigate what leads to change in human behavior in the interest of reducing wildlife-related conflicts.

Marley et al.'s (2017) model specifications assume the existence of an education program that induces long-term changes in human behavior for up to 200 days (the model equivalent to a single summer). Unfortunately, research indicates that current education programs are minimally effective at changing behavior this consistently. For example, in Colorado, researchers found that Bear Aware and on-site education efforts did not result in increased compliance of securing garbage attractants (Baruch-Mordo et al., 2011). In New York, researchers also found that behavior change was rare after implementation of an educational Bear Aware campaign (Gore et al., 2008). More broadly, Balmford et al. (2017) found that knowledge did not lead to 'pro-environmental' behaviors, even within groups expected to perform such behaviors (e.g., conservationists). Thus, people can be "educated" and report knowing the correct behavior (Pienaar et al., 2015), but not have the time, financial resources, or interest in implementing the behavior (e.g., they forget to store garbage or grills inside, or they purposely leave pets/pet food outside). Webb and Sheeran (2006), who conducted a meta-analysis of behavior change studies, found that expected changes in actual behavior were relatively small ($d = 0.36$) even when efforts induce medium-to-large changes in individuals' *intensions* to perform desired behaviors ($d = 0.66$; Cohen, 1992). Unfortunately, education alone rarely equates to sustained behavioral change.

All too often, practitioners assume education can easily solve any conservation challenge by changing an undesired human behavior (e.g., leaving food attractants outside) to a desired behavior (e.g., storing food attractants in bear-proof containers or buildings). This thinking, commonly referred to as "The Knowledge (or Information) Deficit Model", assumes that humans are empty vessels waiting to be filled with knowledge that can be applied in future scenarios without question or error. In reality, preferences are constructed from a combination of existing cognitions and contextual information (Simon, 1990), while human *behavior* is dependent on an interaction of preferences and other cognitions with perceived and actual constraints (Fishbein and Ajzen, 2010). In particular, Bandura (1994) notes that people must believe they are capable of performing a desired behavior (self-efficacy) in addition to believing the behavior itself will result in preferred outcomes (outcome or response efficacy). Thus, simply pulling one lever in this complex operation (e.g., providing education to residents) will not necessarily result in humans performing desired behavior. For example, some residents did not implement techniques recommended by wildlife professionals to reduce human-bear conflicts in their neighborhoods because they did not like the techniques, or they took additional measures that were not recommended (Pienaar et al., 2015).

To further complicate matters, existing educational approaches do not elicit uniform behavior. The content of educational mate-

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rials can affect who receives and responds appropriately (Ferraro et al., 2011), and performance of desired behaviors can vary dramatically based on perceived behavioral control (Ajzen, 2002) or local enforcement practices (Baruch-Mordo et al., 2011). People who care about the topic are more likely to read educational appeals and therefore consider performing the desired behavior. Others may be less attentive to educational appeals, and misinterpret or ignore the materials altogether (Petty and Cacioppo, 1986). Similarly, educated people may adhere to the desired behaviors only when it is convenient to do so. Rarely will everyone respond eagerly (individual level), equally (group level), and in perpetuity (across time) to educational appeals. Involving social scientists in any conceptualization of human behavior around bears is necessary to adequately address the interplay between these levels (Baruch-Mordo et al., 2009).

We also note that the information contained in educational appeals can actually *negatively* impact how people think about black bears. In particular, increasing awareness of black bears in a local area where they are common (or particularly if they are causing problems) can lead to heightened risk perceptions of bears without eliciting performance of conflict-reducing behavior. Increased risk perceptions have been correlated with negative attitudes toward or lower tolerance of black bears, which are both strongly associated with support for lethal control of bears (Don Carlos et al., 2009). Thus, the content of the educational materials is incredibly important. For example, research demonstrated that educational materials focused on the benefits that accrue to society by maintaining healthy populations of wildlife that may otherwise be considered dangerous (e.g., bears, wolves) can be more effective in promoting coexistence (Bruskotter and Wilson, 2014; Slagle et al., 2013). Furthermore, educational appeals that consider the social norms, preferences, and livelihoods of the audiences receiving the information (McKenzie-Mohr, 2000), as well as the barriers those audiences face to performing behaviors (e.g., Hayden and Deng, 2012), are much more effective in eliciting desired behaviors.

We are concerned that Marley et al. (2017) may be misinterpreted as suggesting that residents be educated to apply dangerous aversive conditioning techniques on their own. Banging on pots and pans and calling professionals are appropriate public responses, but techniques such as the use of bear dogs or rubber bullets should only be implemented by trained wildlife management personnel because of risks inherent in these techniques (Spencer et al., 2007). If local residents are encouraged to apply aversive conditioning, they could be placing themselves in direct contact with bears and increasing the potential for injury or even death of either species involved in the interaction. Additionally, residents are not likely to implement this strategy consistently, potentially leading to reduced effectiveness of the approach over time. For example, Mazur (2010) found that food-conditioned bears were not as affected by aversive conditioning compared to bears that were not food conditioned, and that aversive conditioning seemed to wear off after a month (i.e., the bears eventually returned to areas where anthropogenic food sources were available).

As human populations expand and suitable habitat for wildlife becomes fragmented or lost altogether, we will increasingly need to rely on innovative approaches to understand complex socio-ecological relationships. We commend Marley et al. (2017) for the novel use of agent-based modeling in search of viable strategies for reducing human-bear conflicts, but we strongly caution readers and practitioners against believing education alone is a panacea for reducing human-bear conflicts. Education rarely changes human behavior uniformly across a population even in the short term (Baruch-Mordo et al., 2011; Gore et al., 2008). Even when education is augmented with enforcement, a long-term campaign may still be deficient in achieving substantial compliance. Everyday examples include campaigns to prevent smoking or driving drunk, or to promote wearing seatbelts (Feighery et al., 1991; Shults et al., 2009; Vasudevan et al., 2009). Thus, a combination of strategies beyond education alone will be needed in the real world (Can et al., 2014; Spencer et al., 2007), and different methods aimed at addressing human-bear conflicts will be appropriate in different situations. To truly achieve the goal of reducing human-bear conflicts, future research in this area must consider what leads to behavior change, and test the effectiveness of various and coordinated management alternatives (Can et al., 2014).

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