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Human–Black Bear Conflicts: A Review of Common Management Practices

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HUMAN–BLACK BEAR CONFLICTS

A REVIEW OF COMMON MANAGEMENT PRACTICES

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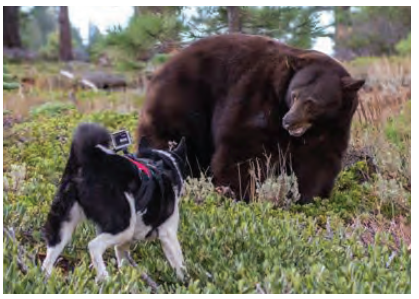

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ABSTRACT

Most human–black bear (*Ursus americanus*) conflict occurs when people make anthropogenic foods like garbage, dog food, domestic poultry, or fruit trees available to bears. Bears change their behavior to take advantage of these resources and may damage property or cause public safety concerns in the process. Managers are often forced to focus efforts on reactive non-lethal and lethal bear management techniques to solve immediate problems, which do little to address root causes of human–bear conflict. As long as bears find easy access to garbage, bird feeders, urban fruit trees, and other food subsidies, conflicts are likely to continue. Managers and the public need to understand the available tools to stop human–bear conflict and reduce effects on bear populations. Rhetorically blaming bears for conflicts by labeling them as problem bears or nuisance bears is becoming increasing unpopular. Ultimately human behavior must change by reducing anthropogenic resources that cause human–bear conflicts. This process requires a different suite of tools and should be the primary focus for bear managers interested in lowering the potential for conflict.

Our objective with this monograph is to provide wildlife professionals, who respond to human–bear conflicts, with an appraisal of the most common techniques used for mitigating conflicts as well as the benefits and challenges of each technique in a single document. Because reducing conflict involves changing human behavior (e.g., securing garbage), we begin with an assessment of the public's desires and role of conflict resolution in the context of the North American Model

"Human–Black Bear conflicts are analogous to heart disease. We all know that prevention is crucial, but too many people wait until the symptoms become a problem to take action and by then it's too late."

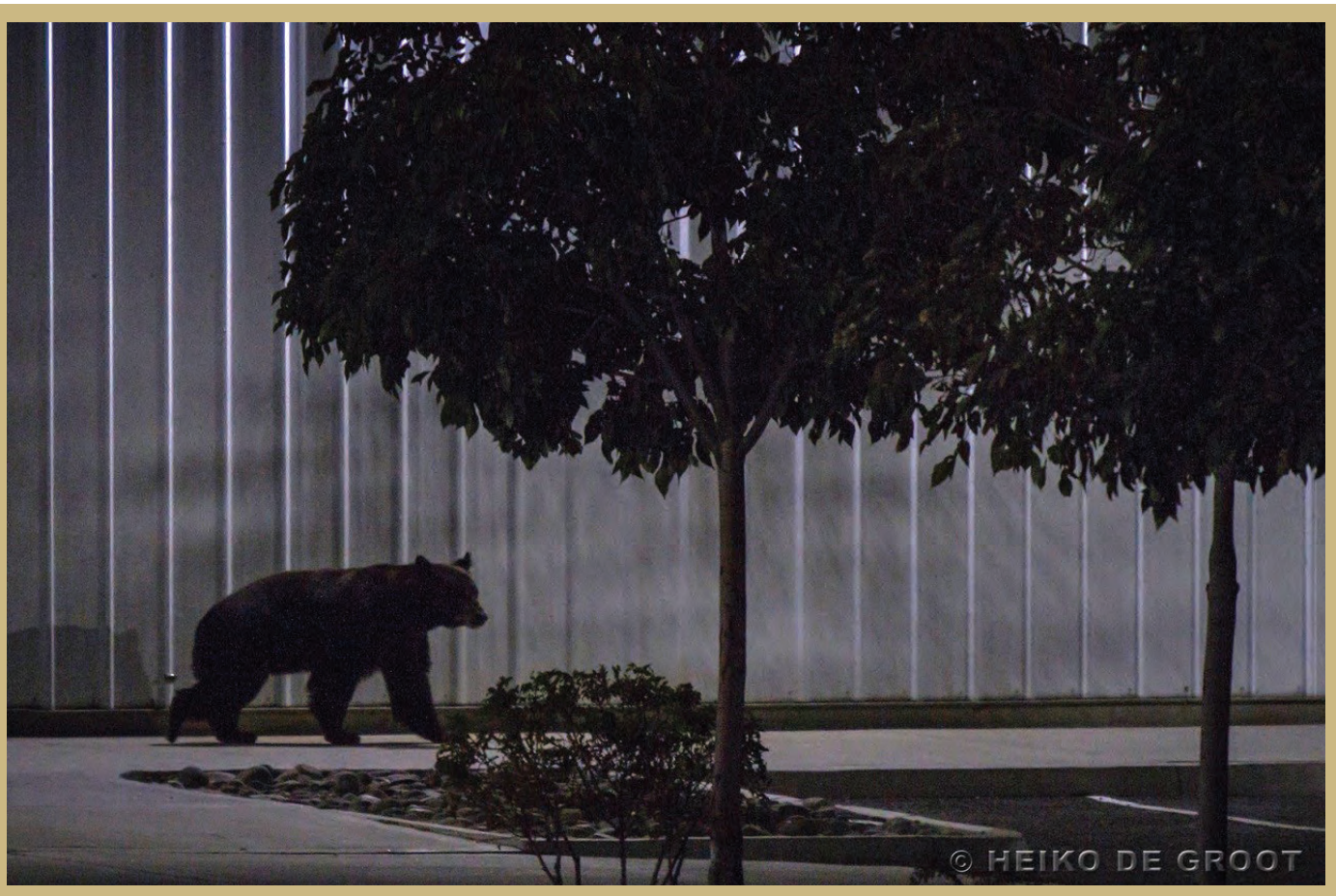
Rich Beausoleil
Washington Department of Fish and Wildlife

of Wildlife Conservation. How the model has influenced conservation of the North American black bear is reflected in the current status of black bears and their remarkable range expansion during the 20th century. Our ability to estimate black bear populations accurately or monitor indices of abundance is important because many jurisdictions base management decisions on these parameters.

We next discuss the need for more standardized reporting and assessment of human–bear conflicts because we cannot manage what we do not measure. Finally, we provide an objective evaluation of the variety of techniques for managing human–bear conflicts. Because management techniques evolved over time through trial and error, we based our evaluations on the published literature and perspective of practitioners with the responsibility of responding to human–bear conflicts.

From Hurst et al. (2012).

This document is not meant to endorse, recommend, or disapprove of any particular techniques; nor does the document constitute an obligation on the part of any jurisdiction to implement or discontinue a particular technique. Each jurisdiction with management authority over black bears must make management decisions based on site- and state-specific conditions, policy, statutes, regulations, and budgets while relying on input and expertise of their staff to ensure optimum resolution of human–bear interactions within their jurisdiction. History and litigation have demonstrated the importance for each jurisdiction to adopt policy relevant to their situation, provide staff with training in its implementation, and adhere to consistent interpretation and use of that policy. We have collaborated to use, with permission, the most pertinent sections of previous publications that have addressed the complexity of issues surrounding the management of human–bear conflicts and the techniques used by managers to successfully contend with these topics.



A black bear patrols an urban neighborhood after dark - Courtesy Heiko De Groot.

INTRODUCTION

Bear with white chest blaze – Courtesy John T. Humphrey AKAwolf.com.

The specifics of human–black bear *(Ursus americanus)* conflict scenarios vary, but managers generally deal with the same issue. Almost invariably human–bear conflicts are due to people allowing bears to gain access to some sort of anthropogenic food. Bears are adaptable and modify their behavior to effectively exploit predictable resources in their environment. They learn from experience, and the outcome of that experience (positive = a food reward; negative = no reward or negative stimuli) may influence future behavior. For example, if the feeding of bears in urban areas results in little or no negative reinforcement, human-habituation and food-conditioning of the bear may occur (Hristienko and McDonald 2007). People are responsible for increased human–bear conflicts by allowing bears to become human-food conditioned and human-habituated.

The difficulty of managing human–bear conflicts can be attributed to a variety of factors. The scientific tools and knowledge that have helped produce growing bear populations may not provide all the necessary answers for managing conflict. While bear population size is among the factors influencing conflict, even this aspect may be difficult to manage. For example, regulated hunting, although an effective tool to manage bear population size, may be equivocal and likely context-specific

in reducing conflict. Further, precise estimates of black bear abundance and trends are often costly and difficult to measure. Many jurisdictions rely on various indices to monitor trends in abundance (e.g., conflicts, bear-vehicle collisions, sightings, bait-station visitations), which have limitations. Methodology may differ among jurisdictions, and direct comparisons are challenging.

The American black bear is one of the most studied mammalian species in North America. Across its range, there are characteristics of black bears that are generally universal, such as life history traits, biology, and behavior. This knowledge combined with a bear population's demographics, reproductive history and potential, denning ecology, and seasonal use of high conflict areas can assist a manager in making sound decisions. Yet an empirical comparison of the effectiveness of the various tools and techniques, or recommendations on best management practices available to assist managers, are often lacking. Conflicts that are reported commonly go into systems that may not keep consistent or easily accessible records (e.g., police dispatch records), that miss important details (e.g., spatial locations), or that differ from one another (e.g., differences between towns or wildlife managers). This information is important because conflicts may pose public safety risks including human injury or death. However, statutes governing agency capacity, management responsibility, and legal authority to use various management tools frequently vary among jurisdictions. Understanding these limitations is important for managers. Continuing research and adaptive management remains important because of the evolving nature of human–bear conflict management. Bear populations in some areas are increasing both in number and distribution, and often within the urban-wildland interface where conflicts are most prominent. Wildlife managers may rely on strategies that often lack scientific evaluation to control conflict and maintain bear populations at targeted levels. With stable-to-growing bear populations and increasing human populations, the science of conflict management needs substantial development.

Proper management requires recognizing and engaging with a public that places egalitarian values on wildlife (i.e., they may view the lives of wild animals on a level with human lives). Manfredo et al. (2009) theorized that mutualist values arose due to a modernized lifestyle causing people to become separated from the natural world and direct contact with wildlife. Additionally, the public may be unfamiliar with the science of wildlife management. Traditionally, wildlife managers engage with the public, who participate in regulated hunting seasons, to receive input about management goals, or with farmers and ranchers where removal of problem animals typically is less controversial. But today, managers are dealing with publics that hold different views on conserving wildlife under sustainable-use principles. In some cases, the killing of even one bear can result in negative media coverage, intense public opposition to lethal removals, and in agency policy. In some areas where bears are expanding their range into habitat that historically, but not recently, supported bears, people may be unaccustomed to bears and may be unwilling to tolerate their presence. Although bears are a charismatic species that can capture people's imagination, they can also instill in humans a powerful fear and abhorrence. Perception and acceptance of bears is driven by books, television, and social media, as well as past personal experiences. How wildlife managers understand, interact with, and influence this diverse public so that conflict is reduced, and bear populations are sustained is a critical endeavor. The challenge for managers is to change these attitudes among the public by offering effective and practical solutions.

THE NORTH AMERICAN MODEL OF WILDLIFE CONSERVATION AND HUMAN–BEAR CONFLICTS

The North American Model of Wildlife Conservation (Geist et al. 2001) is a collection of principles that underpin wildlife management throughout North America. At the heart of the model is the concept of wildlife as a public trust resource, owned by no one but held in trust by the government for the benefit of the people. Further, access to wildlife by the public is provided equally to all, and regulated by law or rule-making with public involvement rather than market pressures, wealth, social status, or landownership. The harvest and use of black bears via regulated hunting is a long-standing cultural heritage throughout North America. Human dimension surveys of the hunting public have documented public support for hunting and have found multiple motives for hunting black bears (Kitayama et al. 2010, Stedman and Heberlein 2001, Teel and Manfredo 2009). Principle motives include providing a valuable source of food, a means of shared time spent with family, and an opportunity to enjoy and appreciate nature. Black bear harvest through regulated hunting remains the most effective tool for managing bear populations throughout North America (Obbard and Howe 2008).

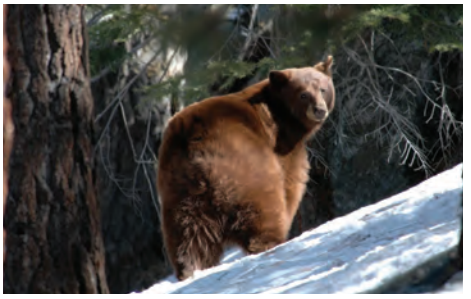
Conflict behavior in bears typically follows a predictable escalation. When a bear moves through the conflict behavioral ladder of progression (Figure 1), it may be subjected to anthropogenic mortality. This is an unfortunate loss of the public trust resource and highlights the importance of communities and agencies working together proactively to deter conflicts through education or enactment and enforcement of ordinances.

Figure 1 - From Living With Bears Handbook by Linda Masterson. Used with permission. Additional graphics added.

Management policy and decisions are rooted in science and support an ethic of fair-chase and legitimate take (e.g., fur, food, protection of property) of harvested wildlife. Adherence to these tenets has allowed wildlife management to function successfully while retaining strong support among the public. For this reason, black bear management programs are based upon the principles of the North American Model of Wildlife Conservation. Though science is a critical component of wildlife policy, it is only one of the many considerations for managers. Conflict mitigation includes local politics and ordinances; agency policies and budgets; and attitudes, perceptions and emotions among the public. The latter emphasizes the intrinsic value people place on bears.

People all have core values; those principles possessed by everyone that dictate our behavior and actions. The individual values people place on wildlife may have broad beginnings, based on ecological, biological, cultural, utilitarian, or aesthetic principles. Core values are established at an early age of life, and seldom will those core values change substantially with age (Clark et al. 2017). The values people place on wildlife are changing, and this evolution in values may be part of the reason for distrust of current wildlife conservation strategies (Manfredo et al. 2017). Recognizing that not all members of the public share similar values about wildlife is important; the public will disengage from the public process if they become disinterested or lose faith in its implementation. Public service personnel (i.e., trust managers of the public trust) must share relevant information with decision makers (i.e., elected officials and appointees, or trustees of the public trust), and it is important that the value the public holds for bears is sustained. Human–bear conflicts test this relationship between bear managers and the public due to differences in core values, especially under contentious conditions.

The North American Model for Wildlife Conservation and the Public Trust Doctrine speaks to this process with one of its main tenants – wildlife should benefit all citizens equally (Geist et al. 2001). Species conservation and maintaining sustainable wildlife populations is the goal for wildlife managers. Wildlife professionals act as the trust managers of the wildlife resource and serve the interests of all beneficiaries, while elected officials and appointees that hold decision-making authority serve as trustees for the wildlife resource. The public, as beneficiaries of the resource, must be cognizant of the issues related to the trust and engage in the public process to hold the trustees accountable. This involves the public as a whole, yet it is especially critical for the public who live with bears to participate in this process (Gallagher and Logsdon-Conradsen 2012). Decisions should balance the values of local and national special interest groups and consider any strong biases that may exist. Because of their controversial nature, bear conflicts are frequently picked up by the mass-media and distributed to a larger audience, regardless of credibility or accuracy.



A western black bear (cinnamon color phase) - Courtesy Jim Nelson.

The only effective way to avoid most bear conflicts is to eliminate anthropogenic food resources. Sometimes some people create conflicts by providing artificial food sources, and then complain if a conditioned bear is lethally removed. In some instances, the public may demand a non-lethal resolution to human–bear conflicts. A wiser use of public funds is to keep human–bear conflicts from occurring in the first place. Creative public–private partnerships may incentivize positive behavior to reduce bear attractants. Municipal ordinances or state statutes may be necessary to prevent irresponsible behavior from creating a financial or public safety liability by small segments of the public. These are the difficult situations that create challenges for effectively managing conflicts.

I HOLD THE SMOKING GUN

An example of The Ladder of Conflict behavior

By Chris Parmeter, Wildlife Manager, Gunnison District, Colorado
(first appeared in the Durango Herald)
Used with permission

It was 3:30 a.m. The acrid smell of gunpowder lingered in the air, mixed with the sweet, sickening smell of bear blood that oozed down the driveway of the home. The blood looked black illuminated in the glow of the porch light and the wavering beams of our flashlights. The bear was also black—big, black and now, lifeless.

I wish that it hadn't ended up this way—the bear's final agonized writhing in the driveway, the smoking shotgun, my hands shaking from the rush of adrenaline and emotion. Unfortunately, neither of us had much say in the matter. This tragic end had been decided long ago.

This is part of my job as a district wildlife manager, a part that I despise. Dozens of wildlife officers must perform this same awful duty every year throughout Colorado. Some bears, no doubt, must be killed. But many of these incidents can be avoided if people used some common sense.

I knew this end would come, long before he did. I met him three years ago, when he was just a cub. He was trapped in a Dumpster that his mother led him into to eat.

I lifted him out with a snare pole and let him go. He was freed from the confines of the dumpster, but he couldn't escape his fate—the end of his story was already being written.

Our paths crossed several times during the next couple of years. He'd pull down bird feeders and I'd give out "Living with Bears" brochures to the homeowners. A month later, I'd see the bird feeders hung again, right against the picture window.

The homeowners would report the bear's "aggressive behavior," how it stood and looked in their window—how it wasn't frightened of people, even as they stood just on the other side of the pane and took pictures of it.

I knew how the bear must have thought, too. Four hours picking berries one by one, versus four minutes munching down birdseed for the same caloric gain. The goofy-looking humans on the other side of the glass had never bothered him, never told him he was trespassing, never tried to stop him, never tried to help him by permanently taking down the bird feeders.

Plainly, that meant the bird seed was his. This side of the window became his turf, not theirs.

Later, we hashed it out over garbage cans and dumpsters. He was a good- sized bear by now, handsome and black as the night. In the dark, he was a mere shadow, or more so, a complete absence of light.

He was big enough to upend a dumpster if he felt like it, but more often he just took advantage of the myriad of garbage cans left casually, thoughtlessly, out on the street. The complaints would come, and the garbage can owners would all cite the same solution—get rid of the bear.

No one wanted him killed, of course. After all, he had only gotten into their garbage. They just wanted him gone; taken away; moved somewhere else so that they would not have to make any changes in the way they did business. It was convenient for them to put their garbage out the night before pickup. Bear-proof garbage cans cost $200 or more.

Then finally one night, inevitably, the old bruin took it too far. Lured by a chain of unwitting and apathetic homeowners, urged on by a string of bountiful successes, he was at last coaxed over the line. It all came down with frustrating irony. Not even the backdrop seemed right: a well-kept, rustically adorned summer home in a forested subdivision. Most ironically though, the homeowners who were his final victims did not feed birds, or leave garbage cans on the street, or feed their pets outside or do anything else to draw him in. They did nothing at all to encourage this bloody outcome, but suffered the ugly consequences of their neighbors' neglect and sloth.

In the end, the bear, driven by biology and emboldened by experience, broke through the kitchen window, only to be run back out by the home's rightful occupants. But the bear was determined now, and lingered, and after a while seconded his attempt to hijack the house.

A second roust, more confrontational than the first—involving thrown objects and much yelling—put the bear out again. But he wasn't going to leave until he got what he wanted.

This is when I met this bear for the last time. Our final encounter, considerably less pleasant for both of us over any previous ones, involved two slugs fired from my 12-gauge shotgun into his chest. As he gasped his last breath and his blood oozed out onto the driveway, I only wished that all those people we had met along the way could have been there to share this moment with us. Maybe then…well…

From Hurst et al. (2012).

STATUS OF THE AMERICAN BLACK BEAR

Throughout much of North America, the management of black bears has followed a similar trend. Following the near extirpation of the species, in part due to extensive cutting of forests, market hunting, and bounties, many states and provinces enacted laws that regulated the taking of bear in the 1900s. Bears were listed as game species in some jurisdictions and were fully protected in others.

Passage of the Federal Aid in Wildlife Restoration Act in 1937 marked the beginning of modern-day wildlife management in the United States. This act earmarked income from an existing excise tax on sporting arms and ammunition for use in wildlife management, restoration, research, and land acquisition. Early bear management efforts featured protection from unregulated hunting. Today, efforts are directed toward maintenance of bear populations at levels intended to: (1) ensure sustainable bear populations now and in the future; (2) provide hunting and viewing opportunities of bears; and (3) reduce conflicts between bears and people. Through the combined benefits of regulated hunting, public land purchases, forest maturation,

bear restoration efforts, and management-based research, bear populations have grown and expanded their range across North America.

Although their historical distribution was larger, black bears are now found in at least 40 states and all Canadian provinces (Figure 2). Many populations are stable or increasing in size (Garshelis 2002, Hristienko and McDonald 2007). The success of black bear conservation and the increase in population size can be attributed to changes in societal views about predators, increased tolerance of bears, effective management by state and provincial governments, and the life history of black bears which has allowed them to thrive in these changed and changing landscapes.

Today, the American black bear is the most abundant bear species on the planet. Populations are currently at their highest levels in the past 100 years, with the North American population estimated at about 700,000–800,000 (Table 1; R. Beausoleil, Washington Department of Fish and Wildlife, and S. Dobey, Kentucky Department of Fish and Wildlife Resources, unpublished report, Masterson 2016).

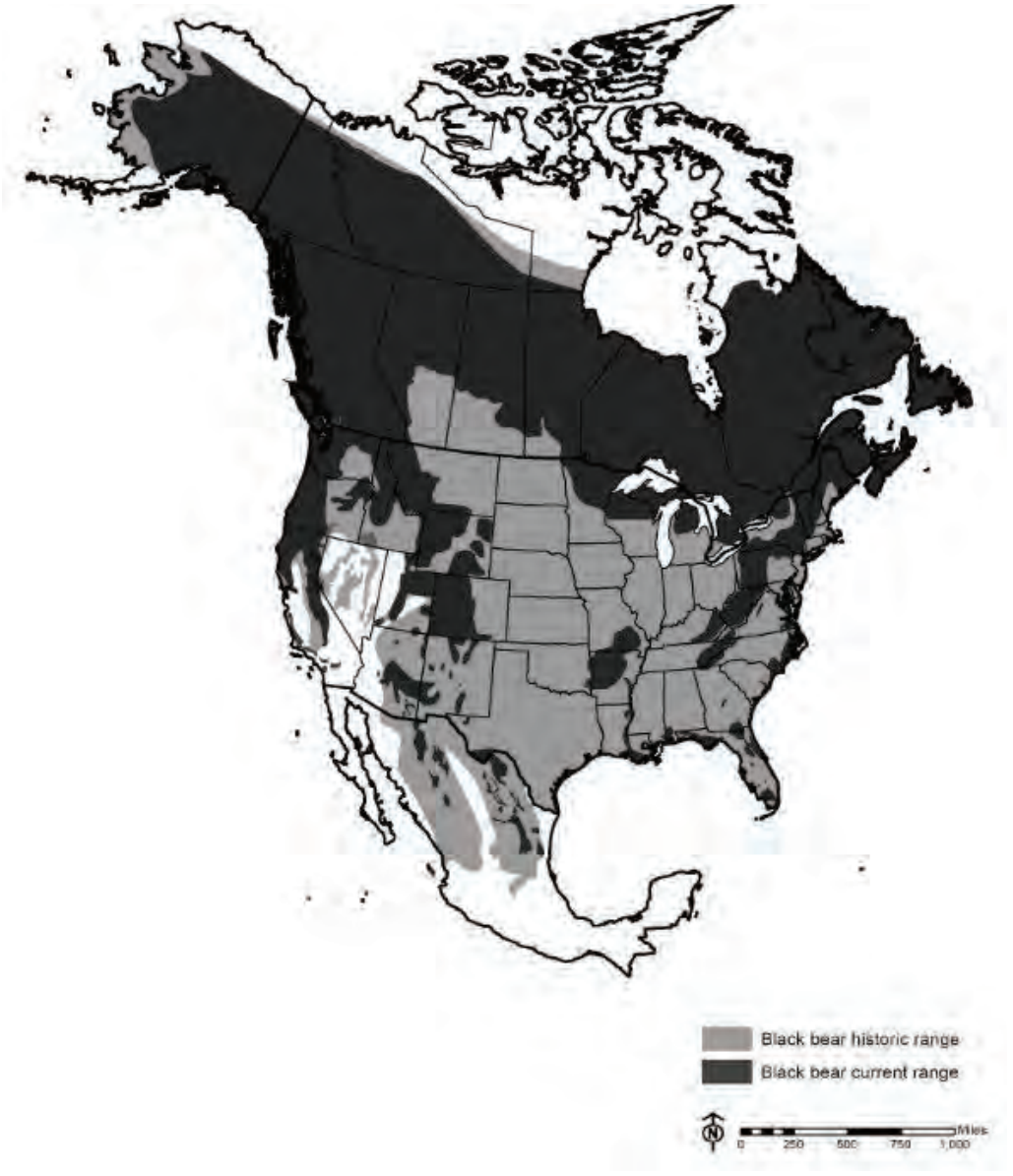


*Figure 2: American black bear (*Ursus americanus*) historical and current range. From Lackey et al. (2013).*

Table 1: State-province population estimates, human–bear conflicts/year, conflict bears (Ursus americanus) killed/year; and conflict trends from Living With Bears Handbook (Masterson 2016) and Survey of Agencies for Western and Eastern Black Bear Workshops (R. Beausoleil, Washington Department of Fish and Wildlife, and S. Dobey, Kentucky Department of Fish and Wildlife Resources, unpublished report). Population estimation methods and techniques vary considerably among jurisdictions. See Garshelis (2002) for more information.

State / Province	2015 BLACK BEAR POPULATION est.	Human-Bear Conflicts/Year	Conflict Bears Killed/Year	Conflict Trend
Alabama	125-225	31	1	Increasing
Alaska	100,000	1,133	27	Stable
Arizona	1,500-2,500	18	18	Stable
Arkansas	4,000-5,000	410	3	Increasing
California [b]	35,000	259	74	Stable
Colorado	17,000-20,000	N/A	275	Increasing
Connecticut	500-700	442	2	Increasing
Florida	3,000	5,584	22	Increasing
Georgia	5,100	1,488	7	Increasing
Idaho	27,000	≤100	≤25	Stable
Kentucky	500-700	386	6	Increasing
Louisiana	500-800	246	2	Increasing
Maine	31,000+	555	12	Increasing
Maryland	1,000+	337	4	Decreasing
Massachusetts	4,000-5,000	145	5	Increasing
Michigan	11,000	250	1	Stable
Minnesota	12,000-14,000	640	20	Stable
Mississippi	150-200	50	0	Increasing
Missouri	300	8	0	Increasing
Montana	13,307	N/A	177	Variable
Nevada	600	402	≤6	Increasing
New Hampshire	5,300	698	14	Stable
New Jersey	3,500	2,612	33	Increasing
New Mexico	6,000-8,000	368	120	Stable
New York	6,000-8,000	768	29	Stable
North Carolina	18,000-20,500	587	10	Increasing
Ohio	75	18	0	Stable
Oklahoma [a]	250	N/A	N/A	N/A
Oregon	25,000	483	361	Variable
Pennsylvania	18,000	2,112	33	Increasing
Rhode Island	10	6	0	Increasing
South Carolina	800-1,200	290	2	Stable
South Dakota	Very few	N/A	N/A	N/A
Tennessee	4,800	428	15	Stable
Texas	300	5	0	Variable
Utah	4,100	65	89	Increasing
Vermont	5,000-6,000	533	18	Stable

Table 1 continued: State-province population estimates, human–bear conflicts/year, conflict bears (Ursus americanus) killed/year; and conflict trends from Living With Bears Handbook (Masterson 2016) and Survey of Agencies for Western and Eastern Black Bear Workshops (R. Beausoleil, Washington Department of Fish and Wildlife, and S. Dobey, Kentucky Department of Fish and Wildlife Resources, unpublished report). Population estimation methods and techniques vary considerably among jurisdictions. See Garshelis (2002) for more information.

State / Province	2015 BLACK BEAR POPULATION est.	Human–Bear Conflicts/Year	Conflict Bears Killed/Year	Conflict Trend
Virginia	17,000	838	3	Increasing
Washington [c]	25,000	529	250	Stable
West Virginia	10,000-12,000	946	80	Increasing
Wisconsin	22,620	1,105	12	Decreasing
Wyoming*	2,500-4,500	154	≤22	Stable
Alberta [d]	40,000	2,532	162	Stable
British Columbia	120,000-160,000	N/A	N/A	N/A
Manitoba [e]	25,000-35,000	1,456	168	Decreasing
New Brunswick	17,000	201	N/A	Increasing
Newfoundland	6,000-8,000	N/A	N/A	Increasing
Northwest Territory	5,000+	N/A	N/A	N/A
Nova Scotia	10,000	471	22	Variable
Ontario	85,000-105,000	5,813	164	Stable
Quebec	71,000-83,000	738	137	Variable
Saskatchewan	24,000	N/A	N/A	N/A
Yukon	10,000	47	172	Increasing

[a] Population numbers from 2005; new data not provided.

[b] Number of depredation permits issued that allows the property owner to kill the offending bear or hire someone to do so. On average 41% of permits issued result in a bear being killed.

[c] 200 of the bears were killed under timber damage depredation permits issued to commercial lumber producers to mitigate damages.

[d] Reported conflicts include sightings.

[e] Conflicts have decreased 17% since implementing Bear Smart Program.

STATUS OF HUMAN–BEAR CONFLICTS

Several generalities about human–black bear conflict are clear. First, human–bear conflicts are increasing throughout most of the black bear range (Hristienko and McDonald 2007, Baruch-Mordo et al. 2014, Beckmann and Berger 2003a, Beckmann et al. 2008) with over 43,000 complaints annually in North America (Spencer et al. 2007; Figures 3 and 4). This is due to a combination of factors including growing human and bear populations, bear foraging behavior and natural food availability (Garshelis 2002, Johnson et al. 2015), and humans allowing bears access to anthropogenic food sources. These food sources include garbage, fruit trees, beehives, and livestock, which are made more plentiful and easier for bears to acquire in the urban-wildland interface. Limiting the availability and access to these resources is the most definitive means for reducing conflict (Spencer et al. 2007). Beyond these generalities, there is limited understanding of effective strategies to reduce human–bear conflict. For example, understanding variations in conflict among municipalities with differing garbage management strategies could provide insight about best management practices for reducing conflict. Unfortunately, no standard reporting practice exists among jurisdictions, and reliable inferences are difficult to obtain. Accurately and consistently measuring conflict and results is needed to improve human–bear conflict management actions.

A vacant home sustained $80,000 USD in damage when two yearling black bears spent approximately six weeks entering the home at will. - Courtesy 9caribou.com.

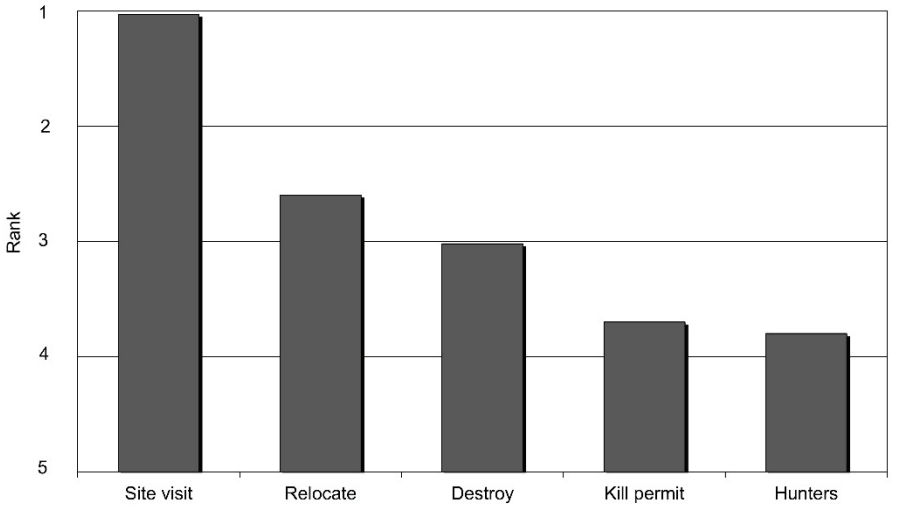


Figure 3: Comparative frequency (rank 1–5; 1 being the most common) of how wildlife agencies in North America respond to human–black bear (Ursus americanus) conflict where public safety is a factor, 2006. From Spencer et al. 2007.

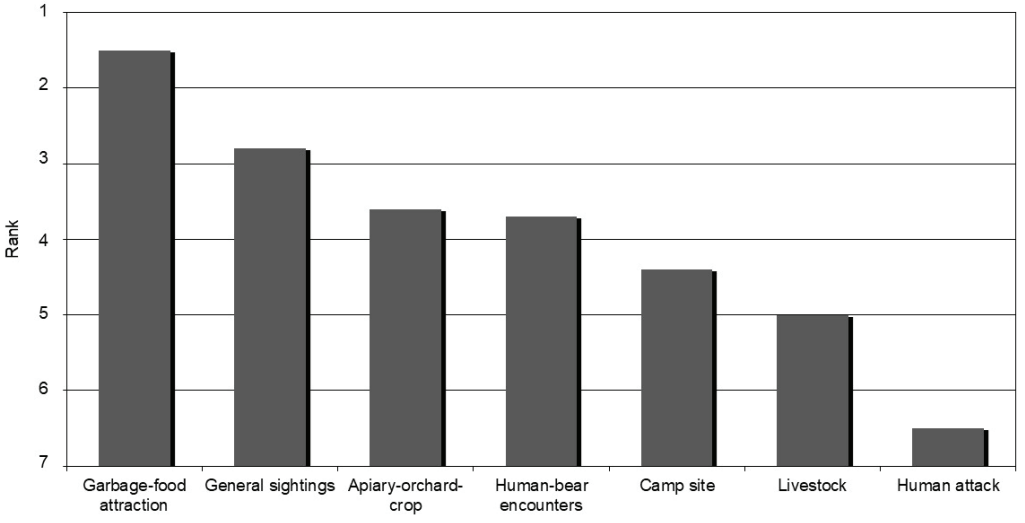


Figure 4: Comparative frequency of reasons given for complaints of human–black bear (Ursus americanus) conflicts as reported by North American wildlife agencies (ranking 1–7, 1 most common), 2006. From Spencer et al. 2007.

QUANTIFYING CONFLICTS

Monitoring conflict has unique challenges. Unlike other important parameters for wildlife management (e.g., population size, demographic rates, resource selection), human–wildlife conflict is a socio-ecological parameter. Human perceptions, attitudes, and beliefs play important roles to accurately quantify conflict, influencing which type of situations are labeled conflicts and which conflicts are reported. A bear walking through a property, entering a house, or destroying a beehive could all be considered conflict depending on the perception and attitudes of the person affected (i.e., labeling bias). Human judgment creates problems with conflict databases by affecting classifications in reports (i.e., reporting bias). For example, a bear attacking a human would presumably always be reported, although bears breaking into structures are not always detected or reported. Hopkins et al. (2010) suggested 3 reasons for standardizing definitions and concepts among jurisdictions: enhancing intra-agency conservation efforts, improving interagency cooperation, and standardizing definitions for researchers who study and evaluate agency programs.

Management agencies can limit reporting bias by evaluating only records that involve management actions (e.g., a physical response to a bear incident). Baruch-Mordo et al. (2008) used this strategy by only using records in which a bear was killed due to conflict to examine spatial and temporal patterns of conflict in Colorado. This strategy is less biased, but it still assumes that all wildlife managers react similarly to calls regarding human–bear conflict.

Standardized reporting is important, and some agencies have made substantive improvements. For example, the New Jersey Division of Fish and Wildlife has consistently recorded responses to reported conflicts since 1987. Bears that were deemed a threat to human safety, damage to agricultural crops or property, or chronic conflict behavior were classified according to a Black Bear Rating and Response Criteria (Raithel et al. 2017). Developing consistent reporting strategies within and among agencies would enhance our ability to evaluate efficacy among management strategies.

Achieving this uniformity among agencies is important for managers, yet standardizing definitions across jurisdictions is not simple. Hopkins et al. (2010) found even the terms “conflict” and “interaction” are interpreted and defined differently among bear managers. Nonetheless, a standard list of definitions is important to common understanding. In this document, we adopt or adapt the definitions developed by Can et al. (2014), Clark et al. (2002), Gunther (1994), Herrero et al. (2005), Herrero and Higgins (2003), Hopkins et al. (2010), Gunther et al. (2000), Gunther et al. (2004), McCullough (1982), Schirokauer and Boyd (1998), Smith et al. (2005), Thompson and McCurdy (1995), and Wilder et al. (2007).

DEFINITION OF TERMS ASSOCIATED WITH HUMAN–BEAR MANAGEMENT

- *Aggressive behavior:* bear behavior (defensive or offensive) that is threatening to people

- *Aggressive bear:* a bear that has displayed aggressive behavior and is a public safety concern
    - *Defensive-aggressive bear:* a bear that may be a public safety concern because it exhibited aggressive behavior in response to being provoked
    - *Offensive-aggressive bear:* a bear that may be a public safety concern because evidence suggests the bear exhibited aggressive behavior and was not provoked

- *Anthropogenic food:* foods or attractants having a human origin

- *Aversive conditioning:* a learning process in which deterrents are continually and consistently administered to a bear to reduce the frequency of an undesirable behavior

- *Bear attack:* intentional contact by a bear resulting in human injury

- *Bear deterrent:* aversive agent administered to bears to cause pain, avoidance, or irritation

- *Bear sighting:* an observation when a bear was seemingly unaware of the person observing it (not a human–bear interaction), had no observable stress-related response to the person during an interaction, and the bear responded to the person by taking evasive action

- *Bear that tolerates people:* a bear that does not take evasive or aggressive action when in the presence of people (habituated or innately tolerant)

- *Biological carrying capacity (BCC):* is the maximum population size of the species that the environment can sustain indefinitely. The point at which black bear populations achieve BCC is not known throughout much of the United States or Canada but will vary regionally and seasonally with habitat quality and food availability.

- *Conditioning:* learning involved in receiving a reward or punishment for a given response (behavioral act) to a given stimulus

- *Conflict bear:* a bear involved in repeated human–bear incidents

- *Cultural carrying capacity (CCC):* is the maximum number of individuals (bears) of a species that the public will tolerate.

- *Food-conditioned bear:* a bear that has learned to associate people (or the smell of people), human activities, human-use areas, or food storage receptacles with anthropogenic food as a result of being repeatedly exposed to anthropogenic foods without substantial negative consequences

- *Habituation:* the waning of a response (or muted response) when a reward or punishment is discontinued

- *Habituated bear:* a bear that shows little to no overt reaction to people as a result of being repeatedly exposed to anthropogenic stimuli without substantial consequence

- *Hard release:* a hazing method where deterrents are administered to a bear as it exits a trap

- *Hazing:* a technique where deterrents are administered to a bear to immediately modify the bear's undesirable behavior

- *Human–bear conflict:* any situation where there is a real or perceived threat to human life or property by bears or where bears use or damage human property; or episodes where bears obtained anthropogenic food, killed or attempted to kill livestock or pets, or were involved in vehicle collisions; or when a bear exhibited stress-related or curious behavior causing a person to take extreme evasive action, made physical contact with a person or exhibited clear predatory behavior, or was intentionally harmed or killed (not including legal harvests) by a person

- *Human–bear interaction:* an occurrence when a person and bear are mutually aware of each other

- *Human food:* anthropogenic foods that only include human foodstuff and food waste

- *Management bear:* a bear that may be monitored for management purposes because it is individually identifiable

- *Management removal:* lethal or non-lethal removal of a bear from the population by or at the direction of management personnel
- *On-site release:* a management method that consists of capturing and releasing a bear at or near the site of capture
- *Overt reaction distance (ORD):* the distance at which a bear visibly responds to people during a human–bear interaction
- *Predatory bear:* a bear that preyed or attempted to prey on people
- *Proactive human–bear management:* a population-level management strategy that aims to deter or prevent individual bears from being involved in human–bear conflicts
- *Reactive human–bear management:* a management strategy that responds to individual bears involved in bear incidents through immediate and direct action or increases the harvest of a local population of bears in an attempt to reduce bear incidents
- *Relocation:* the capture and subsequent transport of a bear from the site of capture to a location within its likely home range often in an attempt to temporarily mitigate bear incidents
- *Stress-related behaviors:* observed bear response when provoked during a human–bear interaction
- *Translocation:* the capture and subsequent transport of a bear from the site of capture to a location outside its presumed home range often in an attempt to permanently mitigate bear incidents or augment a population

Bear climbing tree – Courtesy Nevada Department of Wildlife.

METHODS TO ADDRESS HUMAN–BEAR CONFLICTS

A daytime active human-habituated black bear approaches people in a suburban setting - Courtesy 9caribou.com.

Mitigation of human–bear conflicts involves integration of many management options, and no single option is best for every circumstance. The importance of public education and influencing human behavior remains paramount. Many tools are only short-term solutions to resolving conflicts between people and bears. Successful bear management programs must incorporate comprehensive education and attractant management programs to reduce human–bear conflicts. Appropriate management options are determined by public concerns, extent of damage, type of problem or damage, black bear biology, public safety, animal welfare, and available control methods. The methods discussed here include:

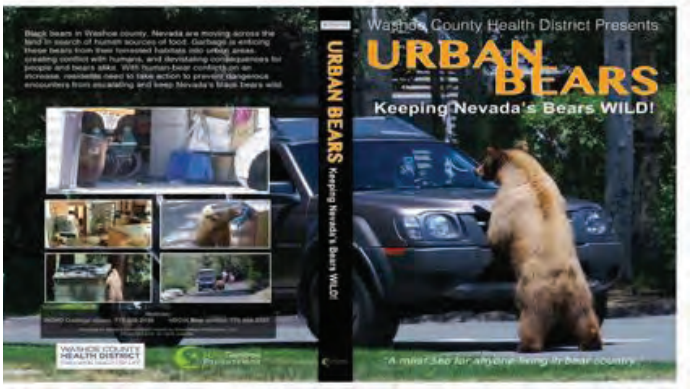
- ✓Public Education
- ✓Law and Ordinance Enforcement
- ✓Exclusionary Methods
- ✓Capture and Release
- ✓Aversive Conditioning
- ✓Repellents
- ✓Damage Compensation Programs
- ✓Supplemental and Diversionary Feeding
- ✓Depredation (Kill) Permits
- ✓Management Bears (Agency Kill)
- ✓Privatized Conflict Management
- ✓Population Management

PUBLIC EDUCATION

The ultimate solution for most human–bear conflict is eliminating the availability of anthropogenic food sources to bears. This principle has been demonstrated in Yellowstone, Great Smoky Mountains, and Yosemite National Parks, a few urban communities like Juneau, Alaska, and with some agricultural commodities, like beehives. But despite these successes, hundreds of municipalities throughout black bear range try and fail to effectively limit the availability of anthropogenic food sources. The challenge for resolving human–bear conflict scenarios is to alter human behaviors to effectively eliminate the food. Education remains an important part of the solution (Carlos et al. 2009, Marley et al. 2017), but education alone is unlikely to be sufficient in most cases (Gore et al. 2008, Dietsch et al. 2017).

Identifying the objectives for education is instrumental in determining if educational efforts are effective. *Bear Wise* in Canada, *Bear Smart Community Program* in Canada, and *Bear Smart Durango* in Colorado are examples of grass-roots campaigns aimed at eliminating garbage from urban areas. Unfortunately, no empirical evidence demonstrates that these efforts substantially reduced conflict or limited garbage availability. Baruch-Mordo et al. (2011) found that techniques like putting up signs or operating a "bear aware" campaign had no effect on how people stored garbage. Reducing food availability so that bears find risk and reward tradeoffs unacceptable (Martin et al. 2010, Baruch-Mordo et al. 2014, Johnson et al. 2015) is complex and often an expensive endeavor. A clear understanding of the costs, benefits, and obstacles for such an effort may not be held by tenants of municipalities or relevant authorities.

Public education may be attempted through signs, stickers, brochures, media releases, interviews, public presentations, and one-on-one interactions with the reporting party. Multiple methods should be employed to increase efficacy. Changing human behavior and attitudes sufficiently to reduce or avoid



Top: Urban Bear Education poster - Courtesy 9caribou.com and Washoe County Health District, Reno, NV.
Bottom: Monitioring a tranquilized bear - Courtesy Nevada Department of Wildlife.

human-bear conflicts can be difficult with standard educational approaches (Marley et al. 2017). For such programs to be successful, educational efforts must be persistent, multi-faceted, and address individuals, communities, institutions, and organizations (Gore and Knuth 2006, Beckmann et al. 2008). Still, educational efforts may need to be augmented with incentive or disincentive programs (e.g., cost-sharing or local ordinances) to encourage behavioral change.

Changing people's beliefs and behaviors is challenging (Dietsch et al. 2017), therefore the motivation to change and the message on the need to change must be compelling. Programs should engage the public, so they have ownership in the bear resource and a desire to effect change. People must change their thinking from "Why do I have to change my behavior if a bear moved into my neighborhood?" to "I understand bears are here

so how can I be more responsible in avoiding conflicts?" Agencies have been somewhat effective at educating the public—most people believe conflicts can be solved with proactive practices (garbage containment) because the agency messages have told them that.

Human–bear conflicts occur in a variety of locations such as agricultural, urban, and back country, necessitating the need for multiple source solutions (Decker et al. 2005). In rural or agro-ecological systems, conflict often results from attacks on livestock or damage to crops. In these areas, the human population is smaller, and generally fewer people are involved in resolving conflict compared with urban environments.

Benefits:

Education is proactive and can reduce time and costs associated with agency personnel handling human–bear conflicts. Removing attractants will typically reduce the conflict markedly. Having a clear and consistent message that is adaptive over time invokes a positive image of the agency and personnel among the public and elected officials. Effective education may also serve to establish the agency as the bear management authority and increase buy-in from the public for the agency's actions.

Challenges:

There must be a constant application of educational plans and methods, reaching a large and diverse public. Efficacy can be gauged by public adoption of the message that the agency delivers. Public information and education may require personnel to deliver personal messages in addition to the consistent, persistent, and focused messages. The human resource costs of this investment must be considered, which is necessary for the process to be successful. Despite a strong educational message, researchers in New York found that the most common reason for taking bear-proofing actions was direct conflict experiences with bears (Gore et al. 2008). Education, despite the best efforts of agencies to deliver messages and encourage appropriate behavior, has limitations.

Regional Example

Bear Smart Durango began in 2003 as the educational arm of a series of community discussions called the Bear and Garbage Roundtable, where varied stakeholders met to troubleshoot growing human–bear conflict. As with many issues, it was decided to first raise awareness in the community. A survey was conducted, and banners, fliers, garbage can tags, and other educational materials were produced, in addition to special events.

The high number of human–bear conflicts during 2007 highlighted the limitations of an education-only approach. La Plata County passed a bear and garbage ordinance in 2008 and the City of Durango followed in 2010 with a wildlife ordinance. However, ordinances and bylaws are only as effective as the level and diligence of enforcement.

While noting the importance of ongoing public education, Bear Smart Durango in recent years has shifted emphasis to attractant removal programs, including assisting county residents with electric fencing, a fruit-gleaning program, and loaning out bear-resistant containers to residents in need. Education has focused on encouraging the next generation to practice Bear Smart measures.

The process has been glacially slow. Public awareness has greatly increased, and many people have taken steps to reduce human–bear conflict. However, a challenge remains in the lack of a mechanism requiring residents to modify their behavior. Efforts of the Bear Smart initiative are designed to assist Colorado Parks and Wildlife by reducing the amount of human foods available to bears, and Bear Smart programs work best when conducted in partnership with wildlife officers. Education has its role in reducing conflict; however, progress is dependent on effective regulation and enforcement.

LAW AND ORDINANCE ENFORCEMENT

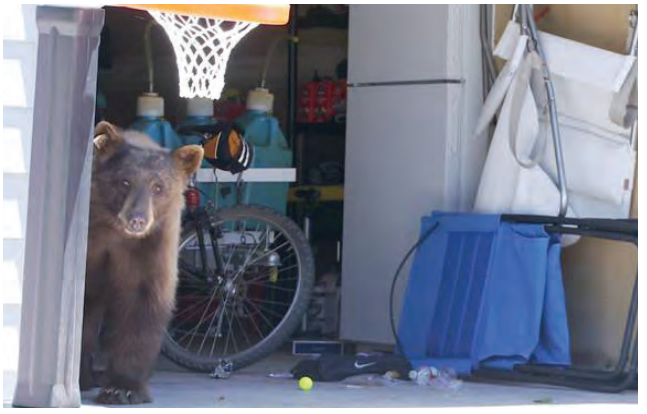
Bear managers have observed that many people will not remove attractants until they personally experience a human–bear conflict or they are forced to do so through regulations (Gore et al. 2008). Baruch-Mordo et al. (2011) reported the only strategy that had an immediate effect on reducing human–bear conflicts in Aspen, Colorado was effective enforcement of garbage-related ordinances. They found that when written warnings were issued by city officials, the number of bear-proof dumpsters increased by 30%. Yet enforcement can only take place if there are laws governing attractants, and sometimes government bodies are reluctant to act due to public sentiment to the contrary. In these cases, educational messaging should be targeted towards elected officials as well as the public.

Efforts to reduce conflict through education can be overwhelming without support from municipalities, law enforcement, and community members. For the wildlife manager, insufficient resources or mechanisms may be available to substantially reduce food sources within an urban environment and limit conflict. Their time may be better spent focused on educating civic leaders and politicians that can create and implement a comprehensive strategy for improving conditions within a municipality. This effort cannot be accomplished without support from the public. Part of an agency's message should target this dynamic.

There can still be a substantial amount of human–bear conflict even in areas where attractant storage is mandated, such as within national parks. Nonetheless, effective regulations can reduce conflicts if they are enforced consistently. In Yosemite National Park, human–bear conflicts decreased in areas where people were forced to follow strict rules (Keay and Webb 1989). Wildlife agencies do not normally have jurisdiction over enforcement of garbage-related laws, and county officials, who do have jurisdiction, may not understand the significance or importance of enforcing garbage violations.

Benefits:
Agency presence in a community can be effective in reducing conflicts because of the one-on-one communication that takes place between uniformed officers and the public. Sometimes just the thought of a violation and being advised there is an ordinance is enough to get people to change their behavior. Permanent ordinances or laws mandated to cover the entire community regardless of prior conflicts may prove to be the most effective means of eliminating attractants on a scale large enough to have meaningful consequences.

Challenges:
Many agencies do not have the personnel or resources to effectively patrol communities for violations involving anthropogenic attractants. Thus, the reporting of violations is often left to the members of the community, who may not want to report their neighbors. Therefore, many communities continue to have a high level of human–bear conflicts despite ordinances that have been carefully worded and crafted to eliminate attractants.



Habituated bear looking for food in a garage – Courtesy 9caribou.com.

EXCLUSIONARY METHODS

Exclusion devices are physical barriers that prevent access by bears to human property, food, or commodities, thereby preventing positive stimuli. Exclusion devices, including electric fencing and bear-resistant containers (BRCs), can eliminate individual, site-specific bear conflicts. Major limitations to exclusion devices are cost and practicality. Additionally, they do not reduce or eliminate odors. Consequently, BRCs should be stored outside and away from any structure. Bear-resistant containers and portable electric fences are cost-effective for camping, backpacking, and other recreational activities in bear habitat (MacHutchon and Wellwood 2002). Fencing, BRCs, and garbage incinerators have been used to address broad-scale solid waste management associated with industrial development in northern Alaska (Follmann 1989). On smaller scales, electric fencing is extremely effective in eliminating bear access to garbage, food stores, and agricultural crops, and preventing beehive destruction in apiaries (Creel 2007). Incidences of bears obtaining human-related food in Denali National Park, Alaska decreased 96% when hikers were provided with BRCs for food storage (Schirokauer and Boyd 1998).

Bear Resistant Containers

There are many makes and models of BRCs that cover an array of applications for residential, commercial, and campground use. No official accreditation standard exists for BRCs, but many manufacturers have their products tested with live bears at the Grizzly and Wolf Discovery Center in West Yellowstone, Montana, and seek endorsement from the Interagency Grizzly Bear Committee. Bear-resistant garbage containers vary in cost depending on intended use. Residential containers, which can vary from a plastic can with a screw-on lid to a metal enclosure designed to hold 2 residential garbage cans, can range from $50–1200 USD, whereas garbage enclosures or dumpsters can cost more than $400 USD. In addition to cost, “bear resistance” is a variable because quality of bear proof exclusion devices varies among manufacturers. A

Top and Middle:
Example of a bear resistant containerfor garbage. (Middle - Courtesy Wildlife Conservation Society).
Bottom:
The root cause of most human-black bear conflicts is improper garbage management - Courtesy Nevada Department of Wildlife.

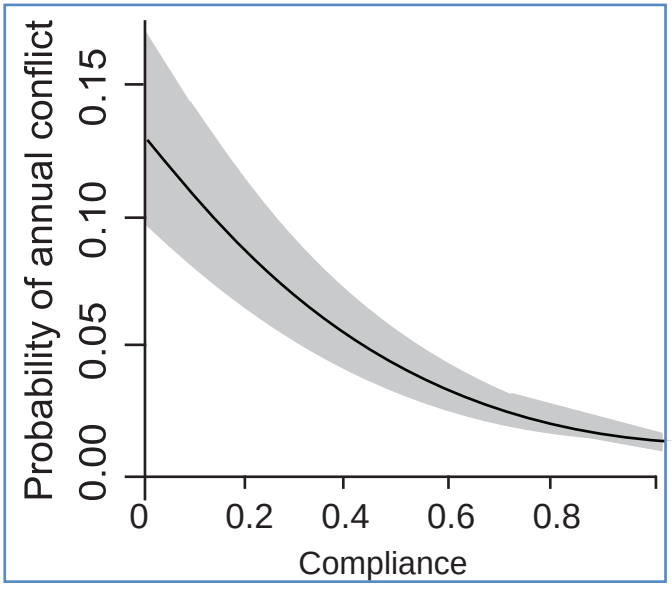
limited number of cases have occurred where bears have been able to break into poorly fabricated or damaged BRCs containing garbage. However, these occurrences are infrequent and are accomplished by a select few bears.

Waste disposal companies may pose additional challenges. Some do not distribute BRCs to their customers, relying on the customers to purchase their own. However, if the BRC is broken by the disposal company they may not take responsibility to fix it. Further, some disposal companies refuse to pick up BRCs owned by customers, and do not offer BRCs as part of their service. This was an issue in western Nevada for years even though some counties had ordinances requiring BRCs under certain circumstances (Nevada Department of Wildlife, unpublished data).

Because a nocturnally active bear accessing human garbage appears to be the first step in the progression of conflict behavior for most urban dwelling bears, increasing the use of BRCs by homeowners would be the most practical means of preventing most human–bear conflicts. Johnson et al. (2018) found that when a compliance threshold of roughly 60% of residents properly using BRCs was met, conflicts decreased significantly.

"Garbage is the ultimate food source for bears. It is always available regardless of environmental conditions, including season. It is predictable in both space and time (i.e., garbage cans are always set out the same day of the week). It is highly clumped (for instance, in residential areas) so that little energy is requires to move from one path (garbage can or dumpster) to the next. And it is always replenished after use. There is no magic wand to make everything bear-proof all at once, or to create one vast law across the land requiring people to act responsibly. We are therefore left with a myriad of solutions to combat human–wildlife conflicts and to convince people to do the right thing."

Jon Beckmann
Wildlife Conservation Society



From Johnson et al. 2018.

Electric Fencing

Electric fencing has proven effective at deterring bears from accessing or damaging apiaries, fruit orchards, garbage facilities, livestock operations, and other attractants. Additionally, electric fencing can be purchased to fit a variety of applications and budgets (e.g., simple fencing or a pre-fabricated bear fencing kit). When properly installed and maintained, electric fences pose no danger to people or pets. Some agencies, like Montana Fish, Wildlife and Parks, offer a guide to electric fencing for bears. The Montana guide offers recommendations on minimum requirements such as height, number of wires, and electric specifications. These recommendations were developed through specific implementation practice and increase probability for successful deterrence.

Top: Electrified fencing used to protect aprivate apiary - Courtesy Kim Annis, Montana Fish, Wildlife & Parks Bear Management Specialist.
Bottom: Electrifying the crawl space under a deck - Courtesy Tahoe Bear Busters.

Other Exclusion Devices

There are other products available which are designed to exclude bears from attractants. A variation on electric fencing, electrified door mats are designed to deliver a shock to a bear attempting to enter a structure. Although effective in keeping bears out of individual homes, they do not eliminate attractants and are only a temporary solution. Electrifying the structure, such as a home, with custom designed electric bungee cords has had some success in the Lake Tahoe area (Tahoe Bear Busters, www.tahoebearbusters.com). Bears that attempt entry to a structure are likely very human-habituated and human-food conditioned, and these devices are unlikely to have more than short-term, site-specific effects. Eliminating access to anthropogenic food sources keeps bears from developing these behaviors, whereas electric deterrents simply limit the locations where conditioned bears seek anthropogenic food.

Animal Husbandry Practices

Black bear depredation on livestock can be reduced using proper animal husbandry practices. Moving livestock into corrals, pens, or sheds at night or using electrical fencing are common methods. Rapid removal and burial of carcasses decreases the likelihood that bears will frequent the

area. Avoidance of pasturing livestock near dense cover is also effective.

Livestock Protection Dogs (LPDs) are a type of stock dog that were bred to protect livestock from predators, such as bears, coyotes (*Canis latrans*), mountain lions (*Puma concolor*), and cheetahs (*Acinonyx jubatus*), by acting aggressive and barking. The use of LPDs was developed in Asia and Europe over 2000 years ago to protect goats and sheep from brown bears and gray wolves (*Canis lupus*) (Gehring et al. 2010). Common breeds are the Great Pyrenees, Anatolian Shepherd, and various Mastiffs. LPDs are raised and imprinted with the herd they are set to protect; they are effective at protecting livestock from black bears (Green and Woodruff 1989). Andelt and Hopper (2000) found that livestock producers without LPDs lost up to 6 times more lambs than producers with LPDs.

Benefits:

Food and waste mismanagement is the primary reason for many human–bear conflicts. Reducing the availability of anthropogenic food sources to black bears would eliminate most human–bear conflicts. Exclusionary methods that secure food and waste are effective at reducing these conflicts and reduce agency personnel time. Other tools may limit the ability of a bear to access specific structures but may not extend this protection to all structures in a neighborhood. Improving animal husbandry practices can decrease conflicts and costs are generally born by the livestock producer. Livestock Protection Dogs can provide long-term security for livestock producers.

Challenges:

Exclusionary devices and methods are a physical barrier only and do not eliminate odor. Proper use, placement, and maintenance of the exclusionary device are required. Costs are borne by the user and some people may resist implementation to reduce their immediate cost. Unless most residents in a community use exclusionary devices (e.g., BRCs), bears will continue to forage in the area, accessing areas that lack exclusionary devices, causing conflicts to continue. Compatibility between BRCs and waste management companies is not always adequate. Costs associated with broad-scale solid waste management can be highly variable depending on the specific needs of each area. For instance, installing bear resistant dumpsters or outfitting an entire community with BRC garbage cans may be cost prohibitive depending on the community. Even electric fences (ranging in cost for installed fences from $1.50–3.00 USD per foot of fencing) may be cost prohibitive for large sites. There is some belief that dogs used for protection of livestock may lose their effectiveness over time as predators learn to circumvent the dogs (Green et al. 1994).

Regional Example

For many years the New York State Department of Environmental Conservation (NYDEC) and the Wildlife Conservation Society (WCS) worked together to resolve bear conflicts in the backcountry of the Adirondack Park. In 2005, a regulation mandated the use of bear resistant canisters in one highly used area of the Park. The combination of education, enforcement of the regulation, and providing proper food storage options to backpackers resulted in a dramatic reduction in bear encounters and human–bear conflicts.

Regional Example

*In a 9-month period in 1999–2000, the Nevada Department of Wildlife, working on a research project with the Wildlife Conservation Society, captured 6 adult bears to mitigate human–bear conflicts within the Lake Village Homeowners Association in Stateline, Nevada on the eastern shore of Lake Tahoe. More than 50 complaints were received by NDOW from the homeowner's association (HOA) between 1998 and 2000 regarding unsecured human food waste and bears. In response to the anthropogenic food availability, the bear population was at a high density (120 bears/100 km²) in this relatively small area (Beckmann and Berger 2003*b*). During December 2000–March 2001, the HOA, at the Department's insistence, installed enough bear resistant containers to cover all 326 condominiums. From 2002 through 2017, the Department received only 3 complaints, resulting in the capture of a single bear. The HOA and the Department have used this as a successful example to share with other HOAs and communities in the Lake Tahoe basin.*

CAPTURE AND RELEASE

Non-lethal management techniques are often used when managers are dealing with a conflict bear, but euthanasia may be the only option for some situations. When a bear is captured and moved, the attractants that initially created the conflict must be removed to prevent reoccurrence of the conflict behavior; relocation alone will have no long-term effect on reducing conflicts. Spencer et al. (2007) reported that 75% of agencies use relocation or translocation, and most did so in part due to public pressure. Only 15% of agencies agreed that relocation or translocation was the most effective tool.

Agency conflict policies usually describe the circumstances under which a bear must be euthanized, but these policies generally allow responding personnel to use discretion in deciding the fate of captured animals. Important considerations include the behavior of the bear, location of conflict, level of human-habituation or human-food conditioning, level of property damage, presence of cubs of the year, and previous reports about the same bear. Marking and recording the identification of every black bear handled within a database will assist in decision making. Marking bears offers the advantage of being able to track conflict behavior and determine whether past management actions have been successful, allowing for evaluation of actions and developing support for agency direction.

Some policies may be more controversial than others. For instance, a policy that dictates that a bear caught more than once with a history of conflict behavior must be euthanized may be unpopular in communities with common and recognizable bears. Public opinion can be instrumental in affecting and influencing agency policy, but public safety concerns may need to supersede other considerations. Again, removing attractants will eliminate most conflicts before they occur.

On-site Release, Relocation, and Translocation

In assessing where to release a captured bear, the behavior and capture history of the bear is important to consider. Other factors include the age, sex, body condition score (BCS), reproductive status, and proposed distance from the capture location that the bear is going to be moved. Generally speaking, bears that are more human-food conditioned carry more fat (Beckmann and Berger 2003*a*). As an example, if a captured bear has no history of being involved in conflict, the bear will probably have a BCS of about 3. Under these conditions, a hard release on-site or somewhere

Body Condition Score – BCS

5 – Obese: exceptional fat stores
4 - Excellent: above average fat stores for the time of year
3 – Good: average fat stores for the time of year
2 – Fair: thin or sickly, ribs and hip bones slightly visible
1 – Poor: emaciated, ribs and hip bones clearly visible

From R. Beausoleil, Washington Department of Fish and Wildlife, and C. Lackey, Nevada Department of Wildlife, unpublished report.

A highly habituated, daytime active, and unyielding black bear inside a garage is about to be tranquilized - Courtesy 9caribou.com.

nearby is a reasonable decision. If the bear has a BCS of 4–5, the bear is likely more human-food conditioned and a translocation to a pre-determined area away from human development is more reasonable.

The type of release should be planned. In general, hard releases are designed to provide negative feedback to a bear with little exposure (habituation or conditioning) to humans. A hard release generally involves some type of aversive conditioning (AC), such as less-lethal ammunition, yelling, sirens, trained bear dogs, or similar deterrents. Soft-releases are those without any AC and are useful when releasing a female with cubs or a bear with minor injuries. Hard or soft releases may be employed either with an on-site release or following relocation or translocation, but on-site releases should employ some type of AC if possible.

On-site releases

On-site releases at or near the point of capture are used by 42% of states (Spencer et al. 2007), and this technique has been used more commonly in the last 20 years (Clark et al. 2002, Beckman et al. 2002). By releasing the bear at or near the point of capture, the bear may associate its treatment with the location and change its behavior or use of the area. Little empirical data supports this theory, and a bear that leaves the immediate area may continue conflict behavior elsewhere. More importantly, the goal remains to change the behavior of the people associated with the conflict. Because on-site releases are performed at or near the point of capture, sometimes the homeowner and local public witness the release. By allowing people to view the release, agency managers help educate citizens that the bear will not simply be moved and reduce the erroneous assumption that moving bears solves conflict problems. On-site releases help gain trust and acceptance for the management decisions because the public sees that not all bears must be euthanized. The public may recognize that the responsibility rests with them in reducing

attractants.

Another goal of on-site releases is to reduce post-release mortalities associated with moving a bear during translocations (Massopust and Anderson 1984*a*, Stiver 1991, Comly 1993). On-site releases limit disruptions to population demographics that can occur when a bear is placed into the occupied home range of another bear. Agencies also avoid moving a conflict bear into an area where its conflict behavior can continue. Agency time and costs are reduced with on-site releases when compared with translocations.

Relocation

Relocation involves releasing a bear away from the capture site but within its assumed home range. Relocation of conflict bears is generally used when the objective is to temporarily remove the bear from a conflict situation. This may be useful if residents need a few days to purchase a BRC or remove attractants. This practice may help management personnel determine if a specific bear may be causing damage in a certain area. If a conflict bear cannot be specifically identified, but the conflict behavior continues after relocating a bear, the relocated bear may be eliminated from those under suspicion for ongoing conflict behavior. Conversely, support for a decision to lethally remove the bear may be greater if the conflict behavior temporarily ceases and begins again once the relocated bear returns to the area. Although most agencies and jurisdictions use relocation as a management tool, only a small percentage believes it is successful in reducing conflict (Spencer et al. 2007). In many cases, relocating a bear may simply delay lethal removal.

Translocation

Translocation involves capturing and moving bears to a new area beyond the bears' assumed home-range. Translocations may be used to introduce bears into new or previously occupied habitats, to establish, reestablish or augment bear populations, or to mitigate conflicts by removing conflict animals from the capture location. In some eastern jurisdictions, bears may be translocated to avoid euthanasia and increase the likelihood that a hunter may harvest the animal (Timmons 2013). In some instances, translocation has been used to restore black bear populations in areas where native bear populations have been extirpated (Shull et al. 1994).

Similar to relocations, translocations receive wide public acceptance as a human–bear conflict control technique because they avoid the lethal removal of bears and provide the perception that a problem is being addressed. However, identifying and selecting suitable release sites can complicate translocation efforts. Release sites must contain suitable habitat, yet suitable habitat is often already inhabited by other bears. (Table 2: Example of site factors to consider when releasing bears involved in human–bear conflict - from R. Beausoleil, Washington Department of Fish and Wildlife, and C. Lackey, Nevada Department of Wildlife, unpublished report). Releases of translocated bears should be compatible with the management objectives of the area. Bears involved in conflicts with humans should be released in areas with good habitat to reduce the dependence on anthropomorphic food and sufficiently distant to preclude returning to the capture location. Release sites should be located away from highways to reduce the likelihood of vehicle collisions. Social concerns surrounding these negative values must be considered when planning a successful translocation program. For instance, Wade (1987) noted that threats to human safety and damage to agricultural commodities are common societal perceptions associated with bears.

A black bear's age, reproductive status, and distance moved from the capture location affects the success of translocation. In some investigations, bears moved >65 kilometers showed reduced likelihood of returning to the capture location, and translocated sub-adult bears are less likely to return than are adult bears (Sauer and Free 1969, Alt et al. 1977, Rogers 1986, Shull et al. 1994). This is somewhat dependent on habitat differences. For

Table 2: Example of site factors to consider when releasing bears (Ursus americanus) involved in human–bear conflict (from R. Beausoleil, Washington Department of Fish and Wildlife, and C. Lackey, Nevada Department of Wildlife, unpublished report).

Key Site Factors	Feasibility of Success Excellent → Poor				
Natural Food Availability	Excellent: All areas abundant	Good: Mixed areas abundant to moderate	Moderate availability	Low: Mixed areas moderate to low	Widespread mast failure
Unnatural Attractants	None: Bear-proof or legally mandated	Low availability: A few sites	Mixed: Low with some areas moderate	Moderate	Widespread
Human and Bear Safety	Isolated site or only 1-2 sites being used	Rural: Mostly large acreages	Semi-rural: Mostly small acreages	Sub-division or Trailer park	Highly developed

example, conflict bears translocated >97 kilometers straight-line distance in Nevada, where suitable habitat is limited in distribution, still returned to the capture location after meandering an estimated 322 kilometers in less than 18 days (Beckmann and Lackey 2002).

Translocation can have many effects on black bears. For the first few months following translocation, bears often travel more, which increases a bear's vulnerability to being struck by a vehicle, shot by a human, or killed by another bear (Massopust and Anderson 1984*a*, Stiver 1991, Comly 1993). However, mortality rates of black bears >2 years old did not increase following translocation in Minnesota (Rogers 1986). Data from Colorado Parks and Wildlife (2015) suggests that adult and sub-adult bears with an unknown conflict history were successfully translocated 64% and 58% of the time, respectively, whereas success was significantly lower for bears with a history of conflict behavior. Additionally, translocation appears to have some short-term effects on reproduction. Comly (1993) and Godfrey (1996) reported females did not give birth to cubs the winter following translocation, but reproduced normally in subsequent years.

Despite these challenges, translocation has been effective at reducing human–bear conflicts (McArthur 1981, McLaughlin et al. 1981, Fies et al. 1987). In North America, 75% of states and provinces use relocation or translocation as one method to manage human–bear conflicts (Warburton and Maddrey 1994, Spencer et al. 2007). However, translocation does not address the situation which led to the conflict behavior, and translocated conflict bears may cause problems while attempting to

return or after returning to the capture location (Massopust and Anderson 1984*a*).

Benefits: By using an on-site release, an agency may reduce costs associated with human resources and equipment deployment. Post-release bear mortalities associated with relocation or translocation are avoided. On-site releases do not require the identification and approval of release sites. Support for the agency message from the public is generally greater because they witness a non-lethal resolution, but the bear remains in the neighborhood. Removing a bear, even if only temporarily, may alleviate immediate concerns over conflict or damage. Non-lethal management techniques are often preferred by the public and can help gain agency support. Moving a bear substantial distances and into high quality habitat may help in stopping the bear from escalating up the ladder of conflict behavior. Additionally, some jurisdictions view translocation as a means of avoiding waste by delaying the bear's mortality until hunting season (Timmons 2013).

Challenges: Highly habituated or food-conditioned bears often will not leave or change their behavior, thereby offering no reduction of conflicts. The public may view on-site releases as the only viable option going forward, resisting other management options like translocation. Neighborhood bears often become recognizable to the community and this may lead to greater public concerns. Relocation or translocation is labor intensive and expensive, although costs vary by state and location. Costs include administrative expenses, capture and handling equipment (i.e., traps, carrying cages and immobilization equipment), purchase of specialized vehicles, and various overhead expenses in addition to staff time. There are also inherent problems associated with moving a bear to an area already occupied by other bears. Bears attempting to return to their home range may also be subjected to increased mortality while crossing roads or moving through human-populated areas. Translocation is generally not advisable for females accompanied by cubs of the year.

A Karelian Bear Dog working with a recently released conflict bear - Courtesy John Axtell.

AVERSIVE CONDITIONING

Human-habituation in bears generally occurs following repeated exposure to humans without negative repercussions (Hopkins et al. 2010). Similarly, human-food conditioning in bears occurs when a bear learns to associate humans or human activities to anthropogenic food sources, usually after repeatedly obtaining anthropogenic food rewards. Bears may learn from a single experience. Operant Conditioning is a form of learning in which a reward or punishment modifies a voluntary behavior, such as accessing or avoiding human foods. Hopkins et al. (2010) defined Aversive Conditioning (AC) as "a learning process in which deterrents are continually and consistently administered to a bear to reduce the frequency of an undesirable behavior." The bear manager's version of AC is therefore a form of operant conditioning causing temporary pain or irritation around humans in an animal displaying objectionable behavior (Brush 1971, Mason et al. 2001, Shivik et al. 2003, Beckmann et al. 2004). In theory, the goal of most bear managers using AC is that the bear will associate humans and human foods with the negative stimulus, thereby avoiding the area, the anthropogenic foods, or both. Another potential outcome of AC is that a bear learns to avoid humans in general by becoming more nocturnal while still engaging in the undesirable behaviors.

Hazing has been defined as a technique where deterrents are administered to a bear to immediately modify the bear's undesirable behavior (Schirokauer and Boyd 1998, Hopkins et al. 2010). By definition, what bear managers do in most instances is a form of hazing, although it can be repetitive if the bear is recaptured on multiple occurrences. Continuously and consistently, as it applies to true AC, has become associated with the management technique of capturing a bear and combining a hard release with some sort of deterrent. Importantly, this form of AC has the potential to temporarily reduce human–bear conflicts (Beckmann et al. 2004, Mazur 2010), offering managers a non-lethal option. About 64% of agencies in North America use a form of AC on conflict black bears (Spencer et al. 2007).

Example of less-lethal ammunition.

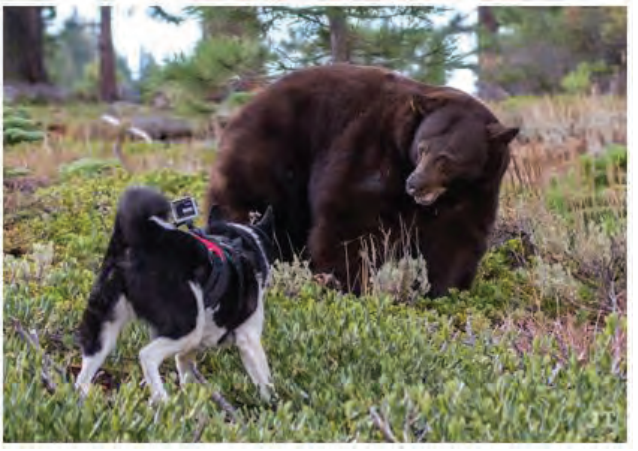
There are several forms of deterrents used for AC in black bears, including trained dogs (Jorgensen et al. 1978, Green and Woodruff 1989), less-lethal ammunition, bear spray, pepper balls, emetic compounds, pyrotechnics, noise makers, and conducted electrical weapons like Tasers. Of these, less-lethal ammunition (rubber bullets) and noise makers are the most common techniques used (Spencer et al. 2007). Conducted electrical weapons have seen relatively little use in wildlife management, and even less in AC of bears. Recently, Alaska and Colorado have expanded the use of conducted electrical weapons in specific, limited conditions. The use of trained dogs is not widespread but has gathered appeal where they are used (Washington Department of Fish and Wildlife; Montana Department of Fish, Wildlife and Parks; Nevada Department of Wildlife; Alaska Department of Fish and Game; Wind River Bear Institute). Aversive conditioning techniques are most effective on bears that have had little previous experience with anthropogenic food rewards and are presumed to be lower on the ladder of conflict, and AC may be more effective on adult than on younger bears (Mazur 2010).

Wildlife Service Dogs

The use of Wildlife Service Dogs (WSD) has been undertaken by a limited number of agencies. Two types of WSD are most commonly used by agencies: the Karelian Bear Dog and the Black Mouth Cur. Due to their fearlessness and aggressive barking, these dogs are adept at locating concealed bears, tracking and treeing bears for capture purposes, and locating dead animals. When bears are candidates for capture and release, the WSD may be used for AC on release of the bear to help make it warier. Bear dogs may act as ambassadors for the education messages that agencies are trying to spread.

Working these dogs off-leash allows them to approach closely, barking within a meter or so of the bear, while avoiding defensive swipes and charges. Unlike typical hound dogs used for hunting bears, WSDs will return to the handler when called. Wildlife Service Dogs can work silently and less aggressively than hound dog breeds, especially on-leash, which is important when tracking a tranquilized animal or locating injured or orphaned wildlife. Their personalities allow them to be used at education events, surrounded by people and pets, greeted and hugged by children, and working long hours at a booth.

Washington's Karelian Bear Dog Cash - Courtesy Richard Beausoleil.



A Karelian Bear Dog at work - Courtesy John T. Humphrey AKAwolf.com.

✓ ***The Karelian Bear Dog*** (KBD) is a specialized breed from Russia and Finland commonly used to track and hunt brown bears (*Ursus arctos*) among other species. Due to the special abilities of the breed, they were first brought to the United States in 1990 by the Wind River Bear Institute. The dogs are intelligent, loyal, loving, quick and light-footed, persistent, and independent. And unlike hounding breeds of dogs, KBDs were bred to simply find and hold a bear while lacking the desire or motivation to attack it. They reduce aggressive actions around sedated bears and cubs. These traits make them ideal for human–bear conflict work. For these reasons the breed has become a standard in several agency bear programs in the U.S. and Canada.

Some jurisdictions use them to assist biologists in locating and treeing mountain lions for capture-collar research, and some serve in a law enforcement capacity for locating evidence such as spent bullet casings and decaying wildlife. Furthermore, their acute sense of smell has allowed them to be very useful in Search and Rescue or recovery operations (R. Beausoleil, Washington Department of Fish and Wildlife, and C. Lackey, Nevada Department of Wildlife, unpublished report).

✓ ***The Black Mouth Cur*** is a medium- to large-sized cattle and hunting dog, which was developed in the southern United States as an all-around working dog. Though no one knows their exact lineage, the Black Mouth Cur is believed to descend from ancient European and Asian Cur-type herding and hunting dogs. The Black Mouth Cur is considered a member of the Herding Group by the United Kennel Club. The breed is short-coated, drop-eared, athletic, tractable, and aggressive with quarry but typically gentle with humans. The Cur is an intelligent and obedient dog that can work in warm to hot, humid conditions when most nuisance bear activity occurs.

Black Mouth Curs in training - Courtesy Patrick C Carr New Jersey Division of Fish and Wildlife.

Usually working in pairs, properly trained Curs will enthusiastically pursue a conflict bear on command, chasing it up a tree or holding it at bay, vigorously barking and growling, with little to no actual contact. After the dogs hold the bear up a tree or at bay, bear managers can restrain the Curs, and apply additional AC. Curs, unlike most hounding breeds, can be called back by their handler. The use of hounding breeds (Walkers, Plott hounds, Blueticks, and Redticks) is common in some jurisdictions. These breeds are popular with houndsmen because of their drive and ability to track bears. As a result, some agencies choose to contract with private houndsmen rather than purchase and train the dogs themselves.

Bear Spray

Bear spray is a capsaicin-based bear deterrent that affects a bear's olfactory and respiratory capabilities and vision, ideally causing the bear to disengage a charge or attack. For AC applications, it is commonly used as an immediate offensive deterrent, either as a bear exits a trap or as a bear displays unwanted behaviors. Spray may also be delivered by a triggered device (Bear-Be-Gone) set to spray when a bear opens a dumpster, garbage can, or cooler.

Emetic Compounds

Emetic compounds typically produce an onset of illness in the bear shortly after it eats the treated food to create a conditioned taste aversion. Evaluations thus far have shown limited efficacy as an aversion training tool (Garcia et al. 1974, Burns 1983, Ternent and Garshelis 1999). Studies have shown that the effectiveness lies only in stopping bears from eating a specific food in recognizable packaging, and even that is for a limited time (Hastings et al. 1981, McCarthy and Seavoy 1994, Ternent and Garshelis 1999).

Less-Lethal Ammunition

Less-lethal ammunition consists of plastic or rubber projectiles fired from a shotgun or other type of projector depending on the type and caliber of projectile used. Similar to police riot ammunition, less-lethal rounds used on wildlife are designed to inflict temporary pain and discomfort. They are referred to as less-lethal because, if used improperly, the potential exists for severe injury or death to the bear. There are many types of less-lethal rounds available, including 12-gauge rubber slugs for medium and long-range applications (30–50 meters), as well as close range rubber

buckshot and bean bag rounds. Less-lethal rounds have applicability in AC and hazing scenarios. Personnel should be trained in the use of less-lethal ammunition and be aware of the limitations it offers.

Pepper Balls

Pepper balls are essentially paint balls filled with a powdered irritant with effects similar to bear spray. They are fired from a specially modified paintball gun using compressed oxygen rather than CO_2. Similar to less-lethal ammunition, they are more commonly used by law enforcement personnel in riot control situations. Applications in human–bear conflicts consist of AC and hazing, and pepper balls have been effective in getting bears to descend from a tree so that they are more easily and safely tranquilized (Nevada Department of Wildlife, personal communication).

Pepper balls are essentially paint balls filled with a powdered irritant with effects similar to bear spray.

Pyrotechnics and Noise Makers

These techniques are usually used in conjunction with some other form of AC, such as during an on-site release using less-lethal ammunition. Pyrotechnics are typically fired into the air where they will make a screeching or whistling noise followed by a loud, explosive bang. They have the potential to be a fire hazard, and care must be used to avoid hitting the bear.
Noise-making devices, in the form of a motion-sensing alarm that, when triggered, emits a loud sound (i.e., screeching, beeping, dogs barking) and flashing lights, may be used as a temporary deterrent to keep a bear away from an attractant or property. Most bears will likely become conditioned to the noise and learn to ignore it, but it provides residents a short reprieve to secure attractants or install a more permanent bear-resistant solution.

Conducted Electrical Weapons

The use of Conducted Electrical Weapons (CEWs) has potential as an effective alternative to chemical restraint or other means of short-term physical capture (Lieske et al. 2018). Conducted Electrical Weapons use electrical impulses to override the sensory and motor nervous systems of animals, immobilizing the animal and causing temporary discomfort. These devices are commonly referred to as "Tasers" which is the name brand of a specific CEW manufacturer. Conducted Electrical Weapons cartridges are typically deployed from distances of 5, 8, or 12 m and release wires with 2 probes attached, which embed in the animal's skin and deliver an electrical charge. Conducted Electrical Weapons are typically used on bears to immediately address an undesirable behavior, such as feeding from dumpsters, and create a negative stimulus directly associated with the conflict event in progress. Conducted Electrical Weapons provide negative physical and auditory stimuli, which may be directly associated with behavior or humans. Additionally, CEWs directly affect only the individual animal, unlike other common deterrents such as pepper balls, which potentially result in airborne exposures of non-target wildlife or people. Optimal CEW exposures require wildlife managers to be in the immediate vicinity during the time the undesirable behavior is occurring and require fairly close proximity to deploy cartridges effectively. Measuring the effectiveness of CEW exposures is difficult without a process for marking and identifying exposed bears to assess post-AC

behavior. Device operators and participating personnel should be trained in the operation and deployment of CEWs. While evidence developed in Colorado using this tool is anecdotal, field assessments of CEWs to deter future undesirable behavior by individual bears appears to show some promise. The Alaska Department of Fish and Game has used CEWs on 440 brown bears and achieved 100% flight response (Larry Lewis, personal communication), and CEWs have been useful in subduing moose in Alaska (Alaska Department of Fish and Game, unpublished data). There is limited scientific research on the use of these devices, but there is evidence that CEW use does not increase the probability of myopathy (Lieske et al. 2018).

Benefits:

Aversive conditioning is popular with the public as it is seen as a non-lethal solution to human–bear conflicts. When combined with an on-site release, it is often less expensive than translocation. Aversive conditioning may temporarily alter some specific black bear behaviors and yield a short-term reduction in human–bear conflicts. Some bears may become more wary of people or may simply decrease their diurnal activity. Ideally, AC should be accompanied or preceded by efforts to address the attractant that instigated the conflict (Leigh and Chamberlin 2008). Aversive conditioning likely has longer-term benefits on bears that are first-time captures and have not ascended the behavioral ladder of conflict. Bear dogs can be effective for implementing AC, and they have further benefits in that they act as agency ambassadors because their friendly personalities naturally offer education and outreach opportunities.

Challenges:

Aversive conditioning is not a permanent solution for human–bear conflicts. Bears can easily learn strategies for evading efforts by managers to apply AC. Effective AC may be expensive and impractical because specialized equipment is often necessary. Trapping of the bear may be required to implement treatments, and professional training is required. Bear dogs can be expensive to purchase and train. Agencies need to develop policies regarding animal ownership, how and whether maintenance costs are covered, and retirement of aging animals. Current literature documenting the effectiveness of aversive conditioning is limited.

Regional Example

The Washington Department of Fish and Game (WDFG) has employed the use of Karelian Bear Dogs since 2003 and now has six working dogs placed with different handlers. The program has been successful due in part due to training the dogs to fill various roles and the commitment by the Department to the program. A non-profit foundation now funds the KBD program through public donations.

The dogs specialize in AC of black bears at releases, but they are also used by WDFG law enforcement personnel in locating evidence, such as spent firearm casings and poached animals. The dogs have been deployed in search and rescue and missing persons cases as well. The dogs have been used in the hazing of ungulates in urban areas, tracking and locating orphaned wildlife, and assisting in mountain lion captures.

REPELLENTS

Repellents are sensory deterrents that are intended to keep bears from entering certain areas or prevent the close approach by bears. Depending on the method of application, repellents may also function as an AC tool. Common repellents include chemical compounds, loud noises, or guard animals.

Capsaicin is a chemical deterrent. When sprayed directly into a bear's eyes, capsaicin was effective at repelling captive and free-ranging black bears (Herrero and Higgins 1998), but only at distances <10 m (Hygnstrom 1994). Additionally, objects or sites sprayed with capsaicin may not repel black bears but rather attract them to the object or site (Smith 1998). Thus, capsaicin is applicable only in situations of close human–bear contact and probably does not have broad application for reducing most forms of human–bear conflicts.

Certain chemical compounds, such as human urine or ammonia, have had mixed results in deterring bears (Creel 2007). Any potential effect of the compounds is likely to decrease over time as the compound degrades or bears become accustomed to the odor. However, ammonia is useful to reduce odors associated with garbage storage in some situations.

As a non-lethal form of control, repellents seem socially acceptable and are relatively inexpensive. Capsaicin is sold commercially and often recommended for individuals hiking in bear habitat. Ammonia is also widely available, but use may be limited.

Several tools discussed in the section on AC can be used as repellents as well. These tools include bear spray, emetic compounds, and pepper balls. Refer to the section on AC for a more detailed description of these tools, but the benefits and challenges of using them are similar to those of other repellents reported here.

Benefits:
Capsaicin has proven very effective at thwarting aggressive bear encounters where a bear is threatening the health and safety of a person. Some chemical repellents are economical and readily available (e.g., ammonia) and may provide short term benefits for site-specific human–bear conflicts, and a sense of relief for the reporting party that action is being taken.

Challenges:
Repellents have shown only limited success at reducing other forms of human–bear conflicts (e.g., agricultural damage, assessing garbage). Repellents are sometimes viewed by the public as the solution to human–bear conflicts, which may result in reductions in BRC acquisition. Some repellents can be toxic if used inappropriately, for example if a homeowner pours such a large quantity of ammonia into a garbage receptacle that it overwhelms the sanitation worker picking up the can and causes minor lung irritation.

Example of bear spray commonly used.

DAMAGE COMPENSATION PROGRAMS

Damage compensation programs, also called reimbursement funds, are seldom used by management agencies. Hristienko and McDonald (2007) reported that only 10 jurisdictions in North America provided partial or full compensation for damages to beehives, crops, or livestock caused by black bears. Although damage compensation programs may satisfy those receiving damage to property or agriculture, they do not prevent damage. Aside from the cost and identification of a permanent funding source, they do not address the problem causing the damage. Without addressing the causal factors, damage is likely to persist. Compensation programs may be popular, and recipients may choose the financial reimbursement in lieu of removing attractants. To avoid this problem, Jorgensen et al. (1978) recommended that compensation programs allocate a portion of reimbursement monies for establishing and maintaining damage prevention measures.

Other limitations of reimbursement programs involve the assessment of damage, determination of the damage payment, and program equitability. Under Wisconsin's Wildlife Damage Compensation Program (1930–1979), landowners were dissatisfied with damage assessments and damage payments, while legislators and wildlife management personnel were concerned about the equity of the program (Hygnstrom and Hauge 1989). In Virginia, Engel (1963) reported that inequity of damage compensation payments hindered program implementation. Ideally, damage assessment and determination of payments would be standardized to ensure equitable distribution of program funds.

The acceptability of damage compensation programs is unclear. Some private organizations are willing to establish compensation funds for damage caused by some species. However, farmers in the United States have preferred other nuisance management options to damage compensation (Arthur 1981, McIvor and Conover 1994). Compensation programs may be appropriate in areas where lethal means of damage abatement is unacceptable.

Costs associated with damage compensation programs vary according to program guidelines. Small-scale compensation programs that restrict reimbursements to the most substantive damage may be more affordable, whereas large-scale programs aimed at reimbursing individuals for any damage incurred are costly.

Benefits:
Reimbursement funds are primarily used for agricultural conflict (e.g., livestock depredation) and can reduce the economic impacts of human–bear conflicts. Reducing the economic burden of conflict may create greater tolerance for bears, thereby reducing mortality on individual bears by persons experiencing damage. Compensation programs can be effective tools when attempting to recover a rare or endangered population.

Challenges:
As with most measures to reduce human–bear conflicts, damage compensation programs are only a temporary solution. Compensation programs can be expensive, and conflicts will likely continue unless proper exclusion or attractant removal is provided. Compensation programs may not actually create greater social tolerance for bears. Unless compensation programs emphasize measures to reduce damage, the incidences of human–bear conflicts are likely to increase.

A human-food conditioned bear looks for food in a vehicle – Courtesy 9caribou.com.

Regional Example

The West Virginia Division of Natural Resources (WVDNR) uses a reimbursement fund to mitigate personal property destruction caused by black bears to private landowners. Hunters that pursue black bears are required to purchase a $10.00 USD "Bear Damage Stamp" which is used to fund private landowners experiencing "real or personal property" damage. The Bear Damage Fund is established in 1974, when bear populations were low. The fund is originally intended to protect bears from being destroyed for killing sheep, but in recent years paid for primarily field corn.

In 2011, the WVDNR paid $345,007 USD in bear damage and sold 25,001 bear damage stamps. Unused money in the Bear Damage Fund carries over from year to year, so there is usually money left from years of low bear damage to cover the years of high bear damage. The costs to investigate and process bear damage claims often equal more than 50% of the total damage and cannot be charged to the fund.

A combination of decreased corn prices per bushel, more accurate measurement of corn damage, legislation to exempt hunting-related items from bear damage reimbursement, and liberalization of bear hunting opportunities and bear harvest have helped reduce the cost of bear damage. Average annual bear damage payments for the period 2013-2017 were $165,704 USD with a decreasing trend ($73,393 USD in 2017). Bear damage, specifically corn damage, occurs every year but is reduced in years of heavy mast crops. A reimbursement fund, while good in principle, may have insufficient funding during years of mast scarcity.

SUPPLEMENTAL AND DIVERSIONARY FEEDING

Supplemental feeding is a technique meant to augment natural foods during food shortages or provide additional nutrition with the intent of preventing starvation, increasing reproduction, prevent extirpation of vulnerable bear populations or improve the physical condition of individual bears (Colorado Parks and Wildlife 2015).

Diversionary feeding is meant to divert bears from certain areas or food resources (e.g., urban areas or crops vulnerable during particular time frames) where their feeding could cause damage, by providing additional food sources to bears through cultivated wildlife plantings or strategically located wildlife feeding stations.

A fundamental question behind these techniques is whether supplemental and diversionary feeding alleviates human–bear conflicts by luring bears away from urban areas or whether it increases conflicts by conditioning bears to human foods (Steyaert et al. 2014). Undoubtedly, the context is critical to consider when evaluating whether these techniques are useful. For example, timber companies in Washington use supplemental feeding to keep bears from causing damage (i.e., stripping bark) to commercial tree growing operations. In 2007 (the last year for which figures were available), timber companies dispensed a reported 230,000 kg of processed food pellets (Washington Department of Fish and Game, unpublished data). Some evidence (Rich Beausoleil, Washington Department of Fish and Wildlife, personal communication) indicates this technique does limit damage to trees, but the long-term effect on the bear population is unknown because most of these bears are trapped and killed as they come into the feeding stations.

Supplemental and diversionary feeding have been proposed to reduce conflicts in urban environments, particularly during years with low natural food availability. Providing anthropomorphic food sources near urban areas may attract urban bears, yet it may also attract bears unfamiliar with anthropogenic food sources as well. Wildland bears may be introduced to human food sources and conditioned to their use. If artificial food sources are available for sufficient time, greater numbers of bears may be supported than in wildland conditions. Little evidence supports supplemental feeding as an effective strategy for reducing bear conflict and may inadvertently increase the risk.

Research suggests that black bears using high-energy, human foods grow faster (Beckmann and Berger 2003*a*) and mature earlier than bears that use only natural foods (Alt 1980, Tate and Pelton 1983, Rogers 1987, McLean and Pelton 1990). Improved fertility through earlier sexual maturation, increased litter sizes, and fewer lapses in the reproductive cycle appears to be common for black bears with supplemented diets (Beckmann and Lackey 2008). Estimates of survival rates for bears with supplemented diets are limited, and thus, it is difficult to make conclusions about the role of supplemental feeding on bear populations. However, there is evidence that bears frequenting urban areas have increased mortality rates (Beckmann and Lackey 2008, Hostetler et al. 2009)

In general, supplemental and diversionary feeding is not widely used by bear managers for several reasons. These techniques present logistical challenges of acquiring and distributing enough feed to accomplish the management goal. This may be confounded by bear social hierarchies and the ability of dominant bears to monopolize the food. Additionally, as bears congregate around feeding sites, the potential for disease transfer or aggressive competition increases (Sorensen et al. 2013). Occasionally, other unintended consequences may arise, such as toxicity from the foods used (Beringer et al. 2016). Use of feed sites by other wildlife may generate unintended population effects or disease concerns. The economic costs and benefits of supplemental and diversionary feeding are not well defined or understood, though wide-scale programs would likely be cost prohibitive. Costs are associated

with acquiring and distributing feed, mitigating human–bear conflicts that arise from the program, and negative effects the program would have on other wildlife populations (e.g., disease concerns or habitat destruction).

Benefits:
Supplemental feeding may have application for managers seeking to restore bear populations or protect threatened populations, as feeding programs may mitigate the effect of temporary natural food shortages. In appropriate contexts (e.g., reducing bear impacts to timber), temporary supplemental feeding may reduce the need to implement other types of control actions like lethal removal.

Challenges:
Bears that exploit human-related food resources are responsible for most human–bear conflicts, thus supplemental feeding could enhance conflict. Supplemental feeding may lead bears to seek out human food sources (i.e., food conditioning) or lose their wariness of people (i.e., habituation). Supplemental feeding by the public has increased human–bear conflicts in areas of high human use. The effects of supplemental feeding on bears in areas of minimal human use are unknown. The feeding of bears in some jurisdictions is illegal.

Regional Example

In July 1999, the Virginia Department of Game and Inland Fisheries adopted a regulation that prohibited the feeding of wildlife on national forest and department-owned lands. In July 2003, another regulation was passed to prohibit all feeding of bears statewide. Prior to the regulation change in 1999, bear hunters annually spent an average of $163 USD/person for baiting bears. The mean amount of food provided by hunters was 10,437 kg/year, or 63 kg food/person/day (Gray 2001). Most feeding occurred in July, August, and September and included shelled corn, pastries, grease, and bread. Supplemental feeding may have provided a substantial amount of food to bears in years of mast shortage, but only about 2% of the bears' diet during good or excellent mast years. This example demonstrates the potential amount of artificial food sources placed on the landscape, but whether this type of feeding affects conflict behavior or influences bear population demographics is unknown.

DEPREDATION (KILL) PERMITS

Many states and provinces issue permits that authorize landowners experiencing bear-related damage to kill the offending bears. Kill permit programs are designed to alleviate human–wildlife conflicts, particularly damage to agricultural commodities, by targeting and removing specific black bears involved in human–bear conflicts. Because kill permits are used to alleviate conflicts at specific locations, it is unlikely that such programs affect black bear populations except at localized levels. For example, California reported issuing 301 depredation permits in one year, which is <1% of the estimated population of 35,000 black bears (R. Beausoleil, Washington Department of Fish and Wildlife, and S. Dobey, Kentucky Department of Fish and Wildlife Resources, unpublished report). Kill permits may increase farmer tolerance for damage by providing additional control over the damage situation (Horton and Craven 1997).

Kill permit programs have some limitations. Kill permits may not be practical for some urban areas where the discharge of firearms may be prohibited. The wide-ranging, nocturnal habits of black bears can complicate removal efforts, requiring substantial time investments to remove specific animals. Additionally, kill permit programs may not be socially acceptable. For example, in New York, 52% of survey respondents were opposed to the killing of bears involved in conflict (Siemer and Decker 2003). Perceiving a loss in recreational opportunities, some hunters object to bear removal from the population via kill permits. However, controversy surrounding a kill permit program in Wisconsin appeared to come from a vocal minority, and hunters and farmers accepted the use of kill permits for reducing crop damage (Horton and Craven 1997).

Benefits:
Kill permits can effectively alleviate site-specific, human–bear conflicts by targeting the problem individuals. Kill permits can also empower a landowner, thereby reducing animosity toward the management agency. Generally, kill permits are used as a last resort in situations where substantial damage has occurred, or human life and safety are threatened.

Challenges:
Because management agency personnel are generally not removing the bear, the accountability for taking the bear is delegated to an individual. Some individuals may not be proficient at using lethal means, thus bears could be injured but not killed. In California, some homeowners that used kill permits were identified publicly, harassed, and targeted for vandalism by special interest and animal rights groups.

A human-food conditioned black bear enters a culvert trap - Courtesy Nevada Department of Wildlife.

MANAGEMENT BEARS (AGENCY KILL)

Capture-and-kill practices by agency staff can effectively target and remove specific bears involved in human–bear conflicts, eliminating future conflicts with that individual bear. The lethal removal of a bear is generally applied in situations where the black bear presents an immediate threat to human safety or has repeatedly been involved in human–bear conflicts. Like other techniques, elimination of conflicts relies on removal of attractants, therefore lethal removal is not a long-term solution, but it can be an important component of an integrated management plan used when an individual bear is highly human-habituated or human-food conditioned. In these cases, non-lethal techniques (e.g., translocation, AC) are often ineffective.

Conflict foraging behavior can be taught to young bears by their mothers (Breck et al. 2008, Mazur and Seher 2008, Morehouse et al. 2016). Food-conditioned bears can have smaller home ranges than wildland bears, at times no bigger than a single community (Beckmann and Berger 2003*a*). Consequently, if adult females are living within a single neighborhood, their cubs have a high likelihood of becoming conflict bears as well. It may be appropriate to lethally remove these conflict females, even if they are not causing substantial damage or posing a public safety threat. Lethal removal is not often supported by the public and killing a female with cubs is particularly publicly distasteful. Yet if a bear is simply perpetuating human–bear conflicts, the social cost of killing the bear may not be as substantial as having to kill multiple bears in the future.

Benefits:
Capture and kill can effectively remove problem bears that cause a disproportionate amount of conflict and therefore significantly reduce site-specific levels of conflict. Capture and kill provides the opportunity to first evaluate the bear, ensuring the correct individual is identified before euthanasia.

"I tell people that although I had to euthanize their bear, I was not the one who killed it. That responsibility lies with every single person in the neighborhood who didn't think it necessary to lock up their trash until after the bear accessed it for the first time."

Heather Reich
Nevada Department of Wildlife

Challenges:
Any time a bear is removed by agency personnel it has the potential to illicit a negative response with the local public and social media. There also can be substantial human resource investment and financial expenses associated with capture and kill implementation.

Regional Example

In Yosemite National Park, conflicts with bears spiked in the late 1990s and early 2000s, with most problems occurring in highly used front-country campgrounds. In these campgrounds, bears were breaking into hundreds of cars each year, stealing food from coolers left out at campgrounds, and becoming aggressive at restaurants in the park. To combat this problem, the Park Service implemented strict food storage policies for visitors, enhanced enforcement of existing regulations, and developed intensive non-lethal measures. Although conflicts declined, they were still at unacceptably high levels, and a small number of highly habituated bears were probably the primary cause of most conflicts. Many of the conflict individuals were lethally removed over a few years and conflict levels dropped to low levels. This example highlights the importance of combining management of attractants (i.e., root cause) with lethal removal to manage outcomes.

PRIVATIZED CONFLICT MANAGEMENT

In most jurisdictions, the agency with authority over wildlife will respond to human–bear conflicts. In some areas, conflict response is contracted to external entities, and the efficacy of this option is variable. Some states and jurisdictions have non-contractual relationships with citizen groups who provide public education (see Public Education section), and in some instances, these relationships are formalized with Memorandums of Understanding to give more latitude to citizens groups in dealing with human–bear conflicts (Updike and Malm 2001). Agencies may form groups with various other agencies and organizations to reach common ground on conflict mitigation techniques, such as providing input on the decision of when to euthanize. The Tahoe Council for Wild Bears was an example of such a group formed in 2003 between the state jurisdictions of California and Nevada, along with other agencies and wildlife advocacy groups. These types of groups are difficult to maintain over time.

Benefits:

Some concerns may be addressed by using another government entity to conduct the necessary work. For example, Wisconsin Department of Natural Resources has had success delegating conflict response to USDA-APHIS-Wildlife Services (David MacFarland, personal communication). Agency time spent on human-bear conflicts decreased substantially while maintaining professionalism.

Challenges:

Criticisms of privatizing conflict management response include:

- Jurisdiction over wildlife is commonly reserved by statute for government agencies
- Vicarious liability may remain with the government agency despite delegation of some responsibilities to a private citizen or organization
- Professionalism and authority may be challenged in some instances
- Agencies lack control of specific messages, and it can be more difficult to ascertain if messages regarding the removal of attractants are delivered effectively
- Agencies lack control of quality control in data acquisition and delivery
- Aversive conditioning may not be conducted appropriately or consistently
- Agencies may lose moral authority or may be viewed differently than if they were consistently on the scene.

A human-food conditioned bear on deck of house – Courtesy 9caribou.com.

POPULATION MANAGEMENT

Population objectives for black bears are designed to increase, decrease or stabilize population levels and are often targeted at a stable harvestable population that is maintained within cultural carrying capacity. Specific population objectives can be achieved through a variety of strategies that primarily involve manipulating the number of bears harvested during regulated hunting seasons. How population management influences levels of human–bear conflicts is not well understood. From a broad perspective, more bears mean more conflict, as bears encounter humans more frequently. Yet the relationship between abundance and conflict is not consistent. For a bear population near carrying capacity, lowering the population by 20% may have little effect on conflict depending upon the context of the conflict (e.g., urban vs. agricultural), availability of natural food, and prevalence of anthropogenic attractants. Conversely, smaller bear populations or small components of a bear population can cause a great deal of conflict if anthropogenic food is readily available and natural food is greatly diminished. Balancing the goals of population management and conflict mitigation are critical research endeavors. Selection of the appropriate population management options must be consistent with the cultural carrying capacity of the management unit, recreational interests, available habitat, and societal concerns for bear-related impacts.

Bear climbing a tree – Courtesy John Axtell.

REGULATED HUNTING AND TRAPPING

As early as 1910, regulated hunting and trapping seasons have been used to foster the wise use of wildlife resources for food, fur, and other utilitarian purposes, and to manage wildlife populations. Specific population levels can be achieved by adjusting season length, season timing, and legal methods of take to manipulate the number of animals and sex and age composition of the harvest. Specifically, wildlife managers collect information from hunting harvest (e.g., hunting effort, success rates, age and sex structure) to determine whether black bear population objectives are being met (e.g., stabilize growth), if a sustainable population is being maintained, and whether hunting regulations need to be modified to meet management goals.

Black bear populations can accommodate regulated hunting on an annual basis (CA FED 2000, Williamson 2002, PGC 2005), and regulated black bear hunting is the major factor controlling most bear populations (Obbard and Howe 2008). Depending on harvest levels, black bear populations can increase, decrease, or remain the same in the presence of hunting.

Black bear populations may decrease with heavy hunting pressure, and because female bears produce only a few cubs every other year, reduced bear populations can be slow to recover. Thus, black bear hunting seasons are generally conservative unless population reduction is the objective (Miller 1990). Bear populations will grow when the number of juvenile bears that reach adulthood (i.e., recruitment) exceeds the number of bears that die (i.e., hunting and non-hunting

Determining Appropriate Black Bear Populations

Decisions about the appropriate distribution and abundance of bears are influenced by the suitability of a particular landscape for bears and the public's desire for and tolerance of bears.

The concept of biological carrying capacity (BCC) suggests that maximum bear abundance is limited by the availability of habitat resources such as food, water, shelter (e.g., den sites), and space. As bear populations approach BCC, increasing bear social pressures may influence population dynamics and population growth may be limited by later ages of first reproduction, longer intervals between litters, smaller litter sizes, decreased cub and yearling survival rates, and greater social conflict.

Cultural carrying capacity (CCC) is the maximum number of bears that humans will tolerate in a certain area. The types of interactions people have with bears influence CCC. Typically, in areas where bear and human populations overlap, the upper limit of CCC falls well below BCC. Consequently, black bear management often centers on CCC, and populations are managed by accounting for differences in stakeholder views, beliefs, and tolerances regarding human bear interactions.

mortality) or emigrate that year. Populations are stabilized when deaths equal annual recruitment (if immigration and emigration are similarly equal). Historically, managed hunting has been an effective system for conserving bear populations because it has enlisted a segment of the public interested in the continued abundance of the resource (Garshelis 2002). Additionally, the North American Model of Wildlife Conservation recognizes that bears should be managed as a wildlife asset to perpetuate and not just treated as vermin to be removed from the ecosystem to eliminate conflicts.

Adjusting the hunting season structure to coincide with periods of crop damage, to enhance hunter effort, or to provide access to urban areas may provide greater opportunities to remove bears from the population that are persistently involved in conflict (Raithel et al. 2016). The establishment of a September black bear hunting season in Wisconsin increased the harvest of black bears that were causing damage and decreased the average number of black bears removed annually using kill permits from 110 to 19 (Hygnstrom and Hauge 1989). Similarly, a season extension in Pennsylvania to allow concurrent bear and deer (*Odocoileus virginianus*) hunting seasons resulted in increased harvest rates of conflict bears (Ternent 2008). However, Treves et al. (2010) concluded that regulated hunting to reduce conflicts may be ineffective unless season structure is designed specifically to attain that goal. Each situation should be evaluated individually to determine if a change in season structure may affect the conflict situation favorably.

Regulated harvest of black bear populations is occasionally a controversial social issue. Perhaps the most contentious issues involve fair chase and the ethics of certain methods of harvest, especially trapping of bears, hunting bears over bait, hunting with dogs, or hunting in the spring. Possible physical effects on black bears from hunting and the expense of regulating various hunting methods also have been questioned by critics of black bear hunting (Beck et al. 1994, Loker and Decker 1995).

A black bear harvested during a regulated hunting season - Courtesy nvhuntingservices.com.

However, few studies have addressed the effects of hunting methods on bears. Massopust and Anderson (1984*b*) concluded that bears were not physically affected when repeatedly chased by hounds. Allen (1984) found that most bears either never left their home range during the pursuit or returned shortly thereafter.

Regulated hunting provides economic benefits in the form of hunting-related expenditures (e.g., food, lodging, equipment, and transportation) and may have a significant economic impact in rural communities. However, economic benefits of regulated black bear hunting are not limited to hunting expenditures. A complete economic evaluation of bear hunting should also include added damage costs (e.g., increased agricultural losses, increased vehicle collisions) that would be incurred with growing bear populations in the absence of hunting. Additionally, by purchasing licenses to hunt bears, hunters contribute financially while they also provide a public service (i.e., bear population control).

Benefits:
Regulated black bear hunting and trapping are compatible with increasing, decreasing, or stable population management objectives. Wildlife managers have the potential to effectively control black bear population levels through the manipulation of season structure and length. Increasing bear populations can be achieved through conservative hunting seasons designed to protect certain segments of the black bear population (e.g., mature females). Stable or decreasing bear populations can be achieved through more liberal hunting seasons that offer reduced protection for adult females. Additionally, regulated bear harvest may reduce human–bear conflicts by controlling population levels. Some potential exists for targeting nuisance black bears by adjusting timing and length of hunting seasons, bag limits, and legal methods of harvest (e.g., implementing seasons coinciding with high levels of agriculture damage).

Challenges:
Increasing hunting quotas may divert agency attention from important preventative measures like limiting the availability of garbage in urban environments to permanently reduce conflict. Most issues faced by management agencies concerning regulated hunting or trapping of black bears are associated with human social dynamics. Proportionally, fewer people hunt today than in previous decades, and groups that oppose hunting are well organized and vocal. Estimating black bear population size has not been standardized, and some methods are more accurate and precise than others. Additionally, regulated hunting with certain methods may not be socially acceptable or feasible near urban areas.

CONTROL OF NON-HUNTING MORTALITY

In black bear populations, non-hunting mortality is highest among young bears. Non-hunting mortality sources include vehicle collisions, poaching, predation, starvation, drowning, and disease (Higgins 1997, Ryan 1997). The non-hunting mortality sources that agencies can influence directly include vehicle collisions and poaching.

Bear–vehicle collisions can be a substantial source of black bear mortality. Highways can alter bear movements and increase human–bear interactions. Roads are not impermeable barriers to bear movement and habitat use (Carr and Pelton 1984, van Manen et al. 2012), but bears cross roads less as vehicle traffic increases (Brody and Pelton 1989). Food availability, including garbage along roadways, may cause bears to use areas adjacent to roads or entice bears to cross highways, increasing bear vulnerability. Bear–vehicle collisions and habitat fragmentation by high-volume roadways are important considerations in areas where bear populations have special administrative designations, such as threatened or recovering populations.

Wildlife crossing structures are designed to facilitate safe passage above or below roadways and are often used as mitigation for areas where roads bisect bisecting wildlife habitats. Black bears use highway crossing structures where convenient (Foster and Humphrey 1995, Clevenger and Waltho 2000), but annual fluctuations in food availability, weather patterns, and bear behavior may influence underpass use (Donaldson 2005). Although crossing structures benefit wildlife and improve public safety in general, no conclusive evidence suggests that highway fencing or underpasses reduce the non-hunting mortality of black bears. Long term studies are still needed.

Bear mortality due to vehicle collision - Courtesy Walt Mandeville.

Regional Example

*Crossing structures developed specifically for black bears are uncommon. In several northeastern states and provinces, crossing structures have been used to reduce vehicle collisions with moose (*Alces *spp.), elk (*Cervus *spp.), or deer (*Odocoileus *spp.) primarily, but black bears are also known to use these structures.*

*However, in Florida, black bear populations are isolated, numbers are low, and new roads are being constructed at high rates. As a result, Florida Fish and Wildlife Conservation Commission and Florida Department of Transportation have designed a wildlife underpass, posted signs to alert motorists of bear crossing areas, and reduced speed limits to reduce bear–vehicle collisions. In addition to black bears, bobcats (*Lynx rufus*), gray foxes (*Urocyon cinereoargenteus*), and white-tailed deer (*O. virginianus*) have used the underpass.*

Adequate assessments of poaching effects on black bear populations are difficult to obtain. Given that black bear populations are stable or increasing throughout most of their range, poaching might not be having substantial negative influences on established black bear populations. Poaching losses may affect population growth rates in areas of low bear densities. Yet, activities of poachers are secretive, complicating quantification of their effects. Effort and exploitation varies with motive and ranges from commercial gain to personal use (Williamson 2002).

Increased levels of law enforcement to limit poaching are also costly. Wildlife law enforcement officers are generally distributed across broad geographic areas and detecting a crime in progress is challenging. Many wildlife crimes are detected only if a citizen reports unlawful activity. Unless black bear populations are small, isolated, and substantially affected by non-hunting mortality, the cost of controlling non-hunting mortality may be prohibitive.

Wildlife underpass - Courtesy Florida Fish and Wildlife Conservation Commission.

Benefits:

In general, controlling non-hunting mortality can help increase bear numbers in small isolated populations but could also be important for established populations during years when natural forage is scarce and non-hunting mortality spikes. Identifying critical areas along roadways where significant road-kill occurs and mitigating these areas could help sustain bear populations and improve public safety. Decreasing poaching and other forms of non-hunting mortality through effective law enforcement and educational efforts can produce positive public image results for the agency.

Challenges:

The financial costs associated with controlling non-hunting mortality can be substantial. For example, a box culvert underpass in Florida was estimated to cost $870,000 USD (Land and Lotz 1996), a bridge extension was estimated at $433,000 USD (Macdonald and Smith 1999), and a wildlife overpass in Alberta, Canada was estimated to cost $1.15 million USD (Forman et al. 2003). Controlling non-hunting mortality does not address root causes of human–bear conflict and could enhance conflict levels by maintaining higher densities of bears. Wildlife crossing structures or barriers can be extremely cost prohibitive.

FERTILITY CONTROL

Fertility control for bears involves the use of chemical contraception (e.g. steroids, estrogens, and progestin) that is injected into a segment of the population. Federal authority to regulate fertility control agents on wildlife is handled by the Environmental Protection Agency (EPA) in the United States and Health Canada in Canada. Neither EPA nor Health Canada has approved any chemical fertility control on an experimental basis for any wild population of bears. The concept of immunocontraception (i.e., vaccines that stimulate the body's immune system to stop production of antibodies, hormones, or proteins essential for reproduction) is a recent technology that might lead to fertility control as a population control option for bears. In most situations, fertility control agents may only slow population growth or stabilize the population at current levels (Garrott 1991). It is unlikely that the cost or efficiency of delivery for contraceptive techniques would allow their use on free-ranging game populations outside of urban areas (Fagerstone et al. 2002). From a population perspective, removing animals directly is the most cost-effective means of controlling population size (Garrott 1995). Although use of fertility control agents may limit population growth, it does not immediately reduce the population size, which is usually the major objective of population control.

Benefits:

Fertility control trials in coyotes have shown that reducing the production of offspring eliminates the need for adults to provision young which in turn leads to reduced predation on sheep. For black bears, there has not been a documented link between conflict and provisioning young. Therefore, the advantages of fertility control would be found primarily in the reduction of bear populations, assuming that bear population density is strongly linked to conflict.

Challenges:

Should fertility control techniques be developed for bears, changes in bear density would only occur over a long-time frame during which human–bear conflicts would continue. Although long-lived species are least suited for population reduction through use of fertility control, most fertility control research and applications have been directed at the management of white-tailed deer and wild horse populations, both long-lived species (Fagerstone et al. 2002). Because research on the use and effectiveness of fertility control agents on black bears is insufficient, fertility control should not be considered a viable option for black bear population management until the efficacy, health effects, behavioral changes, method of administration, and costs are scientifically evaluated and determined to be effective. Fertility control is unlikely to become a feasible means to manage bear populations due to the inherent expense in capturing bears, low population densities, and large movements (Fraker et al. 2006).

Highly productive adult female black bear - Courtesy New Jersey Department of Environmental Protection.

Regional Example

The New Jersey Division of Fish and Wildlife (NJDFW) is responsible for managing black bears to assure their continued survival, while addressing the property damage and safety concerns of New Jersey residents and farmers. The New Jersey black bear population has been growing and its range expanding, leading to an increasing number of conflicts with humans. Although NJDFW biologists have determined that the bear population can support a regulated hunting season, state officials investigated the development of non-lethal management methodologies, recognizing that alternative methods of controlling wildlife populations may be necessary because traditional means, such as recreational hunting and trapping, may not always be appropriate or effective in certain environments.

The New Jersey Department of Environmental Protection (NJDEP), parent agency of NJDFW, entered into a Memorandum of Understanding with the Humane Society of the United States (HSUS) to investigate the feasibility of fertility control to control New Jersey's black bear population. NJDEP entered into this MOU to evaluate 2 approved agents. One immunocontraceptive, Porcine zona pellucida *(PZP) was deemed successful in limiting cub production in captive black bears at Bear Country USA, South Dakota. The FDA also approved Neutersol® as a permanent sterilant for male puppies in 2003 allowing for extra-label use of Neutersol in any nonfood animal. An immunocontraception pilot project on 5 female and 8 male captive black bears at Six Flags Wild Safari was initiated in 2003. One of three treated female bears gave birth to a cub, and the female segment of the study was discontinued after 1 year. The study concluded that, although the male bears were developing testicular degenerative changes from the treatment, sperm production was not completely eliminated, and that the treatment is unlikely to result in sterility (Brito et al. 2011). No further information on the effectiveness of either vaccine has been made available by HSUS (Mike Madonia, NJDEP – personal communication).*

HABITAT MANAGEMENT

Black bears are adapted to use a wide variety of habitat types. Habitat type and diversity is important for satisfying black bear habitat requirements. Managed forests that provide a mix of young and older stands likely provide better black bear habitat than unmanaged forests. Forest management that provides sustained and abundant food supply throughout the year (e.g., hard mast, soft mast, herbaceous foods, and invertebrates), denning sites, and escape cover benefits black bears. Because hard mast is an important fall food source for bears, management strategies should encourage the sustained availability of mature, hard mast producing trees (e.g., oak, hickory, beech, pinon pine) if bears are a management focus. Integration of timber cuttings, prescribed burning, and management of woodland openings affords the greatest potential for improving, maintaining, and establishing black bear habitat (Brody and Stone 1987, Juárez-Casillas and Varas 2013, Hurst et al. 2012).

The urban-wildland interface and encroaching urbanization - Courtesy Jon Beckmann.

Habitat quality, through its influence on food abundance, affects reproduction and survival of cubs. Poor nutrition can delay the breeding season, increase the age of sexual maturity, and lengthen the normal 2-year interval between litters. Following a year of limited fall food availability, females may produce fewer cubs and cub survival decreases (Beckmann and Berger 2003*a*, Beckmann and Lackey 2008, Lewis 2013).

Habitat fragmentation and subsequent isolation of black bear populations is a concern for small bear populations. Corridors connecting isolated black bear populations have been recommended to ensure the long-term persistence of bears (Rudis and Tansey 1995). Human influence on urbanization, agriculture, and high traffic volume roads can affect corridors and linkages among populations. As human populations grow, corridor protection and development become more important for the long-term persistence of bears. Although habitat management has consequences for black

bears, the ability to effectively manage habitat has become more complex. Public land management has been influenced by increased public resistance to silvicultural treatments (e.g., clear cutting, prescribed fire), increased environmental regulation, and decreased budgets (Weaver 2000). Prescribed burning can be challenging to implement due to public perceptions about fire suppression and air quality concerns. Private and corporate land management may not benefit from the professional resource input during public resource management deliberations.

Costs associated with habitat management for black bears depend on management activities conducted. Some silvicultural practices generate revenue for the landowner. However, prescribed burning, maintenance of woodland openings, and activities designed to alleviate site-specific human–bear conflicts may have net costs associated with implementation (Weaver 2000).

Southern Vermont wind farm - Courtesy Vermont Fish and Wildlife Department.

Benefits:

Maintenance of diverse, productive black bear habitat provides a variety of natural food sources that can keep bears from searching for forage in areas developed by people and therefore serve to reduce human–bear conflicts. Future development should integrate into existing bear habitat by eliminating security cover and known attractants (e.g., fruit trees) from development plans. Such considerations prior to development will play an important role in reducing conflict over the long-term. In situations in which development has already occurred and substantial conflict is prevalent, eliminating fruit-bearing trees and modifying natural habitat features in ways that reduce the attractiveness to black bears could help reduce conflict.

Challenges:

Management agencies with responsibility for bears rarely have land management authority over public or private lands. Private property owners and municipalities are often resistant to the elimination or reduction of fruit producing trees or shrubs. Large scale habitat manipulation can be cost prohibitive.

NO POPULATION INTERVENTION

If bear populations were to persist in the absence of human intervention, populations would increase until reaching BCC. The point at which black bear populations achieve BCC is unknown for much of the United States or Canada but would vary regionally and seasonally with habitat quality and food availability. In most locations, BCC for black bear populations exceeds CCC.

Allowing black bears to self-regulate in the absence of regulated hunting is rare and primarily occurs in national parks or other refugia where access is limited. Occasionally this strategy may be suited for areas with low-density black bear and human populations where the incidence of human–bear conflicts is limited, and where increased bear populations are desired. But throughout the vast majority of black bear range, failure to engage in regulated population management (i.e., hunting) may lead to increases in human–bear conflicts, management removals, and mortality due to other factors like vehicle collisions. In both Florida and New Jersey, political pressure closed bear hunts for varying lengths of time and resulted in reduced ability of management agencies to respond to conflict (M. Orlando, personal communication).

Humans have had a dramatic effect on the ecosystems of North America. Among many perturbations, humans have altered landscapes, changed and manipulated plant communities, displaced large predators, eliminated native species, and introduced numerous exotic species. Natural systems and their regulatory processes have changed as a result of these effects. Restoring bear populations and their habitats to a pre-settlement, pristine state is not realistic regardless of whether an intensive management or intentional non-management approach is adopted.

Costs associated with intentional non-management vary with black bear population density. For low-density black bear populations, the cost of implementation is probably minimal. However, as black bear populations grow and exceed CCC, costs associated with the increased conflicts may be substantial. Failure to engage in regulated population management may lead to increased human–bear conflicts, and ultimately the killing of bears by members of the public perceiving risk or by agency staff. Allowing bear populations to increase can have negative population effects on other prey species (Hristienko and McDonald 2007).

Benefits:
Allowing nature to take its course may be the preferred method for specific segments of the public. It may be feasible in areas where the management goal of an increase in the bear population is both sustainable and ecologically appropriate. It can create refugia for bear populations and direct costs to agencies are lower until conflicts increase.

Challenges:
No intervention may have site-specific impacts on human–bear conflicts because generally, as bear populations increase, human–bear conflicts also will increase. Thus, the indirect costs to agencies may increase and negative effects to some prey species populations could occur. Bear populations can exceed CCC and instead of bears being harvested by regulated hunting, increased management removal may be necessary.

Bears may spend a considerable amount of time resting in trees - Courtesy Todd Black.

Regional Example

In the Cranberry Black Bear Sanctuary in West Virginia, and in other areas that prohibit hunting, there was no active management program to control black bear populations. Consequently, on many of these lands, bear management was not focused on population control, and managers allowed nature to take its course with respect to bear population growth rates and demographic parameters. The primary focus was on reducing the effects of visitors on local bear populations. To accomplish this goal, agency personnel attempted to educate visitors and eliminate the intentional or unintentional feeding of bears. In addition, agency personnel were trained to aversively condition or relocate bears that engaged in conflict with visitors to the sanctuary. However, because many bears became human-habituated or human-food conditioned, repeat offenders were ultimately killed. Moreover, because bear populations have become so high in West Virginia and other eastern jurisdictions, there was not an area to relocate animals to that did not already have a population at or above population goals. In many of these areas protected from hunting, bear population growth is relatively high, and visitors often note that observing a black bear in its natural habitat is a highlight of their experience. However, areas surrounding these refugia can experience unusually high levels of human–bear conflicts through increased crop and residential damage and bear–vehicle collisions.

The presence of large refugia where bear population growth is not actively managed is a challenge to state and provincial wildlife biologists who seek to mitigate the impact these bears have on surrounding landscapes and communities. The West Virginia Division of Natural Resources opened the Cranberry Black Bear Sanctuary to hunting in 2007 and has begun to regulate the population through hunting seasons.

A habituated black bear - Courtesy 9caribou.com.

A habituated bear uses dumpster for an easy meal – Courtesy 9caribou.com.

RESEARCH NEEDS

When management agencies become more successful in reducing human–bear conflicts and managing conflict bears, it will be due in part to an improvement in the techniques used to mitigate conflict situations, and an understanding of what it takes to convince people that being proactive in attraction management is imperative. Reliance on current techniques without evolving management strategies that mirror changes in technology and social expectations will not be enough. As society in general has moved further away from a traditional connection with nature (i.e., hunting and fishing) the social expectations regarding human–wildlife conflict resolution has changed. For example, with social media as a platform, activists put increasing pressure on agencies to use only non-lethal control measures. However, the liability that agencies face has not decreased; agencies must still remove bears that pose a public safety risk.

Decades of using translocation as a means of dealing with conflict bears has created a mind-set among the public that their "problem bear" will go away with the setting of a trap. When public education messaging is accurate and widespread, why is it not more effective (Baruch-Mordo et al. 2011)? Do techniques like AC and on-site releases really accomplish anything more than just keeping an individual bear on the landscape a little bit longer? And if so, is it worth the costs and human resources? How can we avoid the repeat performance, whereby a bear is trapped and released but ultimately returns and receives another food reward in the very same neighborhood? And why is it that some people only change their behavior after they have had a personal encounter with a conflict bear, despite being exposed to constant agency messaging (Gore et al. 2008)? The answers to these questions have been elusive. The array of techniques currently used is a result of managers constantly looking for a way to efficiently and cost-effectively deal with human–bear conflicts, and arguably none have proven to be 100% successful.

Recent studies into the social intricacies of wildlife conflict have shed some light on the challenges we still face (Manfredo et al. 2009, Gallagher and Logsdon-Conradsen 2012, Clark et al. 2017, Manfredo et al. 2017), yet much more needs to be done on this front. There is a need for new ideas and for improvement on older techniques. Ultimately, we need the magic wand that makes all the people do the right thing all the time.

Bear fishing from river – Courtesy John Axtell.

AGENCY POLICY

Each agency should develop a policy describing when, where, and under what conditions action should be taken. The policy should provide general guidance, rather than strict direction, for staff and personnel to respond to conflicts between humans and black bears. History and litigation have demonstrated the importance for each jurisdiction to adopt policy relevant to their situation, provide staff with training in its implementation, and adhere to consistent interpretation and use of that policy (e.g., Perry and Rusing 2001). Failure to consistently apply this guidance exposes agencies to substantial liability. Further, periodic review and updating ensures the consideration of new scientific knowledge as it is developed and increased likelihood that conflicts can be prevented.

Wildlife agencies rarely have authority to regulate important aspects that substantially influence the likelihood of future conflicts, such as garbage collection, enforcement of existing local ordinances, or recreational feeding of birds in neighborhoods. Local municipalities often have difficulty enacting the types of ordinances that, if enforced, could reduce the likelihood for conflicts. Consequently, education and cooperation are paramount in preventing conflicts.

A wildlife management agency can be doing everything reasonably necessary to fulfill its obligations regarding animals and people and still remain vulnerable. When developing guidance, the policy should provide discretion as opposed to mandatory edicts. This allows an agency to avail itself or staff of discretionary or administrative immunities that may exist in certain jurisdictions. For example, instead of having a policy say a bear "shall be removed" or "shall be destroyed," such language could be substituted with "may be destroyed" or "may be moved" at the discretion of the wildlife manager (Perry and Rusing 2001).

Another approach is simply kill more bears (Perry and Rusing 2001). This is an approach that is not supported by many interested publics that often initiate feeding or protective organizations. Agencies should not expect to be able to hunt themselves out of the issue of human-black bear conflicts.

Statutory protections providing for specific immunity from attacks by wild animals can be useful to eliminate the possibility of exposure of the wildlife agency to liability. Yet the most effective method to eliminate conflicts with black bears, protect agency from liability, and promote public safety is to remove the anthropomorphic attractants that enticed the wildlife into conflict.

LITERATURE CITED

Allen, R. B. 1984. Experimental pursuit of black bears with trained bear dogs. Proceedings of the Eastern Workshop on Black Bear Management and Research 7:54–58.

Alt, G. L. 1980. Rate of growth and size of Pennsylvania black bears. Pennsylvania Game News 51:7–17.

Alt, G. L., G. J. Matula, Jr., F. W. Alt, and J. S. Lindzey. 1977. Movements of translocated nuisance black bears of northeastern Pennsylvania. Transactions of the Northeastern Fish and Wildlife Conference 34:119–126.

Andelt, W. F., and S. N. Hopper. 2000. Livestock guard dogs reduce predation on domestic sheep in Colorado. Journal of Range Management 53:259–267.

Arthur, L. M. 1981. Measuring public attitudes toward resource issues: coyote control. United States Department of Agriculture Technical Bulletin 1657, Washington, D.C., USA.

Baruch-Mordo, S., S. W. Breck, K. R. Wilson and D. M. Theobald. 2008. Spaciotemporal distribution of black bear-human conflicts in Colorado, USA. Journal of Wildlife Management 72:1853–1862.

Baruch-Mordo, S., S. W. Breck, K. R. Wilson, and J. Broderick. 2011. The carrot or the stick? Evaluation of education and enforcement as management tools for human-wildlife conflicts. PLoS ONE 6:e15681.

Baruch-Mordo S., K. R. Wilson, D. L. Lewis, J. Broderick, J. S. Mao and S. W. Breck. 2014. Stochasticity in Natural Forage Production Affects Use of Urban Areas by Black Bears: Implications to Management of Human–bear Conflicts. PLoS ONE 9(1):e85122. doi:10.1371/journal.pone.0085122.

Beck, T. D. I., D. S. Moody, D. B. Koch, J. J. Beechman, G. R. Olson, and T. Burton. 1994. Sociological and ethical considerations of black bear hunting. Proceedings of the Western Workshop on Black Bear Research and Management 5:119–131.

Beckmann, J. P., and J. Berger. 2003*a*. Rapid ecological and behavioral changes in carnivores: the responses of black bears (*Ursus americanus*) to altered food. Journal of Zoology 261:207–212.

Beckmann, J. P., and J. Berger. 2003*b*. Using black bears to test ideal-free distribution models experimentally. Journal of Mammology 84:594–606.

Beckmann, J. P., and C. W. Lackey. 2004. Are desert basins effective barriers to movements of relocated black bears (*Ursus americanus*)? Western North American Naturalist 64:269–272.

Beckmann, J. P., and C. W. Lackey. 2008. Carnivores, urban landscapes and longitudinal studies: a case history of black bears. Human–Wildlife Conflicts 2:77–83.

Beckmann, J. P., C. W. Lackey, and J. Berger. 2004. Evaluation of deterrent techniques and dogs to alter behavior of “nuisance” black bears. Wildlife Society Bulletin 32:1141–1146.

Beckmann, J. P., L. Karasin, C. Costello, S. Matthews, and Z. Smith. 2008. Coexisting with black bears: Perspectives from four case studies across North America. WCS Working Paper No. 33. Wildlife Conservation Society, New York, New York, USA.

Beringer, J., A. Timmons, and T. L. Hiller. 2016. Unintentional toxicosis from methylxanthines in chocolate-based baits consumed by American black bears. Wildlife Society Bulletin 40:380–383.

Breck, S. W., C. L. Williams, J. P. Beckmann, S. M. Matthews, C. W. Lackey, and J. J. Beecham. 2008. Using genetic relatedness to investigate the development of conflict behavior in black bears. Journal of Mammalogy 89:428–434.

Brito, L. F. C., P. L. Sertich, W. Rives, M. Knobbe, F. Del Perio, and G. B. Stull. 2011. Effects of intratesticular zinc gluconate treatment on testicular dimensions, echodensity, histology, sperm production, and testosterone secretion in American black bears (*Ursus americanus*). Journal of Theriogenology 75:1444–1452.

Brody, A. J., and J. Stone. 1987. Timber Harvest and Black Bear Population Dynamics in a Southern Appalachian Forest. International Conference on Bear Research and Management 7:243–250.

Brody, A. J., and M. R. Pelton. 1989. Effects of roads on black bear movements in western North Carolina. Wildlife Society Bulletin 17:5–10.

Brush, F. 1971. Aversive conditioning and learning. Academic Press, New York, New York, USA

Burns, R. J. 1983. Microencapsulated lithium chloride bait aversion did not stop coyote predation on sheep. Journal of Wildlife Management 47:1010–1017.

CA FED. 2000. California Final Environmental Document, Section 265, 365, 367, 367.5, Title 14, California Code of Regulations Regarding Bear Hunting. April 27, 2000. California Department of Fish and Game, Sacramento, California, USA.

Can, O. E., N. D'Cruze, D. L. Garshelis, J. Beecham, and D. W. Macdonald. 2014. Resolving human–bear conflict: a global survey of countries, experts, and key factors. Conservation Letters 6. https://doi.org/10.1111/conl.12117.

Carlos, A. W. D., A. Bright, T. L. Teel, and J. J. Vaske. 2009. Human-black bear conflict in urban areas: an integrated approach to management response. Human Dimensions of Wildlife 14:174–184.

Carr, P. C., and M. R. Pelton. 1984. Proximity of adult female black bears to limited access roads. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 38:70–77.

Clark, J. E., F. T. van Manen, and M. R. Pelton. 2002. Correlates of success for on-site releases of nuisance black bears in Great Smokey Mountains National Park. Wildlife Society Bulletin 30:104–111.

Clark K. E., K. Cupp, C. L. Phelps, M. N. Peterson, K. T. Stevenson, and C. Serenari. 2017. Household dynamics of wildlife value orientations. Human Dimensions of Wildlife 22: 483–491.

Clevenger, A. P. and N. Waltho. 2000. Factors influencing the effectiveness of wildlife underpasses in Banff National Park, Alberta, Canada. Conservation Biology 14:47–56.

Colorado Parks and Wildlife. 2015. Human–bear conflicts. Colorado Parks and Wildlife Agency publication, Denver, Colorado, USA.

Comly, L. M. 1993. Survival, reproduction, and movements of translocated nuisance black bears in Virginia. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA.

Creel, E. 2007. Effectiveness of deterrents on black bears (*Ursus americanus*) to anthropogenic attractants in urban-wildland interfaces. Thesis, Humboldt State University, Arcata, California, USA.

Decker, D. J., H. E. Kretser, M. L. Gore, K. M. Leong, and W. F. Siemer. 2005. Wildlife management on rural-urban interfaces: cooperation and conflict between science and society. Pages 149–153 in D. N. Laband, editor. Proceedings of Emerging Issues Along Urban/rural Interfaces: Linking science and society. Center for Forest Sustainability, Auburn University, Auburn, Alabama, USA.

Dietsch, A. M., K. M. Slagle, S. Baruch-Mordo, S. W. Breck, and L. M. Ciarniello. 2017. Education is not a panacea for reducing human-black bear conflict. Ecological Modeling https://doi.org/10.1016/j.ecolmodel.2017.11.005.

Donaldson, B. M. 2005. The use of highway underpasses by large mammals in Virginia and factors influencing their effectiveness. Virginia Transportation Research Council, VTRC06-R2. Charlottesville, Virginia, USA.

Engel, J. W. 1963. An analysis of the deer-bear damage stamp funds in Virginia. Proceedings of the 17th Annual Conference of the Southeastern Association of Game, Fish and Conservation Commissioners (currently Southeastern Association of Fish and Wildlife Agencies) 17:100–107.

Fagerstone, K. A., M. A. Coffey, P. D. Curtis, R. A. Dolbeer, G. J. Killian, L. A. Miller, and L. M. Wilmont. 2002. Wildlife Fertility Control. Wildlife Society Technical Review 02-2.

Fies, M. L., D. D. Martin, and G. T. Blank, Jr. 1987. Movements and rates of return of translocated black bears in Virginia. International Conference on Bear Research and Management 7:369–372.

Follmann, E. H. 1989. The importance of advance planning to minimize bear-people conflicts during large scale industrial and transportation developments in the North. Pages 105–110 *in* M. Bromley, editor. Bear-people Conflicts: Proceedings of a Symposium on Management Strategies. Northwest Territories Department of Natural Resources, Yellowknife, Canada.

Forman, R. T. T., D. Sperling, J. Bissonette, A. Clevenger, C. Cutshall, V. Dale, L. Fahrig, R. France, C. Goldman, K. Heanue, J. Jones, F. Swanson, T. Turrentine, and T.C. Winter. 2003 Road Ecology: Science and Solutions. Island Press, Washington, D.C., USA.

Foster, M. L., and S. R. Humphrey. 1995. Use of highway underpasses by Florida panthers and other wildlife. Wildlife Society Bulletin 23:95–100.

Fraker, M. A., P. D. Curtis, and M. Mansour. 2006. An analysis of the feasibility of using fertility control to manage New Jersey black bear populations. New Jersey Department of Environmental Protection, Division of Science, Research and Technology, Trenton, New Jersey, USA.

Gallagher, G. R., and S. Logsdon-Conradsen. 2012. Tactical to practical: The human component of human–wildlife conflict resolution. Proceedings of the Vertebrate Pest Conference 25:317–321.

Garcia, J., W. G. Hankins, and K. W. Rusiniak. 1974. Behavioral regulation of the milieu interne in man and rat. Science 185:824–831.

Garrott, R. A. 1991. Feral horse fertility control: potential and limitations. Wildlife Society Bulletin 19:52–58.

Garrott, R. A. 1995. Effective management of free-ranging ungulate populations using contraception. Wildlife Society Bulletin 23:445–452.

Garshelis, D. L. 2002. Misconceptions, ironies, and uncertainties regarding trends in bear populations. Ursus 13:321–334.

Gehring, T. M., K. C. VerCauteran, and J. M. Landry. 2010. Livestock protection dogs in the 21st century: is an ancient tool relevant to modern conservation challenges? Bioscience 60:299–308.

Geist, V., S. P. Mahoney, and J. F. Organ. 2001. Why hunting has defined the North American Model of Wildlife Conservation. Transactions of the North American Wildlife and Natural Resources Conference 66:175–185.

Godfrey, C. L. 1996. Reproductive biology and denning ecology of Virginia's exploited black bear population. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA.

Gore, M. L., and B. A. Knuth. 2006. Attitude and behavior change associated with the New York NeighBEARhood Watch Program. HDRU Publ. 06-14. Department of Natural Resources, Cornell University, Ithaca, New York, USA.

Gore, M. L., B. A. Knuth, C. W. Scherer, and P. D. Curtis. 2008. Evaluating a conservation investment designed to reduce human–wildlife conflict. Conservation Letters 1:136–145.

Gray, R. 2001. Impacts of feeding on black bear nutrition, reproduction, and survival in Virginia. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA.

Green, J. S., and R. A. Woodruff. 1989. Livestock-guarding dogs reduce depredation by bears. Pages 49–54 *in* M. Bromley, editor. Bear-people conflicts: proceedings of a symposium on management strategies. Northwest Territories Department of Natural Resources, Yellowknife, Canada.

Green, J. S., R. A. Woodruff, and W. F. Andelt. 1994. Do livestock guardian dogs lose their effectiveness over time? Proceedings of the sixteenth vertebrate pest conference, W. S. Halverson and A. C. Crabb, editors. http://digitalcommons.unl.edu/vpc16/22.

Gunther, K. A. 1994. Bear management in Yellowstone National Park, 1960–93. International Association for Bear Research and Management 9:549–560.

Gunther, K. A., M. T. Bruscino, S. Cain, J. Copeland, K. Frey, M. A. Haroldson and C. C. Schwartz. 2000. Grizzly bear-human conflicts, confrontations and management actions in the Yellowstone ecosystem, 1999. Pages 55–108 *in* Yellowstone grizzly bear investigations. US Geological Survey, Bozeman, Montana, USA.

Gunther, K. A., M. A. Haroldson K. Frey, S. L. Cain, J. Copeland, and C. C. Schwartz. 2004. Grizzly bear-human conflicts in the Greater Yellowstone ecosystem, 1992–2000. Ursus 15:10–22.

Hastings, B. C., B. K. Gilbert, and D. L. Turner. 1981. Black bear behavior and human–bear relationships in Yosemite National Park. Cooperative Park Studies Unit Technical Report 2, University of California, Davis, USA.

Higgins, J. C. 1997. Survival, home range use and spatial relationships of Virginia's exploited black bear population. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA.

Herrero, S., and A. Higgins. 1998. Field use of capsaicin spray as a bear deterrent. Ursus 10: 533–537.

Herrero, S., and A. Higgins. 2003. Human injuries inflicted by bears in Alberta: 1960–1998. Ursus 14:44–54.

Herrero, S., T. Smith, T. D. Debruyn, K. Gunther and C. A. Matt. 2005. From the field: brown bear habituation to people-safety, risks and benefits. Wildlife Society Bulletin 33:362–373.

Hopkins, J. B., S. Herrero, R. T. Shideler, K. A. Gunther, C. C. Schwartz, and S. T. Kalinowski. 2010. A proposed lexicon of terms and concepts

for human–bear management in North America. Ursus 21:154–168.

Horton, R. R., and S. R. Craven. 1997. Perceptions of shooting-permit use for deer damage abatement in Wisconsin. Wildlife Society Bulletin 25:330–336.

Hostetler, J. A., J. W. McCown, E. P. Garrison, A. M. Neils, M. A. Barrett, M. E. Sunquist, S. L. Simek, and M. K. Oli. 2009. Demographic consequences of anthropogenic influences: Florida black bears in north-central Florida. Biological Conservation 142:2456–2463.

Hristienko, H., and J. McDonald, Jr. 2007. Going into the 21st Century: A Perspective on Trends and Controversies in the Management of the American Black Bear. Ursus 18:72–88.

Hurst, J. E., C. W. Ryan, C. P. Carpenter, and J. L. Sajecki. 2012. An evaluation of black bear management options. Northeast black bear technical committee – Report of the Northeast Black Bear Technical Committee.

Hygnstrom, S. E. 1994. Black bears. Pages C-5 – C-15 *in* S. E. Hygnstrom, R. M. Timm, and G. E. Larson, editors. Prevention and control of wildlife damage. University of Nebraska Press, Lincoln, Nebraska, USA.

Hygnstrom, S. E., and T. M. Hauge. 1989. A review of problem black bear management in Wisconsin. Pages 163–168 *in* M. Bromley, editor. Bear-people conflicts: proceedings of a symposium on management strategies. Northwest Territories Department of Natural Resources, Yellowknife, Canada.

Johnson, H. E., S. W. Breck, S. Baruch-Mordo, D. L. Lewis, C. W. Lackey, K. R. Wilson, J. Broderick, J. S. Mao, and J. P. Beckmann. 2015. Shifting perceptions of risk and reward: Dynamic selection for human development by black bears in the western United States. Biological Conservation 187:164–172.

Johnson, H. E., D. L. Lewis, S. A. Liska, and S. W. Breck. 2018. An experimental test of bear-resistant containers to reduce human-black bear conflicts and improve public perceptions. Journal of Wildlife Management doi:10.1002/jwmg.21472.

Jorgensen, C. J., R. H. Conley, R. J. Hamilton, and O. T. Sanders. 1978. Management of black bear depredation problems. Proceedings of the Eastern Workshop on Black Bear Research and Management 4:297–319.

Juárez-Casillas, L. A., and C. Varas. 2013. Evaluation of black bear (*Ursus americanus*) diet and consequences in its conservation in Sierra de Picachos, Nuevo León, Mexico. Revista Mexicana de Biodiversidad 84:970–976.

Keay, J. A., and M. G. Webb. 1989. Effectiveness of human–bear management at protecting visitors and property in Yosemite National Park. Pages 145–154 *in* M. Bromley, editor. Bear-people conflicts: proceedings of a symposium on management strategies. Northwest Territories Department of Natural Resources, Yellowknife, Canada.

Kitayama, S., L. G. Conway III, P. R. Pietromonaco, H. Park, and V. C. Plaut. 2010. Ethos of independence across regions in the United States: the production-adoption model of cultural change. American Psychologist 65:559–574.

Lackey, C. W., J. P. Beckmann, and J. Sedinger. 2013. Bear historical ranges revisited: Documenting the increase of a once-extirpated population in Nevada. The Journal of Wildlife Management 77:812–820.

Land, D., and M. Lotz. 1996. Wildlife crossing designs and use by Florida panthers and other wildlife in southwest Florida. Pages 379–386 *in* G. L. Evink, P. Garrett, D. Zeigler and J.

Berry, editors. Trends in addressing wildlife mortality: proceedings of the transportation related wildlife mortality seminar, Florida, USA. ER-58-96. Florida Department of Transportation, Tallahassee, Florida, USA.

Leigh, J., and M.J. Chamberlain. 2008. Effects of aversive conditioning on behavior of nuisance Louisiana black bears. Human–Wildlife Conflicts 2:175-182.

Lewis, D. L. 2013. Influence of urban environments on black bear populations and foraging behaviour. Thesis, Colorado State University, Fort Collins, Colorado, USA.

Lieske, C. L., K. B. Beckmen, and L. L. Lewis. Physiological responses in reindeer to the application of a conducted electrical weapon. Human-Wildlife Interactions 12:*In press*.

Loker, C. A., and D. J. Decker. 1995. Colorado black bear hunting referendum: what was behind the vote? Wildlife Society Bulletin 23:370–376.

Macdonald, L. A., and S. Smith. 1999. Bridge replacements: An opportunity to improve habitat connectivity. Pages 233–237 *in* G. L. Evink, P. Garrett, and D. Zeigler, editors. Proceedings of the Third International Conference on Wildlife Ecology and Transportation, FL-ER-73-99. Florida Department of Transportation, Tallahassee, Florida, USA.

MacHutchon, A. G., and D. Wellwood. 2002. Reducing bear-human conflict through river recreation management. Ursus 13:357–360.

Manfredo, M. J., T. L. Teel, and K. L. Henry. 2009. Linking society and environment: a multi-level model of shifting wildlife value orientations in the western U.S. Social Science Quarterly 90:407–427.

Manfredo, M. J., T. L. Teel, L. Sullivan, and A. M. Dietsch. 2017. Values, trust and cultural backlash in conservation governance: The case of wildlife management in the United States. Biological Conservation 214:303–311.

Marley, J., A. Hyde, J. H. Salkeld, M. C. Prima, L. Parrott, S. E. Senger, and R. C. Tyson. 2017. Does human education reduce conflicts between humans and bears? An agent-based modeling approach. Ecological Modeling 343:15–24.

Martin, J., M. Basille, B. Van Moorter, J. Kindberg, D. Allainé, and J. E. Swenson. 2010. Coping with human disturbance: spatial and temporal tactics of the brown bear (*Ursus arctos*). Canadian Journal of Zoology 88:875–883.

Mason, J. R., J. A. Shivik, and M. W. Fall. 2001. Chemical repellants and other aversive strategies in predation management. Endangered Species Update 18:175–181.

Massopust, J. L., and R. K. Anderson. 1984*a*. Homing tendencies of translocated nuisance black bears in northern Wisconsin. Proceedings of the Eastern Workshop on Black Bear Research and Management 7:66–73.

Massopust, J. L., and R. K. Anderson. 1984*b*. The response of black bears to being chased by hunting dogs. Proceedings of the Eastern Workshop on Black Bear Research and Management 7:59–65.

Masterson, L. 2016. Living with bears handbook. PixyJack Press, Inc., Masonville, Colorado, USA.

Mazur, R. 2010. Does aversive conditioning reduce human-black bear conflict? Journal of Wildlife Management 74:48–54.

Mazur, R., and V. Seher. 2008. Socially learned foraging behaviour in wild black bears, *Ursus americanus*. Animal Behaviour 75:1503–1508.

McArthur, K. L. 1981. Factors contributing to effectiveness of black bear transplants. Journal of Wildlife Management 45:102–110.

McCarthy, T. M., and R. J. Seavoy. 1994. Reducing non-sport losses attributable to food-conditioning: human and bear behavior modification in an urban environment. International Conference on Bear Research and Management 9:75–84.

McCullough, D. R. 1982. Behavior, bears, and humans. Wildlife Society Bulletin 10:27–33.

McIvor, D. E., and M. R. Conover. 1994. Perceptions of farmers and non-farmers towards management of problem wildlife. Wildlife Society Bulletin 22:212–221.

McLaughlin, C. R., C. J. Baker, A. Sallade, and J. Tamblyn. 1981. Characteristics and movements of translocated nuisance black bears in north-central Pennsylvania. Pennsylvania Game Commission Report, Harrisburg, Pennsylvania, USA.

McLean, P. K., and M. R. Pelton. 1990. Some demographic comparisons of wild and panhandler bears in the Smoky Mountains. International Conference on Bear Research and Management 8:105–112.

Miller, S. D. 1990. Impact of increased bear hunting on survivorship of young bears. Wildlife Society Bulletin 18:462–467.

Morehouse, A. T., T. A. Graves, N. Mikle, and M. S. Boyce. 2016. Nature vs. nurture: Evidence for social learning of conflict behavior in grizzly bears. PLOS ONE 11(11): e0165425. https://doi.org/10.1371/journal.pone.0165425.

Obbard, M. E., and E. J. Howe. 2008. Demography of black bears in hunted and unhunted areas of the Boreal Forest of Ontario. Journal of Wildlife Management 72:869–880.

Pennsylvania Game Commission (PGC). 2005. Management plan for black bear in Pennsylvania. Pennsylvania Game Commission, Harrisburg, Pennsylvania, USA.

Perry, G. L., and M. J. Rusing. 2001. The changing dynamics of black bear management: Arizona's experience with litigation from a black bear mauling. Western Black Bear Workshop 7:1–8.

Raithel, J. D., M. J. Reynolds-Hogland, D. N. Koons, P. C. Carr and L. M. Aubry. 2016. Recreational harvest and incident-response management reduce human–carnivore conflicts in an anthropogenic landscape. Journal of Applied Ecology doi:10.1111/1365-2664.12830.

Raithel, J. D., M. J. Reynolds-Hogland, P. C. Carr, and L. M. Aubry. 2017. Why Does the Regulated Harvest of Black Bears Affect the Rate of Human–bear Conflicts in New Jersey? Case Studies in the Environment doi: https://doi.org/10.1525/cse.2017.sc.415535.

Rogers, L. L. 1986. Effects of translocation distance on frequency of return by adult black bears. Wildlife Society Bulletin 14:76–80.

Rogers, L. L. 1987. Effects of food supply and kinship on social behavior, movements, and population growth of black bears in northeastern Minnesota. Wildlife Monographs 97.

Rudis, V. A., and J. B. Tansey. 1995. Regional assessment of remote forests and black bear habitat from forest resource surveys. Journal of Wildlife Management 59:170–180.

Ryan, C. W. 1997. Reproductive biology, survival, and denning ecology of Virginia's exploited black bear population. Thesis, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, USA.

Sauer, P. R., and S. Free. 1969. Movements of tagged bears in the Adirondacks. New York Fish and Game Journal 16:205–223.

Schirokauer, D. W., and H. M. Boyd. 1998. Bear-human conflict management in Denali National Park and Preserve 1982–94. Ursus 10:395–403.

Shivik, J. A., A. Treves, and P. Callahan. 2003. Nonlethal techniques for managing predation: primary and secondary repellents. Conservation Biology 17:1531–1537.

Shull, S. D., M. R. Vaughan, and L. Comly. 1994. Use of nuisance bears for restoration purposes. Proceedings of the Eastern Workshop on Black Bear Research and Management 12:107–114.

Siemer, W. F., and D. J. Decker. 2003. 2002 New York State black bear management survey: study overview and findings highlights. HDRU Publ. 03-6. Department of Natural Resources, Cornell University, Ithaca, New York, USA.

Smith, T. S. 1998. Attraction of brown bears to red pepper spray deterrent: caveats for use. Wildlife Society Bulletin 26:92–94.

Smith, T., S. Herrero, and T. D. Debruyn. 2005. Alaskan brown bears, humans and habituation. Ursus 16:1–10.

Sorensen, A., F. M. van Beest, and R. K. Brook. 2013. Impacts of wildlife baiting and supplemental feeding on infectious disease transmission risk: a synthesis of knowledge. Preventive Veterinary Medicine 113:356–363.

Spencer, R. D., R. A. Beausoleil, and D. A. Martorello. 2007. How Agencies Respond to Human-Black Bear Conflicts: A Survey of Wildlife Agencies in North America. Ursus 18:217–229.

Stedman, R. C., and T. A. Heberlein. 2001. Hunting and rural socialization: contingent effects of the rural setting on hunting participation. Rural Sociology 66:599–617.

Steyaert, S. M. J. G., J. Kindberg, K. Jerina, M. Krofel, M. Stergar, J. E. Swenson, and A. Zedrosser. 2014. Behavioral correlates of supplementary feeding of wildlife: can general conclusions be drawn? Basic and Applied Ecology 15:669–676.

Stiver, W. H. 1991. Population dynamics and movements of problems black bears in Great Smoky Mountains National Park. Thesis, University of Tennessee, Knoxville, Tennessee, USA.

Tate, J., and M. R. Pelton. 1983. Human–bear interactions in Great Smoky Mountains National Park. International Conference on Bear Research and Management 5:312–321.

Teel, T. L., and M. J. Manfredo. 2009. Understanding the diversity of public interests in wildlife conservation. Conservation Biology 24:128–139.

Ternent, M. A. 2008. Effect of lengthening the hunting season in Northeastern Pennsylvania on population size and harvest rates of black bears. Proceedings of the 19th Eastern Black Bear Workshop 19:90–97, Shepherdstown, West Virginia, USA.

Ternent, M. A., and D. L. Garshelis. 1999. Taste-aversion conditioning to reduce nuisance activity by black bears in a Minnesota military reservation. Wildlife Society Bulletin 27:720–728.

Thompson, S. C., and K. E. McCurdy. 1995. Black bear management in Yosemite National Park: more a people management problem. Proceedings of the Fifth Western Black Bear Workshop. 5:105–115, Provo, Utah, USA.

Timmons, A. 2013. Translocation of bears in New Hampshire: history and current status. Proceedings of the Eastern Black Bear Workshop 21:44–46.

Treves, A., K. J. Kapp, and D. M. MacFarland. 2010. American black bear nuisance complaints and hunter take. Ursus 21:30–42.

Updike, D., and B. Malm. 2001. New alliance between agency and public reduces bear problems. Western Black Bear Workshop 7:9–12.

van Manen, F. T., M. F. McCollister, J. M Nicholson, L. M. Thompson, J. L. Kindall, and M. D. Jones. 2012. Short-term impacts of a 4-lane highway on American black bears in Eastern North Carolina. Wildlife Monographs 181:1–35.

Wade, D. A. 1987. Economics of wildlife production and damage control on private lands. Pages 154–163 *in* D. Decker and G. G. Goff, editors. Valuing Wildlife. Westview Press, Boulder, Colorado, USA.

Warburton, G. S., and R. C. Maddrey. 1994. Survey of nuisance bear programs in eastern North America. Eastern Workshop on Black Bear Research and Management 12:115–123.

Weaver, K. M. 2000. Black bear ecology and the use of prescribed fire to enhance bear habitat. Symposium proceedings Fire, People, and the Central Hardwood Landscape, Eastern Kentucky University, Richmond, Kentucky, USA.

Wilder, J. M., T. D. Debruyn, T. S. Smith, and A. Southwould. 2007. Systematic collection of bear-human interaction information for Alaska's national parks. Ursus 18:209–216.

Williamson, D. F. 2002. In the Black: Status, Management, and Trade of the American black bear (*Ursus americanus*) in North America. TRAFFIC North America, World Wildlife Fund, Washington, D.C., USA.

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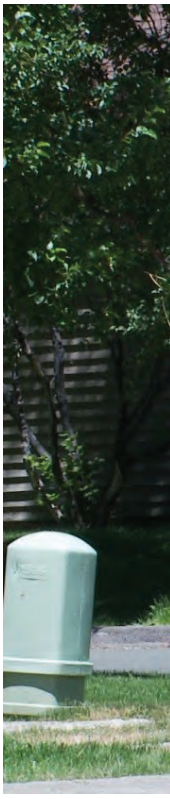

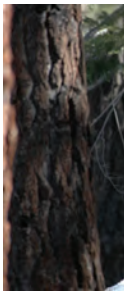

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