University of Nevada, Reno

Non-lethal Management of Black Bears to Alleviate Human-Bear Conflicts: Human Education and Hazing with Dogs

A thesis submitted in partial fulfillment of the
Requirements for the degree of Master of Science in
Natural Resources and Environmental Science

by

Heather Reich

Dr. Kelley Stewart/Thesis Advisor

August, 2024

THE GRADUATE SCHOOL

We recommend that the thesis
prepared under our supervision by

Heather E. Reich

entitled

Non-lethal Management of Black Bears to Alleviate Human-Bear Conflicts: Human Education and Hazing with Dogs

Be accepted in partial fulfillment of the
requirements for the degree of

Master of Science

Kelley M. Stewart, Ph.D.
Advisor

Kevin Shoemaker, Ph.D.
Committee Member

Jon P. Beckmann, Ph.D.
Committee Member

Brian F. Wakeling, M.S.
Committee Member

Christopher Morgan, Ph.D.
Graduate School Representative

Markus Kemmelmeier, Ph.D., Dean
Graduate School

August, 2024

Thesis Abstract

Black bears (*Ursus americanus*), once extirpated across most of their range in North America, have been a conservation success story. Since the early 1900s, black bear populations have been recovering and reincorporating historical ranges (Beckmann & Lackey, 2008). As black bear populations and occupied range expand, human populations are also expanding into black bear habitat. Urban development within occupied black bear range is leading to increased human-bear conflict. This conflict may involve bears getting into garbage and bird feeders, yet interactions may escalate and include property damage and human injury. As charismatic megafauna, bears elicit a strong emotional response from the public that often demands non-lethal management of bears involved in conflict with humans. These public responses challenge management agencies to find management techniques that will help keep bears at a low level of conflict while keeping the public safe. Management techniques include education and outreach along with physical management of individual bears. With this demand for non-lethal management of bears, I investigated the benefits and costs of education and outreach along with different hazing options for black bears. Reviewing 54 different publications, we found room for both techniques combined to be advantageous to bears and plausible options for management of human-bear conflicts.

Furthermore, I studied the use of dogs as a form of hazing for bears. Dogs as a non-lethal management tool is gaining in popularity among agencies that manage bears. There is lack of data on the use of dogs for hazing bears and few published studies compared the use of dogs coupled with less-lethal ammunition or the dogs alone (Beckmann et al., 2004; Leigh & Chamberlain, 2008; Comeau, 2013; Klip 2018). I had the opportunity to investigate how to use dogs to get the best response from bears treated by dogs. I used 3 treatments to apply to bears: 1) releasing dogs off-leash to pursue and potentially make physical contact with the bear, 2) releasing the bear with dogs on-leash to pursue the bear with no potential for contact, and 3) a

control group of bears released without dogs involved. After the treatments, I looked at how many days it took an individual bear to return to chronic conflict and the percentage of time treated bears spent in residential areas after release. My study found no significant difference between treatments and the variables examined. Despite the lack of support for the hypotheses presented in this study, dogs have benefits as part of a bear management program. These benefits include opportunities for education and outreach by drawing the public to them, safety for handlers and law enforcement in situations involving an injured human or bear, field assistance for finding injured or orphaned wildlife, dropped collars, or carcass location. Ultimately, this study should provide added information to managers considering incorporating dogs into their human-bear conflict programs.

Beckmann, J., & Lackey, C. (2008). Carnivores, urban landscapes, and longitudinal studies: a case history of black bears. Human-Wildlife Conflicts, 2(2), 168-174.

Beckmann, J., Lackey, C., & Berger, J. (2004). Evaluation of deterrent techniques and dogs to alter behavior of "nuisance" black bears. Wildlife Society Bulletin, 32(4), 1141-1146.

Comeau, N. A. (2013). *Evaluation of Two Methods of Aversive Conditioning on Nuisance Activity Levels of New Hampshire Black Bear*. ProQuest Dissertations Publishing.

Klip, J. M. K. (2018). *Can a bite in the butt change black bear behavior? Effects of aversive conditioning on predators of bear-human conflict*. ProQuest Dissertations Publishing.

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

Acknowledgements

I would like to first and foremost thank my advisor and friend, Dr. Kelley Stewart for seeing the potential in me for completing a master's project. This master's was the result of me giving lectures to her undergraduate classes and always encouraging them to pursue their master's as I regretted not having done one. This led to her approaching me wanting to remedy this regret. Our shared love of wildlife and Karelian Bear Dogs created a simple step into what we wanted to look at. Her support, knowledge, and friendship carried me through what was often an overwhelming task of completing this thesis. Despite my full-time job and the question of if I would actually get this done, she remained unwavering in her optimism and I will have her, forever, to thank for finishing it.

Dr. Kevin Shoemaker also has my deepest gratitude. Kevin's door was always wide open to me as I tried to figure out which appropriate analysis to conduct and then the modeling and coding to get it done. Often my mistakes were simple and, despite finding those simple mistakes, Kevin always smiled, helped me through it, and patted me on the back on the way out of his door.

Dr. Marcus Blum, former lab mate to co-author of my thesis, thank you! You have always put a smile on my face as a friend. But you rescued me by taking on my collar clean up while I was struggling with crazy bear conflict seasons and classes. You saved me and I can never thank you enough.

I must acknowledge the rest of my committee members, Dr. Jon Beckmann who has been a friend since I started here in Nevada, whether he likes it or not! Dr. Chris Morgan, thank you for your willingness to be on my committee and the time and attention you have put into this. Brian Wakeling, your time is precious and so is your knowledge, thank you for your leadership and your attention.

I appreciate the generous funding of the Nevada Record Book that allowed us to procure enough collars to make this study possible. Similarly, the Nevada Department of Wildlife

provided endless support. Within the Nevada Department of Wildlife, I owe Carl Lackey a huge thank you. His support, encouragement, knowledge, and advice have been crucial to me reaching the end of this thesis. By my side through most of the bear releases, thick and thin, Carl is a friend, colleague, and mentor. Carl started the Karelian Bear Dog hazing program in Nevada in 2001 and was the reason I came to Nevada in the first place.

My fellow lab mates in the Stewart Lab at the University of Nevada, Reno were always there for me. M. Osterhout, J. Vasquez and E. Hagler, you three, especially, were my rocks through classes and studying. N. Jackson, you always knew I could do it. J. Merrell, thank you for being my fellow "advanced age" lab mate and sharing whatever you could with me to make it easier. J. Gundlach, S. McCane, H. Grock, Dr. A. Andreason, my lab mates extraordinaire, thank you for helping me through questions and for the laughs during long sessions at the computer in the lab.

I must give my husband, Derek Reich, a most heartfelt thank you for his unending support of me while I toiled away at graduate school and writing. He held down the house and our company while I spent hours at class, studying, or writing. Never uttering a word of disapproval, his love and moral support were unwavering during these last few years. Likewise, I thank my parents for instilling in me a love of wildlife and supporting me in my early career years in wildlife biology.

The bears, both grizzly and black bears, that I have worked with throughout my career continue to teach me and make me a better biologist. They are the reason for it all.

Lastly and most importantly, I thank my Karelian Bear Dogs. Past and present: Usko, Fancy, Sputnik, Orca, Kondii, Gimbal, and Lumi, we have been through grizzly bears and black bears. Hazing, tracking, protection during investigations, and going into tight dark places, these beloved dogs provided me with confidence that I could work a bear in close proximity and not get injured. Their love of the job and their love of me was always overwhelming and to allow them

to do what they were bred to do, and the joy of watching them work, has kept me steadfast in my belief in using dogs during my bear management career. Thank you for making me a better biologist.

Table of Contents

EDUCATIONAL OUTREACH VERSUS INDIVIDUAL BEAR MANAGEMENT IN CONFLICT RESOLUTION FOR BLACK BEARS: WHY NOT BOTH?

Heather E. Reich, Kelley M. Stewart, Brian F. Wakeling

H. E. Reich and K. M. Stewart, Department of Natural Resources and Environmental Science, University of Nevada, 1664 N. Virginia St, MS186, Reno, Reno, NV 89557

B. F. Wakeling, Montana Fish, Wildlife, & Parks, 1420 E. 6th Ave, Helena, MT. 59601

Corresponding author: Heather E. Reich

Address: Natural Resources and Environmental Science
1664 N. Virginia St, Mail Stop 186
University of Nevada, Reno
Reno, NV 89557
Tel: (775) 721-2513
Email: heather@beariersolutions.com

List of Tables

List of Figures

Abstract

Black bear (*Ursus americanus*) populations are expanding across the United States, presenting a challenge for wildlife agencies charged with managing their populations. As black bears reestablish their historical ranges, human populations are also increasing and encroaching into bear habitat. Managers are subjected to growing pressure from concerned stakeholders to focus on education and outreach of the public over management of bears. Research shows that both management of individual bears and outreach to educate human populations have a positive effect on conflict management and could be used in tandem. We reviewed 54 papers to compare outreach and education and management of individual bears. While education and outreach can reach a broader audience to deliver the message of responsibility in bear country, research shows that proactive changes by individual people are extremely low, despite targeted messaging. In the absence of complete compliance among humans with the security of anthropogenic attractants by stakeholders, individual bears at low levels of conflict may need to be targeted by managers for management. Non-lethal bear management options have support from the public, allowing managers to try to keep an individual bear at a low level of conflict, although have limited efficacy in addressing chronic conflicts. Education and outreach should not be considered a complete solution for solving human-bear conflict. Similarly, managing individual bears is not going to stop bears from coming into conflict with humans. A combination of education and outreach techniques to address human-bear conflicts and managing individual bears to try to keep them at low levels of conflict are methods that may be advantageous for managers.

KEYWORDS

Ursus americanus, anthropogenic, attractants, conflict, education, outreach, hazing

1. Introduction

Black bear (*Ursus americanus*) restoration is a conservation success story across most of North America. By the early 1900s, black bears were extirpated from most of their historical range because of destruction of habitat, unregulated hunting, and overall persecution (Lackey et al., 2013; Scheick & McCown, 2014). The Industrial Revolution led to an increased dependency on fossil fuels, rather than wood-burning fuels, and led to beneficial changes in forest management (Lackey et al., 2013; Scheick & McCown, 2014). These changes and resultant habitat regeneration allowed bear populations to recover across much of their historical ranges (Lackey et al., 2013; Scheick & McCown, 2014). Black bears are now common across most of their historical range and most populations are increasing (Servheen, 1989; Lackey et al., 2013). Black bears are considered a species of least concern by the International Union for the Conservation of Nature (IUCN), and the current population estimate for black bears in North America is 850,000 – 950,000 (IUCN 2021).

Concurrent with increasing black bear populations, human populations also are expanding across North America, leading to bears and humans increasingly coming into direct conflict (Conover & Decker, 1991; Conover, 1998; Messmer, 2000; Beckmann et al., 2004). Strictly speaking, conflict is defined as a situation that occurs when 2 or more parties with intensely held opinions strongly disagree over conservation objectives and 1 party is perceived to assert its interests at the expense of another (Redpath et al. 2013). Conflict, then, occurs among people, and effects of wildlife on people (or effects of people on wildlife) may be catalysts for conflict if management objectives and approaches are not mutually acceptable. Nevertheless, in this paper we define human–bear conflict as any situation where there is a real or perceived threat to human life or property by bears. Human-bear conflicts also include situations, where bears use or damage human property, episodes where bears obtained anthropogenic food, where bears killed or attempted to kill livestock or pets, were involved in vehicle collisions, when a bear

exhibited stress-related or curious behavior causing a person to take extreme evasive action, made physical contact with a person, exhibited clear predatory behavior, or was intentionally harmed or killed (not including legal harvests) by a person (Lackey et al. 2018). This latter definition is commonly used among bear managers when addressing interactions among bears and humans. Two levels of human-bear conflict will be discussed in this paper. We describe low-level conflict as human-bear conflict involving bears accessing anthropogenic food resources without property damage or public safety concerns (Table 1). This description includes, but is not limited to, accessing garbage cans, bird feeders, pet food, apiaries, chicken coops, and habituation to the presence of humans. We describe high-level conflict as human-bear conflict involving bears causing property damage, structure entry, human injury, or human death (Table 1).

Human development within urban-wildland interfaces that include public land occupied by bears leads to a high likelihood of conflicts (Beckmann & Berger 2003; Cleary et al., 2021, Figure 1). Bears in urban-wildland interfaces and urban areas using anthropogenic foods had higher population density, individual mass, litter size, and young-bearing years than bears accessing only wild foods (Beckmann & Berger, 2003). Those same bears had smaller home ranges and shorter duration of hibernation than bears in wildland areas (Beckmann & Berger, 2003). Marley et al. (2017) noted in modeling options for management of human-bear conflicts that for every 1% increase in human population there was a corresponding 91% increase in the chance of an individual bear becoming involved in some form of conflict with humans. In other words, a small increase in human population leads to a large chance of an individual bear coming into conflict with that human population.

The value that the human population places on bears has changed since the early 1900s (Hopkins et al., 2010). Once considered a form of vermin, bears are now considered charismatic megafauna with many stakeholders having a mutualistic, or emotional, connection to them (Hopkins et al., 2010; Manfredo et al., 2018). State and federal wildlife agencies mandated with

managing human-bear conflicts are increasingly pressured to include both proactive and reactive strategies for addressing concerns to limit the use of lethal removal of an individual bear (Dubois & Fraser, 2013; Hopkins et al., 2010).

Human-bear conflict may result from bears accessing garbage, pet food, birdfeeders, backyard apiaries, and chicken coops to larger issues of livestock loss, property damage, and public safety. In the past, human-bear conflicts were resolved by either translocating bears or lethally removing them (Hristienko & McDonald, 2007). Since the 1980s, research has increasingly been focused on resolution of human-bear conflicts through non-lethal actions.

Unsecured anthropogenic food is the primary cause of most human-bear conflicts. (Manfredo et al., 2018; Clearly et al., 2021). Anthropogenic food is defined as "foods or attractants having a human origin" (Hopkins et al. 2010). Anthropogenic attractants may include garbage (McCarthy & Seavoy, 1994), bird or game feeders (Campbell, 2012; Marley et al., 2017; Cleary et al., 2021), barbecues, compost, pet food (Cleary et al., 2021), fruit trees (Gore et al., 2008), livestock (including chickens) (Smith et al., 2000; Garshelis et al., 2020), stored commodities (Fall & Jackson, 2002), crops (Fall & Jackson, 2002; Hristienko & McDonald, 2007), apiaries (Otto & Roloff, 2015; Pienaar et al., 2015), improper food storage at campsites (Madison, 2008; Mazur, 2010), and intentional feeding (Hristienko & McDonald, 2007). Those attractants are both numerous and difficult to address, especially on a landscape scale.

State agencies mandated with managing wildlife populations, have primary statutory authority for management of black bears and their populations across North America, and are under pressure from the public for non-lethal options to manage human-bear conflicts. As a result, those agencies are required to balance scientifically supported methods for resolution of conflicts with political and emotional pressure from various stakeholders. Past research seems to indicate that management of human-bear conflicts can only come from large-scale security of the anthropogenic attractants that cause human-bear conflict rather than managing individual bears

(Gore et al., 2006; Dietsch et al., 2018). Yet both forms of management may have value in reducing conflicts between humans and bears.

We conducted a literature review, which included 54 peer-reviewed publications of non-lethal management practices for black bears across North America. Our objective was to investigate the efficacy of public outreach to increase attractant security as a method of reducing conflicts between bears and humans at the population level versus the use of techniques to manage individual bears. Indeed, using public outreach to encourage the public to secure attractants may be a more effective approach to reduce conflicts between bears and humans compared with attempting to manage behaviors of individual bears.

2. Education and Outreach

As black bear populations began to rebound across North America during the 1980s, inevitably, conflicts between bears and humans also increased (Conover & Decker, 1991; Conover, 1998; Messmer, 2000; Beckmann et al., 2004; Gore et al. 2006; Spencer et al.,2007; Hristienko & McDonald, 2007; Campbell, 2012; Garshelis et al., 2020; Cleary et al., 2021). Wildlife management agencies initially addressed human-bear conflicts by focusing on individual bears involved in the conflict. Techniques for resolving these situations often involved either translocation or lethal removal of the offending bear without addressing the cause of bear's presence in the area (Gore et al., 2006; Baruch-Mordo et al., 2011; Pienaar et al., 2015). Wildlife managers and stakeholders alike quickly realized that lethally removing or translocating a bear did not solve the problem or reduce the overall number of conflicts because those attractants remained present after the removal of individual bears. At the same time, translocation also proved to be an inconsistent solution because bears would frequently return to the location of conflict (McArthur, 1981; McCarthy & Seavoy, 1994; Beckman et al., 2004)

The use of aversive conditioning for deterring black bears involved in conflict began gaining momentum in the late 1990s and early 2000s with more than half of state wildlife agencies in the United States using this tool for management of individual bears (Beckman et al., 2004; Homstol et al., 2024). Despite the focus to address conflicts between humans and bears in a non-lethal manner, managers quickly recognized the futility of addressing individual bears without securing the anthropogenic food sources that initially attracted them (Campbell, 2012). The need for a large-scale change in human behavior was recognized as imperative to reduce conflicts by reducing the availability of anthropogenic food sources for bears (McCarthy & Seavoy, 1994). The Alaska Department of Fish and Game in Juneau established an education and outreach campaign from 1988 through 1991 in combination with a garbage containment ordinance, which included a fine for first-time offenders (McCarthy & Seavoy, 1994). That effort resulted in increased compliance with the garbage containment ordinance. This increased compliance did not stop food-conditioned bears from gaining access to garbage that was not secured (McCarthy & Seavoy, 1994). That campaign was one of the first documented efforts appealing to stakeholders to voluntarily change their behavior to reduce conflicts between humans and bears.

Spencer et al. (2007) did a comprehensive survey of agencies that had bear management programs and found that 81% of them had public outreach and education programs to reduce human-bear conflicts by teaching people to contain their garbage and to make other attractants secure from bears. Several private organizations in collaboration with state wildlife agencies formed efforts to provide education and outreach to the public, including general information on bear biology along with tools to secure attractants both locally and nationally. Examples of those efforts include: the Bear Aware campaign (www.bebearaware.org), Be Bear Smart (www.bearsmart.com) and BearWise (www.bearwise.org). The BearWise campaign is supported by wildlife agencies, including the Association of Fish & Wildlife Agencies.

Education and outreach efforts typically take the form of brochures, stickers, signs, and other written material that is provided to the public either individually or posted in highly visible locations to reach a broad audience. For example, in Yosemite National Park (hereafter Yosemite), visitors may encounter more than 400 different outreach communications during their visit, including providing 95% of their visitors with a food-storage brochure when they enter the park (Cella & Keay, 1979; Lackey, 2003). Despite this extensive attempt at widespread visitor outreach and education with signs and brochures in Yosemite, 92% of visitors thought they were storing their food properly, but only 3% were appropriately excluding bears from their food (Cella & Keay, 1979; Lackey, 2003). In Black Mountain, North Carolina, an outreach campaign involved both education and outreach including presentations, flyers or brochures, social media outreach, stickers, public service announcements, and articles in the newspapers (Poole, 2011). Of 157 residents surveyed after that effort, slightly more than half (53%) of respondents said they had seen the materials (Poole, 2011). When the survey asked residents if the material changed their minds about coexisting with black bears in their community, 70% responded "no" without further explanation (Poole, 2011). Interpreting those responses is difficult because it is unknown whether those 70% lived responsibly in bear country already or if those 70% had no intention of changing their habits to improve security of potential attractants for bears (Figure 2). In the same study, when asked about using a bear-resistant container, only 71% of respondents confirmed that they would be willing, leaving the remaining 29% unwilling to use a bear resistant container (Poole, 2011). Poole's (2011) study was inconclusive regarding education and outreach affecting voluntary change in residents. Similarly, Gore et al. (2008) assessed the benefits of public outreach and education in the state of New York to help people remove or secure attractants from bears. They provided a set of 8 different materials addressing different known bear attractants and suggestions for removing or securing those attractants. A survey one year after the information was provided to residents, with a response from 950 residents, found that only 3% of

residents changed some behavior (Gore et al., 2008). The 3% changed due to direct altercations with bears rather than the outreach materials (Gore et al., 2008). Similarly, despite the creation of a well-known Bear Aware program in Colorado, education efforts did little to encourage humans to change their behavior (Baruch-Mordo et al., 2011). Likewise, Howe et al. (2010) stated that education and outreach programs did not always lead to modification of responsible behavior or improve the public's understanding of ways to address attractants.

In Florida, however, suggested conflict resolution advice provided by the Florida Fish and Wildlife Conservation Commission (FWC) was adopted for garage security by 56.2% of 1,649 respondents (Pienaar et al., 2015). That survey found that interactions with FWC staff may have played a larger role in outreach and education than printed materials (Pienaar et al., 2015). They also found that securing attractants, other than garbage, was less effective because fewer than 15% of survey respondents were willing to take on measures to secure items including bird feeders or barbecue grills (Pienaar et al., 2015). A local "Bear Smart" effort in Manitoba summed up the issues of education and outreach well when they reported that, despite overwhelming support for the program, the actual change in human behavior was ineffective (Campbell, 2012). That result was further supported by a survey of residents and campers in New Mexico after exposure to outreach and education efforts (Dunn et al., 2008). They found the knowledge about bears and bear attractants increased after residents and visitors were exposed to the outreach materials, however no measurement was provided regarding compliance by these groups (Dunn et al., 2008).

Another factor affecting the absorption of outreach and education is the overall attitude of the people targeted by the information (Harris, 2011). Campbell (2012) found that, despite an overall positive reaction to the development of a Bear Smart program in Manitoba, 30% of individuals had a negative response to removal of known bear attractants. Some people may feel that they should not have to change their lifestyle or may not like the suggestions offered by a

wildlife management agency (Peine, 2001; Hristienko & McDonald, 2007; Campbell, 2012; Pienaar et al., 2015; Dietsch et al., 2018). For others, following suggestions provided through education and outreach is financially difficult (Poole, 2011). Lackey's (2003) study in Yosemite suggested that the outreach efforts may create a situation where stakeholders become overwhelmed by the amount they are exposed to and then become apathetic. Conversely, Howe et al. (2010) suggested that education and outreach must be conveyed repeatedly and over long periods of time.

Attractant security does substantially reduce the incidences of human-bear conflicts (Baruch-Mordo et al. 2011, Johnson et a. 2018). Perhaps more effective than education and outreach is the need to impose ordinances and the threat of fines. Ordinances alone have been shown to have little effect on human behavior in bear country, but rather, change comes from the enforcement of those ordinances (Baruch-Mordo et al., 2011). Multiple studies have demonstrated a positive effect of fines or even the threat of fines to motivate the public to secure their attractants (Baruch-Mordo et al., 2011; Scott et al., 2018; Johnson et al., 2018).

With the benefit of securing attractants across large spatial scales, however, Honeyman (pers comm 2021) cautions that, once one source of food is removed, bears using urban areas will find a new one. For example, the securing of garbage and bird feeders in the Bow Valley of Alberta led to a spike in bears using fruit trees and natural vegetation within the same urban areas (Honeyman pers comm, 2021). The suggestion by Honeyman (pers comm, 2021) was that this change did not qualify as a desirable outcome for the community because the bears remained in the developed areas. Many stakeholders argue that the only solution to human-bear conflict is outreach and education to attain attractant security. Complete compliance seems unattainable, however, because of differences in human responses. Education and outreach will have a positive impact on wildlife conservation efforts, but those efforts likely will need to be augmented with a secondary tool of enforcement, a 'carrot and stick' approach (Gore et al., 2008). Following initial

efforts in Juneau, Alaska, new management plans for conflict resolution appear to benefit from increased enforcement rather than leaving it up to individuals to voluntarily secure attractants (McCarthy & Seavoy, 1994; Beckmann et al., 2004; Baruch-Mordo et al., 2014).

Complicating this effort is the fact that wildlife management agencies have no authority over control of municipal garbage (Johnson et al., 2018). Close relationships between governmental agencies that manage wildlife conflicts, those that manage municipal garbage, and the municipalities experiencing increased conflicts between humans and bears could prove to be an important one. If municipalities create enforceable ordinances regarding anthropogenic attractants to bears such as garbage, wildlife agencies could assist with outreach and education to inform residents of them. Wildlife agencies and other concerned citizens could also assist in the enforcement of the ordinances by reporting violations to the proper enforcement entity. When compliance with ordinances reaches 60% or greater, a linear decrease in conflict has been shown to occur (Baruch-Mordo et al., 2015; Johnson et al., 2018). Coupling outreach and education with enforcement should be a solution agencies and municipalities work toward achieving.

3. Management of Individual Bears

Lethal removal of bears, taste aversion chemicals, hazing, and simple translocation are methods of conflict resolution that have been used by biologists in the past. These methods may work in specific situations, but generally do not prove to be applicable policies for most situations addressing human-bear conflicts. The lethal removal of bears, however, through hunting seasons in Minnesota was an effective way to reduce the number of human-bear conflicts occurring in the area (Garshelis et al., 2020). McCarthy and Seavoy (1994) stated strongly that allowing "nuisance" bears to remain after attractants had been secured from bears, as opposed to lethal removal, would only perpetuate the conflict. Lethal removal of bears, however, is not popular with the public, and in states where stakeholders are fighting existing or proposed bear hunts, this

form of management likely would lose public support for wildlife agencies managing those conflicts (Dunn et al., 2008; Agee & Miller, 2009; Lewis et al., 2019).

Taste aversion has been tried as a method to reduce conflicts, but the logistics of applying taste aversion solutions to food sources is complicated, expensive, time consuming, and often ineffective (Homstol, 2011; Signor, 2010). Signor (2010) reported that a standard 10 mg dose of thiabendazole on food left out for free-ranging black bears, did not appear to have a strong enough effect to deter bears. Effective doses may be dependent upon the weight of a bear and the individual reaction to the chemical (Polson, 1983; Signor, 2010). In urban settings, taste aversion did not alleviate bear conflict, and the positive reward of attractants seemed to negate any effects of ingested aversions (McCarthy & Seavoy, 1994). Additionally, the use of taste aversion techniques in a large spatial scale such as urban and suburban settings may not be practical or affordable for bear managers.

Translocation, another option available to managers, is defined as "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." Lackey et al. (2013). Translocation is used by 75% of agencies despite the knowledge that many translocated bears will return to the area where the original conflict occurred (Lewis et al., 2019). This option may be effective for temporary resolution of human-bear conflicts, because translocation allows for the non-lethal, temporary removal of a bear from the area of conflict, giving managers time to address attractants (Beckmann et al. 2004).

4. Hazing

Aversive conditioning is defined as "a learning process in which deterrents are continually and consistently administered to a bear to reduce the frequency of an undesirable behavior" Hopkins et al. (2010). This method is different from hazing, which is defined as "a

technique where deterrents are administered to a bear to immediately modify the bear's undesirable behavior" (Schirokauer & Boyd, 1998; Hopkins et al., 2010). Repeated implementation of hazing practices on an individual bear could be considered aversive conditioning, yet most agencies do not have the financial or human resources to apply true aversive conditioning. For the purposes of this review, we will focus on hazing bears rather than aversive conditioning. Both the public and wildlife agencies seem to think the outcome from hazing is to change the behavior of the bear for the rest of its life (Beckmann et al. 2004). While studies have proven that hazing of bears is not a solution to stopping conflict, those same studies have pointed that of hazing may increase the ability to keep bears at a low level of conflict by causing the bear to disperse from the immediate location of conflict (Hopkins et at., 2010, Homstol et al., 2024).

Despite high reproductive rates in urban areas likely resulting from anthropogenic resources, these populations are exposed to higher levels of mortality due to increased road mortality and lethal removal by managers (Beckmann & Lackey, 2008; Baruch-Mordo et al., 2014). As a result, urban areas are often population sinks for bears (Beckmann & Lackey 2008). The simple process of capturing a bear to apply hazing may help gain further cooperation from stakeholders, helping them invest more in attractant security for the bear's well-being. The setting of a trap at a location of conflict also provides the opportunity for a bear manager to conduct an on-site visit to address and advise the steward or stakeholder on how to secure attractants. Hazing may also provide managers with the ability to keep individual bears at a low-level of conflict, potentially avoiding the necessity of lethal removal of the bear altogether. Unfortunately, agencies often keep incomplete records of individual bears that are treated through hazing and any known outcome of hazing those bears (Spencer et al., 2007).

Deterrents used in hazing typically are meant to deliver a pain stimulus to the bear in the form of a less-lethal projectile, noise making devices like horns, conductive electrical weapons, or

using trained dogs (Beckmann et al., 2004, Homstol et al., 2006; Madison, 2008; Mazur, 2010). Additionally, individuals, residents, or stakeholders may use hazing in the form of auditory stimulus. Pain stimulus is often more effective because it is not dependent upon the behavior of the person delivering the stimulus (Homstol et al., 2006; Madison, 2008). A flight response was elicited from a bear 100% of the time when the bear was treated with a pain stimulus, such as less-lethal ammunition (Homstol et al., 2006). In general, hazing a bear will not keep it from coming back to unsecured sources of anthropogenic food or prevent other bears from finding it (Beckmann et al., 2004; Mazur 2010). Moreover, Beckmann et al. (2004) strongly cautioned agencies from assuming that treated bears would stop the conflict behavior. McCarthy and Seavoy (1994) found that of the 14 bears shot with rubber bullets from a 12-gauge shotgun, 43% vacated the area, however, 93% of the treated bears continued their unacceptable behavior in the general vicinity. Studies in Yosemite and Sequoia National Parks found that bears treated with hazing in the form of noise making devices, bear-spray, less-lethal projectiles, and being chased by bear-management personnel ($n \geq 150$ bears) continued to use human-occupied areas, but after treatment, those individuals caused less damage, and accessed fewer anthropogenic sources of food (Madison, 2008; Mazur, 2010). Mazur (2010) found that less-lethal projectiles elicited an immediate response more effectively than bear-spray and chasing. Following hazing, many bears became wary of approaching human-occupied areas and spent less time in those areas (Madison, 2008). Hazing methods are best assessed by the amount of time before a bear returns to urban areas or exhibits conflict behavior, rather than the complete absence of the bear from an urban landscape (Beckmann et al., 2004). Beckmann et al. (2004), in a study comparing 6 different hazing treatments, found the treated bears stayed away from urban areas longer than untreated bears, returning on average within about a month. Bears also traveled further away from the release site when hazed versus just released (Leigh & Chamberlain, 2008; Comeau, 2013). Hazing with a pain stimulus has been more effective than simply yelling or asserting human

dominance in the form of posturing (Homstol et al., 2006; Homstol, 2011). Pain-stimulus created more wariness in bears around humans for up to 3 weeks post-treatment compared to control bears that became more habituated to humans (Homstol 2011). Additionally, hazing with the use of dogs rather than less lethal ammunition, has been shown to increase the amount of time before a treated bear returns to conflict behavior (Beckmann et al., 2004; Leigh & Chamberlain, 2008; Comeau, 2013; Klip, 2018, Figure 3). This time frame is extremely variable among studies, with Beckman et al. (2004) noting the return of bears treated with dogs to an urban area varied from 5 to 641 days. In contrast, Leigh & Chamberlain (2008) noted bears treated with dogs returned to conflict behavior on average 21.9 hours after treatment compared to bears not treated with dogs returning, on average, after only 7.2 hours. Klip (2018) found that bears treated by dogs returned to their treatment area on average 150 days after treatment, compared to 28 days for control bears. Leigh and Chamberlain (2008) noted that bears treated with dogs stayed away from the treatment site 10 days longer than bears not treated with dogs.

Hazing bears early in their conflict behavior is more effective than hazing bears with a longer history of conflict behavior (Clark et al., 2002; Mazur, 2010; Poole, 201; Heneghan & Mores, 2019). Females with dependent young were the most difficult to deter from anthropogenic food sources (Clark et al., 2002). While hazing bears will not solve human-bear conflicts, its advantages include both in the ability to keep bears at a low-level of conflict, and as a method of management that is appealing to stakeholders (Heneghan & Mores, 2019).

5. DISCUSSION

Although conflict between black bears and humans are fewer during years of good production of natural foods than years of food shortage, some conflicts can be expected annually regardless of availability of natural foods (Gore et al., 2008; Merkle et al., 2013; Baruch-Mordo et al., 2014). Both human and bear populations are increasing across North America, and

availability of anthropogenic foods, human behavior, and behaviors of individual bears increase the odds of conflicts. The values that humans hold toward bears have been changing, and a greater proportion of the public believes that bears should be allowed specific rights when involved in conflicts with humans (Dubois & Fraser, 2013). Many people believe that lethal removal of bears, because humans fail to remove anthropogenic attractants, is unfair (Dubois & Fraser, 2013). Municipalities and managers must bridge the knowledge gap between science and human dimensions through investment in education along with management of individual bears (Dubois & Fraser, 2013).

In the decades-long efforts of scientists, managers, and stakeholders to find the ultimate solution to reducing conflict between humans and bears, no single answer has been found. Education and outreach are generally given more attention to management of individual bears because effective outreach may influence a larger proportion of the public. Because individual altercations are likely to continue, the need for management of individual bears remains. With the concerns of various stakeholders and the emotional reaction that many people have to bears, municipalities and managers should invest human and financial resources to avoid, mitigate, and manage conflicts between humans and bears. Many managers already practice both education and outreach along with management of individual bears. There is certainly a place for treating an individual bear that is of concern along with treating the bear population as a whole while simultaneously trying to secure attractants to avoid bears from becoming habituated or food conditioned. Bears that have been involved in low-level conflict with humans could be managed or conditioned to try to keep them at a low level of conflict.

As many have said in the literature, agencies may consider management that involves both education and outreach along with working with municipalities to enforce attractant security through penalties while managing individual bears (Baroch-Mordo et al., 2015; Johnson et al., 2018). Yosemite National Park has been using this multi-tool technique for two decades and has

seen a marked decrease in bear incidents and property damage to both visitor property and park infrastructure (Madison, 2008). Yosemite uses a combination of education and outreach of visitors, providing secure storage of food and garbage, along with management of individual bears (Madison, 2008). This interdisciplinary effort within Yosemite, which includes biologists, law enforcement, maintenance crews, and others, has been touted as a success since its inception in 1999. That program has shown a 31% decrease in human-bear incidents and a 63% decrease in property damage (Madison, 2008). These decreases in conflict and property damage through this multi-tool strategy should be an example of the benefits of bear management involving multiple stakeholders that participate in activities to reduce conflicts between humans and bears.

The use of non-lethal approaches to resolving human-bear has been studied for about 30 years (Spencer et al, 2007). The effects of different education and outreach techniques, the role of enforcement of municipal ordinances and state laws, along with treatment of individual bears involved in conflict should continue to be rigorously studied. Managers should maintain a complete database of individual bears involved in conflicts, not only to help assess different methods for reducing such incidents, but also to document efforts for individual bears, especially if lethal removal of the bear is the outcome. The ability of managers to demonstrate management activities prior to lethal removal may help the public understand the overall approach to limiting altercations, human conflicts, and lethal removals of black bears.

Ideally, the public would incorporate the necessary tools for attractant security in areas also occupied by bears. Realistically, bear-resistant containers or electric deterrents such as electric fencing, to secure attractants are expensive, and may not be an option for many residents because of financial and logistical constraints. Johnson et al. (2018) suggests agencies work with municipalities to implement ordinances to secure garbage and reduce or eliminate feeding of bears. Franchise agreements between municipalities and sanitation companies to provide bear resistant containers to clients takes a large financial strain off the public and helps increase

compliance for secure garbage storage (Johnson et al. 2018). By combining enforcement of those ordinances with provision of bear-resistant containers by sanitation companies or municipalities, agencies could see a reduction in the amount of garbage available to bears and increased compliance by residents on attractant security (Johnson et al., 2018). Coupling these actions with the ability of agencies to haze individual bears as a form of non-lethal management may reduce human-bear conflicts overall. Those combined measures may be an effective plan for a future with fewer conflicts between humans and bears, and fewer bears being killed.

Literature Cited

Agee, J., & C.A., M. (2009). Factors Contributing Toward Acceptance of Lethal Control of Black Bears in Central Georgia, USA. Human Dimensions of Wildlife, 14(3), 198-205.

Baruch-Mordo, S., Breck, S. W., Wilson, K. R., & Broderick, J. (2011). The carrot or the stick? evaluation of education and enforcement as management tools for human-wildlife conflicts. PLoS One, 6(1), e15681.

Baruch-Mordo, S., Wilson, K. R., Lewis, D. L., Broderick, J., Mao, J. S., & Breck, S. W. (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.

Beckmann, J., & Berger, J. (2003, May). Using Black Bears To Test Ideal-Free Distribution Models Experimentally. Journal of Mammalogy, 84(2), 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(2): 269-272.

Beckmann, J., & Lackey, C. (2008). Carnivores, urban landscapes, and longitudinal studies: a case history of black bears. Human-Wildlife Conflicts, 2(2), 168-174.

Beckmann, J., Lackey, C., & Berger, J. (2004). Evaluation of deterrent techniques and dogs to alter behavior of "nuisance" black bears. Wildlife Society Bulletin, 32(4), 1141-1146.

Campbell, J. (2012). The effect of education in reducing bear attractants on cottage properties: Manitoba's "Bear Smart" program. Forest Policy and Economics, 19, 56-65.

Cella, B., & Keay, J. (1979) Annual bear management and incident report, Yosemite National Park, 1979.

Yosemite National Park, CA: National Park Service. 22p. Unpublished report.

Clark, J., van Manen, F., & Pelton, M. (2002). Correlates of Success for On-Site Releases of Nuisance Black Bears in Great Smoky Mountains National Park. Wildlife Society Bulletin, 30(1), 104-111.

Cleary, M., Joshi, O., & Fairbanks, W. S. (2021). Factors that Determine Human Acceptance of Black Bears. The Journal of Wildlife Management, 85(2), 582-592.

Comeau, N. A. (2013). Evaluation of Two Methods of Aversive Conditioning on Nuisance Activity Levels of New Hampshire Black Bear. Plymouth State University.

Conover, M. (1998). Perceptions of American Agricultural Producers about Wildlife on Their Farms and Ranches. Wildlife Society Bulletin, 26(3), 597-604.

Conover, M. & Decker, D. (1991). Wildlife Damage to Crops: Perceptions of Agricultural and Wildlife Professionals in 1957 and 1987. Wildlife Society Bulletin, 19(1), 46-52.

Dietsch, A. M., Slagle, K. M., Baruch-Mordo, S., Breck, S., & Ciarniella, L. M. (2018). Education is not a panacea for reducing human-black bear conflicts. Ecological Modeling, 367, 10-12.

Dubois, S., & Fraser, D. (2013). Local Attitudes toward Bear Management after Illegal Feeding and Problem Bear Activity. Animals, 3, 935-950.

Dunn, W. C., Elwell, J. H., & Tunberg, G. (2008). Safety education in bear country: Are people getting the message? Ursus, 19(1), 43-52.

Fall, M. W., & Jackson, W. B. (2002). The tools and techniques of wildlife damage management - changing needs: an introduction. International Biodeterioration & Biodegradation, 49, 87-91.

Garshelis, D. L., Noyce, K. V., & St-Louis, V. (2020). Population reduction by hunting helps control human-wildlife conflicts for a species that is a conservation success story. PLoS One, 15(8), 1/20.

Gillin, C. M., Hammond, F. M., & Peterson, C. M. (1994). Evaluation of an Aversive Conditioning Technique Used on Female Grizzly Bears in the Yellowstone Ecosystem. Bears: Their Biology and Management, 9(1), 503-512.

Gore, M. L., Knuth, B. A., Curtis, P. D., & Shanahan, J. E. (2006). Education programs for reducing American black bear-human conflict: indicators of success? Ursus, 17(1), 75-80.

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

Harris, H. B. (2011). The Return Of The Black Bear To Eastern Kentucky: Conflict And Tolerance Between People And Wildlife. University of Kentucky. University of Kentucky Doctoral Dissertations.

Heneghan, M. D., & Morse, W. C. (2019). Acceptability of Management Actions and the Potential for Conflict Following Human-Black Bear Encounters. Society & Natural Resources, 32(4), 434-451.

Homstol, L. (2011). Applications of learning theory to human-bear conflict: the efficacy of aversive conditioning and conditioned taste aversion. University of Alberta, Edmonton.

Homstol, L., Brabyn, N., Hamilton, A., & von der Porten, M. (2006). Whistler Black Bear Aversive Conditioning and Monitoring Project. Whistler: Bear Aversion Research Team.

Homstol, L., Raymond, S., Edwards, C., Hamilton, A. N., & St Clair, C. C. (2024). Aversive conditioning increases short-term wariness but does not change habitat use in black bears associated with conflict. PloS One, 19(1), e0295989–e0295989. https://doi.org/10.1371/journal.pone.0295989

Hopkins III, J. B., Herrero, S., Shideler, R. T., Gunther, K. A., Schwartz, C. C., & Kalinowski, S. T. (2010). A proposed lexicon of terms and concepts for human-bear management in North America. Ursus, 21(2), 154-168.

Howe, E. J., Obbard, M. E., Black, R., & Wall, L. L. (2010). Do public complaints reflect trends in human-bear conflict? Ursus, 21(2), 131-142.

Hristienko, H., & McDonald Jr, J. E. (2007). Going into the 21st century: a perspective on trends and controversies in the management of the American black bear. Ursus, 18(1), 72-88.

IUCN. (2021, 8 16). The IUCN Red List of Threatened Species. Retrieved from The IUCN Red List of Threatened Species: https://www.iucnredlist.org

Johnson, H. E., Lewis, D. L., Lischka, S. A., & Breck, S. W. (2018). Assessing ecological and social outcomes of a bear-proofing experiment. The Journal of Wildlife Management, 82(6), 1102-1114.Keay, C. W. (1979). Annual bear management and incident report. El Portal, CA: Yosemite National Park.

Lackey, B. (2003). Contextual Analysis of Interpretation Focused on Human-Black Bear Conflicts in Yosemite National Park. Applied Environmental Education and Communication: An International Journal, 2(1), 11-21.

Lackey, C. W., Beckmann, J. P., & Sedinger, J. (2013, May). Bear Historical Rangers Revisited: Documenting the Increase of a Once-Extirpated Population in Nevada. The Journal of Wildlife Management, 77(4), 812-820.

Lackey, C. W., S. W. Breck, B. F. Wakeling, and B. White. 2018. Human-Black Bear Conflicts: A review of common management practices. Human-Wildlife Interactions Monograph 2:1-68.

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

Lewis, J. H., Alldredge, M. W., Dreher, B. P., George, J. L., Wait, S., Petch, B., & Runge, J. P. (2019). Summarizing Colorado's Black Bear Two-Strike Directive 30 Years After Inception. Wildlife Society Bulletin, 43(4), 599-607.

Klip, J. M. K. (2018). Spatial and Temporal Patterns of a Generalist Urban Carnivore; American Black Bears (Ursus americanus) at Lake Tahoe (CA). ProQuest Dissertations Publishing.

Madison, J. H. (2008). Yosemite National Park: the continuous evolution of human-black bear conflict management. Human-Wildlife Conflicts, 2(2), 160-167.

Manfredo, M. S., Don Carlos, A., Dietsch, A., Teel, T., A.D., B., & Bruskotter, J. (2018). America's Wildlife Values: The Social Context of Wildlife Management in the U.S. Colorado State University, Department of Human Dimensions of Natural Resources. Fort Collins.

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

Mazur, R. (2010). Does Aversive Conditioning Reduce Human-Black Bear Conflict? The Journal of Wildlife Management, 74(1), 48-54.

McCarthy, T. M., & Seavoy, R. J. (1994). Reducing Nonsport Losses Attributable to Food Conditioning: Human and Bear Behavior Modification in an Urban Environment. Bears: Their Biology and Management. 9, pp. 75-84. Missoula: International Association for Bear Research and Management.

Merkle, J. A., Robinson, H. S., Krausman, P. R., & Alaback, P. (2013). Food availability and foraging near human developments by black bears. Journal of Mammology, 94(2), 378-385.

Messmer, T. A. (2000). The emergence of human-wildlife conflict management: turning challenges into opportunities. International Biodeterioration and Biodegradation, 45, 97-102.

Otto, T. E., & Roloff, G. J. (2015). Black bear exclusion fences to protect mobile apiaries. Human-Wildlife Interactions, 9(1), 78-86.

Peine, J.D. (2001) Nuisance Bears in Communities: Strategies to Reduce Conflict, Human Dimensions of Wildlife, 6:3, 223-237.

Pienaar, E. F., Telesco, D., & Barrett, S. (2015). Understanding People's Willingness to Implement Measures to Manage Human-Bear Conflict in Florida. The Journal of Wildlife Management, 79(5), 798-806.

Samuelson, M.M. (2020). Bear Management. In: Vonk, J., Shackelford, T. (eds) Encyclopedia of Animal Cognition and Behavior. Springer, Cham. https://doi.org/10.1007/978-3-319-47829-6_2094-1

Poole, T. B. (2011). Effects of educational strategies on black bear-human conflicts in Black Mountain, North Carolina. Montreat College. Ann Arbor: ProQuest LLC.

Redpath, S. M., J. Young, A. Evely, W. M. Adams, W. J. Sutherland, A Whitehouse, A. Amar, R. A. Lambert, J. D. C. Linnell, A. Watt, and R. J. Gutierrez. 2013. Understanding and managing conservation conflicts. Trends in Ecology and Evolution 28:100–109.

Scheick, B. K., & McCown, W. (2014). Geographic distribution of American black bears in North America. Ursus, 25(1), 24-33.

Schirokauer, D. W., & Boyd, H. (1998). Bear-human conflict management in Denali National Park and Preserve 1982-1994. Ursus, 10, 395-403.

Scott, A. M., Kocka, D. M., & Mitchell Jr., G. W. (2018). Human-bear conflicts in Massanutten Village: achieving success requires partnerships. Human-Wildlife Interactions, 12(3), 405-410.

Servheen, C. (1989). The Status and Conservation of the Bears of the World. Eighth International Conference on Bear Research and Management. International Association for Bear Research and Management.

Signor, K. D. (2010). Investigating Methods To Reduce Black Bear (Ursus americanus) Visitation To Anthropogenic Food Sources: Conditioned Taste Aversion And Food Removal. Utah State University, Wildland Resources. Logan: UMI Dissertation Publishing.

Smith, M.E., Linnell, J.D.C., Odden, J., & Swenson, J.E. (2000). Review of Methods to Reduce Livestock Depredation II. Aversive conditioning, deterrents and repellents. Acta Agriculturae Scandinavica, Section A — Animal Science, 50, 304-315.

Spencer, R. D., Beausoleil, R. A., & Martorello, D. A. (2007). How agencies respond to human-black bear conflicts: a survey of wildlife agencies in North America. Ursus, 18(1), 217-229.

Table 1. Definitions of levels of conflict.

Conflict Level	Definition
Low	Human-bear conflict resulting from bears using food resources in urban areas without causing property damage or threatening human safety. This level of conflict includes, but is not limited to, bears accessing garbage, birdfeeders, pet food, fruit trees, apiaries, and chicken coops.
High	Human-bear conflict resulting in property damage, structure entry, human injury, or human death

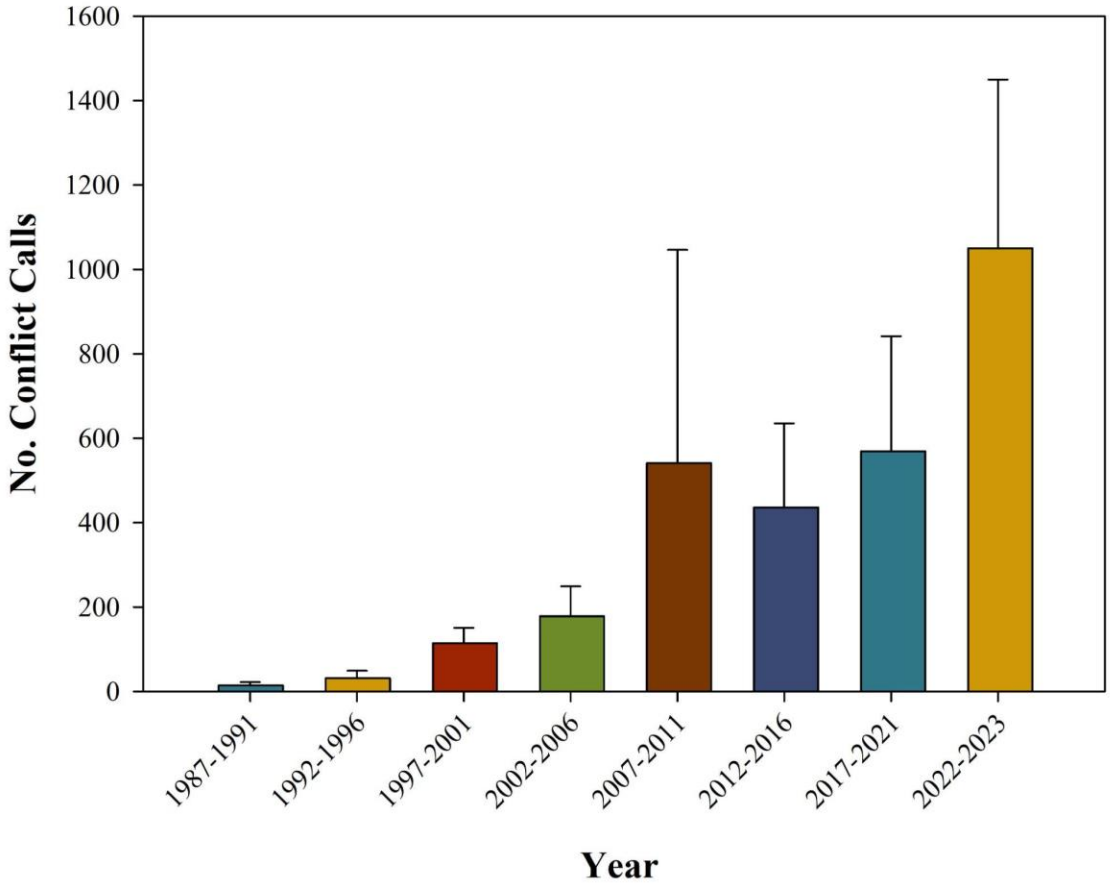

Figure 1. *An illustration of the increase in conflict calls as reported by the Nevada Department of Wildlife from 1987-2023 in 5-year averages.*

Figure 2. *An example of residents needing to voluntarily change behaviors. Despite bear-resistant garbage cans being available to residents, not all residents put forth the effort to obtain one. This photo illustrates that one resident has a bear-resistant container (circled, left) with two neighbors that have not voluntarily reached out to their waste management company to obtain one and the result of a bear gaining access to their garbage (right). (Photo courtesy Heather Reich/NDOW 2019)*

Figure 3. *An example of hazing of a black bear in Nevada with the use of Karelian Bear Dogs. (Photo courtesy of John T. Humphrey)*

USE OF KARELIAN BEAR DOGS FOR MANAGEMENT OF BLACK BEARS: IS A BITE BETTER THAN A BARK?

Heather E. Reich, Kelley M. Stewart, Kevin T. Shoemaker, Marcus E. Blum, and Brian Wakeling

H. E. Reich, K. M. Stewart, and K. T. Shoemaker, Ecology Evolution and Conservation Biology Graduate Program and Department of Natural Resources and Environmental Science, University of Nevada, 1664 N. Virginia St MS186, Reno, Reno, NV 89557

M. E. Blum, Natural Resources Institute, Texas A&M University, College Station, TX, 77840

B. F. Wakeling, Montana Fish, Wildlife, & Parks, 1420 E. 6th Ave, Helena, MT. 59601

Corresponding author: Kelley M. Stewart

Address: Natural Resources and Environmental Science
1664 N. Virginia St, Mail Stop 186
University of Nevada, Reno
Reno, NV 89557
Tel: (775) 313-5280
Email: KelleyS@unr.edu

List of Tables

List of Figures

the same letter are not significantly (P>0.05) different. Sample sizes for each treatment are indicated on the corresponding bar.

Figure 4.

Photos showing examples of (top) a bear being treated with dogs off-leash and (bottom) a bear being treated with dogs on-leash. (Photos courtesy NDOW/Heather Reich)

Abstract

Human-bear conflict is a well-studied issue for management with both education and outreach along with non-lethal techniques being evaluated for multiple species and different geographical areas. With increasing interest in non-lethal management of bears that come into conflict with humans, the use of dogs as a management tool is growing. Dogs may be used for a variety of uses, including personal protection, location of injured or dead wildlife, location of dropped radio telemetry collars, and hazing. Few studies have assessed the benefits of dogs as a tool to be used by bear managers. For agencies mandated with managing bears that may be considering the use of dogs in their management protocols, how or if to use the dogs when hazing bears is an unanswered question. Frequent altercations between black bears and humans in the Tahoe Basin of Nevada provided a scenario where we could test the use of Karelian bear dogs in hazing of bears coupled with other hazing techniques to determine if the various treatments influenced subsequent behavior and timing. We evaluated the number of days before bears returned to chronic conflict and the percentage of time bears spent in residential areas after one of three treatments of hazing. We hypothesized that hazing bears with dogs off-leash would keep bears out of chronic conflict longer than bears hazed with dogs on-leash or not treated with hazing. We found no significant difference between treatments. Despite our inability to detect any differences in response to treatments of human-bear some benefits, the public is often mollified by the presence of dogs.

Key Words: Human-bear conflict, *Ursus americanus*, hazing, Karelian Bear Dogs, management

1. Introduction

The return of the black bear (*Ursus americanus*) from extirpation across most of the United States is a conservation success story (Hristienko and McDonald 2007, Scheick and McCown 2014). Historically, by the early 20th century, most black bear populations in the United States had been decimated due to habitat loss, unregulated hunting and trapping, and general persecution (Lackey et al., 2013; Scheick & McCown, 2014). These black bear populations began rebounding in the 1970s to 1980s (Hristienko and McDonald, 2007). Garshelis and Hristienko (2006) showed that 35 of 49 jurisdictions surveyed in North America were documenting a continuing increase in black bear populations in both survey years of 1997 and 2001. Corresponding with black bear population increases in North America is the increasing human population across North America. This has resulted in bears and humans overlapping and suffering conflicts as a result of that overlap as bears take advantage of the availability of food resources in urbanized areas (Gore et al. 2006, Marley et al. 2019; Baruch-Mordo et al. 2011).

Conflicts with humans typically are the result of bears becoming conditioned to anthropogenic sources of food including garbage, bird feeders, pet food, chicken coops, and apiaries with concomitant escalation of property damage and likelihood of home entry (Mattson 1989, Beckmann et al. 2004, Lackey et al. 2013, Lackey et al. 2018, and Homstol et al. 2024). We have separated human-bear conflict into two levels. For this paper, low-level conflict is considered human-bear conflict involving bears accessing anthropogenic food resources without property damage or public safety concerns (Table 1). This includes, but is not limited to, accessing garbage cans, birdfeeders, pet food, apiaries, chicken coops, and habituation to the presence of humans. High-level conflict is defined as human-bear conflict involving bears causing property damage, structure entry, human injury, or human death (Table 1). Low-level conflict between humans and bears are likely to continue to increase as human populations

expand into habitats occupied by wildlife. Marley et al. (2017) reported a positive relationship between the likelihood of a bear becoming involved in conflict with small increases in human population size.

Despite widespread education, outreach, and management actions by wildlife agencies, conflicts between humans and bears will never be fully resolved. Clark et al. (2002) stated that the frequency of conflicts between humans and bears will increase with increasing population density of humans and bears, with effects from an expanding wildlife-urban interface. Bears in residential areas, while increasingly fecund, experience elevated risks of mortality, largely from vehicle collisions (Beckmann and Lackey 2008). Compounding this effect with the increasingly mutualistic social culture of residents in North America (Manfredo et al. 2021), and the growing unacceptability of lethal control of bears (Cleary et al. 2021, Homstol et al. 2024), hazing of individual bears is often an important part of management of human-bear conflicts. Hazing is defined as the delivery of deterrents to a bear for immediate behavior modification (Schirokauer & Boyd 1998, Hopkins et al. 2010). This differs from aversive conditioning, which is the continual and consistent application of deterrents to a bear to modify behavior (Hopkins et al. 2010). Members of the public began pressuring wildlife management agencies for non-lethal alternatives to management of conflicts between humans and bears rather than just removals (Spencer et al. 2007). Gillin et al. (1992) suggested that bear managers in the United States look into the use of hunting dogs commonly used in Russia and Finland as a tool for reducing conflicts between humans and bears (*Ursus* spp), because combining the use of dogs with other negative reinforcement techniques may help modify bear behavior in conflict situations. Moreover, use of dogs may help provide a negative reinforcement to bears in different forms of human-bear conflict (Gillian et al. 1992). Since the mid-90s, when the suggestion was put forth by Gillin et al. (1992) and despite the paucity of science on the efficacy of using dogs as a tool for bear

management, interest in use of dogs has increased. Specifically, use of Karelian Bear Dogs (KBDs) as a tool for managing bears has grown nationally and globally.

By the mid-1990s to early 2000s biologists from Montana, Nevada, and Washington incorporated the use of dogs into their toolkits for non-lethal management of bears. Dogs have proven useful for providing personal safety and to alert personnel to the presence of a bear when investigating sites of attacks on humans by bears. They are also helpful in tracking injured bears or carcasses that a bear may be feeding on, allowing the dogs to alert to or encounter a bear ahead of their handlers. Similarly, dogs have helped locate orphaned bears and mountain lion cubs. Dogs have also assisted in clearing bears out of crawl spaces, finding dropped radio collars, tracking bears that have been chemically immobilized but flee before the full effects of the immobilization take place, and as an attraction for outreach and education among the public. Beyond bears, dogs are used for detection of scat, reptiles, and amphibians for other wildlife conservation efforts.

The use of dogs began without any scientific data to support them as a non-lethal tool for management of human-bear conflicts, in part, because of the positive response by the public to this method of management. Since then, more states, provinces, and countries have embraced the use of dogs in an effort to manage bears using non-lethal methods. The first study of nonlethal deterrents, including the use of dogs for management, found that bears chased by hounds upon release from a culvert trap returned to conflict slightly later than bears from other treatment groups (Beckmann et al., 2004). In most instances, use of dogs was combined with "less-lethal" ammunition, including rubber bullets or rubber buckshot (Beckmann et al. (2004); Leigh and Chamberlain 2008). When less-lethal ammunition alone was compared with use of dogs alone, bears treated with hounds remained out of the community or treatment location longer than bears treated with rubber bullets (Comeau 2013). In the case of Comeau's study (2013), the amount of time was a difference of only hours, with bears with dogs averaging 21.9 hours before a return to

conflict in contrast to bears treated with rubber bullets returning after 7.2 hours on average. Recently, Klip (2018) reported that bears treated with Karelian Bear dogs (hereafter dogs) alone stayed away from the capture site and release locations for an average of 150 days, compared to bears treated with dogs coupled with less-lethal ammunition, which returned after an average of 130 days.

Karelian bear dogs are currently used by the Nevada Department of Wildlife (NDOW) as a non-lethal tool for hazing black bears involved in conflicts with humans. This method allowed us an opportunity to evaluate different methods of using the dogs during the hazing of black bears in Nevada. With the growing interest in using dogs as a non-lethal tool, we asked the question, is the effect of the dogs the result of the presence of the dog or does releasing the dogs to chase and potentially make contact or bite the bears more effective for conflict management of bears? We hoped to determine if there was an effective way for wildlife management agencies to incorporate dogs as a non-lethal method for managing conflicts between humans and bears. NDOW currently uses KBDs for hazing bears captured because of low levels of conflict as opposed to higher levels of conflict that include property damage or entry. Based on prior studies, we hypothesized that releasing the dogs off-leash to pursue and contact the bears as they were released would cause a higher probability of avoidance by bears for a longer period. We further hypothesize that bears hazed with dogs off-leash would have a higher probability of avoiding spending most of their time in residential areas or close to human habitation.

2. Methods

The focus of our study was western Nevada, specifically in areas that experienced high levels of conflicts between humans and bears. The study area includes all towns and cities within the Lake Tahoe Basin, the metropolis of Reno and Carson City, and the smaller towns of Minden, Gardnerville, Dayton, Virginia City, and Wellington (Figure 1). These areas are contained with 5

counties that contain the currently documented population of bears in western Nevada (NDOW 2018). Washoe County, the largest in western Nevada, which contains the city of Reno, boasts a human population of >486,000. Carson City follows with >58,000 residents, and Douglas County has ≥50,000 residents. These counties all show a trend of increasing human habitation coinciding with a stable or increasing population of black bears (NDOW. 2022). The population size of black bears in western Nevada is estimated at about 418 bears (95% CI=239–740) (Sultaire et al.2023).

We obtained data from global positioning system (GPS) radio collars from bears associated with conflicts with humans that were captured by the Nevada Department of Wildlife. Collars were placed on bears from 2019-2022, with 5 collars being placed on bears from August to November of 2019, 16 collars being placed on bears from June to November of 2021, 24 collars being placed on bears from May to November of 2021, and 3 collars being placed on bears from January to June of 2022. Bears were captured in culvert traps or by free-range darting on-site by NDOW biologists (van Manen et al., 2019). Upon capture, bears were sedated with a mixture of Telazol and Xylazine and marked with identification tags, tattoos, and passive integrated transponders (PIT) tags (Biomark LLC, Boise, Idaho, USA) for identification of individuals over time. Bears were then fitted with Vectronic GPS+, iridium and globalstar collars (Vectronic Aerospace GmbH, Berlin, Germany). The duty cycle on the collar was set to collect a location every 3.5 hours from April 1 to December 31. From January 1 to March 30 collars were set to collect a single GPS location once a day to conserve life during the winter. Bears were released from culvert traps 12-24 hours after capture and handling and were released either on-site, relocated within their home range, or translocated outside of their home range. All animal handling was performed by Nevada Department of Wildlife biologists and was in keeping with guidelines specified by the American Society of Mammalogists for care and use of wild mammals (Sikes et al. 2016).

We began with a dedicated study period from August 2019 to April 2023 and 43 bears were randomly assigned to three different treatment groups: hazed by dogs off-leash (n=17), hazed by dogs on-leash (n=12), control (release, no dogs used n=14). Treatments were assigned after capture of the bear with considerations given to the release location and the safety of bear and dogs. The randomness was sometimes influenced by supervisors within the Nevada Department of Wildlife that required off-leash for certain bears. For the off-leash treatment, dogs were immediately released with the bear to make contact (bite), although this contact was not always made in these treatments. Dogs on-leash were not allowed to make contact but were allowed to bark as dogs and handlers chased the bear upon release. Our control group had humans on site and dogs that remained inside stationary vehicles that often barked. Bears were included in our study based on their conflict level at the capture. Based on prior studies, bears in low levels of conflicts with less human-habituation and food-conditioning tend to be more responsive to hazing than bears involved in property damage or that had become public safety concerns due to property damage or had caused human injury (Beckmann et al. 2008, Mazur 2010, Homstol et al. 2024). Females with dependent young were not included in the study to prevent separating the family group or injury to dependent young.

Because of limited sample size in our treatment groups, we created a second study group of 42 radio collared bears from NDOW's database from September 2012 - May 2019 along with the radio collar data from the 2019-2023 group. The addition of these data resulted in 4 bears having duplicate treatments with different radio collars. These duplicate treatments occurred greater than one year apart. Due to a lack of information in the data provided by NDOW from 2012-2019, we were unable to determine if those releases included less-lethal ammunition nor how treatments were assigned. Therefore, those data are presented separately from the previously described treatments (2019-2023). Treatments were split into the same three treatment groups based on those data with enough detail to determine how dogs were used during the releases. To

look at the difference between the presence or absence of dogs, we created a third study group using all collar data from 2012-2023. Those collar data were separated into two treatments that were assigned as bears treated with dogs and no dogs used. Treatment 1 included all bears treated with dogs, no matter if they were on-leash or off-leash. Treatment 2 was the control group of no dogs used.

We used radio-collar data to quantify how many days after release a bear returned to chronic conflict. Chronic conflict was defined as two consecutive GPS locations, timed 3.5 hours apart at human-occupied residences within the same residential area. This was done to avoid mistaking a bear moving through an area as one that had returned to chronic conflict. We also determined the percentage of time bears spent in residential areas by GPS points located within areas we subjectively determined as urban versus outside of those designated polygons (Figure 1).

We analyzed data using non-parametric Kaplan-Meier (K-M) analysis modified to focus on the probability of a bear remaining outside of urban areas. Traditional K-M focuses on the probability of survival. The Kaplan-Meier analysis was modified to a "time to event" analysis that provided the time a bear was in the study before having an event within the study (in our case, the day they return to chronic conflict, or the percentage of time spent in an urban area). Kaplan-Meier analysis also provided us with a way to address staggered timing of entrance and exit for individuals to and from the study. Using the K-M analysis further allowed us to censor individuals that exited the study due to a mortality event (such as being hit by a car, management removal, or harvested in a hunt) or the loss of data from a collar failing or dropping off. Censoring those individuals permitted us to use the data with the acknowledgment that they did not return to chronic conflict (Rich et al. 2010). This method allowed the event interval to continue despite the loss of the one individual in the study and the acknowledgement that the duration of their known survival cannot be determined with accuracy, including bears that never returned to chronic conflict by the end date of the study (Rich et al. 2010). We ran six K-M

analyses, three of these analyses looked at the amount of time a bear took before returning to chronic conflict after treatment. One analysis used was done with the short-term study period from 2019-2023 (n=43, with 9 censored individuals). The second analysis looked at the longer-term dataset from 2012-2023 (n=85, 23 censored individuals). The third analysis looked at the long-term dataset with treatments being separated into dogs used (n=62, 15 censored individuals) and control (n=23, 8 censored individuals).

We further investigated the treatment effect on the percentage of time bears spent in residential areas versus out of residential areas using a one-way analysis of variance. Due to older collars in the 2012-2019 dataset not providing correct year assignments to the downloaded data, this analysis resulted in a smaller sample size, which included dogs off leash (n=29), dogs on leash (n=11) and control (n=14).

For our study, we did not account for the time that bears were in their dens and technically unavailable to come into conflict with humans.

3. Results

For the designated study period of 2019-2023, bears receiving treatment with dogs off-leash took about 148 days to return to chronic conflict ($\pm$ 273.8 days, Table 2), which was 45.6 days longer than bears treated with dogs on-leash (102.4 days $\pm$ 283.8 days, Table 2) and 31.5 days longer (179.5 days $\pm$178 days, Table 2) than bears in the control group, although those confidence intervals overlapped one another (Kaplan-Meier, p=0.51, figure 2).

When looking at the longer-term collar data from 2012 to 2023, bears receiving treatment with dogs off-leash returned to chronic conflict on average 498 days after treatment ($\pm$1056.4 days, Table 2). Compared with bears treated with dogs on-leash that entered conflict 149.2 days sooner at 348.8 days ($\pm$ 997.2 days, Table 2). Interestingly, bears in the control group returned to chronic conflict only 35.2 days sooner than bears with dogs off leash (462.8 days $\pm$882.6 days,

Table 2). Those confidence intervals also overlapped with one another (Kaplan-Meier p=0.49, figure 2). To determine if there was any effect of the dogs at all, we used the combined data from 2012-2023 and designated two treatments, dogs versus no dogs (control). Bears treated with dogs (n=62) stayed out of conflict for 421 (±882.7, Table 2) days versus bears not treated with dogs upon release (n=23) which stayed out of conflict on average 462.6 (±1035.6, Table 2) days, but the confidence intervals overlapped one another (Kaplan-Meier p=0.24, figure 2).

The results of the ANOVA revealed that bears that were not treated with dogs spent less time in residential areas than bears hazed by dogs on leash, ($F_{2,104} = 4.88$, p=0.029, figure 3). Specifically, the mean percentage of time bears spent in urban areas after treatment by dogs on-leash was 18.62%, which was significantly higher than the mean percentage for the control group of 5.60% (p = 0.015).

4. Discussion

Our hypothesis that bears treated with dogs, either on or off leash would result in a longer return to conflict by bears was not supported. Our initial sample size of 43 individuals in the designated study period was not large enough to detect a difference in the 3 treatments we compared, no dogs, dogs on leash, dogs off leash. Beckmann et al. (2008), noted that the variation in the effectiveness of the three treatments could be attributed to individual variation by bears in their responses to dogs. Many bears in the study area have become highly habituated to residential areas that include consistent sounds of humans and barking dogs. This habituation to dogs and humans may dampen responses of bears to the presence of dogs.

Our analysis was conservative in that we defined a return to chronic conflict as 2 consecutive locations in a residential area. This was done to discount a single location as having the potential for being a bear simply moving through the area. Further affecting the analysis is a caution made by Carter and Huange (2009), such that in the K-M analysis, as individuals exit the

analyses and remaining members dwindle through the study, this leads to a small risk set (Carter and Huange, 2009). The result of a smaller risk set leads to a larger variation in the estimation of the probability of avoidance (Carter and Huange, 2009). In the case of this study, our risk set was small, and the resultant avoidance and associated confidence intervals should be interpreted with caution (Carter and Huange 2009).

Three of the four prior studies that focused on hazing of bears using dogs with less-lethal ammunition indicated that coupling dogs with less-lethal ammunition showed a slight increase in time before bears re-entered conflict, and increased distance traveled by bears from the source of conflict (Beckmann et al. 2004, Leigh and Chamberlain 2008, Comeau 2013 and Klip 2018). Bears may receive multiple hazing treatments throughout their life, and it would be beneficial to be able to determine if those events continued to keep individual bears from escalating in conflict to become a public safety concern. Drought and a resulting food failure may cause any hazing to be ineffective if food resources are not available in wildland areas and anthropogenic food is too great of a draw to offset the negativity of hazing (Lewis et al. 2014, Johnson et al. 2017). The bulk of the 2019-2023 study group occurred during an intense drought, which resulted in a collapse in production of natural foods on the landscape. This drought prevented the state wildlife agency from being successful in attempts to keep bears out of conflict, because many bears were driven into residential areas to search for anthropogenic sources of food in the absence of natural food. Models show that climate change will continue to cause those types of events, so knowledge of how to manage opportunistic omnivores like bears could benefit from the fact that our study was conducted during a D2 drought (Johnson et al. 2018).

Many wildlife managers believe that hazing should permanently change the behavior of bears exposed to it. Beckmann et al. (2008) suggested that if agencies are looking to define success as changing bear behavior to never have to deal with an individual bear again then they will likely find only failure in these efforts. We suggest that the goal of hazing should not be to

change the behavior of bears permanently, but to keep a bear out of conflict. The use of dogs may address concerns from stakeholders that managers explored all options to prevent individual bears in low-level conflict from escalating conflict behaviors to the point of becoming a public safety concern, likely requiring lethal removal. There needs to be a shift to define success as a treated bear remaining at a low level of conflict because of hazing rather than hoping for a permanent change in behavior.

While hazing bears with dogs is not a silver bullet for resolution of human-bear conflict, managers may be looking to incorporate dogs into their management of human-bear conflicts. The effect of hazing with dogs, regardless of the way dogs are used, could have limited short-term benefits (Leigh and Chamberlain 2008, Homstol et al. 2024). The small benefits may be worth the use of dogs, especially if the gain is increasing public support with corresponding increased trust in wildlife management agencies. Beckmann et al. (2004) stated that the increase in public trust and the avoidance of dealing with a bear for some period of time could make the effort of hazing and deterrents a beneficial aspect of management of bears involved in low-level conflict.

5. Conclusion

Our study demonstrated that the way dogs are used as part of a non-lethal tool in management of human-bear conflict does not have a significant effect on the probability of avoidance of conflict by bears in an urban environment. While our study shows the use of dogs lacks any effectiveness for reducing human-bear conflicts, incorporating specially trained dogs into human-bear conflict management may be beneficial to agencies in other capacities.

Dogs have many benefits to a wildlife management agency, aside from hazing, in positive public perception and acceptance. Use of dogs in bear management has proven effective in multiple situations including personnel safety, tracking injured or orphaned wildlife, clearing

bears out from under homes, finding dropped collars, and as ambassadors during outreach and education efforts. In Montana, KBDs have been used to provide security for law enforcement investigating a self-defense shooting of brown bears (Manley, pers comm). In those instances, dogs provide safety for law enforcement where an attack on a human occurred, and the bear may still be in the area (Manley, pers comm). Handlers with dogs can provide a lookout and early detection of a bear in the immediate vicinity while law enforcement focuses on evidence gathering (Manley, pers comm). They have also been used in both Montana, Nevada, and Washington for tracking injured bears to determine if there is a carcass or a bear that may require euthanasia. Dogs are used in Nevada to accompany biologists into crawl spaces where bears have created an urban den to evict the bear from the space and to help biologists determine the presence and location of bears that have broken into houses. Karelian Bear dogs also are used as ambassadors, drawing attention from the public at outreach events. Similarly, an agency employee may be more approachable and appear more compassionate to the public accompanied with a dog to address the conflict compared with a firearm. The benefits of dogs used in human-bear conflict go beyond the individual hazing of captured bears and should be considered as a tool for agencies tasked with managing bears.

Literature Cited

Baruch-Mordo, S., Breck, S. W., Wilson, K. R., & Broderick, J. (2011). Carrot or the Stick? Evaluation of Education and Enforcement as Management Tools for Human-Wildlife Conflicts. *PloS One*, *6*(1), e15681–e15681. https://doi.org/10.1371/journal.pone.0015681

Beckmann, J. P., Lackey, C. W., & Berger, J. (2004). Evaluation of deterrent techniques and dogs to alter behavior of "nuisance" black bears. *Wildlife Society Bulletin*, *32*(4), 1141–1146. https://doi.org/10.2193/0091-7648(2004)032[1141:EODTAD]2.0.CO;2

Beckmann, J. P., & Lackey, C. W. (2008). Carnivores, urban landscapes, and longitudinal studies: a case history of black bears. *Human-Wildlife Conflicts*, *2*(2), 168–174.

Cleary, M., Joshi, O., & Fairbanks, W. S. (2021). Factors that Determine Human Acceptance of Black Bears. *The Journal of Wildlife Management*, *85*(3), 582–592. https://doi.org/10.1002/jwmg.21999

Comeau, N. A. (2013). *Evaluation of Two Methods of Aversive Conditioning on Nuisance Activity Levels of New Hampshire Black Bear*. ProQuest Dissertations Publishing.

Gillin, C. M., Chestin, I., Semchenkov, P., & Claar, J. (1997). Management of Bear-Human Conflicts Using Laika Dogs. *Bears, Their Biology and Management*, *9*, 133–137. https://doi.org/10.2307/3872673

Gore, M. L., Knuth, B. A., Curtis, P. D., & Shanahan, J. E. (2006). Education programs for reducing American black bear–human conflict: indicators of success? *Ursus (International Association for Bear Research and Management)*, *17*(1), 75–80. https://doi.org/10.2192/1537-6176(2006)17[75:EPFRAB]2.0.CO;2

Graber, D. M., & White, M. (1983). Black bear food habits in Yosemite National Park. *Bears: Their Biology and Management*, 1-10.

Heneghan, M. D., & Morse, W. C. (2019). Acceptability of Management Actions and the Potential for Conflict Following Human-Black Bear Encounters. *Society & Natural Resources, 32*(4), 434–451. https://doi.org/10.1080/08941920.2018.1556756

Homstol, L., Raymond, S., Edwards, C., Hamilton, A. N., & St Clair, C. C. (2024). Aversive conditioning increases short-term wariness but does not change habitat use in black bears associated with conflict. *PloS One, 19*(1), e0295989–e0295989. https://doi.org/10.1371/journal.pone.0295989

Hopkins, J. B., Herrero, S., Shideler, R. T., Gunther, K. A., Schwartz, C. C., & Kalinowski, S. T. (2010). A proposed lexicon of terms and concepts for human–bear management in North America. *Ursus (International Association for Bear Research and Management), 21*(2), 154–168. https://doi.org/10.2192/URSUS-D-10-00005.1

Johnson, H. E., Lewis, D. L., Verzuh, T. L., Wallace, C. F., Much, R. M., Willmarth, L. K., Breck, S. W., & Bieber, C. (2018). Human development and climate affect hibernation in a large carnivore with implications for human–carnivore conflicts. *The Journal of Applied Ecology*, *55*(2), 663–672. https://doi.org/10.1111/1365-2664.13021

Klip, J. M. K. (2018). *Can a bite in the butt change black bear behavior? Effects of aversive conditioning on predators of bear-human conflict.* ProQuest Dissertations Publishing.

Lackey, C. W., Beckmann, J. P., & Sedinger, J. (2013). Bear historical ranges revisited: Documenting the increase of a once-extirpated population in Nevada. *The Journal of Wildlife Management, 77*(4), 812–820. https://doi.org/10.1002/jwmg.548

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

Manfredo, M. J., Berl, R. E., Teel, T. L., & Bruskotter, J. T. (2021). Bringing social values to wildlife conservation decisions. *Frontiers in Ecology and the Environment, 19*(6), 355–362. https://doi.org/10.1002/fee.2356

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

Mattson, D. J. (1990). Human Impacts on Bear Habitat Use. *Bears, Their Biology and Management*, *8*, 33–56. https://doi.org/10.2307/3872901

Mazur, R. L. (2010). Does Aversive Conditioning Reduce Human–Black Bear Conflict? *The Journal of Wildlife Management, 74*(1), 48–54. https://doi.org/10.2193/2008-163

R Core Team (2022). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Scheick, B. K., & McCown, W. (2014). Geographic distribution of American black bears in North America. Ursus, 25(1), 24-33.

Sikes, R.S. and the Animal Care and Use Committee of the American Society of Mammalogists. 2016. 2016 Guidelines of the American Society of Mammalogists for the use of wild mammals in research and education. Journal of Mammalogy, 97:663–688.

Spencer, R. D., Beausoleil, R. A., & Martorello, D. A. (2007). How Agencies Respond to Human–black Bear Conflicts: A Survey of Wildlife Agencies in North America. *Ursus (International Association for Bear Research and Management)*, *18*(2), 217–229. https://doi.org/10.2192/1537-6176(2007)18[217:HARTHB]2.0.CO;2

Sultaire, S. M., Kawai-Harada, Y., Kimmel, A., Greeson, E. M., Jackson, P. J., Contag, C. H., Lackey, C. W., Beckmann, J. P., Millspaugh, J. J., & Montgomery, R. A. (2023). Black bear density and habitat use variation at the Sierra Nevada-Great Basin Desert transition. *The Journal of Wildlife Management, 87*(3). https://doi.org/10.1002/jwmg.22358

van Manen, J.T., Lackey, C.W., Beckmann, J.P., Muller, L.I., Li, Z. (2019). Assimilated diet patterns of American black bears in the Sierra Nevada and western Great Basin. Ursus, 30(3). https://doi.org/10.2192/URUS-D-17-00031.2

Table 1. *Definitions for levels of conflict.*

Conflict Level	Definition
Low	Human-bear conflict resulting from bears using food resources in urban areas without causing property damage or threatening human safety. This level of conflict includes, but is not limited to, bears accessing garbage, birdfeeders, pet food, fruit trees, apiaries, and chicken coops.
High	Human-bear conflict resulting in property damage, structure entry, human injury, or human death

Table 2. *Days ($\bar{x}$ ± SD) to return to conflict and percentage time ($\bar{x}$ ± SD) bears spent in residential areas per study group for bears in Western Nevada (2012-2023). N indicates the number of individual bears in each treatment group.*

Date Range	Treatment	Time to return to chronic conflict (days)	Time in urban environments (%)
		$\bar{x}$ ± SD	$\bar{x}$ ± SD
2012-2023	Control (n=23)	462.8 ± 882.6	14.3 ± 14.8
	Off-leash (n=47)	498 ± 1056.4	13.8 ± 13.5
	On-leash (n=15)	348.8 ± 997.2	19.8 ± 15.6
2019-2023	Control (n=14)	179.5 ± 178.0	14.3 ± 14.8
	Off-leash (n=17)	148.0 ± 273.8	13.8 ± 13.5
	On-leash (n=12)	102.4 ± 238.8	19.8 ± 15.6
2012 – 2023	Control (n=23)	421.0 ± 882.7	14.3 ± 14.8
	Dogs used (n=62)	42.6 ± 1035.6	15.3 ± 14.2

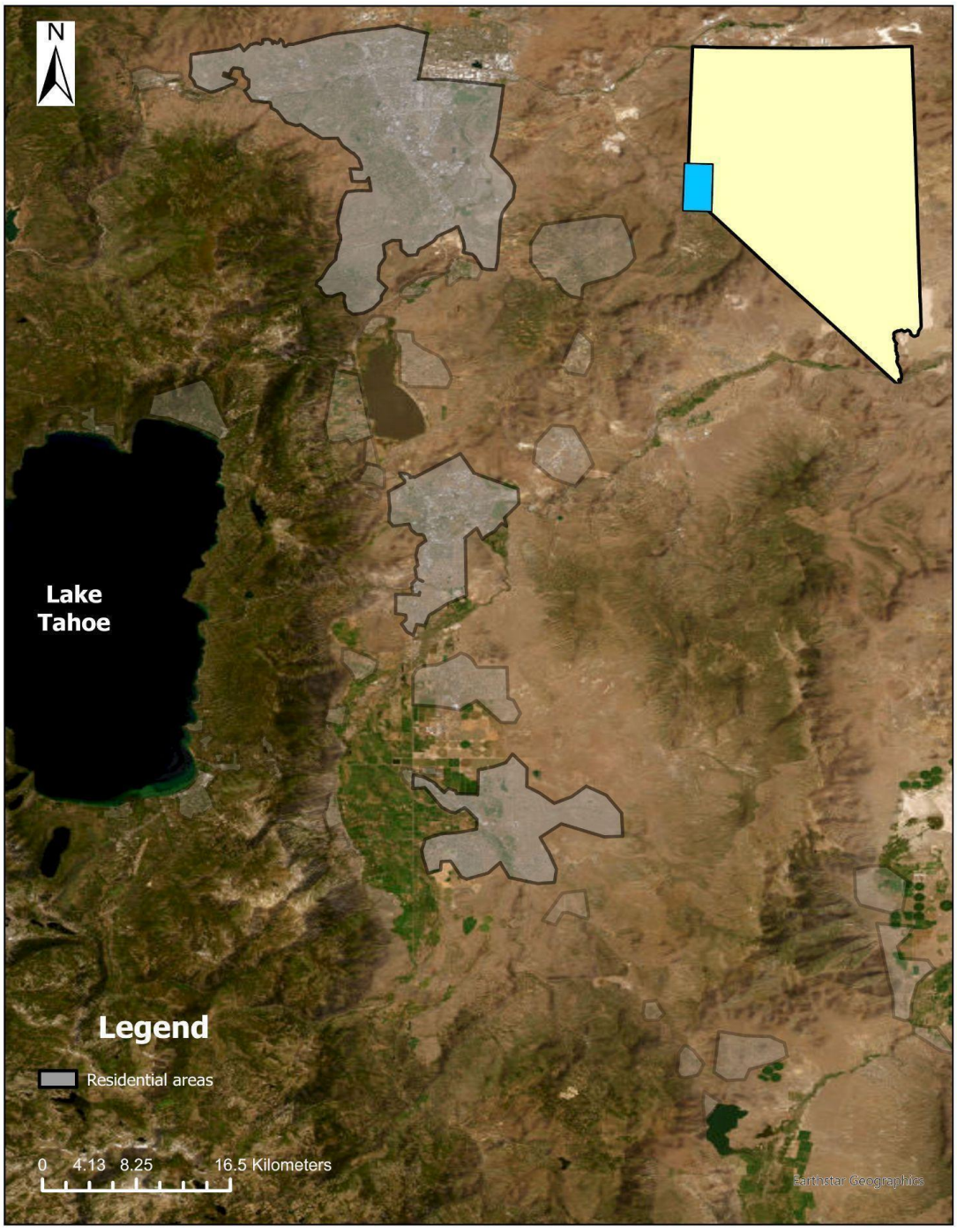

Figure 1. *Map of study area with residential areas indicated by gray polygons*

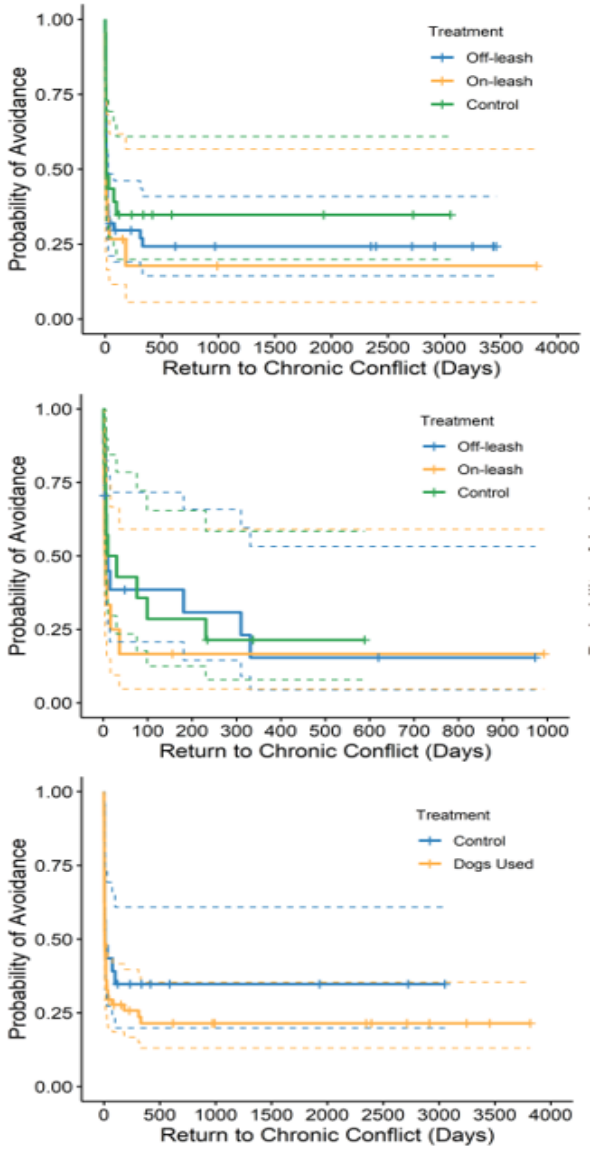

Figure 2. *Non-parametric Kaplan-Meier survival curves illustrating probability of avoidance based on the effect of number of days before a bear returns to conflict. On (top row) all collared bears from 2012-2023 from three treatment groups, (middle row) collared bears from 2019-2023 from three treatment groups, and (bottom row) collared bears from 2012-2023 from two treatment groups. Dotted lines represent 95% confidence intervals.*

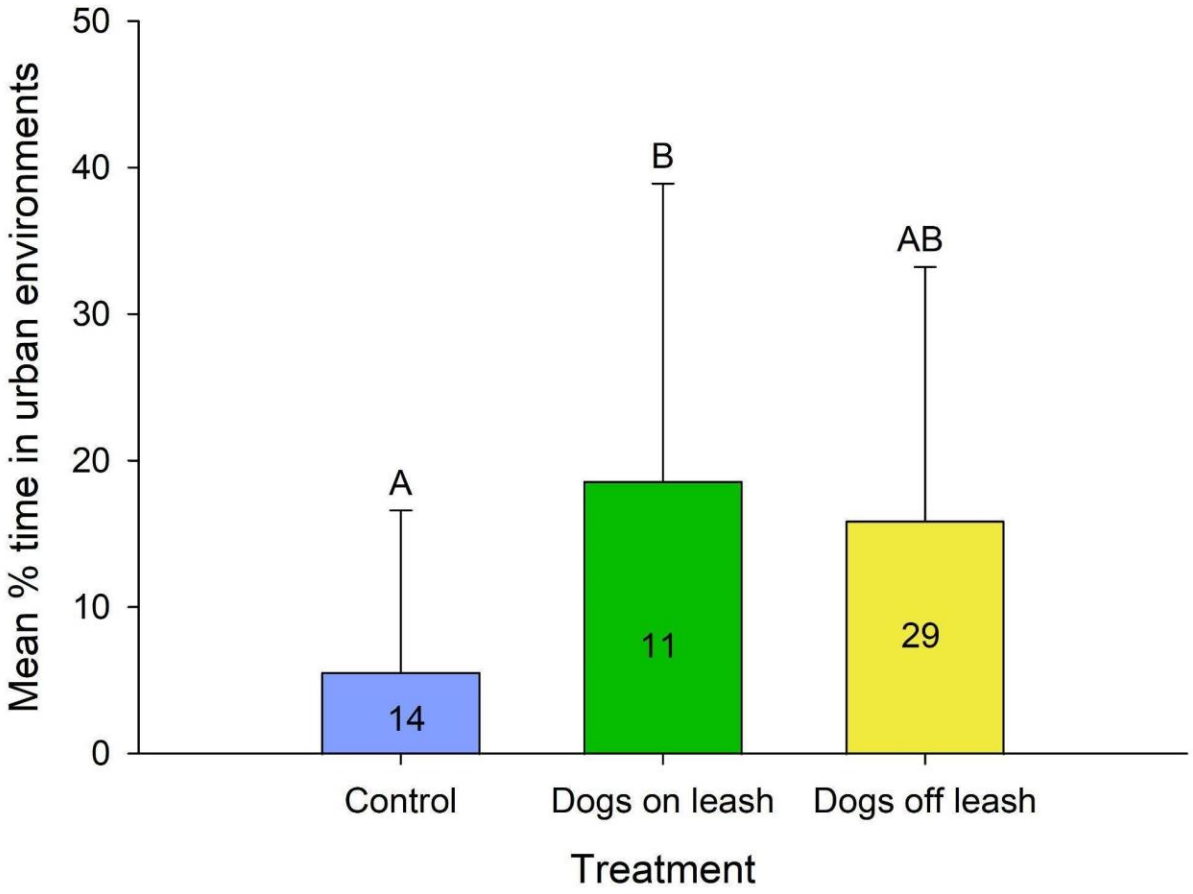

Figure 3. *Results from ANOVA (mean and SE) illustrating the difference in the percent of time spent in urban environments for each treatment type for bears in Western Nevada (2012-2023). Note that letters over the bars indicate the result of Tukey's HSD test, bars with the same letter are not significantly (P>0.05) different. Sample sizes for each treatment are indicated on the corresponding bar.*

Figure 4. *Photos showing examples of (top) a bear being treated with dogs off-leash and (bottom) a bear being treated with dogs on-leash. (Photos courtesy NDOW/Heather Reich)*