BLACK BEAR ATTACK ASSOCIATIONS AND AGENCY RISK MANAGEMENT

By

Janel Marie Scharhag

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APPROVED BY THE GRADUATE COMMITTEE OF:

_____

Dr. Cady Sartini, Graduate Advisor, Assistant Professor of Wildlife

_____

Dr. Shawn Crimmins, Assistant Professor of Wildlife

_____

Dr. Scott Hygnstrom, Professor of Wildlife

_____

Dr. Jeff Stetz, Research Coordinator, Region IV Alaska Fish and Game

ABSTRACT

Attacks by bears on humans have increased in the United States as both human and bear populations have risen. To mitigate the risk of future attacks, it is prudent to understand past attacks. Information and analyses are available regarding fatal attacks by both black (*Ursus americanus*) and brown bears (*U. arctos*), and non-fatal attacks by brown bears. No similar analyses on non-fatal black bear attacks are available. Our study addressed this information gap by analyzing all agency-confirmed, non-fatal attacks by black bears in the 48 conterminous United States from 2000-2017. Government agencies across the country are responsible for species conservation, population management, and conflict control. State, federal, and tribal agencies are required to make decisions that communicate and mitigate the risk of an attack to the public. Agencies have been held legally responsible for those decisions, consuming time and money in litigation. This had led to a call for a more refined way to assess the risk of a bear attack with the creation of a risk management model (RMM). We used an email survey targeted at bear managers throughout the U.S. to 1) identify the primary challenges involved in mitigating the risk of a bear attack, 2) understand their perceptions of managing risk, and 3) assess their support for using an RMM. We further explored these objectives by using a focus group of bear managers at the 5th International Human-Bear Conflict Workshop.

We identified 210 attacks by black bears on humans. Most (52%) were defensive, 15% were predatory, and 33% were of a new behavioral category we termed “other.” Of defensive attacks, 85% were by female bears, and 91% of those females had young. Ninety five percent of predatory attacks were by male bears, and 80% of other attacks were by male bears. Sixty-four percent of incidents had an attractant present during the

attack, and 74% had prior bear damage or a food reward reported in the area prior to the attack. A classification tree model showed the highest proportion of severe attacks were among a victim with a dog, who was female, and who fought back during an attack. When compared with previous studies of fatal attacks by black bear, our results illustrate clear differences between fatal and non-fatal attacks.

In the survey, managers identified human behavior and attractants as the biggest challenge associated with attack risk management. Managers showed moderate support for using a risk management model. Federal managers and less experienced managers were more likely to support a model. Of the three proposed theoretical models (quantitative, qualitative, or mixed) a qualitative model was preferred. The feedback during the focus group supported these results and provided further clarification. These results will help create a future RMM and have implications for risk assessment, attack mitigation, and how we advise the public to respond to an attacking bear.

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CHAPTER 1

INTRODUCTION AND LITERATURE REVIEW

INTRODUCTION

Perceptions of the of the American black bear (*Ursus americanus*) have undergone a transformation during the past century. In many areas of the country, people killed black bears to local extinction between 1850 and 1950. They were classified as a problem species which were permissible to be shot on sight during any time of the year. Bounties were used as incentives for their eradication. Black bears were viewed as a nuisance and a predator. Views began to shift as popular media (Winnie the Pooh, Smokey the Bear, the Teddy bear, etc.) changed the predator into a cherished figure and symbol of the American wilderness. In addition, the rise of wildlife management and ecology increased our understanding of the role black bears play in the environment. Previous eradication efforts resulted in small populations and many states reclassified them from nuisance animals to protected game species. This further increased their value to humans and expanded conservation efforts. The black bear population is now estimated to be greater than 800,000 individuals in North America and they occupy much of their historic range (Scheik and McCown 2014, Dobey 2015).

The U.S. human population has more than doubled since 1970 (U.S. Census 2010), and the U.S. black bear population has increased nearly four-fold during the same time period (Cowan 1972, Dobey 2015). This has led to human populations expanding

into the black bear range and to black bear populations returning to landscapes that are now human dominated. These landscapes are exploited by black bear for food resources. Bears have a high adaptability to new environments and food sources. They seek out human resources such as refuse, birdseed, pet food, livestock, and compost, which all provide a high-calorie food reward. These resources are more likely to be exploited in times of low natural food production (Azad 2012, Baruch-Mordo 2014). Conflict is not restricted to bears seeking food in human dominated landscapes. Problems also occur when humans use bear habitat for recreation, work, and research. Public lands, like National Parks and National Forests, have been struggling with human-bear conflict for decades. When humans visit these areas, they bring food and create trash which often attracts bears. Other vertebrates like meso-predators, rodents, and avian species also exploit human resources, but managers are often particularly concerned with bears because they have the potential to injure or kill humans.

A bear attack has been defined as an intentional contact by a bear on a human which results in injury, and have been broadly classified as defensive or predatory in nature (Hopkins et al. 2011). Defensive attacks occur when a bear injures a human in defense of itself, its young, or its food from a perceived threat. Predatory attacks occur when a bear uses or attempts to use a human as a food source. There have been several scientific examinations of fatal attacks by both black and brown bears (*U. arctos)* and non-fatal attacks by brown bears (Herrero and Fleck 1990, Herrero 2002, Herrero and Higgins 2003, Herrero et al. 2013). However, there has been little examination of non-fatal black bear attacks.

State agencies in the U.S. are the primary executors of wildlife management. They are charged with species conservation and population management. Only two federal agencies, the National Park Service and the Fish and Wildlife Service, also have legal authority over wildlife populations. Other federal agencies such as the Bureau of Land Management (BLM) and the Forest Service (USFS), manage the land but have no authority over wildlife populations. All agencies, state and federal, have similar legal responsibilities to mitigate and communicate the risk of potentially dangerous wildlife to the public (Francis vs the United States 2011). Decisions are made by agencies on how to manage the risk of a bear attack when there are specific known risks or warning signs. Agencies have been held legally responsible for those decisions, or lack of decisions, creating a call for a more refined way to assess the risk of a bear attack (Francis vs the United States 2011, Stringham 2013).

To better protect people from bear attacks and agencies from litigation in the aftermath of an attack, it is prudent to look to past cases to understand warning signs and trends. A risk management model (RMM) in which agencies would input relevant, situation-specific information could provide multiple benefits to this process. Several RMMs exist that agencies and corporations use to determine the level of risk in a situation. There are several popular models that are used in search and rescue, firefighting, and crisis response. A similar model could give bear managers a broad assessment of attack risk and provide guidelines for decision making. Currently, there is no such model available to agencies. However, it is unknown if managers would be willing to use this type of tool.

My objective of Chapter 2, Non-fatal Black Bear Attacks in the Conterminous United States: 2000-2017, was to fill the information gap on non-fatal attacks by black bears with three specific research questions:

1) Are the conditions or factors preceding and during non-fatal and fatal black bear attacks different? If so, how?,

2) What influences the severity of a non-fatal attack?, and

3) Are environmental variables predictors of an attack?

In this chapter, I compiled and analyzed all agency-confirmed non-fatal attacks by black bears between the years of 2000-2017 in the conterminous United States.

My objectives of Chapter 3 Bear Managers' Perceptions of Risk, Litigation, and Policy, was to:

1) Assess bear managers' support of using an RMM and identify the type of model they would find most helpful,
2) Identify the primary challenges of mitigating the risk of a bear attack, and
3) Understand manager perceptions of managing the risk of a black bear attack.

For this chapter, I reported on a survey of bear managers across the U.S. using a 25-question online survey. As a qualitative supplement to the survey, I also conducted a focus group at the 5th International Human-Bear Conflict Conference in Gatlinburg, TN March 2018.

This thesis is organized in a manuscript style. Chapter 1 is an introduction to the study and a review of the relevant background and motivations. Chapter 2 is an analysis of the data on non-fatal attacks by black bears and will be submitted to the Journal of Wildlife Management. Chapter 3 is the analysis of the bear manager survey and focus group and will be submitted to the journal Human Dimensions of Wildlife. Chapters 2

and 3 are in the format of journal articles. Chapter 4 is a conclusion and synthesis of the previous three chapters.

BACKGROUND LITERATURE AND MOTIVATION

Bear Attacks

Much of the examination of bear attacks has been conducted by Stephen Herrero and his colleagues (Herrero and Fleck 1990, Herrero 2002, Herrero and Higgins 2003, Herrero et al. 2013). Research was done by exhaustively collecting information on past attacks and analyzing them by looking for trends and reporting percentages of attacks with similar traits. For example, when examining fatal black bear attacks, they documented 63 confirmed cases since 1900 (Herrero et al. 2011). Of these 63 cases, they were able to determine that there was an anthropogenic attractant near the attack in 40 cases. Of those cases, 38% (15/40) had an attractant that likely contributed to the bear being at the scene of the attack. Throughout the book *Bear Attacks: their Causes and Avoidance* (2002) and many journal articles, they also discuss common circumstances of bear attacks.

They show the most common type of fatal and non-fatal attacks by a brown bear are defensive in nature (Herrero and Fleck 1990). Attacks are often provoked by unintended proximity, e.g. a human getting too close to a bear during a surprise encounter. During the less frequent cases of brown bear predation, habituation and food conditioning were frequently associated with the attacking bear (Herrero and Fleck 1990). Unlike grizzly bear attacks, when a black bear attack results in a fatality, it is more

often predatory in nature (Herrero et al. 2011). Of 63 known black bear fatalities in North America, 88% were classified as predatory and 92% of those incidents involved a male bear (Herrero et al 2011). Little research has been conducted on non-fatal black bear attacks. The most complete estimate is that there were approximately 500 injuries to humans by black bear between 1960-1980 (Herrero and Fleck 1990). Ninety percent of these were thought to be inflicted by food-conditioned bears and resulted in minor injuries.

The distinction between fatal and non-fatal bear attacks is important because they are thought anecdotally to happen for very different reasons. For example, fatal black bear attacks tend to be caused by predatory male bears. Conversely, it appears that most non-fatal attacks are defensive in nature and involve sows with cubs and humans with domestic dogs (Herrero et al. 2011, Herrero and Hristienko 2014). Many other factors may play a role in non-fatal attacks, such as natural food abundance, age and sex of the bear, victim response to the encounter, and anthropogenic attractants (Herrero 2002). Distinguishing between the risk of a fatality and the risk of an injury is necessary in order to correctly mitigate risk. Managers cannot do this unless both risk associations have been scientifically defined.

Risk Management

Risk management is the systematic identification, evaluation, and prioritization of risk for a given organization or project (McNeil et al. 2005). Risk mitigation consists of the steps which can be taken to reduce risk. Risk is often defined as the frequency or exposure of an incident multiplied by the possible severity of an incident (McNeil et al.

2005). Many organizations and agencies attempt to quantify risk by using an RMM. This often includes a systematic calculation of risk and accompanied management recommendations.

The problem of bear attacks as a risk management issue was clarified by Stephen Stringham in his 2013 *Human-Wildlife Interactions* editorial. He highlighted the need for a more sophisticated RMM due to a lawsuit filed against the USFS and the state of Utah after an 11-year-old boy was killed by a black bear (Stringham 2013, Francis vs the United States 2011). He explained that agencies must have a better way to assess risk when management negligence can result in injuries and litigation. Risk assessment should assist in both reducing attacks by correctly identifying potentially dangerous situations and protecting agencies from litigation by ensuring due diligence. Stringham (2013) highlights five recommendations for an appropriate RMM, suggesting that an RMM should be 1) cost effective, 2) not a result of fear, 3) adaptive to varying situations, 4) similar to a cost-benefit analysis, and 5) sufficient to ensure managers meet the minimum due diligence.

Varying standards of legal due diligence exist in state and federal agencies. Most agencies are immune to lawsuit under the Federal Tort Claims Act (U.S. 28.171) or similar state tort claims acts. Federal agencies that do not manage wildlife populations are not required to communicate a general risk of a bear attack, but they are required to respond when a specific risk occurs (Francis vs the United States 2011). Whenever a person is within bear range, there is a general risk of a bear attack. However, when an event such as a bear destroying a tent occurs, a general risk becomes a specific known risk and agencies are required to respond. This may be done with actions such as closing

a campground or placing warning signs. Federal agencies like the BLM and USFS who do not manage wildlife populations are also required to work with state wildlife agencies to address a specific risk; the state, in turn, is required to work with the federal agency (Francis vs the United States 2011).

Ordinary negligence is another aspect of legal due diligence that has not successfully played out in the courts. Ordinary negligence applies when agencies are not immune under tort laws. Negligence is based on creating or ignoring the conditions for an attack to occur. This is outlined in the Florida Bar Journal in relation to private property, which states ordinary and reasonable care must be taken to prevent and look for dangerous situations (Kaleita and Simmons 2017). Negligence in this case hinges on to what extent the risk was known and to what extent were reasonable attempts made to mitigate risk. For example, if a bear enters a property due to the presence of attractants and the owner is aware of this issue and makes no effort to remove the attractants, they could face liability for damages, injury, or death (Kaleita and Simmons 2017). While these assertions are specific to private property, they are analogous to a government agency responding to a known risk when not considered immune under tort law.

Agency Policy

Spencer et al. (2007) highlights the need for better documentation and analysis of bear management, and calls human-bear conflict the most complicated issue wildlife managers face today (Spencer et al. 2013). With their 2013 bear manager survey, they showed that what managers do and what managers believe to be effective may differ. To illustrate, 89% of agencies sampled by Spencer et al. (2013) had defined protocols for

dealing with human-bear conflict. Seventy-five percent of these protocols involved relocating or translocating problem bears. Yet only 14% of managers indicated they believe this to be the best management action. Other studies have shown that relocation of bears is not successful at reducing the animal's involvement in damaging activity (Massopust & Anderson 1984, Comly 1993, Landriault et al. 2009, Hopkins and Kalinowski 2013). This shows a disconnect between policy, manager opinion, and scientifically successful management actions. Spencer et al. (2013) recommended that more research be conducted to evaluate the effectiveness of management actions. This relates directly to managers' perceptions of risk management. How can managers make appropriate cost-benefit analyses when their actions are bound by policy that may not be scientifically sound? How can we make a model that not only assesses the risk of an attack by a bear but also recommends an appropriate management action, and will managers be open to this?

Other species

Examining how other species with the potential to attack humans are managed for attack risk provides additional insight. There have been similarly thorough studies of coyote (*Canis latrans*) and cougar (*Puma concolor*) attacks. Baker and Timm (2017) provide an excellent example of defining an attack as occurring "when physical contact between ≥1 non-rabid coyote and ≥1 person occurred at a single location at a point in time, when contact was not initiated by the person(s)." This is the most complete definition of an attack and reduces the concerns of inflating attacks numbers by including cases where a person acted recklessly.

Mattson et al. (2011) provides a unique method for analyzing cougar attacks. The authors used three encounter levels, defined as: 1) encounter no physical contact, 2) encounter injury, and 3) encounter fatality. They then modeled the transitions between the three categories. However, their sample size for no physical contact was small and incomplete. This is because it is not standard practice to document encounters which do not result in an attack, and therefore most of these encounters are not reported. Most attack studies merely describe a set of cases and take no further statistical approach. This is because an analysis of a suite of case studies does not meet the assumptions for many of the commonly used statistical analyses. These examples of studies investigating attacks by other species helped inform how I set up my methods to examine attacks in Chapter 2.

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CHAPTER 2

CHARACTERISTICS OF NON-FATAL BLACK BEAR ATTACKS IN THE CONTERMINOUS UNITED STATES: 2000-2017

ABSTRACT

Attacks on humans by bear species have increased in recent decades, as both human and bear populations have grown. To mitigate the risk of future attacks, we must understand past attacks. Information and analyses exist regarding fatal attacks of both black (*Ursus americanus*) and brown bears (*U. arctos*), and non-fatal attacks by brown bears. No similarly thorough analyses on non-fatal black bear attacks are available. Our study addressed this information gap by analyzing all agency-confirmed, non-fatal attacks by black bears in the 48 conterminous United States during 2000-2017. We identified 210 non-fatal attacks on humans by black bears. Most attacks were defensive (52%), while 15% were predatory and 33% were a behavioral category we added termed "other." Of defensive attacks, 85% were by female bears, and 91% of those females had young. Of predatory attacks, 95% were by male bears, and of other attacks, 80% were by male bears. Forty percent of defensive attacks by female bears involved dogs. Sixty-four percent had an attractant present during the attack and 74% had prior bear damage or a food reward reported in the area prior to the attack. A classification and regression tree model show the highest proportion of severe attacks were among a victim who was with a dog, female, and fought back during an attack. When compared with previous studies of

fatal attacks by black bears, our results illustrate clear differences between fatal and non-fatal attacks. Our study also lends evidence to the hypothesis that dogs can trigger defensive attacks by black bears. These results have implications for risk assessment, attack mitigation, and how we advise the public to respond to an attacking bear.

KEYWORDS

Bear attacks, black bear, human-bear conflict, risk assessment, *Ursus americanus*, wildlife attacks

Our three North American bear species, the American black bear (*Ursus americanus*), the brown (grizzly) bear (*U. arctos*), and the polar bear (*U. maritimus*), all have challenges associated with their management and relationship to people (Stenhouse et al. 1988, Spencer et al. 2007, Chamberlain et al. 2012). One of these challenges is that they have the potential to injure or kill humans (Herrero 2002, Herrero et al. 2011). These incidents are extremely rare events (Eager and Pelton 1979, Herrero 2002), yet state and federal agencies in the United States (U.S.) are required to reasonably communicate and mitigate risk associated with bears and other wildlife (Francis vs United States 2011). One way to assess this risk is by examining past attacks. Trends, risk factors, and intervention points have all been successfully identified by examining past attacks by potentially lethal wildlife (Herrero 2002, Mattson et al. 2011, Herrero et al. 2011, Baker and Timm 2017).

Scientific examinations are available on fatal and non-fatal attacks by brown bears and polar bears and on fatal attacks by black bears. In North America, brown bears

fatally injure 1-2 persons and injure 3-4 persons per year (Herrero and Higgins 2003, Herrero 2012). The most common type of brown bear attacks are defensive (Herrero and Fleck 1990, Herrero 2002). These cases are often triggered by a human getting close to a bear during a surprise encounter. A less frequent scenario is when a brown bear acts as a predator. In these situations, the attacking bear is often associated with both habituation and food conditioning (Herrero and Fleck 1990). There have been 73 polar bear attacks in the last 144 years world-wide (Wilder et al. 2017). Twenty of these were fatal. Most attacks were perpetrated by nutritionally stressed male bears who acted as a predator (Wilder et al. 2017). Unlike fatal attacks by brown bears and similar to polar bear attacks, a fatal black bear attack tends to be predatory in nature (Herrero et al. 2011). Of the 63 known fatalities caused by black bear in North America between 1900 and 2009, 88% were classified as predatory and 92% of those incidents involved male bears (Herrero et al. 2011).

There has not been similar examination of non-fatal attacks by black bears. The most complete estimate is that black bears caused approximately 500 injuries to humans in North America between 1960-1980 (Herrero and Fleck 1990, Herrero 2002). Ninety percent of these were inflicted by food-conditioned bears and resulted in minor injuries. This estimate suggests that non-fatal attacks may occur under different circumstances than fatal attacks. Additional information is needed on non-fatal attacks for variables that are similar to those collected while examining past fatal attacks. The addition of environmental variables such as mast production, wildland urban interface (WUI), and harvest-related management practices may provide additional insight on attack rates. Decreased mast production, for example, has been correlated with an increase in general

human-bear conflicts (Howe et al. 2012, Baruch-Mordo el al. 2014, Obbard et al. 2014, Azad et al. 2017). WUI originated as a tool for determining high priority areas for suppression during a wildland fire event. These areas have also been shown to be zones of increased human-wildlife conflict (Lee and Miller 2003, Baruch-Mordo et al. 2014). Specific harvest practices of black bears, such as the use of hounds, longer seasons, and the number of years a population has been hunted, have also been linked to increased wariness in bears and have been associated with decreases in conflict (McCullough 1982, Conover 2000, Hristienko and McDonald 2010).

The objective of our study is to fill this information gap by answering three specific research questions: 1) Are the conditions or factors preceding and during non-fatal and fatal black bear attacks different? If so, how? 2) What influences the severity of non-fatal attacks? and 3) Are environmental variables predictors of an attack? We predicted that non-fatal attacks would be primarily associated with defensive reactions by females with young which often involve a dog and result in minor injury (Hristienko and Herrero 2014), and that severe attacks will be primarily associated with predatory attacks by male bears (Herrero and Fleck 1990, Herrero 2002, Herrero et al. 2011). We also predicted that drought, WUI (Baruch-Mordo et al. 2014, Azad et al. 2017), and areas with reduced harvest practices linked to increased wariness in black bears will be associated with attack locations (Conover 2000, Hristienko and McDonald 2010). In addition to these predictions, we sought to provide general descriptive statistics for all data collected which may provide additional identification of trends and risk factors.

STUDY AREA

Our study area is the black bear range in the conterminous 48 United States. Climate, terrain, and habitat vary considerably within this area. We decided to exclude Canadian provinces and Alaska due to documented differences in relative bear and human densities as well as attack rates (Herrero et al. 2013). Both Alaska and Canada tend to have higher black bear to human densities, and higher reported fatalities of humans by black bears then our study area (Herrero et al. 2013). We conclude that there may be different motivations or conditions for attacks in these areas. The black bear range was determined using the map from Scheick and McCowan (2014), which represents the most recent and best available bear distribution.

METHODS

We compiled all available cases of agency-confirmed, non-fatal attacks by black bears in the conterminous 48 states during 2000 to 2017. The year 2000 was selected as a starting point due to the widespread changes in management practices and populations of black bear since the latter half of the 20th century. These include nation-wide efforts to 1) reduce the availability of human attractants to bears, 2) increase public education on bear encounters and proper management of attractants, and 3) changes in policy such as anti-feeding ordinances and enforced safe viewing distances (Herrero 2002, Hristienko and McDonald 2010, Mazur 2015). In addition, populations of black bear in the eastern U.S. have increased in recent decades, which has been attributed to an increase in conflicts (Spencer et al. 2007). Our goal by limiting data collection to post-1999 is to reduce the

bias of attacks by food conditioned black bears on humans and increase the accuracy and availability of information about the attacks.

We began case collection with a media search conducted with Google™ Media Archives using the search terms “black bear” AND “attack” OR “injury” OR “mauling” AND “x: |*State Name*|”. Following the search, we contacted each state wildlife department’s bear biologist by email and/or phone to confirm the media-sourced cases, provide additional cases, and add information on the variables specific to their state. Federal agencies were contacted when states lacked data on federal lands. Tribal lands were not contacted because no cases were discovered during the search that occurred on tribal lands. We only included cases from a media source if they were also confirmed by a state or federal agency.

A bear attack is defined differently depending on the agency. Some agencies consider an attack to be any time that physical contact is made between a bear and a human, while others only consider attacks to be unprovoked injuries. To standardize the definition of attack across the study area we combined two formalized definitions (Hopkins et al. 2010, Baker and Timm 2017). We defined an attack as an intentional contact initiated by ≥ 1 non-captive, non-rabid bear on a human that resulted in injury and that occurred on ≥ 1 individual and at a specific location and point in time. We classified a case as an attack if it satisfied this definition and only included those cases considered an attack in our analyses. A case was considered intentional when the bear had made purposeful contact. An example of unintentional contact were situations where a bear knocked over a person while attempting to flee an area. A case was considered initiated by a bear if it made the first approach or physical contact. Examples of situations not

initiated by a bear were when a person approached too close for a photograph, when a person attempted to pet a bear, when a hunter approached a wounded bear, or when a person inserted themselves between a fighting bear and dog. These cases were not classified as attacks.

We evaluated 19 independent variables associated with each non-fatal attack. They were broadly classified into two groups: encounter specific and non-encounter specific (Table 1 and Table 2). As with other studies of attacks, data for some of these variables were not available for all cases. When reporting data on attack variables, we indicated the total number of cases in which a variable was known. This created a different sample size for each category. We reported each variable as a percentage of the known total. For example, if we knew the bear's sex in 120 cases and the bear was female in 72 of those, we would report 60% (72/120) cases were by female bears.

We used specific, standardized definitions for each independent variable, many of which have been defined in previous publications (Table 1 and Table 2). Additional clarifications were made to other variables. For instance, an additional category was added to bear behavior. Past attack studies have defined attacks as predatory or defensive (Herrero and Fleck 1990, Herrero and Higgins 1999, Herrero 2002). We maintain those formalized definitions. However, while categorizing, cases emerged that satisfied the definition of an attack but did not meet the definition of either predatory or defensive. These cases often involved a bear who appeared to be willing to injure a human to investigate or obtain food. An example of this behavior would be a bear approaching a camper and swatting at them. After the contact, the bear then grabs a piece of food and

runs away. This bear is not attempting to prey on a person, and it is not defending itself from a perceived threat.

Consistently measured data on hard and soft mast production were not available throughout the study area. Some locations, particularly eastern states, directly track natural food production in the form of hard mast (Azad at al. 2017). However, because most attacks occurred in June, July, and August before hard mast ripens, these measurements were inapplicable. This caused us to seek an available index of natural food production. The normalized difference vegetation index (NDIV) has been used and was considered as an alternative index of natural food production (Pettorelli et al. 2011). However, a recent studies casts doubt on the accuracy of using NDIV to determine natural food production for black bears (Wiegand et al. 2008, Baldwin and Bender 2010). Therefore, we used drought as an index of food production (Miller at al. 2016). Drought data was obtained by the National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center (NOAA 2017), and we used the Palmer drought severity index to determine the drought status for the year and month of the attack (Miller et al. 2016).

We determined WUI percentage by county using the United States Department of Agriculture (USDA) United States Forest Service (USFS) WUI map of the U.S. (2010). An index of harvest-related management was determined for each state by 1) the number of years black bear game harvest had taken place in the state between 1950 and 2017; 2) season length in days, determined by the maximum possible season length; 3) if baiting is permitted; 4) if hunting with the use of hounds is permitted; 5) if there is a spring hunt; and 6) how many chase days by hounds are permitted outside of season. Each component

of the index is expected to affect bear behavior by increasing the fear response of humans in bears (Conover 2000, Hristienko and McDonald 2003). All information was compiled with public state regulation handbooks for the 2017 season. The collected information was then standardized on a 1-3 scale, calculated by dividing the range into three categories. The binary categories of baiting, hounding, and spring hunt were given a score of 0 if no and 3 if yes. The final index was the calculation of [years(season length + baiting + hounding + chase days)].

In addition to reporting descriptive statistics, we compared data related to our predictions using chi-squared tests of independence, analysis of variance, and a classification and regression tree (CART) model. A map of attacks was created with AcrMap 10.1 (ERSI, Redlands, CA, USA). Attacks were calculated per capita, by state, as the number of attacks per 500,000 people (Spencer et al. 2007). Metropolitan counties where bears do not occur were removed to reduce the effect of high population centers not exposed to bears (Spencer at al. 2007). We analyzed encounter specific variables (Table 1) as predictors of severity using a CART model. We compared our non-encounter specific variables (Table 2) at attack locations to randomly generated locations at the county scale. We calculated random locations through a uniform distribution for years. We used a discrete probabilistic distribution to calculate month, based on the month distribution within our database. We used a discrete probabilistic distribution for county, based on the percentage of acreage of the county within the total bear range (Schiek and McCowan 2014). For WUI and the harvest-related management index, we compared attack locations to the random locations using a t-test statistic for samples of unequal variance after performing an F test. For drought we used a chi squared test of

independence. All statistical analyses were performed in program R version 3.3.1 (R Development Core Team 2016), using rpart and rplot to fit the CART model. Statistical significance was set at $\alpha \geq 0.05$.

RESULTS

The media search identified 113 cases. Agency information discredited eight of these media stories, in addition to providing information about 186 cases not identified in the media search. In total we identified 291 cases with 210 of those satisfying our definition of attack. There was an average of 11.7 attacks per year with no discernable trend over time (Figure 1). The majority of attacks occurred in the month of July (Figure 2). Half of all incidents occurred in California (n=63) and Colorado (n=42) (Table 3). Colorado and California also had the highest number of attacks per capita (Table 3). Sixty-nine percent (113/165) of all attacks occurred at front-country locations. Two attacks involved injury to more than one person, and none involved multiple attacking bears. One case had the characteristics of a non-fatal attack, but the victim later died from an infection of her wounds. This case was not included. Five bears were implicated in more than one attack, totaling 10 attacks. Of these attacks, three were other, three were predatory, and four were of unknown behavior. All included male bears. In only two of all the attacks was the bear's health listed as a contributing factor. In one case a bear that had injured a person went on to fatally attack another person. However, the injury did not satisfy the definition of an attack and was not included in our study.

Significantly more attacks were defensive than predatory or other [$\chi^2(2,n=197)=43.83.p<0.05$]. The behavior of the bears was classified as defensive in

52% (103/197) of attacks, as other in 33% (65/197), and as predatory in 15% (29/197). Attacking bears were adults in 83% (91/109) of all attacks. Bears that attacked were adults more often in defensive attacks 91% (61/67) than other 70% (14/20) or predatory 74% (14/19) attacks. The sex of the bear was female in 57% (51/90) of all attacks. Of those, 86% (44/51) were females with young. Significantly more defensive attacks were by female bears [$\chi^2(1,n=53)=1.90.p<0.05$]. Eighty-five percent (45/53) of defensive attacks were by female bears, and 91% of those were by female bears with young. Eighty percent (12/15) of other attacks and 95% (18/19) of predatory attacks were by male bears. Twenty-five percent (41/164) of all attacks involved a dog. Of those, in 79% (23/29) of attacks the dog was off leash. Significantly more defensive attacks by females involved a dog [$\chi^2(1,n=73)=5.813$, $p<0.05$]. Out of all defensive attacks 40% (37/93) involved a dog. Out of all predatory attacks 8% (2/24) involved a dog, and 3% (1/38) of other attacks involved a dog.

Of the victims, 71% (139/195) were male and 29% (58/195) were female. Sixty-one percent (61/100) of victims were adults, 21% (21/100) were teenagers, 10% (10/100) were elderly, and 8% (8/100) were children. The most common activity of the victims was camping 44% (92/208), followed by being at home 21% (44/208), slow sports (Table 1) (18% (38/208), other 5% (11/208), hunting 5% (10/208), fast sports (Table 1) 4% (9/208), and conducting natural surveys 2% (4/208). Of those who were attacked while camping, 66% (52/78) were at front-country campsites. Seventy-three percent (48/66) of those who were attacked while camping were attacked while in a tent, 24% (16/66) while they slept on the ground with no shelter, and 3% (2/66) while in a hammock. People who were alone comprised 69% (118/171) of all attacks, 18% (30/171) were in a group of

two, and 14% (23/171) were in a group of three or more. For 10 of the 53 cases that occurred on a group of people, we were able to determine the size of the victim relative to the others in the group. Fifty percent (5/10) of those occurred on the smallest member of the group, 30% occurred on the largest member of the group, and 20% occurred on a middle size member of the group. The victim's responses to the bear directly before the attack were classified as dominant (Table 1) in 35% of cases (60/170), submissive (Table 1) in 22% (38/170), sleeping in 22% (38/170), no time to respond in 11% (18/170), run in 6% (10/170), and other in 4% (6/170). The victim's responses during the attack were classified as fight in 48% (56/118), play dead in 16% (18/118), other in 14% (16/118), run in 10% (12/118), weapon in 8% (9/118), climb tree in 3% (3/118), and in bear spray 3% (3/118).

An anthropogenic attractant was present at 64% (93/145) of attack locations. Eleven of those incidents had multiple attractants. The most common type of attractant was human food in 51% (46/90) of cases, followed by garbage in 31% (28/90), non-food scented items in 15% (14/90), birdseed in 9% (8/90), carcass in 2% (2/90), bait intended for other species in 2% (2/90), and pet food in 1% (1/90). Seventy-four percent (54/73) had a prior bear food reward or bear damage reported in the area prior to an attack. A high proportion of attacks that occurred while camping involved a prior bear food reward or bear damage 93% (27/29), and also a high proportion of attractants 71% (41/58). Attacks occurred in both day and nighttime hours with 61% (83/135) occurring at night.

Twelve percent (23/188) of all cases were classified as severe (Table 1). A CART model showed non-encounter specific variables with the highest proportion of severe attacks were a victim who was 1) with a dog, 2) female, and 3) fought back during an

attack (Figure 3). Upon review of those results, we further disaggregated the specific predictors for comparison. Forty percent (15/38) of all cases involving a dog were severe. Of attacks with a dog and involving a female victim, 56% (12/22) were severe. Of attacks with a dog and a female who fought back, 75% (3/4) of cases were severe. All of the severe attacks with a dog and a female victim who fought back also involved a female bear with young. Conversely, of attacks with a dog and a male victim, 20% (3/15) were severe. Of attacks with a dog and a male who fought back, 43% (3/7) were severe. For further clarification, 19% (17/91) of all defensive attacks, 2% (1/62) of all other attacks, and 12% (3/25) of all predatory attacks were severe. Thirty percent (13/44) of all attacks by female bears were severe and 6% (2/32) of all attacks by male bears were severe.

There was a significantly higher [$t(413)=1.92$, $p<0.05$] percentage of WUI in attack locations ($\bar{x}=14.2$) verses random locations ($\bar{x}=11.4$). No significant relationship [$\chi^2=(1,n=198)=0.9103$, $p>0.05$] was found for the percentage of locations in drought conditions in attack locations (36%) and random locations (33%). There were significantly lower [$t(404)=-3.6$, $p<0.05$] harvest-related management indices found in attack locations ($\bar{x}=10.3$) versus random locations ($\bar{x}=14$) (Table 3).

DISSCUSION

The results supported our prediction that most non-fatal attacks are defensive reactions by females with young which often involve a dog and result in minor injury. When compared to a similar study of fatal black bear attacks, we see major differences in the proportions of behavior and bear sex (Herrero et al. 2011). Additionally, non-fatal attacks displayed a higher proportion of cases where an attractant probably contributed to

the bear's presence at the attack location than fatal attacks (Herrero et al. 2011). The bears' health was also categorized as a contributing factor more often in fatal attacks (Herrero et al. 2011) than in our study of non-fatal attacks.

Our second prediction, that severe attacks would be primarily associated with predatory attacks by male bears was not supported by our results. The combination of variables that resulted in the highest proportion of severe attacks was a victim who was with a dog, female, and fought back during the attack. This suggests that severe non-fatal attacks are not the result of a failed predation attempt, but are instead a defensive reaction aggravated by the presence of a dog, which may be more severe when female victims fight back during an attack. However, as the variables are filtered, the sample size reduces to a point where the addition of one or two cases could change the results. Therefore, the most robust estimates are those with the largest sample size, a female with a dog.

Our next prediction, that increased drought would be associated with attack locations was not supported. We did not see a difference in the proportion of attack locations under drought conditions versus random locations. These results were similar to studies which found no relationship between conflict and drought (Miller et al. 2016) and were dissimilar to studies which showed a direct positive relationship between poor natural food production and conflict (Howe et al. 2012, Baruch-Mordo 2014, Obbard et al. 2014, Azad et al. 2017). However, the studies that found a relationship used a direct measurement of natural food production. This may indicate that drought, as has been suggested of NDVI, may not be a suitable index of natural food production; or, it may

indicate that the relationship between attacks and natural food is not similar to the relationship between other conflicts and natural food availability.

As predicted, we found significantly higher WUI percentages in attack locations. This is consistent with other literature which found increased wildlife use of high WUI locations which can result in increased human-wildlife conflict (Lee and Miller 2003, Baruch-Mordo et al. 2014, Moss et al. 2016). In the case of a bear attack, we suggest that the WUI increases the chance of human-bear encounters and defensive reactions. Many of the defensive reactions occurred in high WUI areas while a person was walking their dog or letting their dog out into their yard. The bears were likely attracted to these areas because of the availability of anthropogenic attractants (Herrero 2002, Baruch-Mordo et al. 2014). This supports the case for increased proactive management in these areas (Fall and Jackson 2002, Hristienko and McDonald 2007).

As predicted, we found lower harvest related management indices in attack locations versus random locations. However, our harvest index is a coarse measurement. Each state was given one score across their total bear range, excluding National Parks. This does not account for differences in methods across geographic regions within a state. There are many states which allow varying methods in different management areas. At best, this result suggests there may be a positive relationship between methods associated with increased wariness and attack rates. Additional analyses which account for within-state differences and other possible factors such as hunter intensity, harvest restrictions, and season overlap need to be considered. It may also be valuable for each factor to be looked at individually and as additive or interactive effects of other components using more advanced modeling techniques.

We wish to place these results in a proper context to fully understand the situations that contribute to the risk of a non-fatal attack. We noted three common scenarios that may not have been obvious from the results. The first was where someone was in their home and they opened their door to let a dog outside. At the same time, a bear, usually a female with young, was in their yard consuming or investigating an attractant. The dog would then bark at the bear and then the person would become aware of the bear and call to their dog. The bear would then target the person and attack.

The second was where a person was camping and woke up to a bear biting their foot, hand, or head. In some cases, they were attempting to drag the individual away. Nearly all of these incidents reported either a prior bear food reward or property damage, involved male bears, and resulted in minor injuries. Some of these were classified as predatory, for example, if the bear was attempting to drag a person. Some were classified as other if there was also an attractant present and there were no dragging or other predatory behaviors reported. Predation in this case appears to be an opportunistic attempt by a food conditioned bear. The bears in these incidents, however, did not display the same persistence observed in bears whose predatory attacks resulted in fatality and consumption (Herrero et al. 2011). In most cases it was reported that the bear was relatively easy to scare away.

The third common scenario was when a person was walking or hiking with a dog and had a surprise encounter with a female bear. Many of these cases resulted in a severe attack. In these situations, it was commonly reported by the victim that they initially fought back but then changed strategies to play dead when they realized fighting back was not effective. Upon playing dead, the bear would then back away. In some cases, the

victim would then attempt to leave the area which triggered the bear to attack again, sometimes repeating the attack up to five times. Understanding these scenarios is important for developing management prevention strategies and reducing personal risk.

The disproportionally high numbers of incidents in California and Colorado merits further investigation. One reason for this could be reporting bias, as, unlike most states, both documented every reported incident. This may account for some of the disproportion, but is unlikely to account for it all. The most apparent differences in California and Colorado was that they involved a higher proportion of the other behavior. These involved high numbers of incidents involving attractants, male bears, and minor injuries. Many of these occurred while the victim was camping. In California, a relatively high number of incidents occurred in the three Sierra National Parks: Yosemite, King's Canyon, and Sequoia. These parks have much lower bear densities than the northern California region but receive higher levels of recreation and visitation by humans. These parks have seen a dramatic decrease in human-bear conflicts in recent decades because of aggressive management action aimed at reducing the availability of anthropogenic attractants (Mazur 2015). During the peak of human-bear conflict in the 1970s, dozens of injuries by black bears were reported each year in those parks (Mazur 2015).

We do not consider our database to be a complete account of all attacks within the area and time-period. Reporting bias likely exists, and minor injuries may be less likely to be reported. Each state has its own system for recording incident data. Some states do not keep specific records on injuries. Seven of the 32 states had databases on attacks by black bear and they had the highest numbers of incidents. It is likely that the databases were created because incidents had become more common. Therefore, our database likely has

a bias toward severe cases. We did not contact tribal lands and other private lands and acknowledge that cases may have been missed in these areas.

For many areas, we were unable to obtain reliable data on two variables we consider to be important for the study: bear density and the availability of bear resistant trash and food storage. Densities of black bear typically were unknown, except through coarse extrapolation, at large scales or known for only small areas where previous research led to accurate estimates of density. Most of the attack locations had no associated published density estimate. The availability of bear resistant trash and food storage was difficult to obtain except in areas where storage was publicly listed, as in the case of National Parks and Forests. For communities and state managed areas this information was often unavailable. Even if we could account for the availability of bear resistant storage, we would likely not have been able to determine its proper use.

Our results also suggest that agencies could be more specific about the way they advise people to respond to an attacking black bear. It has been previously stated that playing dead in a defensive encounter is the best way to lessen the severity of an attack and that fighting back during a predatory encounter is the best way lessen the severity of the attack (Herrero 2002). However, the majority of current messaging advises to playing dead with a brown bear and fighting back with a black bear. This is likely due to the fact that most brown bear attacks are defensive and that most fatal black bear attacks are predatory. Yet our results show that more non-fatal attacks by black bears occur than fatal attacks. We agree that when and if it can be determined that an attacking black bear is acting defensively, playing dead is more effective at stopping an attack and results in less severe injuries.

We believe it would be useful for all agencies to keep a database of incidents to aid further investigations like this one. Where possible, it would also be useful to track encounters which do not result in attacks for the purpose of comparing them to encounters which do result in attacks. This would give researchers the ability to assess what may influence or trigger an encounter to become an attack. The availability of direct measures of natural food production and accurate black bear densities would also assist in the analyses of future cases.

The addition of our results to the literature on bear attacks by North American species adds to our understanding of the trends, risk factors, and intervention points of bear attacks. By correctly identifying situations and conditions which are associated with attacks by any wildlife with the potential to injure or kill humans, both individuals and agencies may use this knowledge to prevent attacks from occurring where possible. By doing so we believe support for the continued co-habitation with these wildlife species will increase.

MANAGEMENT IMPLICATIONS

Our results suggest that keeping anthropogenic attractants away from bears is still one of the most important practices for maximizing human safety. Availability of these attractants has led to black bears receiving food rewards or damaging property who were then frequently involved in cases of non-fatal attacks. This is justification to increase efforts which reduce the access of human attractants to bears. Our results provide additional justification for closing particular areas to dogs, especially when a female with young is present. We suggest a change in how agencies advise people to respond to an

attacking black bear: play dead for defensive reactions and fight back for predatory assaults. This will require additional education that helps people identify the differences in these behaviors. However, if a black bear is with young, it can be reasonably assumed that most attacks will be defensive.

Table 1. Encounter-specific variables recorded for each non-fatal black bear attack case on a human in the conterminous U.S. between 2000-2017 and their associated definitions and attributes.

Variable		Attributes	Definition or citation of the previous definition
Bear	age	subadult, adult	(Herrero et al. 2011)
	sex	male, female, female with young	-
	behavior	defensive, predatory, other	(Herrero and Higgins 2003, Herrero et al. 2011) Other: a bear that appeared willing to injure a human to obtain or investigate food.
Victim	age	child (≤12), teenager (13-19), adult (20-66), and elderly (≥67)	-
	sex	male, female	-
	activity	camping, at home, slow sports, fast, hunting, conducting natural surveys, and other	Slow sports: hiking or walking. Fast sports: running or biking.
	response before	dominant, submissive, sleeping, running, no time to respond, or other	Dominant: yelling, throwing things, waving arms. Submissive: backing away, freezing, climbing a tree.
	response during	fight, play dead, run, climb tree, bear spray, weapon, or other	
Attractant		yes/no	(Herrero et al. 2011)
Prior bear activity		yes/no	Food reward or property damage reported or observed with 10.4km2 of the attack, prior to the attack, within that season.
Front/back country		front or back country	(Herrero et al. 2011)
Severity		yes/no	Default to agency language. When absent multi-day hospitalizations, loss of limb or sensory organ, or long-term damage considered severe.
Dog		yes/no	-
Time of day		hour or day/night	-

Table 2. Nonencounter-specific variables recoded for each non-fatal black bear attack case in the conterminous U.S. between 2000-2017 and their associated definitions and attributes.

Variable	Definition	Attributes
Drought	Palmer Z-index	yes/no
Wildland urban interface	(USFS 2010)	continuous
Harvest related management	State calculated index	continuous
Year	-	Year
Month	-	1-12

Table 3. Actual and per capita non-fatal black bear attacks by state per 500,000 people within the black bear range, excluding large metropolitan areas, and harvest related management indices, 2000-2017.

State	Attacks	Attacks per capita	Harvest related management index
Arkansas	1	0.25	8
Arizona	7	3.58	14
California	63	9.75	6
Colorado	42	13.44	3
Connecticut	1	0.34	0
Florida	7	0.90	0
Idaho	6	5.26	42
Kentucky	1	0.57	7
Massachusetts	3	0.66	3
Maryland	1	0.64	1
Maine	1	0.57	15
Michigan	2	0.13	27
Minnesota	9	2.04	12
Montana	8	5.89	15
North Carolina	2	0.24	24
New Hampshire	1	0.41	30
New Jersey	7	0.44	8
New Mexico	17	9.72	15
Nevada	1	0.87	5
New York	3	0.27	6
Oregon	1	0.28	18
Pennsylvania	3	0.14	6
Tennessee	2	0.43	18
Utah	3	1.95	39
Virginia	2	0.19	21
Vermont	1	0.81	24
Washington	5	0.98	15
Wisconsin	4	0.80	27
West Virginia	3	0.81	24
Wyoming	3	4.25	24

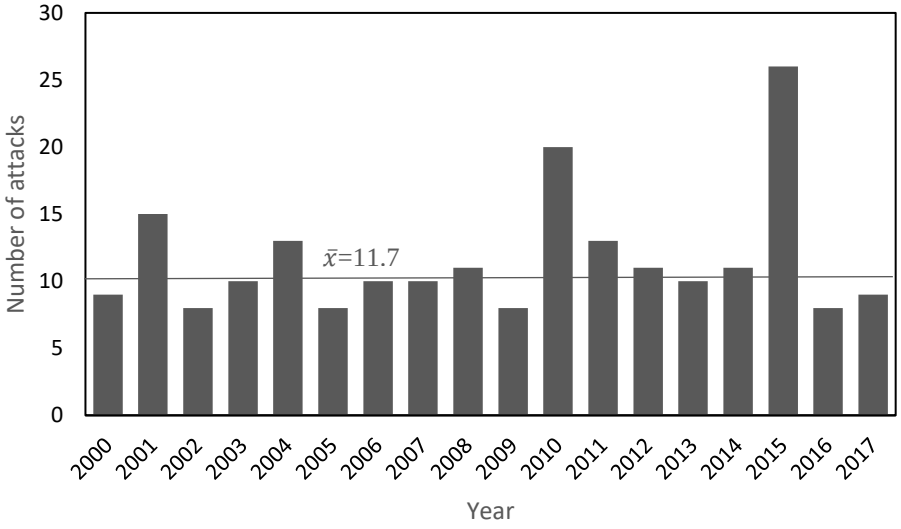

Figure 1. Non-fatal black bear attacks per year in the conterminous U.S., 2000-2017.

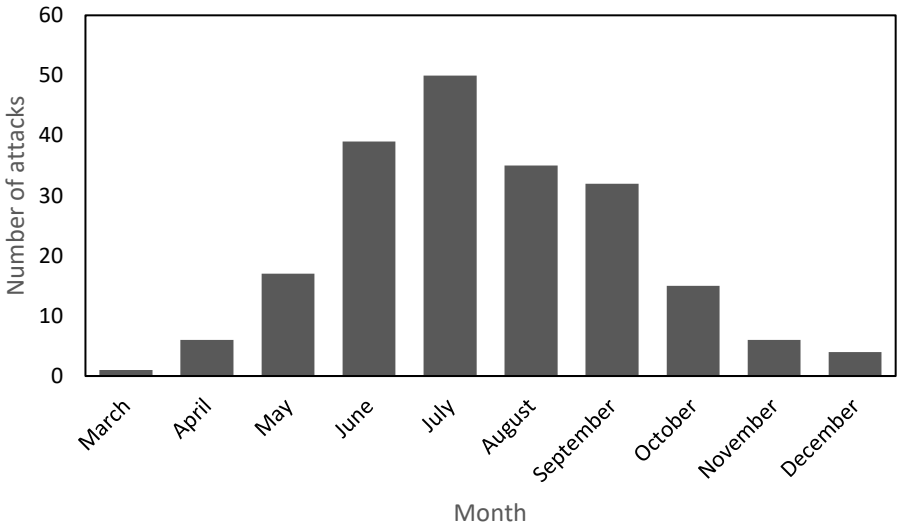

Figure 2. Non-fatal black bear attacks per month in the conterminous U.S., 2000-2017

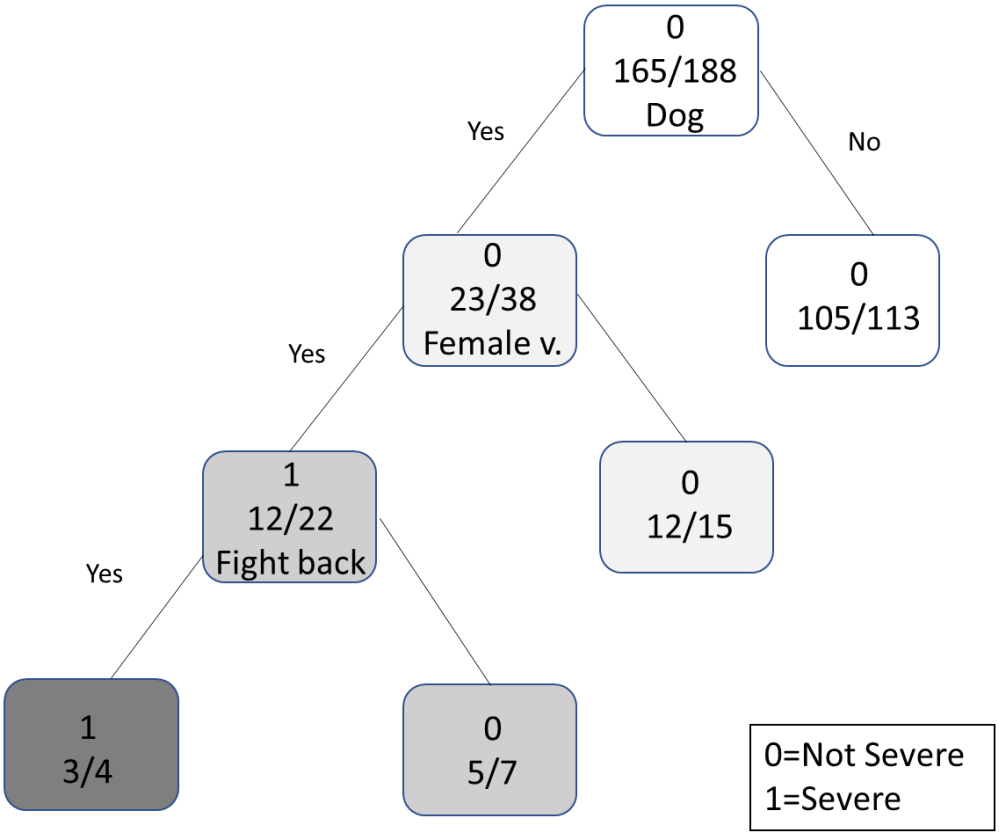

Figure 3. Classification and regression tree (CART) model predicting severity of a non-fatal attacks by black bear recorded in the conterminous U.S., 2000-2017.

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CHAPTER 3

BEAR MANAGER PERCEPTIONS OF ATTACK RISK MANAGEMENT AND AN ASSESSMENT OF THEIR SUPPORT FOR USING A RISK MANAGEMENT MODEL

Abstract

Human-bear conflicts have increased in the United States as both human and bear populations have risen. Government agencies across the country are responsible for species conservation, population management, and human-wildlife conflict control. State and federal agencies are required to make management decisions that communicate and mitigate the risk of a wildlife attack to the public. Agencies have been held legally responsible for those decisions, consuming time and money in litigation. This had led to a call for a more refined way to assess the risk of a bear attack through the creation of a risk management model (RMM). We surveyed bear managers throughout the United States to 1) assess their support for using an RMM, 2) identify the primary challenges involved in mitigating the risk of a bear attack, and 3) understand perceptions of bear managers regarding managing the risk of an attack. We further explored these objectives with the use of a focus group. In the survey, managers identified human behavior and attractants as the biggest challenges associated with attack risk management. In the survey, managers showed moderate support for using an RMM. Federal managers and less experienced managers were more likely to support a model. Of three proposed

theoretical models (quantitative, qualitative, or mixed), a qualitative model was preferred. The focus group supported these results and provided further clarification and expansion. These results will assist in the creation of an RMM, which may assist in the reduction of attacks where known conditions make it possible to do so.

Keywords

Black bear, human-wildlife conflict, risk management, *Ursus sp*., wildlife attacks

Introduction

The recovery of many North American wildlife species and an increasing and expanding human population have led to an increase in human-wildlife conflicts, which wildlife agencies are required to address. Managing conflict is often confounded by a suite of wildlife that has the potential to injure or fatally wound humans. These include some species of ungulates and reptiles, but are most notably larger carnivores such as the puma (*Puma concolor*), coyote (*Canis latrans*), and black (*Ursus americanus*) and brown bear (*U. arctos*).

Human-bear conflicts have increased in many parts of the United States in recent decades (Spencer et al. 2007). While only a very small proportion of these conflicts are injuries or fatalities of humans (Herrero and Fleck 1990, Spencer et al. 2007), a positive correlation exists between the number of fatal attacks by black bears (*Ursus americanus*) and the human population size in North America (Herrero et al. 2011). If this trend continues, increases in both human-bear conflict and injuries to humans are expected.

Governments across the U.S. are responsible for species conservation, population management, and conflict control. State agencies are the primary executors of wildlife management. Only two federal agencies, the National Park Service (NPS) and the Fish and Wildlife Service (USFWS), also have legal authority over wildlife populations. Other agencies, such as the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS), manage landscapes but have no authority over wildlife. Yet all state and federal agencies have similar legal responsibilities to mitigate and communicate the risk of potentially dangerous wildlife to the public (Francis vs the United States 2011).

Identification of situations which may increase the risk of bear attacks are required to mitigate the risk of an attack. These situations are often specific behaviors by bears. These behaviors can include habituation to humans, food-conditioning, property damage, and aggressive behavior (Hopkins et al. 2010). Habituation is defined as the waning of a response (or muted response) when a reward or punishment is discontinued (McCullough 1982). Food-conditioning occurs when a bear that has learned to associate people, human activities, human-use areas, or food storage receptacles with caloric reward (Hopkins et al. 2010). Many habituated bears are not food conditioned but many food conditioned bears are habituated. Aggressive behavior can be further categorized as defensive or offensive. Defensive is when a bear may be a public safety concern because it exhibited aggressive behavior in response to being provoked (Hopkins et al. 2010). Offensive is when a bear may be a public safety concern because evidence suggests the bear exhibited aggressive behavior and was not provoked (Hopkins et al. 2010).

Citizens have used litigation against governments in the aftermath of a bear attack (e.g. Rubenstein vs the United States 1972, Martin vs the United States 1975, Knochel vs

the United States 1998, and Francis vs the United States 2011). Most cases are dismissed due to government immunity under the Federal Tort Claims Act and similar state tort claims acts. Exceptions to immunity occur when it has been proven that an "employee violated a specific statute, regulation, or policy that is both 'specific and mandatory'" or when acts of discretion were not grounded in policy (Francis vs the United States 2011). Some cases have been settled out of court when the government failed to meet immunity under tort claims acts (e.g., Carlson vs the State 1979, Knochel vs the United States 1998). Only one trial case against an agency resulted in a favorable ruling for the plaintiff (Francis vs the United States 2011). In this case, the USFS was not protected under the Federal Tort Claims Act because an employee violated a specific regulation, resulting in a lack of action on a specific known threat. The court awarded the family of the victim 1.9 million dollars (Francis vs the United States 2011). The state of Utah was also deemed partially responsible for the incident when it failed to communicate with the USFS. The state of Utah settled with the family out of court.

Legal realities require proper identification and response when a risk is known, creating a call for a more refined way to assess the risk of a bear attack (Stringham 2013). A risk management model (RMM) in which agencies input relevant, situation-specific information could provide multiple benefits to this process. Several risk management models exist that agencies and corporations use to determine the level of risk that exists in a particular situation. A popular model is the Green-Amber-Red, which assesses risk as low, medium, or high reflected by a color scale where green is low and red is high. This model is popular in search and rescue operations. Another is the Severity-Probability-Exposure, which is a quick numerical assessment of risk determined by the likely

severity, probability, and exposure to a risk. This is widely used in industry, wilderness medicine, and firefighting.

A similar model could provide bear managers a broad assessment of attack risk and provide guidelines for decision making. Currently, there is no such model available. It is unclear, however, if bear managers would like to use this type of tool for calculating the risk of a bear attack. A thorough assessment is not available on what managers would find most helpful when assessing attack risk and what are their biggest challenges are to risk assessment. A survey of bear managers similar to our own addressed management, conflicts, and population levels, but did not specifically look at managing the risk of a bear attack (Spencer et al. 2007). For these reasons, we will be using the model of planned behavior and elements of product development to explore our objectives (Ajzen 1991, Brown and Eisenherdt 1995).

Our objectives are to 1) assess managers' support for using an RMM and identify the type of model they would find most helpful, 2) identify the primary challenges of mitigating the risk of a bear attack, and 3) understand manager perceptions of managing the risk of a black bear attack. We expect to see a negative correlation between support for use and experience because experienced managers may have well established practices or methods which they do not wish to deviate from and which they feel work well. We expect a positive correlation between support for use and contact because we suspect managers would want a tool to assess risk if encounters were perceived to be more frequent. Finally, we expect that federal agencies will be more likely than state agencies to support a risk management model because federal agencies have been targets

of litigation in the past and may be more used to and willing to accept risk management assessments.

Methods

We used a mixed methods approach to address our objectives and test our predictions. First, we used a quantitative method consisting of a 25-question, self-administered, emailed survey. We solicited bear managers and biologists in state and federal agencies across the United States The survey was created, distributed, and scored using Qualtrics software (Qualtrics, Provo, UT 2018). Second, we conducted a qualitative focus group to add depth to the information in the survey. Research was approved by the Institutional Review Board at the University of Wisconsin Stevens Point (protocols 17-18.026 and 17-18.034).

Survey

We attempted to survey, or census, the complete population of government-employed bear managers. We targeted all state bear managers and managers from two federal land management agencies that regularly manage human-bear conflicts. Other federal agencies were excluded because they manage a much smaller proportion of recreational lands that experience frequent human-bear conflicts. We maintain the anonymity of these agencies as a condition of participation.

To generate a sampling frame, we began by researching each state bear biologist. This information was publicly available using online state wildlife department websites. We generated a list of federal lands that supported bear populations within our two target

agencies. We contacted regional wildlife biologists in these areas and requested contact information for the biologists in individual districts, units, or parks. A survey request was sent, and two weeks later a reminder email was sent to all non-responders. The survey was open for a total of four weeks. This allowed for a two-week response time after the initial email, and another two-week response time after the follow-up email.

Our survey used a combination of multiple choice, five-point Likert scale, slider bar, ranking, and free response questions. We measured four independent variables: agency type, region, experience level, and contact (Table 1). We also measured five dependent variables: support for use; favored model type; and perceptions of responsibility, litigation, and agency policy (Table 1). Perception of responsibility was defined as to what extent a manager thought their agency was responsible for preventing a bear attack. Perception of litigation was defined as how they perceived the use of litigation by citizens in the aftermath of an attack. Perception of agency policy was defined as the level of support a manger had for their own agency's policies. We added an additional free response question at the end of the survey about their greatest challenges when assessing the risk of an attack.

We scored data when the survey period was complete. For each dependent variable except 'favored model type,' we divided the totaled scores by the total possible points for each respondent's completed questions within the variable. This produced a rate score between 0-1. Favored model type was the response to only one question. For independent variables, all were categorized based on the response to one question except experience. For experience, we divided the score range by three to produce a category of experience as low, medium, or high. Our primary tools for analysis of the survey were: 1)

Pearson's correlations for testing the relationship between the independent variables, 2) one-way analysis of variance (ANOVA) to test our predictions, and 3) content analysis of free responses to identify the biggest challenges in managing the risk of an attack. These responses were open coded into challenge categories. Categories were not mutually exclusive, and a respondent's answer could contain multiple challenge categories. Statistical significance was set at $\alpha \geq 0.05$ and all analyses were performed in IBM SPSS Statistics for Windows (Version 25.0, Armonk, NY).

Focus group

To add depth to the information in the survey, we recruited participants for a focus group at the 5th international Human-Bear Conflict Workshop in Gatlinburg, TN March 2019. The focus group consisted of a series of questions designed to collect qualitative information on many of the same variables that were assessed in the survey. The first question assessed their agency type, region, and experience. Remaining questions assessed challenges of attack risk management, whom they felt was responsible for preventing a bear attack, what they thought were the key risk factors needed to identify risk, their willingness to use an RMM, what they would find helpful in an RMM, and what they have found to be most important when assessing the risk of an attack. We used a combination of classical content and micro-interlocutor procedures to analyze the focus group (Onwuegbuzie et al. 2009). Micro-interlocutor procedure is a method to analyze a focus group which emphasizes the level of consensus to the responses of each question to prevent misunderstanding when the entire group's opinions are aggregated (Onwuegbuzie et al. 2009). Consensus was assessed for each question by recording

indicators of agreement, dissent, and the number of participants who did not respond. Indicators of consent and dissent were verbal comments such as “yes,” “no,” “I agree,” and “I disagree,” or non-verbal affirmations such as nodding or shaking of the head.

Results

Survey

Of the 121 survey invitations that we sent, 118 had working email addresses. We received 70 responses. Of those, 55 were complete and useable surveys for a response rate of 47%, which is an adequate response for ±10% sampling error with a 95% confidence interval (Dillman and Smyth 2007, Vaske 2008). No apparent differences were found in individual responses to questions after the initial invitation and the follow-up invitation which was sufficient to show that there was not a significant non-response bias (Vaske 2008). There were 24 respondents from state agencies and 31 from federal agencies. We were unable to sample one of our target federal agencies due to complications with forwarding content. Regional response consisted of 18 from the West, 12 from the Southeast, 10 from the Northeast, 7 from the Midwest, 6 from Alaska, and 2 from the Southwest. Fifty-five percent (n=30) of respondents reported that they had low experience with human-bear conflicts, 24% (n=13) had medium experience, and 22% (n=12) had high experience. Thirty-eight percent of managers reported humans and bears come into contact in their jurisdictions multiple times a day, 24% (n=13) reported multiple times a week, 13% (n=7) reported multiple times a month, 18% (n=10) reported multiple times a year, and 7% (n=4) reported almost never.

On a scale of 0-1, with 0 being not in support of and 1 being in complete support of, on average respondents indicated slight to moderate support for using an RMM ($\bar{x}$ = 0.66), responsibility ($\bar{x}$ = 0.61), litigation (- $\bar{x}$ = 0.67), and agency policy ($\bar{x}$ = 0.67). All correlations of dependent variables were positive, and all were significantly correlated with each other, except for policy with responsibility and likelihood of use (Table 2). When asked to rank the three theoretical RMMs in order of preference, 54% (n=25) of mangers ranked the qualitative model number 1, 44% (n=20) the mixed model, and 2% (n=1) the quantitative model. Forty-nine percent of respondents (n=27) were familiar with the Francis vs the United States case and 74% (n=20) of those were state employees. Forty-four percent of those who were familiar with the case (n=12) agreed with the court's decision, 33% (n=9) were unsure, and 22% (n=6) disagreed.

Federal managers ($\bar{x}$ =0.70) were significantly ($F_{1,53}$= 5.777, p =0.020) more likely than state managers ($\bar{x}$ =0.61) to support the use of an RMM. Mangers with more experience were less likely to support an RMM ($F_{2,52}$=4.405, p=0.017). The average likelihood of use for those with low experience was $\bar{x}$ =0.70, with $\bar{x}$ =0.65 for medium experience, and with $\bar{x}$ =0.57 for high experience. There was not a difference between contact and support for use ($F_{4,50}$=1.520, p=0.211). There was also not a difference between region and support for use ($F_{5,49}$=2.259, p=0.063).

Most respondents listed human behavior as the biggest challenge (81%, n=40) in managing human-bear conflicts. Attractant management was the next most identified challenge (38%). Other common challenges listed were lack of agency support (12%), unpredictable bear behavior (12%), the unpredictability of each situation (8%), the public's lack of acknowledgement that there is a real risk of an attack (8%), and the

public's misunderstanding that the risk of an attack is very low (6%). The remaining challenges were listed only once: conflicts with other agencies, lack of public support for euthanasia, balancing a healthy bear population with conflict control, social media, litigation, habitat encroachment, dogs, and lack of data.

Focus group

There were 13 participants in the focus group. Seven were state employees, five were federal, and one was from Canada. Five were from the Southeast region, four from the west, two from the Southwest, one from Alaska, and one from a Canadian province in the Southwest of Canada. Two federal agencies and five states were represented. Three were female and 10 were male. Seven individuals had experience with injuries to people by bears during their employment, and five had experience with both injuries and fatalities. The number of times each participant responded varied greatly for questions 2-8. The following is a summary of the themes and consensus of each question.

What are your biggest challenges and problems when trying to assess the risk of an attack?

The biggest challenges discussed among the group were lack of proper reporting of potentially dangerous bear behavior from field staff, lack of proper agency response due to inadequate staffing, and getting members of the public and recreational visitors to change their behavior in bear country. Participants disagreed regarding what types of bear behavior constituted a warning sign for an attack while all appeared to agree that most predatory attacks were unpredictable. Participants disagreed about the extent with which

habituation and food-conditioning contributes to the risk of an attack. Some asserted both behaviors were warning sings, and others that only food-conditioning was a threat. They agreed that risk assessment differed between black and brown bears, and between wilderness and developed landscapes. There were seven indicators of agreement, two indicators of dissent, and five non-responders for this question.

W*hat are the biggest factors that each of you consider when determining if an individual bear is going to become a threat to human safety?*

All but one participant stated that their agency had specific policy that dictates risk assessment. The remaining participant stated that each case was assessed individually. Some federal employees stated that their policies deferred to the state in which the federal land was located. Several participants stated that a specific bear behavior, such as breaking into a house, triggered a specific management action. Others reported a frequency trigger where action is taken when a bear displays certain behavior for a specific number of incidents. Many reported that an escalation in the severity of the behavior was a trigger to euthanize an animal. There were no indicators of agreement, four indicators of dissent, and three non-responders for this question.

Who do you view as holding the responsibility for keeping users of public lands safe from wildlife attacks?

Most participants agreed that the agency was responsible, at least in part, for preventing wildlife attacks. They noted that areas with dual jurisdiction, such as National Forests, are responsible for communicating and cooperating with other agencies to deal

with risk. Other entities such as communities, municipalities, and recreation planners may need to share responsibility. The group indicated that if an agency creates or fails to address an attractant issue, that agency should be responsible. Backcountry users were also brought up as a group that needs to share responsibility for managing attack risk because they have a higher risk and their actions can directly contribute to risk. There were eight indicators of agreement, no indicators of dissent, and four non-responders for this question.

Would you use a risk management model and what would you find helpful in a model?

Participants indicated that an RMM might be helpful as long as it is not "overly prescriptive." One federal manager explained, "As a federal agency, we are a big target for lawsuits…and we wouldn't like very specific protocol like that because if you varied from it, you are wide-open to a lawsuit." This statement was followed by near unanimous consent. Another individual expanded, "Anytime you try and come up with some kind of chart or matrix or something like that, you really run the risk of oversimplifying the situation… and [as agencies] we all get compared to each other… I've been in that courtroom, where they are pulling up bear management plans from states and agencies all around and they are looking at how yours compares."

Another participant explained that while they would not like a prescriptive model, they do need something like "a progression chart or something I can hand to our officers and say, [if a bear is doing a specific thing], then you need to start… spending a bit more time in that area talking to people, watching them, and making sure other things aren't going on. To me [a model is] more… to help our field personnel that aren't as

experienced." There was some agreement with this statement. Participants said that general guidelines should be available, but every situation is different and needs to be handled on a case by case basis. They were also concerned that a model could not capture unpredictable bear behavior.

A federal manager stated that they were striving to create a consistent approach that could be used in many areas which have a high turn-over of employees. They wanted "something [for employees] to refer to that gives them an idea of… what [they] need to do." This was clarified by the statement, "Even though you don't want a prescription, there are some consistent questions you ask yourself on a case by case basis. So, I think a structure [would be useful] where you list, what are the questions I consider when evaluating [risk] is useful." There were 13 indicators of agreement, no indicators of dissent, and no non-responders during this question.

Do you have any final comments or feel like we missed anything during our discussion?

The group emphasized the difference in the level of risk between wilderness and urban areas. Others stated that using their experience, knowledge of bear behavior, and "going with their gut" in a context-specific approach is an important part of gauging risk. It was reiterated that inexperienced staff need more guidance on potentially dangerous situations. One participant brought up that agencies should improve efforts to communicate risk to the public. There was some final discussion regarding the difficulty of public backlash for management actions like euthanasia, and the need for better reporting and communication across agencies. There were four indicators of agreement, one indicator of dissent, and five non-responders during this question.

Throughout the focus group there was also a discussion that arose spontaneously regarding what the appropriate action to a warning sign of an attack should be from an agency. Some were adamant that strict responses, such as euthanasia, should be used for any warning behavior. There was disagreement on what behaviors classified a true warning of an attack. The two most debated behaviors were defensive aggression and habituation. Managers who did not think habituation or defensive aggression were warning behaviors did not agree that euthanasia was the proper response. This disagreement appeared to track with the participant's agency type. State managers appeared less tolerant of perceived warning behavior than their federal counterparts.

A federal manager stated, "Where I work, almost all of our attacks are defensive aggression… if we can clearly show it's defensive aggression, we don't take any action against the bear. We close the area and we have not ever had a repeat incident from one of those bears." In contrast, a state manager said, "In a 13-month period, we had 4 people get attacked… and no behavioral stuff was a warning sign to us it was just habituated, and food conditioned… we did a complete about face. We've redone all our policies and guidelines… I'm telling you right now what I heard from [the federal agency] scares…me that [managers] let animals go that have already made contact with people… and our [agency's] experience is [that] a habituated and food conditioned animal, that you can't scare off, is one that's going to hurt somebody."

Discussion

Support for using an RMM was moderate among surveyed bear managers. Federal managers and managers with less experience were more likely to support the use

of an RMM. Neither the region nor the amount of contact managers thought bears had with people seemed to affect their support of a model. An RMM was also somewhat favored in the focus group. No one in the focus group wanted a model that dictated management action, as they thought it would increase liability and not allow for proper discretion on the part of the manager. Instead, managers wanted a consistent, non-prescriptive set of guidelines or questions to be used by field staff. The focus group agreed that an RMM could be a good tool for inexperienced staff, but the differences between state and federal employees regarding an RMM were not as clearly demonstrated as in the survey.

The most highly ranked theoretical model in the survey was qualitative, with a smaller number of respondents preferring a mixed model. Almost no respondents preferred a quantitative model. A numerical or calculated assessment of risk was met with suspicion in the focus group primarily because there was no confidence that risk could be accurately assessed through this type of model.

The primary challenges of managing the risk of an attack listed in the survey were issues of problematic human behavior and attractants. The participants in the focus group listed the lack of proper reporting and identification of warning signs from field staff as the biggest challenges. The challenges most often identified in the survey seem to be things that may increase the risk of an attack. In contrast, the challenges identified in the focus group are things that may prevent quality risk assessment. The high level of experience with attacks represented in the focus group may have influenced these results. These managers may have been more clearly able to identify what hinders their ability to assess attack risk.

We attempted to understand perceptions of risk management through the survey, as measured by responsibility, litigation, and policy. Weak support was shown for the assertion that an agency is responsible for preventing an attack. Moderate support was shown for the use of litigation against an agency. Moderate support was also shown for managers' own agency's policies regarding attack risk management. Based on the Pearson's correlations, the more a manager believed that their agency was responsible for preventing an attack, the more they favored the use of litigation against an agency, and the more likely they were to support an RMM. The correlations also showed that the more a manager agreed with their own agency's policy the more they favored the use of litigation. These favorable attitudes toward an agency's policy contrast another study which suggested a disconnect between agency policy and manager opinion (Spencer et al. 2007). In this study, only 14% of managers indicated that their agency's policy of translocation was the best management action suggesting that managers may not view their own agency's policies favorably. Our study suggests that the opinions expressed in Spencer et al. (2007) may be specific to translocation and not relate to a general dissatisfaction with agency policy.

Only half of all survey responders were aware of the details of Francis vs the United States (2011) and most of those were state employees. This is surprising considering that the trial judgement was against a federal agency. We believe this case provides a relevant and meaningful example of the unfortunate outcomes and legal concerns of managing the risk of attack. We believe the case should be a known example by anyone who makes decisions about the risk of a bear attack.

Some state managers were surprised by, and did not agree with, strategies on federal lands for managing human-bear conflict. These states appeared to be stricter in their response toward perceived warning behavior. The focus group also revealed clear differences in how agencies may define warning behavior. For example, some federal agencies may tolerate habituation and defensive aggression, but do not tolerate food conditioning or predatory aggression. This may be because federally-managed lands often are in more rural or wilderness settings than many state-managed lands, which often include conflicts in urban areas. There are also different public expectations and tolerances for management practices in places like National Parks (Zube 1986, Petchenik et al. 2018), which have led to state and federal agencies responding differently to similar situations. This is supported by statements made in the focus group that risk assessment differs depending on the jurisdiction and purpose of the land.

Survey responses revealed conflicting ideas by managers about the public's perception of risk. Some respondents identified that it is a challenge to get people to realize that there is a real risk of a bear attack, and others reported the difficulty of getting people to realize that the risk of an attack is extremely low. This most likely reflects divergent human behavior. Some people may take risks, such as leaving their food or trash accessible to bears, because they do not recognize that attractants create a real risk. Other people may change their behavior, such as avoiding areas with bears or displaying fear of bears, because they overestimate the risk of an attack. Both situations were identified as problematic for bear managers.

We were unable to sample one of the targeted federal agencies due to complications with forwarding content and the inability of the agency to generate a list of

managers whom we could contact directly. This skewed the results of the study toward one federal agency, which may have caused us to miss differences between federal agencies. In addition, because our population size was reduced to all state agencies and only one federal agency, we were only able to generate a ±10% sampling error, which is higher than we wished. In addition, response rates varied greatly in the focus group, and information from less responsive participants may have been missed. This could be due to the setting, in which more introverted individuals or individuals of differing opinions may not feel comfortable speaking up. In only one question did we receive a response from all participants, and some participants spoke only once or twice.

Our results have direct implications on the creation of a future RMM that may assess the risk of a bear attack. For a model to be accepted and used by managers it should be of a qualitative or mixed nature and be targeted to staff with less experience. The assessment should consider differences in agency type, land type, and bear species. A model should also address the primary challenges noted by managers. It should be a general, broad guide that recommends a response, but does not give specific and mandatory actions. A flow chart would fit these criteria well. These recommendations also work with the language of the Federal Tort Claims Act, under which discretionary measures are immune when grounded in policy and discretion is only available when an action is not specific and mandatory.

Conclusion

To reduce risk to the public and protect agencies from litigation, a more refined management model should be developed to assess attack risk by bears. An RMM could

provide multiple benefits to risk assessment, but our study clearly shows that bear managers are cautious of its application. Managers clearly expressed a need, however, for a set of broad guidelines which could be used as a consistent approach among field staff that could reduce some challenges listed, such as lack of proper reporting and identification of risk. Managers agreed that these guidelines should not dictate action and that discretion should be left to the responding agent. We believe it would benefit managers and anyone involved in human-bear conflict to become aware of cases such as Francis vs the United States, which can shed light on proper response, communication, and actions. Principals of risk assessment can be applied to other wildlife species that may pose a risk to human health and safety.

Table 1.1. Variables used in a survey of bear managers in the U.S. 2018.

Scored Manager Survey Metrics		
Independent Variables	**Question**	**Response Options**
Agency Type	*What type of agency is your employer?*	State, Federal
Region	*In which region of the country is your jurisdiction located?*	NE, SE, SW, MW, W, AK
Experience	*What percentage of your duties involves human-bear conflict management?*	Slider bar 0-100
	How many years has part, or all, of your job involved bear management?	0-5, 6-10, 11-15, 15+
	How often do you, as a representative of your agency, respond in any capacity (phone, email, sending technicians out, or going to the field yourself), to a nuisance bear complaint during active bear months?	Multiple times a: day, week, month, or year
	Have you, as a representative of your agency, ever had to respond, in any capacity, to an attack on a human by a bear?	Yes, No
	How many times?	1-3, 4-6, 6-8, 8+
	Have you every responded to a fatal attack?	Yes, No
Contact	*Based on what you have observed and recorded, how often do people in your jurisdiction encounter bears?*	Multiple times a: day, week, month, or year
Dependent Variables	**Question**	**Response Options**
Likelihood of use	*4 statements about the likelihood of using an RMM*	5-point Likert scale block
	With the slider bar, indicate your percent likelihood of using an RMM to aid in decision making for each scenario (3 scenarios proposed).	Slider bar 0-100
Favored model type	*Assume no agency restrictions and think about what you would find helpful. Drag and Drop: 1 being your most favored model and 3 being your least favored.*	Quantitative, Mixed, Qualitative
Responsibility	*6 statements about the likelihood of using an RMM*	5-point Likert scale block
Litigation	*I am familiar with the 2013 ruling against the federal government regarding the death of 11-year-old Samuel Ives by a black bear in Utah.*	Yes, No
	If yes, I agree with the Utah Supreme Court's decision, which found the federal government partially responsible for the fatal attack.	Yes, No, Unsure
	6 statements about the likelihood of using an RMM	5-point Likert scale
Policy	*6 statements about the likelihood of using an RMM*	5-point Likert scale

Table 2.1. Correlations (2-tailed, n=55) between dependent variables used in a survey of bear managers in the U.S. 2018.

	Likelihood	Responsibility	Litigation	Policy
Likelihood	1	.481**	.272*	.111
		.000	.045	.419
Responsibility	.481**	1	.344*	.213
	.000		.010	.119
Litigation	.272*	.344*	1	.497**
	.045	.010		.000
Policy	.111	.213	.497**	1
	.419	.119	.000	

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CHAPTER 4

CONCLUSION

Bear attacks are very rare events that can have severe consequences for people, agencies, and bears. In Chapter 1, I established the need to look at past attacks to identify specific trends and risk factors in order to accurately assess the risk of a bear attack and illustrated the need for more information on non-fatal black bear attacks. I also established that there is a gap in the assessment of attack risk which could be filled by the creation of a risk management model (RMM). However, it was unclear if managers would want to use this kind of tool and what they viewed as their biggest challenges in attack risk management. I then highlighted my objectives and provided a literature review of bear attacks, risk management, agency policy, and attacks by other species.

In Chapter 2, I constructed and analyzed a database of non-fatal black bear attacks and found many specific trends and themes. Most attacks were a defensive reaction by female bears who were often with young and which often involved an attractant or prior food reward or damage. I found that a severe attack was predicted by the presence of a dog, if the victim was female, and if they fought back during the attack. My data also suggest that attacks are more likely to occur in areas with higher wildland urban interface (WUI) percentages and areas with limited or restricted hunting methods and seasons. Form these results, I recommend that 1) agencies continue and increase efforts to reduce the availability of anthropogenic attractants to bears, 2) that restricting dogs in a

recreation area should be considered if an area is being frequented by a female bear with cubs, 3) that we should modify the way we advise people to respond to an attacking bear, and 4) that all agencies should keep a database on human-bear encounters and attacks.

In Chapter 3, I found managers were skeptical of using an RMM, especially if it provided mandatory action. Federal managers and less experienced managers were more supportive of an RMM. Most managers favored a qualitative or mixed model over a quantitative model. Managers listed human behavior, attractants, lack of proper reporting, and accurate identification of warning behaviors as the biggest challenge involved in attack risk management. Less than half of managers had knowledge of Francis vs the United States, a pivotal case regarding attack risk management. From these results, I recommend 1) that a bear attack risk management model should be created that is guided by the concerns and considerations of bear managers from the survey and focus group, 2) it should be targeted to managers of less experience, 3) be qualitative in nature, and 4) provide general risk assessment that is accompanied by broad guidelines which are not specific and mandatory.

I believe this work has important implications for bear attack risk management, including applications for both risk assessment by individuals recreating in bear country and for agencies charged with managing those bears and properties. For an agency, they can inform risk management strategies, help with the creation of an RMM, and assist decision making. For the assessment of personal risk, individuals can use the information learned in the attack study to identify high-risk situations and to take measures which reduce risk.

Personal Risk

A criticism of attack studies has been that they may create unnecessary fear of bears among people. I recognize this and acknowledge any discussion of bear attacks should be tempered with evidence that they are very rare events. So rare, in fact, that the odds are difficult to calculate. Considering the overall population of the conterminous U.S. is 322.44 million (U.S. Census 2010), the odds of any person being fatally or non-fatally attacked by a bear are about 1 in 18 million. Yet risk differs based on the person's location and activity. The risk is virtually non-existent for a person who spends most of their life in a large metropolitan area, or an area of the country with no bears, and who does not recreate in bear country. In general, a person has some risk if they live, work, or recreate in bear habitat. I calculated that approximately 91 million people live within the primary or secondary black bear range in the conterminous U.S. It is estimated that 144 million people engage in outdoor recreation a year (Outdoor Foundation 2017). There is no data on how many people recreate specifically in bear habitat or how many people work, but do not live, in bear habitat. This makes a probabilistic calculation of risk difficult. Anywhere between 166-235 million people may have some risk of being attacked by a bear in the conterminous U.S. This is approximately a 1 in 11 million, or 0.00000009%, chance of being attacked, presenting a risk that is orders of magnitude smaller than dying by a bee sting (1 in 6 million), getting hit by lightning (1 in 84,079), being killed by a dog (1 in 120,864), or even of being murdered by a serial killer (1 in 2 million; National Safety Council 2011). There are millions of times a year when bears and people come into contact and no injury occurs (Herrero 2002). A discussion of

attacks should increase our awareness of risk factors, but not prevent our engagement in outdoor recreation or living and working in bear habitat.

This study shows that risk can be elevated for many reasons and in many circumstances. Specifically, we found that risk of a non-fatal black bear attack may be elevated under certain conditions (not in a hierarchical order):

1. In the months of June, July, and August;
2. In an area where a bear has obtained a food reward or damaged property;
3. In an area with a high WUI;
4. In an area with little or no available black bear hunting methods;
5. If a person has a dog with them, especially if it is off-leash;
6. If there are unsecured anthropogenic attractants;
7. If a person is camping in bear habitat; and,
8. If a person is alone.

When these factors combine, risk may further elevate. For example, if you are camping in bear habitat, in the month of July, have an unsecured attractant, and you are in an area where a bear had previously gotten a food reward, the risk may be much higher. A person can take measures to reduce this risk, such as securing all attractants, not taking a dog or keeping the dog on a leash, traveling in groups, and avoiding areas that have food conditioned bears or bears that have damaged property. A person can also reduce the severity of an attack by responding appropriately. As discussed in Chapter 2, I

agree with Herrero (2002) who advised that an individual's response should be based on the intent of the attack. For example, it may be possible to reduce the severity of a defensive attack by playing dead and the severity of a predatory attack by fighting back. Our results suggest this is the case for black bear, but further studies may be needed to conclude the same for brown or polar bears.

Agency Risk

Agencies that reduce the risk to individual users will also reduce the risk of litigation against their agency. In Chapter 3, I established that an agency must deal with two levels of risk: a known risk and an unknown risk. An unknown risk is a general risk that at any time within bear habitat a bear may attack a person. A risk becomes specific and known when it is reported that a bear engaged in a behavior which elevates risk, such as obtaining a food reward, damaging property, or displaying aggression. As soon as a risk is reported, it becomes the agency's legal responsibility to make a decision about the situation, even if the decision is to do nothing (Francis vs the United States 2011). Doing nothing, when it is a specific decision to do so, is still covered by discretionary immunity in the Federal Tort Claims Act. In Francis vs the United States, an employee failed to report a previous attack to any other USFS employee and did not act themselves as was mandated by policy. They failed to act, or report the incident to anyone else, and therefore every other employee was unable to act on the known risk. This contributed to the loss of Samuel Ives life. The state agency which did respond was also found partially responsible because they failed to communicate with the federal agency regarding their attempt to remove the offending bear.

Agencies can avoid these situations by following consistent response and communication procedures. When a risk becomes known, a decision-making process must occur which is discretionary but grounded in policy. If a risk occurs in an area frequented by the public, consideration needs to be given on how best to communicate that risk. The situations which are identified as a bear warning behavior differ between agencies and should be determined by the specific agency and based in their policy.

Where multiple jurisdictions occur, the known risk and subsequent decision needs to be communicated between agencies. This will remove the possibility of a failure to act by engaging each agency in the decision-making process. Agencies should operate as if they were not immune under tort laws. When tort laws fail to provide immunity, ordinary negligence laws apply. Under these laws, negligence usually hinges on to what extent was a risk known and, if known, where reasonable measures were taken to address the risk.

Even though bear attacks are rare events, consideration needs to be given to reduce risk. The best way to identify risk is by examining past attacks. Other studies have done this with fatal black and brown bear attacks and non-fatal brown bear attacks. Our study provided this for non-fatal black bear attacks, and we have identified many trends. We also explored the way bear managers understand attack risk, and what they would find helpful for risk assessment. From these we have made recommendations which address personal and agency risk management.

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APPENDIX A

EMAIL LANGUAGE

Initial Survey Invitation

Dear ${m://FirstName} ${m://LastName},

You are being invited to take part in a Human-Bear Conflict, Risk Management Survey. This survey is part of a graduate thesis project for the University of Wisconsin-Stevens Point. The survey will take approximately 15 minutes of your time and is entirely voluntary.

Follow this link to the Survey:
${l://SurveyLink?d=Take the Survey}

As a wildlife professional, your participation is invaluable to understanding the complexities of human-bear conflict in relation to risk management. It is our goal that the information gathered in this study will help create a better way to protect both visitors from wildlife attack, and agencies from litigation in the aftermath of an attack.

Thank you very much for your time.

Sincerely,

Janel Scharhag
Graduate Student
University of Wisconsin-Stevens Point
janel.m.scharhag@uwsp.edu
715-699-5593

Or copy and paste the URL below into your internet browser:
${l://SurveyURL}

Follow the link to opt out of future emails:
${l://OptOutLink?d=Click here to unsubscribe}

Non-Respondents follow-up email

Dear ${m://FirstName} ${m://LastName},

We see that you have not responded to our initial invitation to take part in our Human-Bear Conflict, Risk Management Survey. We would like to give you another opportunity to participate. This survey is part of a graduate thesis project for the University of Wisconsin-Stevens Point. The survey will take approximately 15 minutes of your time.

Follow this link to the Survey:
${l://SurveyLink?d=Take the Survey}

As a wildlife professional, your participation is invaluable to understanding the complexities of human-bear conflict in relation to risk management. It is our goal that the information gathered in this study will help create a better way to protect both visitors from wildlife attack, and agencies from litigation in the aftermath of an attack.

[Same Signature]

Appendix B:

Informed Consent and Survey

Manager Perceptions of Risk, Litigation, and Policy

Start of Block: Default Question Block

Informed Consent to Participate in Human Subject Research

Dr. Cady Sartini, Professor of Wildlife Ecology at the University of Wisconsin-Stevens Point, and her graduate student, Janel Scharhag, are conducting a study on bear manager perceptions of risk. We would appreciate your participation in this study, as it will help us understand management attitudes toward risk, policy, and litigation, with the ultimate objective of creating a better way to protect people from bear attacks and agencies from litigation in the aftermath of an attack.

You are being asked to complete an **anonymous** survey that should take up no more than 15 minutes of your time. We anticipate no risk to you because of your participation in this study other than the inconvenience of the time to complete the survey. You could, however, experience some discomfort if you have ever responded to a bear or other wildlife attack and your completing the survey causes you to remember this.

There are multiple methods our study could use to meet our objectives, such as interviews, content analysis, and focus groups. We believe that the use of an online survey is the best way to reach bear managers across the country in a thorough, convenient, and manageable method.

While there may be no immediate benefit to you because of your participation in this study, it is hoped that we may gain valuable information about how managers interpret

risk, policy, and litigation, which will help create recommendations for a risk management model that could be used by agencies.

The responses that you give us on the questionnaire will be recorded anonymously by Qualtircs software. No personally identifiable information will be available to the researchers, the public, or employers.

If you wish to withdraw from the study at any time, you may do so without penalty. Simply exit out of the survey, and the information collected up to that point will be destroyed.

Once the study is completed, we would be glad to give you a copy of the final report. In the meantime, if you have any questions, please ask us or contact:

Dr. Cady Sartini or Janel Scharhag
Department of Wildlife Ecology
University of Wisconsin-Stevens Point
Stevens Point WI 54481
(715) 346-4546 cady.sartini@uwsp.edu
(715) 699-5593 janel.m.scharhag@uwsp.edu

If you have any complaints about your treatment as participant in this study, please call or write:

Dr. Debbie Palmer,
Chair Institutional Review Board for the Protection of Human Subjects
Department of Psychology Science Building
D240 University of Wisconsin-Stevens Point
Stevens Point, WI 54481
(715) 346-3953 irbchair@uwsp.edu

Although Dr. Palmer will ask your name, all complaints are kept in confidence.

This research project has been approved by the UWSP Institutional Review Board for the Protection of Human Subjects.

- ○ I have received a complete explanation of the study and agree to participate. (1)
- ○ I do not wish to participate in this study. (2)

Skip To: End of Survey If Informed Consent to Participate in Human Subject Research Dr. Cady Sartini, Professor of Wildl... = I do not wish to participate in this study.

Page Break

Human-bear conflict refers to multiple situations including:

- damage inflicted by bears on property or person
- attractant management (food, trash, birdseed, grills, etc.)
- facility and area closures in response to nuisance or dangerous bear activity
- relocation or euthanasia in response to nuisance or dangerous bear activity.

Does any part of your employment duties involve making decisions about human-bear conflict?

○ Yes (1)

○ No (2)

Skip To: End of Survey If Does any part of your employment duties involve making decisions about human-bear conflict? = No

The following statements refer to the use of a risk management model (RMM). For the purposes of this survey, a RMM is defined as a systematic tool that evaluates the risk of a bear attack and/or guides decision making based on current conditions. While no such RMMs exist at this time, we wish to assess the likelihood that managers would use a RMM if one were available. We also aim to explore what you would find helpful or not helpful in a model.

We envision three possible types of models:

1) Quantitative model. An equation designed to input **local statistics** and

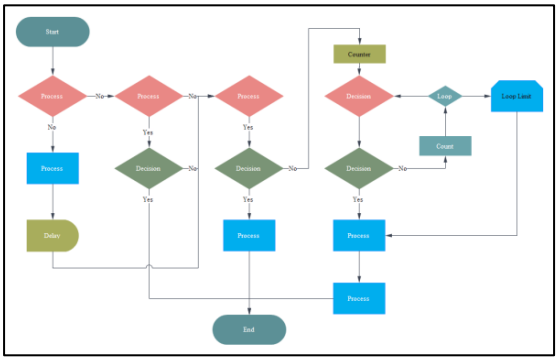
$$P(attack) = \frac{P(encounter)}{framework\ risk * personal\ risk}$$

OR

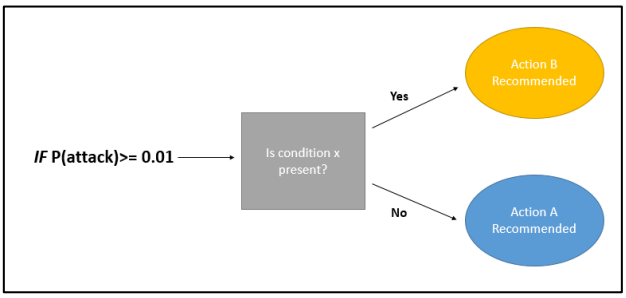
Risk score= framework score + personal score

output a probability of attack or another quantitative measure of risk. For example, a probability of attack using a probabilistic model based off peer reviewed attack statistics:

2) Qualitative model. A guide for managers, a decision-making tree or flow chart, that reviews management options for specific situations, and has no associated numerical calculation of risk. For example, managers could follow the current situation to a recommended management option:



3) Mixed model. A quantitative risk assessment with an accompanied management recommendation(s). For example, if the risk assessment is within a given range, a management recommendation or series of recommendations would follow:



Please use your preference as a bear manager, not an agency representative, to rank

the following statements to the best of your ability. Assume no agency restrictions, and think about what you would find helpful.

	Strongly Agree (1)	Agree (2)	Neither agree nor disagree (3)	Disagree (4)	Strongly disagree (5)
I would like to use a RMM to help me decide management actions for problem bears. (1)	○	○	○	○	○
I would **not** like to use a RMM under any circumstance. (2)	○	○	○	○	○
I feel I currently have enough information and support to make my own decisions about human-bear conflicts. (3)	○	○	○	○	○
I think human-bear conflict is well suited for a model. (4)	○	○	○	○	○

Please use your preference as a bear manager, not an agency representative, to rank

the models. Assume no agency restrictions, and think about what you would find helpful. Drag and Drop: 1 being your most favored model and 3 being your least favored.

_____ Quantitative Model. (1)
_____ Qualitative Model. (2)
_____ Mixed Model. (3)

Page Break

With the slider bar, indicate your percent likelihood of using a RMM to aid in decision making for each scenario:

	0 20 40 60 80 100
A bear has been caught eating out of dumpsters three times, and has been relocated twice. The last time he was found at a dumpster, he charged anyone that approached. (1)	
A solo adult bear has been reported following several people along a section of trail. The bear has not shown any signs of aggression. (2)	
A sow with cubs has a home range encompassing an area around a popular hiking trail with a plentiful berry crop. She is habituated to people, but has been showing, through vocalizations, intolerance for dogs on the trail. (3)	

Page Break

The following statements refer to your perception of responsibility in a wildlife attack. Please use your personal opinion as a bear manager, not an agency representative, to rank the following statements to the best of your ability.

	Strongly Agree (1)	Agree (2)	Neither agree nor disagree (3)	Disagree (4)	Strongly disagree (5)
I feel that it is my responsibility as a manager to keep people safe from wildlife attacks. (1)	○	○	○	○	○
If someone were attacked in my jurisdiction, I would feel partially responsible. (2)	○	○	○	○	○
I believe it is people's responsibility to keep themselves safe from wildlife when recreating in the outdoors/wilderness. (3)	○	○	○	○	○
People have all the tools necessary to keep themselves safe from wildlife in the outdoors or wilderness. (4)	○	○	○	○	○
I believe it is my agency's responsibility to keep visitors safe from wildlife attacks. (5)	○	○	○	○	○
I believe my agency has a responsibility to implement the best strategies to keep visitors safe. (6)	○	○	○	○	○

Page Break

I am familiar with the 2013 ruling against the federal government regarding the death of 11-year-old Samuel Ives by a black bear in Utah.

- Yes (1)
- No (2)

Display This Question:

If I am familiar with the 2013 ruling against the federal government regarding the death of 11-year-... = Yes

I agree with the Utah Supreme Court's decision, which found the federal government partially responsible for the fatal attack.

- Yes (1)
- No (2)
- Unsure (3)

Display This Question:

If I am familiar with the 2013 ruling against the federal government regarding the death of 11-year-... = Yes

*

Optional, use the comment box below to add any additional information about your attitude of the Court's decision. (Max 200 characters)

Page Break

The following statements refer to your perception of litigation. Please use your personal opinion as a bear manager, not an agency representative, to rank the following statements to the best of your ability.

	Strongly Agree (1)	Agree (2)	Neither agree nor disagree (3)	Disagree (4)	Strongly disagree (5)
I think it is understandable that someone might sue an agency after a wildlife attack. (1)	○	○	○	○	○
I believe state and federal governments should be immune from lawsuits in cases of wildlife attack. (2)	○	○	○	○	○
There needs to be clear negligence by an agency, for citizens to sue in an instance of wildlife attack. (3)	○	○	○	○	○
I think agencies must ensure they meet their minimum legal obligation to prevent litigation. (4)	○	○	○	○	○
I believe policy makers, not managers, should have to	○	○	○	○	○

worry about litigation. (5)					
I think we, as managers, must consider the possibility of litigation when making decisions. (6)					

Page Break

The following statements refer to your perception of your agency's policies. Please use your personal opinion as a bear manager, not an agency representative, to rank the following statements to the best of your ability.

Agency policies are predefined courses of action that must take place in response to specific situations. These can include a three-strike rule, relocation requirements, and euthanasia criteria.

	Strongly Agree (1)	Agree (2)	Neither agree nor disagree (3)	Disagree (4)	Strongly disagree (5)
My agency has policies in place that dictate management action regarding human-bear conflict. (1)					
I believe my agency's policies help protect from litigation involving human-bear conflict. (2)					
I think my agency has too					

many policies in place. (3)					
I perceive my agency's policy as hindering my ability to make good decisions regarding human-bear conflict. (4)	○	○	○	○	○
I think my agency's policies are a smart way to ensure due diligence (the minimum legal requirements of responsibility). (5)	○	○	○	○	○
I would like it if I were able to make decisions regarding problem bears without policy constraints. (6)	○	○	○	○	○

Page Break

Please answer the following questions to the best of your ability.

What type of agency is your employer?

- State (regional/provincial) (1)
- Federal (national) (2)

Is your jurisdiction in the United States?

- Yes (1)
- No (2)

Display This Question:

If Is your jurisdiction in the United States? = Yes

In which region of the country is your jurisdiction located?

- Northeast (ME, VT, NH, NY, MA, RI, CT, PA, DE, NJ, MD) (1)
- Southeast (FL, SC, GA, AL, MS, LA, AK, TN, NC, KY, VA, WV) (2)
- Southwest (AZ, NM, OK, TX) (3)
- Midwest (OH, IN, IL, MO, KS, NE, SD, ND, MN, WI, MI) (4)
- West (WA, OR, MT, ID, WY, CO, UT, NV, CA) (5)
- Alaska (6)

What percentage of your duties involves human-bear conflict management?

	0 10 20 30 40 50 60 70 80 90 100
Slide bar to choose a percentage (1)	

How many years has part, or all, of your job involved bear management?

- 1-5 (1)
- 6-10 (2)
- 11-15 (3)
- 15+ (4)

How often do you, as a representative of your agency, respond in any capacity (phone, email, sending technicians out, or going to the field yourself), to a nuisance bear complaint during active bear months (active months vary by location but generally are May-October)?

- Multiple times a day (1)
- Multiple times a week (2)
- Multiple times a month (3)
- Multiple times a year (4)
- Almost never (5)
- Never (6)

Have you, as a representative of your agency, ever had to respond, in any capacity, to an attack on a human by a bear?

- Yes (1)
- No (2)

Display This Question:

If Have you, as a representative of your agency, ever had to respond, in any capacity, to an attack... = Yes

How many times?

- 1-3 (1)
- 4-6 (2)
- 6-8 (3)
- 8+ (4)

Display This Question:

If Have you, as a representative of your agency, ever had to respond, in any capacity, to an attack... = Yes

Have you ever had to respond to a fatal attack?

- Yes (1)
- No (2)

Based on what you have observed and recorded, how often do people in your jurisdiction encounter bears? Please include sightings and interactions.

Sightings: defined as an observation when a bear is seemingly unaware of the person observing or responds to the person observing with evasive action. Interaction: defined

as an occurrence when a person and bear are mutually aware of each other and one or both exhibited an intentional negative reaction.

- ○ Multiple times a day (1)
- ○ Multiple times a week (2)
- ○ Multiple times a month (3)
- ○ Multiple times a year (4)
- ○ Almost never (5)
- ○ Never (6)
- ○ No ability to make an educated guess (7)

Page Break

*

What do you believe to be the most significant challenge in human-bear conflict risk management? (Max 500 characters)

_____

_____

_____

_____

_____

End of Block: Default Question Block