



A Behavior-Based Framework for Managing Human-Wildlife Interactions in Parks

Managing Individual Animal Behavior

Natural Resource Report NPS/NRSS/BRD/NRR—2016/1288



ON THE COVER

Photograph of black bear in dumpster in Great Smoky Mountains National Park.
Photograph courtesy of the National Park Service.

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Managing Behavior of Individual Animals

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Kirsten M. Leong¹, Bill Stiver², Lindsey Donaldson³, and Scott Bates⁴

¹National Park Service
Biological Resources Division
Natural Resource Stewardship and Science
1201 Oakridge Drive
Suite 200
Fort Collins, CO 80525

²National Park Service
Great Smoky Mountains National Park
107 Park Headquarters Road
Gatlinburg, TN 37738

³National Park Service
Catoctin Mountain Park
6602 Foxville Road
Thurmont, MD 21788

⁴National Park Service
National Capital Region
4598 MacArthur Blvd NW
Washington, DC 20007

August 2016

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science
Fort Collins, Colorado

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Please cite this publication as:

Leong, K. M., B. Stiver, L. Donaldson, and S. Bates. 2016. A behavior-based framework for managing human-wildlife interactions in parks: Managing individual animal behavior. Natural Resource Report NPS/NRSS/BRD/NRR—2016/1288. National Park Service, Fort Collins, Colorado.

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Executive Summary

Wildlife are an important component of the natural resources protected by the National Park Service (NPS); national parks provide habitat for wildlife, and park staff restore species and help to preserve the important role of wildlife in naturally functioning ecosystems. In addition, national parks welcome over 307 million visitors annually, and wildlife viewing is an important activity for many visitors. When people interact with animals, wildlife learn from these experiences and may modify their behavior. For example, rather than keep their distance or flee from people, animals in parks may approach people in search of food or simply ignore approaching people. People, in turn may try to get close to animals perceived to be tame. While these behavioral changes can have benefits, such as increasing the probability that visitors will see wildlife, they also can negatively affect wildlife health and reproduction, current and future visitor experiences, and the safety of both humans and wildlife.

NPS managers have indicated a need for guidance to improve consistency in how the NPS manages individual animals that interact with humans, especially because the appropriate management response often will depend on the specific situation and overall management context. To address this need, the NPS Biological Resources Division (BRD) of the Natural Resource Stewardship and Science Directorate has been working with wildlife biologists across the National Park System to share knowledge and best practices related to changes in wildlife behavior that result in problematic management situations. Managing the human-wildlife interactions that result in wildlife behavior change can be achieved through a broad range of actions, from managing human behavior through area closures, education, outreach, and enforcement; to managing attractants such as human food, water and infrastructure; to managing the animals themselves via hazing, aversive conditioning, capture, and removal. While these actions often need to be used together, BRD most often receives questions about techniques to manage animals. This report is the result of a workshop held in August, 2014 in Fort Collins, CO to begin to structure and summarize information related to managing animal behavior, with the ultimate goal of improving visitor and wildlife safety in parks.

Part I of the report begins with background information on animal behavior and learning. Key terminology is defined, especially the distinction between habituation (when an animal's response to a stimulus with no consequences weakens after repeated exposure, e.g. elk no longer running away from visitors in parks) and conditioning (when an animal increases the frequency or intensity of its response to a stimulus that has positive or negative consequences, e.g. bears approaching people or breaking into vehicles looking for food). Whether an animal shows attraction, avoidance, or no response to people is not intrinsically good or bad. However, in the context of U.S. National Parks, managers who were part of this project tended to view an avoidance response as the most "natural" or "wild," and therefore desired. Managing towards this behavioral "state" also maintains more distance between animals and people, reducing the probability of potentially dangerous interactions or interactions that lead to wildlife habituation and conditioning. There are pros and cons to managing for all three types of behavioral responses; which one is desired in a specific situation may be influenced by factors such as the physical environment, species, season, enabling legislation, zone within a park (e.g., frontcountry vs. backcountry), and social context. Managing wildlife in National Park System units involves a number of different policy considerations. This report is intended to

provide guiding principles and be a reference resource for park managers to aid them in their decision-making. It is not intended to set forth any specific course of action in any given context that park managers are required to follow.

To help park staff diagnose and manage effects on wildlife from interacting with people, we applied concepts from animal behavior to an established framework used to modify human behavior: select behaviors, identify attractants and deterrents, develop strategy, pilot strategy, implement and evaluate. For each step in the framework, diagnostic questions and corresponding principles were developed to help guide analysis of the situation. Diagnostic questions include: Do you need to manage the animal? Is the behavior of interest habituation or conditioning? Is the behavior a symptom of a systematic problem? What is the stimulus of interest? Are certain individuals more easily attracted/deterred from the stimulus in question? What is the relative exposure to management actions vs. visitor behavior? Is human safety at risk? How will success be measured? Answering these questions will help ensure that the most appropriate course of action is selected. The corresponding principles can serve as a helpful reference and guideline:

1. Have a plan before you act;
2. Be proactive; don't wait until an animal is conditioned to take action;
3. Consider any parallel actions to manage human behavior at the root of the problem;
4. Match the management action to the stimulus;
5. Strive to identify the individual animal(s) involved in any interaction;
6. Consider the management context and individual animal's history;
7. Relocation or removal (including lethal removal) may be appropriate in certain cases, but must be carefully evaluated;
8. Good data helps make good management decisions.

Part II outlines additional guidance for three groups of animal that are often involved in human-wildlife interactions: ungulates (hoofed animals, such as, bison, elk, deer, mountain goats, bighorn sheep), mesocarnivores (medium sized carnivores, like coyotes, bobcats, raccoons and foxes), and bears (black bears and brown/grizzly bears). Each group of animals has unique aspects of its biology that will require different management approaches. For example, ungulates are often attracted to unnatural yet high-quality forage provided in developed areas of parks, such as lawns, ornamental gardens, agricultural fields, and areas with exotic plant species. Mesocarnivores also are often prevalent around developed areas, but usually due to food conditioning. In addition, mesocarnivores can serve as reservoirs for rabies, which can be transmitted to both people and pets. Because they are carnivores, they also may prey on animals that are important to people (e.g., pets, domestic livestock, and poultry), leading to additional concerns. Bears add a further level of concern, as they may attack or prey on humans. For each of these groups, we also provided suggestions for how to identify and respond to distant sightings; close sightings (including flight response, defensive behavior, or habituation); food conditioned interactions; offensive encounters; predatory encounters with pets, domestic livestock, and poultry; and predatory encounters with people.

Considering the diagnostic questions, principles, and strategies before potentially dangerous human-wildlife interactions occur can help managers in developing potential plans of actions with contingencies for risk management. In addition, advance consideration improves transparency and facilitates communication with the public by demonstrating the logic behind management actions. The concepts, framework, and suggested strategies outlined in this paper were an important first step to help managers assess situations that may require managing individual animals. To comprehensively consider, and if appropriate address, potentially dangerous human-wildlife interactions in parks, these approaches should be integrated with proactive efforts to explicitly manage human behavior, based on expertise from fields such as social psychology and communication.

Acknowledgments

This project was made possible by many hours of conversations and contributions from the Biological Resources Division, park, and regional staff involved in the NPS Human-Wildlife Habituation Steering Committee and Managing Animal Behavior Workshop over a number of years. The team was led by the primary author, co-authors led sub-teams for bears, ungulates, and meso-carnivores, respectively. We could not have created this report without the range of experience and thinking from stellar team members, most of whom contributed to the writing of this report: L. Barish, S. Colwell, B. Connery, D. Foster, K. Fristrup, P. Happe, G. Hilderbrand, R. Kahn, D. Licht, B. Merkle, C. Ogden, P. Owen, T. Pinion, J. Schaberl, D. Shirokauer, M. Sturm, F. Turina, J. Van Stappen, M. Wild, K. Wilmot, and M. Wrigley. In addition, many others were included in the writing process: D. Gammons, K. Gunther, C. Lee-Roney, R. Mazur, B. McCann, M. Romanski, G. Schroeder, J. Yarkovich, P. J. White, and S. Windels.

We also thank external partners and contributors, D. Decker, H. Wieczorek-Hudenko, and J. Barber, attendees at the numerous conference workshops and symposia that helped shape thinking on the topic, and Department of the Interior Solicitors who provided helpful guidance and input.

Part I: Background and Framework

Introduction

The mission of the National Park Service (NPS) is to preserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations. Wildlife are an important component of the natural resources protected by the NPS. The NPS Organic Act specifically includes wildlife in the NPS purpose, which is “...to conserve the scenery, natural and historic objects, and the wild life in the System units and provide for [their enjoyment] in such manner and by such means as will leave them unimpaired for the enjoyment of future generations...” (54 U.S.C. § 100101(a), amending and replacing 16 U.S.C. § 1 repealed 2014). National parks also provide habitat for wildlife, and park staff restore species and help to preserve the important role of wildlife in naturally functioning ecosystems. In addition, national parks welcome over 307 million visitors annually, and wildlife viewing is an important activity for many visitors.

The dynamic between people and wildlife is often different in parks and protected areas compared to other locations. When people interact with animals, wildlife learn from these experiences and may modify their behavior. For example, rather than keep their distance or flee from people, animals in parks may approach people in search of food or simply ignore approaching people. People, in turn may try to get close to seemingly “tame” animals. While these behavioral changes can have benefits, such as increasing the probability that visitors will see wildlife, they also can negatively affect wildlife health and reproduction, current and future visitor experiences, and the health and safety of both humans and wildlife (e.g., via injury and disease transmission). In addition, human-wildlife interactions that result in property damage or injury can lead to litigation that has impacts locally and across the System. The animals involved may be considered “problem” or “nuisance” individuals because the behaviors they are expressing are undesired or are not considered “natural.” Yet, the causes of undesirable or unsafe animal behaviors often relates to the environment, including problematic visitor behavior.

NPS managers have indicated a need for guidance to improve consistency in managing “problem wildlife” across the National Park System, especially recognizing that the appropriate management response often will depend on the specific situation and overall management context. In addition, managers have different levels of experience with the range of wildlife species and situations found in parks and have indicated that pooling knowledge would be of assistance. This type of guidance also would assist NPS staff who are not wildlife biologists but may be first to respond to potentially dangerous human-wildlife interactions (such as interpretive or law enforcement rangers) and must make decisions about how best to proceed, either immediately or long-term.

To address this need, the NPS Biological Resources Division (BRD) of the Natural Resource Stewardship and Science Directorate (NRSS) has been working with wildlife biologists across the National Park System to share knowledge and best practices related to changes in wildlife behavior that result in problematic management situations, with the ultimate goal of improving visitor and

wildlife safety in parks. We have convened a number of workshops and symposia to explore the issue and collected materials on intranet and SharePoint sites.¹

This report is the result of a workshop held in August, 2014 in Fort Collins, CO and following discussions. It summarizes:

- background information on animal behavior and learning and implications for behavior change in wildlife in parks;
- a framework to help guide management of animal behavior, including diagnostic questions and overarching principles;
- more specific guidance for three groups of animal that are often involved in human-wildlife interactions:
 1. **Ungulates** - These are hoofed animals, such as, bison, elk, deer, mountain goats, bighorn sheep. Ungulates in parks are highly visible and sought by the public for wildlife viewing. They are often perceived by the public as less threatening than carnivores, but due to their greater numbers; wider distributions; behaviors; and hooves, horns, and antlers, there is still a considerable opportunity for human injury or fatality to occur.
 2. **Mesocarnivores** - These are medium sized carnivores, like coyotes, raccoons and foxes. While there is less risk to humans than from larger carnivores, there are still risks from interactions. These species can be prone to becoming food conditioned and are much more common than the larger carnivores. This group of species likely poses the greatest risk for disease transmission to humans as well as risks to pets.
 3. **Bears** - Black bears and brown/grizzly bears are prone to becoming food conditioned and can pose significant threats to humans; they have caused injuries and fatalities in parks. Due to their low visibility (relative to other wildlife species, such as ungulates and mesocarnivores) and public appeal they are also among the most highly valued species by NPS visitors for wildlife viewing. Both brown bears and grizzly bears will be referred to as “brown bears” throughout the rest of this document.

We hope that these materials not only serve as resources for NPS staff, but are the beginning of a rich and ongoing dialogue that continues to improve our management practices.

Focus: managing behavior of individual animals or groups of individuals

Managing the human-wildlife interactions that result in wildlife behavior change can be achieved through a broad range of actions, from managing human behavior through area closures, education, outreach, and enforcement; to managing attractants such as human food, non-native vegetation, water

¹ <http://www1.nrintra.nps.gov/brmd/humandimensions/habituation/index.cfm> and <http://share.inside.nps.gov/sites/nrss/div/brmd/human/habit/Pages/Home.aspx>, respectively.

and infrastructure; to managing the animals themselves via hazing, aversive conditioning, capture, and removal (Table 1).

Table 1. Potential actions for managing human-wildlife interactions caused by changes in individual animal behavior.

Category of Action	Focus of Action	Potential Actions
Manage Human Access^B	- Human Behavior - Remove animal's access to people - Proactive/prevention	- Temporary, seasonal, or permanent area closures - Infrastructure such as viewing platforms, blinds or buses that physically separate people and animals - Encourage compliance with area closures and infrastructure use (via education and outreach, law enforcement)
Manage Environment^B	- Human Behavior - Remove animal's access to attractants - Proactive/prevention	- Provide food storage and garbage receptacles and maintain regularly - Encourage use of food storage and garbage receptacles (via education and outreach, law enforcement, human behavior change) - Modify native vegetation in developed areas
Manage Animal Behavior^A	- Change animal's behavior - Proactive or Reactive	- Conditioned taste aversion (limited applicability; not appropriate for human food) - Hazing (e.g., use of rubber bullets, cracker shells, air horns) - Aversive Conditioning (more consistent use of hazing techniques)
Manage Animal^A	- Remove animal - Reactive	- Relocation (e.g., capture and removal to another location in the wild) - Lethal Removal (e.g., capture and euthanasia)

^A This report focuses on when and how to use techniques to directly manage animals (rows also with white cells).

^B Proactive/prevention techniques to manage human access and the environment (rows also with gray cells) require different expertise targeting human behavior (of managers, park staff and visitors) and should be utilized whenever feasible if situations are arising that require management of animals.

In discussion of these activities, it was recognized that the options for managing animal behavior in parks are somewhat limited and often controversial. Proactive management strategies were preferred, most of which involve managing the human behavior that leads to animal learning, whether the behavior of visitors (e.g., via communication, interpretation, and outreach) or of NPS staff (e.g., setting maintenance schedules, directing resources towards infrastructure, landscaping choices). Yet, design of interventions targeting people vs. animals requires different skills and disciplinary knowledge. Although this paper will discuss when to consider using techniques to manage human behavior, specific guidance in design of effective messages and incentives/disincentives requires foundations in social psychology, communication, interpretation, and even criminology, which is beyond the scope of this report. These skills are crucial in developing effective proactive management strategies. Partnerships with interpreters, social scientists, and evaluators should be sought for those efforts. It is noteworthy that managers identified a broader range of crucial management actions targeting human vs. animal behavior.

While the actions identified in Table 1 typically need to be used together, BRD most often receives questions about techniques to manage animals, which led to the initial focus on animal behavior. Specifically, this report centers on managing individual animals or groups of individuals that have changed their behavior due to interactions with people, such that their behavior is different from the norm for the broader population in a park or surrounding areas. This tends to occur more frequently in generalist species that can tolerate and adapt to a variety of food sources and levels of disturbance, such as those chosen for additional guidance in this report (ungulates, mesocarnivores, and bears). Animals that have changed their behavior are often referred to as “problem” or “nuisance” animals by park staff, and effective management must focus at the individual level. Just like humans, individual animals within a population have different levels of curiosity, tolerance of humans, or aggression (Réale, 2007). Similarly, individual animals may have different abilities for learning or have different histories of interactions with humans that result in different types of learning. For example, elk on public lands open to hunting and motorized recreation have been shown to be more vigilant to people than those in national parks in summer (Ciuti et al., 2012). The techniques to manage behavior change of individuals within a population also will be more targeted than techniques to manage behavior of an entire population (such as rats in buildings or geese at airports), another important topic but also beyond the scope of this report.

Animal Behavior and Learning

To guide our thinking about managing individual animals, we turn to the field of animal behavior. Animal behavior, as a discipline, is rooted in evolutionary biology and seeks to understand underlying causes of an animal's behavior, how the behavior developed within an individual animal's lifetime, the function(s) it serves, and how the behavior may have evolved over time, while learning is an adaptive modification of behavior that results from experience (see Alcock, 2009; Drickamer, Vessey & Jakob 2002; McFarland 1999). A handful of key concepts help describe the relationship between learning and behavior:

- Animals respond to stimuli (e.g., human presence, disturbance, food reward);
- Stimuli can have consequences to animals (e.g., positive or negative);
- Animals learn from repeated exposure to a stimulus with consistent consequences;
- Learning can result in an animal changing its behavioral response to a particular stimulus (e.g., avoiding it, ignoring it, or becoming attracted to it);
- Learning is a natural process that helps animals adapt to their environment;
- Learning happens at the individual level but can also be transmitted socially (e.g., bear cubs learning from their mothers or siblings).

In addition, other key concepts are essential to the framework: learning processes (including the distinction between habituation and conditioning), and behavioral motivations (especially whether the animal's behavior is provoked or unprovoked).

Learning processes

Below, we describe a number of common learning processes that are important to understand to effectively manage individual animal behavior. The terms habituation and conditioning are often used interchangeably, yet they are different learning processes and require different management techniques to effectively address them (see McCullough, 1982 for an overview of bears in park settings). For wildlife management, specific aspects of conditioning are important to understand, specifically food conditioning, aversive conditioning and hazing, and conditioned taste aversion.

Habituation

Habituation is defined as the waning of a behavioral response following repeated exposure to a nonthreatening stimulus (Bernstein, Penner, Clarke-Stewart, & Roy, 2006; McFarland, 1999, Figure 1). With respect to human-wildlife interactions, the animal's response the first time it encounters people (the stimulus) may be attraction or avoidance, but if there are no consequences from the interaction, animals will eventually learn to ignore people. While the term habituation can describe the loss of either an initial attraction or avoidance response, in wildlife management, habituation is usually used to describe an animal's lack of fear response to the presence of humans after repeated, nonconsequential encounters (see Herrero, Smith, DeBruyn, Gunther, & Matt, 2005; McNay, 2002).

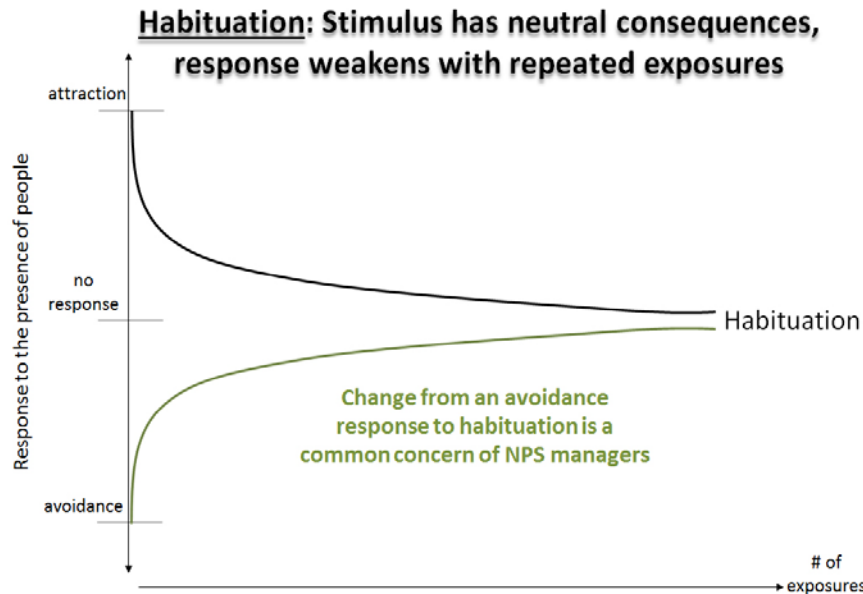


Figure 1. Graphical representation of habituation, using idealized curves for illustration purposes (the actual slope may vary by species, contexts, and life stage). With repeated exposure to a non-consequential stimulus (in this example, the presence of people), an animal's response changes from initially being attracted to or avoiding the stimulus to ignoring it.

This can be a concern because it brings people and animals in closer contact, facilitating accidental injuries or the animal receiving food or other rewards. There is less concern about animals losing an initial attraction response. Because habituation involves lack of consequences, it is easily destabilized upon the introduction of a novel stimulus (McFarland 1999); even infrequent rewards or punishments associated with a stimulus may prevent habituation (McCullough 1982).

Habituation can improve an animal's fitness by reducing resources expended in reactions to stimuli that have no consequences to the animal. For example, animals that no longer perceive people in parks as a threat may save energy and have access to habitat they would not if they always fled from people. However, sometimes behaviors that appear to be habituation are actually tolerance of a stressful disturbance. For example, in one study, American kestrels (*Falco sparverius*) nesting in higher disturbance areas appeared to ignore humans, yet they exhibited higher rates of nest failure than those nesting in areas with lower disturbance (Strasser and Heath 2013). American black bears (*Ursus americanus*) have also been shown to exhibit an elevated heart rate in the presence of unmanned aerial vehicles, even though they exhibited no behavioral response (Ditmer et al., 2015). In these and similar cases, while the animals appeared habituated, they experienced physiological stress, indicating that they were responding internally to the disturbance, even though their outward behavior did not change (see also, Steen et al., 1988; Wild, 2002).

Conditioning

Conditioning, on the other hand, is the process by which an animal's response to a stimulus becomes more frequent or more intense as the result of a reward or punishment (also known as a reinforcer) associated with the stimulus (McFarland, 2009, Figure 2). A stimulus paired with a reward results in

the animal seeking out the reward more frequently/intensely, whereas a stimulus paired with a punishment results in the animal seeking to avoid the punishment more frequently/intensely.

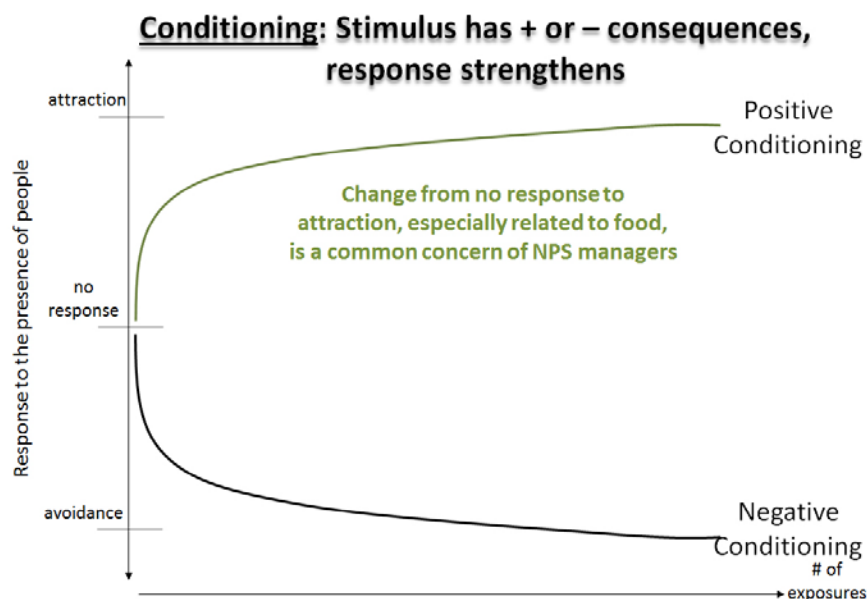


Figure 2. Graphical representation of conditioning, using idealized curves for illustration purposes (the actual slope may vary by species, contexts, and life stage). With repeated exposure to a stimulus (in this example, the presence of people) that has either positive or negative consequences, an animal's initial lack of response changes to attraction or avoidance.

In parks, the reward associated with people is usually food, and animals learn very quickly to approach people for potential food rewards. Other attractants may include salt on roads or vehicles, supplemental water sources in arid regions, or other “unnatural” environments (e.g., developed areas) with high-quality forage areas such as lawns, ornamental gardens, agricultural fields, or exotic plant species. Punishments from interacting with people are less frequent in parks, but are experienced by hunted populations.

There are a number of other terms related to conditioning that are important in wildlife management.

Food Conditioning occurs when an animal learns to associate a stimulus with a food reward, and is a form of positive conditioning. In the context of wildlife management, animals learn that people or the smell of people, human activities, human-use areas, or food storage receptacles are a source of anthropogenic or other food sources (Hopkins III et al., 2010). Food conditioning is undesirable, as it can lead to negative outcomes for both wildlife (e.g., sub-optimal diet or habitat) and people (e.g., injury or death from an encounter), and food conditioned animals regularly involved in encounters with people often must be removed or destroyed. To address this concern, NPS developed regulations that became codified in 36 CFR § 2.2(a)(2), which prohibits wildlife feeding. However, even a low failure rate of compliance with these regulations can perpetuate food conditioned responses (McCullough, 1982). Thus, prevention of food conditioning is crucial; once animals learn

to associate people with food, only infrequent rewards are necessary to reinforce potentially dangerous food conditioned responses.

Aversive Conditioning is a form of negative conditioning that occurs when an animal learns to associate a stimulus with a negative consequence and is sometimes used as a wildlife management technique (Mazur, 2010). Managers apply pain or fear stimuli in the presence of humans or human-use areas, so that animals learn to associate humans or human spaces with negative consequences. Techniques (depending on the species and situation) can include physical stimuli such as rubber bullets and bean bags, auditory stimuli such as cracker shells and air horns, and visual stimuli such as fladry, predator mimics, and lights; however, an animal may quickly habituate to the pain- or fear-provoking stimuli when it learns they pose no real threat (Conover, 2002), especially if the animal has already learned that food rewards are consistently present in the same spaces. Park staff typically do not have the resources to conduct aversive conditioning. In most cases, hazing (see below) is the best that can be achieved. An exception would be when curious animals are first beginning to explore a developed area (e.g., campground, picnic area). In this case, if attractants are removed and aversive conditioning is applied aggressively before the animal receives rewards for being in that area, it may stay away (Mazur, 2010).

Hazing uses many of the same techniques as aversive conditioning, but with a more limited application. While it can be used effectively to move an animal from an area in the short-term, diffusing an immediate situation, the negative stimuli are not applied with enough consistency to result in long-term avoidance of an area. Instead, the animal often returns as soon as managers and the negative stimuli are gone. Hazing and aversive conditioning are important preventative tools to discourage animals from spending time in developed areas where they are more likely to receive food rewards (and become food conditioned) or face other risks such as vehicle collisions (Mazur, 2010; McCullough, 1982).

Conditioned Taste Aversion (CTA) is another form of negative conditioning that teaches an animal to associate negative consequences with a specific food. Typically, the food source of interest is treated with a substance that induces nausea or vomiting. When naïve animals are exposed to the treated food source, they have a physiological reaction and learn to avoid that food item. This is the same mechanism that causes people to avoid foods they happened to eat when they had the flu; even though the food did not cause the illness, the body associates illness with the food item and has a physical negative reaction when that food is encountered again. CTA does not work with dietary specialists, such as vampire bats, but has been shown to work in a number of dietary generalists (Alcock 2009). CTA has been successfully used in experiments to deter corvids (crows and jays) from predating on marbled murrelet eggs at Redwoods National and State Parks (Gabriel and Golightly 2011) and in Joshua Tree National Park to deter coyotes from frequenting campgrounds where specific food items were often received (Cornell and Cornely 1979). It is important to note that conditioned taste aversion can only teach an animal to avoid a specific food, it is not generalizable to other foods or the source of food (e.g., picnic area). Using CTA to teach animals to avoid all human foods (e.g., hot dogs, and potato chips, and sandwiches, etc.) is not practical, nor safe for the animals. CTA to address conditioning to human foods in general is not recommended for use in parks.

Habituation and Conditioning in Parks

Habituation and food conditioning are learning processes that are likely to occur in parks, through animal interactions with visitors who are seeking wildlife watching experiences and have food. This progression is illustrated in Figure 3. In the context of U.S. national parks, managers tend to view avoidance of humans as the most “natural” or “wild” response, as animals that have evolved under predation pressure would naturally flee potential threats. However, because the presence of people is not paired with a negative consequence, animals in parks often lose their fear response. When a positive consequence of being near people is introduced, such as food, animals quickly learn to seek out those rewards. This progression may appear to be an escalating continuum, however, because there are different learning processes at play, animals that are habituated but not conditioned respond differently to management than animals that are already conditioned. From a managerial standpoint, habituation and food conditioning represent escalating conditions of concern because management tools to specifically address conditioned behavior are limited and managers must rely on the same prevention tools used for habituation.

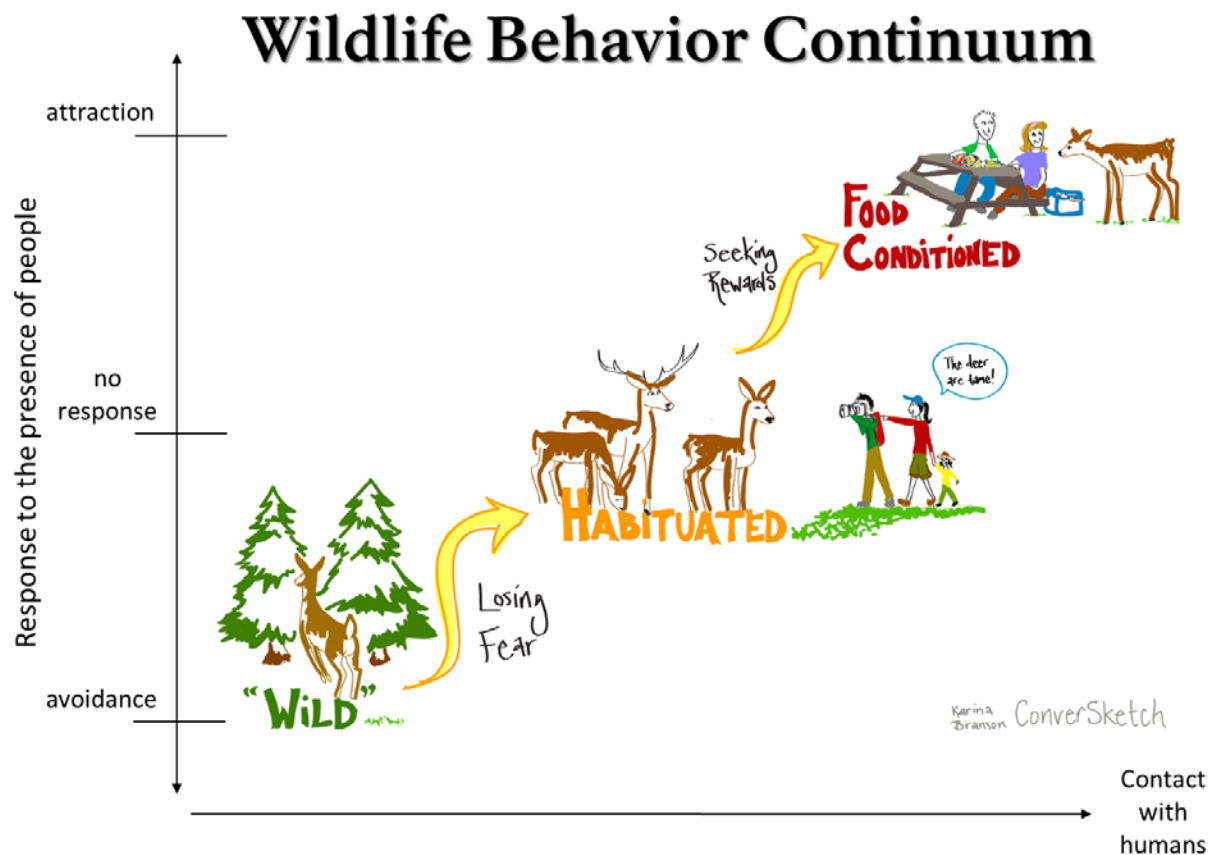


Figure 3. Wildlife Behavior Continuum. Generalist species in parks are likely to become habituated and food conditioned. Because these are different processes, animals that are habituated but not conditioned may respond differently to management than animals that are already conditioned.

Aversive conditioning, hazing, and conditioned taste aversion are typically used as management tools, in response to these behavior changes. As these tools are considered, it is important to match the tool to the stimulus. Research has shown that animals can learn to form an association between taste and nausea and between sounds and pain; yet they have difficulty learning to associate pain with taste or sound with nausea (Garcia et al., 1974). This is known as the “Garcia effect” and is the reason that using rubber bullets or bean bags (a pain stimulus) typically will not affect food conditioning (a taste stimulus). Animals may learn to avoid the area associated with the pain source (or more likely to avoid the people in NPS vehicles and green and grey uniforms); however, this does not teach them negative consequences associated with human food and they will still seek food from people in other areas, or in the same areas, when the people in NPS vehicles and green and grey uniforms are not present. Consequently, aversive conditioning and hazing may be effective at addressing habituation; yet, because it is so difficult to reverse food conditioning once an animal has learned to associate people with food, capture and removal may be the only options to manage animals that are food conditioned. This relationship was borne out in a study at Sequoia National Park that found aversive conditioning was less successful on food-conditioned bears, some of which had to be removed or destroyed (Mazur, 2010). This is why prevention of food conditioning is so important, and also why many managers work to prevent habituation in situations where access to human food is likely if people and wildlife come into close proximity.

Behavioral Motivations

Understanding the learning processes described above can help a manager assess the situation, especially if individual animals and their histories are known. When a history of interactions is not known, other considerations can help determine whether habituation or conditioning might be involved. While it is impossible to be certain of an animal’s motivations, knowledge of species biology and the behavior of other individuals in the population can be used for reference. Specifically, it will be important to determine whether behavior is provoked or unprovoked, and therefore whether the animal is acting defensively or offensively. Bath and Enck (2003) refer to provoked, defensive behaviors as “unintentional” and unprovoked, offensive behaviors as “intentional” (from the animal’s perspective). These assessments are crucial, as they affect the management actions selected, and should be made in conjunction with a wildlife biologist.

Defensive behavior

Defensive behaviors typically occur when animals are defending themselves, their offspring, or food sources from a perceived threat. This could be when an animal is surprised or otherwise provoked by people and its reactions are what would be considered “natural” responses to a threat. There is no indication that these animals are habituated or conditioned. In this situation, even if substantial injury or fatality occurred, the animal may not be automatically removed. For example, in the summer of 2011, a hiker was killed in Yellowstone by a grizzly sow. Evidence and his wife’s eyewitness report indicated that the attack likely occurred because the sow had two cubs and the couple ran, triggering a chase response. In this instance, the bear had no previous history of interactions with humans and the park did not have enough evidence to determine that this individual was more dangerous than any other bear in the park.

Offensive behavior

Offensive behavior occurs when unprovoked animals initiate interactions with people. This is most easily observed when conditioned animals approach people seeking rewards. In addition, animals that have become habituated may go a step farther than ignoring people and begin to treat them as their equals, asserting dominance in perceived disputes over resources. For example, in developed areas at Olympic National Park elk become aggressive towards people, defending the habitat. Management might be indicated if the situation escalated because the animal's behavior has changed from what would be expected.

Predatory behavior

Predatory behavior is an extreme case of offensive behavior that involves an animal treating a human or pet as prey, for example deliberately stalking and attacking them. Although pets may be viewed by predators as natural prey items or competitors, situations where predators are comfortable getting close to people who have attended pets could warrant management. Depending on the situation, this could range from temporary closure to removal of the individual. When there is an animal that is known to treat humans as prey, some management action is always warranted.

Management Considerations

Goals

As noted by Whittaker and Knight (1998), whether an animal shows attraction, avoidance, or no response to people is not intrinsically good or bad. However, in the context of U.S. National Parks, managers tend to view an avoidance response as the most “natural” or “wild,” and therefore desired. Managing towards this behavioral “state” also maintains more distance between animals and people, reducing the probability of potentially dangerous interactions or interactions that lead to habituation and conditioning. NPS Management Policies (2006) states that the NPS will preserve and restore natural behaviors of animal populations, in addition to abundances and distributions, and may manage recreational activities that impact park resources. Thus, managing behavior change in wildlife requires a consideration of the desired outcomes for both people and wildlife stemming from human-wildlife interactions.

Potential Goals for Humans

The NPS generally strives to provide opportunities for safe and meaningful wildlife experiences, to the extent that these experiences do not lead to unacceptable impacts on the wildlife resources—in this case, unacceptable changes in wildlife behavior. At the site-specific scale, managers may have more specific goals based on the natural resource context (e.g., making people's activity predictable while viewing habituated bears at a hyper-abundant resource at Brooks Camp in Katmai National Park & Preserve, Alaska; encouraging appropriate food storage at Yosemite National Park, California, where bears have learned how to break into certain types of vehicles). However, the overall desire for safe and meaningful wildlife experiences, without unacceptable effects on wildlife behavior, is a constant that underlies these efforts.

Potential Goals for Wildlife

Desired conditions for wildlife behaviors are less clear-cut. Here, we consider the three potential animal responses: attraction, avoidance, or no response as potential goals to manage towards. There are pros and cons to managing for all three types of behavioral responses; which one is desired in a specific situation may be influenced by factors such as the physical environment, species, season, enabling legislation, zone within a park (e.g., frontcountry vs. backcountry), and social context. These pros and cons are summarized in Table 2 and should be weighed carefully.

Table 2. Pros and cons associated with striving to maintain each potential animal behavior response.

Behavioral Response (Goal for Wildlife)	Pros	Cons
Attraction (Conditioned)	• There are no benefits that NPS would seek to encourage	• Counter to law and policy • Increased risks of human injury from offensive or predatory behaviors • Animals more exposed to sources of human-caused injuries or mortality (e.g., poisoning, antler entanglement, vehicle collisions) • Animals susceptible to intentional human-caused mortality (poaching/hunting) • Increased risks of animal removal/death due to human safety concerns • Animals perceived as a “problem” or “nuisance”
No response (Habituated)	• Lower observable stress for wildlife • Increased access to habitat and other resources • Greater wildlife viewing opportunities • Fewer opportunities for human injury from surprise/provoked encounters (defensive behaviors)	• Animals may not attend to important stimuli that are masked by human presence (e.g., sounds) • Potential for misdiagnosis if animals still experience physiological stress when they appear to be ignoring people • Animals are more likely to congregate in unnaturally dense aggregations which can lead to disease transmission • Increased risks of human accidental human injury due to close proximity to animals • Increased risks of human injury from offensive behaviors of habituated animals • Increased risk that animals will receive food or other rewards, becoming conditioned • Animals more exposed to sources of human-caused injuries or mortality (e.g., poisoning, antler entanglement, vehicle collisions) • Animals more susceptible to poaching/hunting • Animals perceived as “tame”
Avoidance (“Wild”)	• Fewer encounters, resulting in less potential for human injury • Lower potential for conditioning • Animals less exposed to sources of human-caused injuries or mortality (e.g., poisoning, antler entanglement, vehicle collisions) • Animals less susceptible to poaching/hunting • Animals perceived as “wild”	• Few opportunities for wildlife viewing • Animals subjected to stress from humans • Potential for injury from surprise/provoked encounters (defensive behaviors)

Strategies

A variety of management strategies designed to reduce wildlife-human interactions can be taken, with many parks' philosophy focused on the management of human activities as the first priority. Direct management of animals is usually considered only after management of human activities fails or is not likely to remediate the issue. Human-wildlife management can be divided into proactive and reactive approaches that can be employed together in adaptive management.

Proactive Strategies

The objective of proactive strategies is to prevent the situations that lead to human-wildlife interactions resulting in human injuries, property damage, or wildlife injuries (the gray cells in Table 1 and actions labeled as “prevent” in Table 3). Proactively addressing habituation would involve strategies that keep people and animals from physically interacting, such as closures, or infrastructure, and any related communication or enforcement efforts that encourage people to comply with those strategies. In addition, native vegetation may be modified in developed areas to reduce interactions, for example mowing native vegetation near roads to keep animals away from roadsides, or removing native vegetation in campgrounds if it is plentiful outside of the campground. Proactively addressing conditioning requires strategies to prevent access to rewards, such as supplying and maintaining food storage and garbage receptacles and encouraging visitors to comply with their use.

As mentioned previously, specific strategies and messages encouraging human compliance should be developed in partnership with people skilled in designing and evaluating programs intended to affect human behavior. Values, beliefs, social norms, and context play a significant role in how people behave in specific situations. A large body of literature demonstrates that increasing awareness and knowledge often does not lead to desired behaviors (for example, see Hungerford & Volk, 1990; Jacobson, 1999, Newhouse, 1990). Instead, approaches that draw on the fields of social psychology, communication, and human dimensions of natural resources are necessary. Individual parks have engaged in efforts to reduce “non-compliant” or “depreciative” behaviors, but few empirical studies have been conducted, and an overarching methodology has not yet emerged (Widner and Roggenbuck, 2000). Bath and Enck (2003) outline a number of approaches to better understand audience attitudes, beliefs, and risk perceptions related to human-wildlife interactions in parks, but do not address behavior modification directly. Social marketing is one approach that is particularly well-suited to managing human behavior. It is grounded in many of the same social psychology concepts and adapts principles used to persuade people to purchase products and directs them at encouraging positive or pro-environmental behaviors. Social marketing campaigns focus on understanding what impedes and motivates a target audience to act in a certain way. Common applications of social marketing include public health campaigns, such as smoking cessation and heart disease prevention. With respect to environmental behaviors, a process called Community-Based Social Marketing (CBSM) has been developed to deliver initiatives at the community level that foster sustainable environmental behaviors (McKenzie-Mohr, 2011). Examples of community-based social marketing include recycling and composting campaigns and adoption of water and energy saving practices (available on the CBSM webpage, <http://cbsm.com/>). Another useful resource is The Audubon Society's Tools of Engagement, especially the module on Influencing

Conservation Action (available at: <http://web4.audubon.org/educate/toolkit/module3.php>). While there are few case studies from parks and protected areas, the CBSM approach has great potential for managing human behavior in parks.

Reactive Strategies

Reactive strategies respond to individual habituated, or conditioned animals (i.e., displaying offensive or predatory behavior), through immediate and direct action (the white cells in Table 1). The goal of reactive management is to address the immediate situation in a way that prevents future conflicts or other incidents with specific individual animals. It is unlikely that reactive strategies would be used alone. In addition, proactive strategies would either need to be developed (if not already in place) or modified to address the underlying behavior that led to the need for reactive strategies.

Adaptive Management

A dynamic management strategy that adjusts to experience and new knowledge is referred to as adaptive management. Data designed to evaluate the effectiveness of the proactive and reactive management strategies implemented should be collected to measure program success, justify the use of new untested methods, and predict the efficacy of future strategies. This would include management techniques focused on changing or altering either human or animal behaviors, or both. Part II outlines a range of actions to consider in different types of encounters for ungulates, meso-carnivores and bears.

Managing Animal Behavior Framework

To help park staff diagnose and manage effects on wildlife from interacting with people, we can apply concepts from animal behavior to an established framework used to modify human behavior. For each step in the framework, diagnostic questions and corresponding principles were developed to help guide analysis of the situation. The steps and related diagnostic questions and principles are summarized in Table 3 for ease of reference.

Table 3. Management steps with corresponding diagnostic questions and principles.

Management Steps	Diagnostic Questions	Principles
Foundation	Do you need to manage the animal?	1. Have a plan before you act
Step1. Select Behaviors	- Is the behavior of interest habituation or conditioning? - Is the behavior a symptom of a systematic problem?	2. Be proactive; don't wait until an animal is conditioned to take action 3. Consider any parallel actions that must be taken to manage human behavior at the root of the problem
Step 2. Identify Attractants & Deterrents	- What is the stimulus of interest? - Are certain individuals more easily attracted/deterred from the stimulus in question?	4. Match the management action to the stimulus 5. Strive to identify the individual animal(s) involved in any interaction
Step 3. Develop Strategy	- What is the relative exposure to management actions vs. visitor behavior? - Is human safety at risk?	6. Consider the management context and individual animal's history 7. Relocation or removal (including lethal removal) may be appropriate in certain cases, but must be carefully evaluated
Step 4. Pilot and Step 5. Implement, Evaluate	How will success be measured?	8. Good data helps make good management decisions

Even before delving into how best to manage the animal(s), a crucial diagnostic question and principle must be addressed.

Diagnostic question: Do you need to manage the animal?

It is crucial to determine “acceptable” wildlife behaviors (based on management objectives/goals for wildlife) before problems are encountered. Any species can be susceptible to behavior change, but some species are more tolerant of humans (and therefore prone to behavior change), typically generalist species such as deer, coyotes, and bear. When these species are present in a park, managers should be thinking proactively about the potential for human-wildlife interactions that may affect wildlife behavior.

In many national parks and other protected areas, wildlife typically are not systematically pursued by people (e.g., hunted, harassed), and wildlife viewing opportunities are promoted. This leads to a situation that can result in animals learning that people are not threats and may even provide some benefits, causing them to stop fleeing and start approaching people, becoming more visible. People may then start to believe that these animals are less wild or dangerous and try to get close for a photo

or feed them. As discussed in Figure 1, this positive feedback loop is likely to result in animal behavior changing from one that we think of as “wild” to habituated to food conditioned.

In general, clearly “acceptable” behaviors are those associated with “wild” behaviors, where animals tend to flee or retreat from humans or treat them as dominant and individual animals or groups of animals are not acting differently from the overall population. Most importantly, unprovoked animals are not actively seeking out and interacting with people in ways that threaten people’s health or safety, property, the animals themselves, or other park resources (e.g., offensive or predatory behaviors). While defensive interactions may occur, those reactions are provoked by people’s behavior.

In some park contexts, habituation may be desirable or allowable. For example, habituation of brown bears (*Ursus arctos*) at Katmai National Park and Preserve is manageable because bears are focused on hyperabundant natural resources (salmon) and viewing platforms can control visitor activities and keep them physically separate from the bears—there is virtually no opportunity for food-conditioning to develop. Similarly, visitors flock to Rocky Mountain National Park to view habituated elk, including large bulls and groups of cows, during the mating season. The elk and visitors tend to congregate in predictable areas where staff and Volunteers in Parks are deployed to keep visitors from approaching too closely or feeding elk. Yet in other parks habituation may not be desirable because it is more difficult to manage, for example where visitors are dispersed and their behavior is more difficult to control.

Food conditioning is never desired, because of the associated risks to both human and wildlife health and safety; 36 CFR § 2.2(a)(2) prohibits wildlife feeding in part for this reason. Clearly defining goals for wildlife behavior and human-wildlife interactions before potentially dangerous encounters occur will help park staff assess each situation to determine whether an animal’s behavior is acceptable or requires a management response (either proactive or reactive). While it is not always practical to fully develop objectives and plans for every species and situation in parks, periodically discussing the types of human-wildlife interactions that are occurring in a park and any changes in dynamics will help managers anticipate and plan for potentially undesirable interactions.

There also may be different goals for different areas of the park, for example in developed frontcountry vs. remote backcountry areas. It will be important to clarify which areas are thought of as primarily designated “for people,” (e.g. campgrounds, picnic areas) where visitors have been invited to congregate and there is more of an expectation for managers to implement visitor safety measures. It is also important to prevent animals prone to interacting with people from frequenting these areas as much as possible to reduce the potential for habituation and food conditioning from human-wildlife interactions. At the same time, because these areas are easier to access, a broader suite of tools may be available for management. For example, aversive conditioning or hazing may be potential tools to help move animals out of these areas. In more remote areas, accessibility may limit the options for management actions. For example, it may not be possible to haze wildlife animals because response times would be greatly delayed. Instead, closures may be used, which may not be acceptable in a popular campground. By identifying in advance which types of behavior are

acceptable in which area of the park, managers can be more prepared to have a plan of action when certain types of human-wildlife interactions are observed.

In addition, in some situations, a negative human-wildlife interaction may take place but management focused on the animal would be unlikely to affect future interactions. For example, if there is a drought that results in a poor mast or berry crop, animals may need to travel farther in search of food, including into human spaces. In these cases, animals may temporarily access human spaces but not become irreversibly habituated or food conditioned. Once natural food sources become abundant elsewhere, these animals no longer frequent developed areas. If those individuals had been removed due to concerns about human-wildlife interactions there could be negative population effects (Baruch-Mordo et al., 2014; Johnson et al., 2015). In some cases however, some individuals may rely heavily on human food sources regardless of natural food availability, as was found by Beckmann, Lackey, and Berger (2003) with bears in Lake Tahoe, California. Removal of such individuals due to concerns about human-wildlife interactions may be necessary but often the animal will be quickly replaced by another exhibiting similar behavior if attractants are not removed.

Animals provoked into a single interaction, whether accidentally (e.g., surprise encounters) or intentionally, might not automatically be a candidate for active management. Again, management of animals is most warranted when offensive or predatory behaviors occur. That is, when unprovoked animals are actively seeking out and interacting with people in ways that threaten or are likely to threaten people's health or safety, property, the animals themselves, or other park resources, or when the risk of this happening is high (e.g., a bear known to have killed, or consumed, people). Additional considerations include the season, age and sex of the animal, and whether it is a threatened or endangered species. The steps outlined below will help refine thinking about the situations in which managing the animal is necessary.

Principle 1: Have a plan before you act.

Regardless of the situation, it is crucial to have a plan in place before taking action, especially if the action involves manipulating animals. This should include identifying in advance who needs to be involved in a decision to take action (or not), which could depend on scope. In some instances, decisions may be made by an individual (e.g., biologist, law enforcement, public information officer), but for other situations, especially those that may involve lethal removal or precedent-setting actions, the Superintendent and leadership team, or even regional and Washington offices (BRD) may be involved. Regardless, to the extent practicable, decisions should be informed by someone who has a good understanding of animal behavior, presumably a wildlife biologist, and the primary decision maker should be clearly identified in advance. Documenting to the extent practicable and appropriate and communicating that decision-making process should also be considered.

In some cases, a human-wildlife interaction that requires response (e.g., causes human injury) may be the catalyst for putting resources towards a formal plan. But even in the absence of a fully developed and vetted plan, it is important to consider in advance the possible outcomes of management actions. For example, if utilizing hazing, where might the animal go and what is the likelihood for continued negative interactions there? How would neighbors react to moving that animal near their property, and what policies or procedures do they have in place? If the animal will be trapped, what is the plan

once the animal is in hand? Who will receive it and what paperwork is required for transfer? Is it more humane to euthanize an animal than to relocate it? What other ethical, humane, or legal aspects should be considered?

Again, these actions would ideally be tied back to overall objectives for animal behavior related to human-wildlife interactions at the park. Those desired conditions can then serve as a benchmark against which to compare current conditions to determine when action is needed (and what type of action) or to identify emerging issues that may not have been observed in the past. These objectives should include considerations of both visitor and staff safety.

The public also may need to be kept informed about why certain management actions are being taken and their role in creating the situation. In some cases, park staff may need to engage in broader dialogue, especially for potentially controversial actions, to be able to adequately address public concerns. Considering in advance the potential collateral impacts of management actions (such as public response) will help NPS staff be prepared to respond to questions and concerns.

Step 1: Select Behavior(s)

Once it has been determined that the animal needs to be managed, it is important to identify the behavior in question to determine whether behavior modification is likely to succeed. Because habituation and conditioning are different learning processes, they require different approaches to management to be successful. Similarly, there may be some situations where attempts at behavior modification are unlikely to have an effect. In these situations, area closures or animal removals may be warranted.

Diagnostic question: Is the problem behavior habituation or food conditioning?

Habituated animals have lowered fear response and food conditioned animals seek out food rewards. Thus, to reverse habituation requires teaching fear (i.e., through aversive conditioning), while reversing food conditioning involves teaching an animal to associate food with negative consequences (i.e., conditioned taste aversion). However, as previously mentioned, CTA is not recommended to address conditioning to human food because of the lack of generalizability. In this case, relocation or removal of the animal might be the only options. An exception would be if the situation involves a single food item that consistently attracts animals, which is rare for human food in parks.

If the “problem behavior” was not a learned behavior, e.g., a surprise encounter, or due to temporary environmental conditions, then there is no behavior to modify. Instead, emphasis might be placed on separating people and animals via closures or hazing.

Principle 2: Be proactive; don't wait until an animal is conditioned to take action.

Once an animal is conditioned, the opportunities to reverse this learning are slim. For food conditioned animals, often the only recourse is to remove the individual. For this reason, it is especially important to focus on prevention whenever there is potential for behavior change that may escalate to food conditioning. Preventive measures include: ensuring the availability of wildlife-resistant food storage and trash receptacles and that they are emptied on a schedule that corresponds

with heaviest use; outreach and enforcement that encourages proper wildlife viewing etiquette (such as appropriate viewing distances) and proper food storage/garbage disposal, as well as discourages wildlife feeding; and use of infrastructure such as walkways and blinds to reduce wildlife disturbance (see Table 1). Area closures also may be used proactively, for example to prevent interactions with people when animals seasonally or temporarily visit areas with high natural forage. This strategy is used at Grand Teton National Park along the Moose-Wilson Road; when bears are observed accessing high quality forage in the fall (chokecherries and hawthorn berries), the road is closed to reduce stress to the animals, allow them to utilize these important feeding areas, and minimize the potential injury or death of bears from vehicle collisions. Typically, the suite of preventive measures would not be used separately but would be used together to reinforce an overall management strategy that reduces undesired human-wildlife interactions.

Similarly, in park contexts where some degree of habituation has been identified as a desired condition, managers still may employ hazing techniques whenever possible to prevent animals from becoming so habituated that it is easy for them to receive accidental or intentional food rewards.

Diagnostic question: Is the behavior a symptom of a systematic problem?

If human activities such as unsecured food or unmitigated wildlife feeding are causing a chronic syndrome of unacceptable human-wildlife interactions, steps should be taken to address the underlying syndrome not just the specific interaction. For example, if animals have access to unsecured food, removing one food conditioned animal will not resolve the underlying issue; other animals are likely to become food conditioned in the future. From a management perspective, allowing this situation to persist does not resolve the source of the problem and is not practicing good conservation or stewardship.

In some cases, a dangerous animal encounter may raise awareness of the underlying situation that needs mitigation. While the animal engaged in the encounter may need to be addressed immediately, preventive measures should be put into place following the incident to reduce the likelihood of future animal manipulation/removal.

Principle 3: Consider any parallel actions that should be taken to manage human behavior at the root of the problem.

Human behavior is often the root of changes in animal behavior. As far back as 1943, Aldo Leopold noted that, "...the real problem of wildlife management is not how we shall handle [wildlife]...the real problem is one of human management" (in Kellert, 1997). We identified a number of proactive/preventive actions in Table 1 to address human behavior. Yet, often managing human behavior is not a straightforward endeavor. As described in the section on Proactive Strategies, partners versed in community-based social marketing or objectives-based communication should be used to develop this type of strategy. While preventive strategies ideally would be in place before problems with individual animals arise, they may need to be revisited or refreshed periodically, especially as *people* habituate to the information targeting them.

Step 2: Identify Attractants & Deterrents

Because behaviors are responses to stimuli, identifying attractants and deterrents is closely related to step one. Attractants may be a source of the undesired behavior, and deterrents can be used to mitigate undesired behavior. Deterrents should always be related to the stimulus of interest.

Diagnostic question: What is the stimulus of interest?

Although both are related to interactions with people, habituation and conditioning result from different stimuli. Habituation is related to the presence of people, whereas positive conditioning is due to the presence of an attractant associated with people. In parks, the attractant is usually human food. However, attractants may include other artificial food sources, such as lawns or ornamental plantings. In addition, at Glacier National Park and Olympic National Park, urine from visitors along certain popular trails has become a mineral attractant for mountain goats. In Grand Canyon National Park, elk are attracted to water bottle refilling stations designed for human use. Animals may be attracted to other types of stimuli as well. For example, at Fire Island National Seashore, white-tailed deer (*Odocoileus virginianus*) seek shelter under raised houses during the winter. In all of the above cases, animals became difficult to move or even aggressive in defending artificial food sources or other resources associated with human spaces. Ungulates at Grand Teton National Park also appear to use roads and human presence as predator shelters, becoming less vigilant in the presence of people (Shannon et al., 2014).

Principle 4: Match the management action to the stimulus.

The Garcia effect makes the choice of deterrent a non-trivial task. In most cases, it will be unreasonable to use a taste stimulus as a deterrent for food-conditioned animals. Moving the animal using pain stimuli may provide a short-term fix, but will not break the food conditioned response and will only move the problem somewhere else. Area closures also might prevent contact with the animal for the short term; however, removing access to human food in that space may result in the animal looking elsewhere for human food. When this is the case, especially if the animal is aggressive, the only management option may be removal.

Often, opportunities to remove access to the attractant may be more successful in the long run than hazing or aversive conditioning. Wildlife-resistant food storage and garbage receptacles have reduced human-wildlife interactions in many parks. This approach can be applied to other types of attractants as well. For example, Fire Island National Seashore encourages homeowners to close off access to spaces under homes (especially for houses that will be vacant during the winter), and Grand Canyon National Park is replacing irrigated lawns that acted as artificial high quality forage attractants for elk and deer with native xeriscaping in the developed zone.

Diagnostic question: Are certain individuals more easily attracted/deterred from the stimulus in question?

In addition to considering attractants and deterrents in general, it is important to consider how individual animals respond to the attractants and deterrents. Recent studies have revealed the importance of considering an individual animal's temperament; individual animals may be more bold or shy compared to the average population (Réale et al., 2007). In other words, what leads one deer to flee from people may not affect another. In addition, individual animals' learning may be related

to their history of exposure to the stimulus, and any social learning (e.g., cubs learning to rely on human food from their mothers).

Principle 5: Strive to identify the individual animal(s) involved in any interaction.

If managing an animal is being considered due to human-wildlife interactions, a good faith effort should be made to correctly identify the individual involved. As described above, individual animals may respond differently to people and human environments. The human-wildlife interactions driven by animal learning will not be effectively resolved if the individual that has learned the behavior is not the management target. This may seem obvious, but if a human injury is sustained from a human-wildlife interaction, managers may receive pressure from the public to kill any individual representing the species in the general vicinity of the incident, with the assumption that this will alleviate future risk. Park staff will need to effectively communicate that if the actual individual involved in the injury is not the one removed, the potential for future dangerous encounters is not alleviated and the search for the target animal will necessarily continue. Conversely, managers may also receive pressure from the public to verify with 100% certainty that the target individual has been identified *before* taking action. Managers should be wary of yielding to either of these pressures and focus instead on making a good faith effort to identify the target animal (and documenting this effort), while realizing that it may not always be possible with 100% certainty. Individuals with unique markings or that have been previously tagged can be identified more easily. In other cases, DNA analysis may be used to corroborate involvement in an incident, although parks may not have facilities that allow holding animals while waiting for results of DNA tests.

At the same time, from an NPS policy perspective, the overall population is more important than the individual. NPS Management Policies (2006) clearly states this focus on populations in the general principles for managing biological resources outlined in section 4.4.1. This focus may affect the potential management actions that may be considered for an individual. For example, rabies vector species (e.g., bats, raccoon, skunks, fox that serve as a reservoir of a species-specific rabies strain) should not be relocated due to the risk of spreading the disease to a new geographical area. Similarly, due to concerns about chronic wasting disease, cervids (e.g., deer, elk, moose) should not be relocated unless stringent conditions are met (NPS, 2002). Members of the public may not understand or agree with this population approach to management. For example, some members of the public place extreme high value on the life of individual animals (e.g., Facebook pages have been created for named or numbered animals in parks), and motives may be driven by emotional rather than ecological considerations (Wright, 1998). However, as mentioned above, NPS policies clearly speak to a focus on populations rather than individuals, and parks may need to make unpopular management decisions, based on the considerations outlined above. Communication will again be important to clarify the reasons behind chosen management actions.

Step 3: Develop Strategy

As outlined in Table 1, management actions directed towards animals include conditioned taste aversion (which has limited applications in parks), hazing, aversive conditioning, relocation, and lethal removal. Many of these result in high costs to the animals, may be logistically and socially challenging, and likely do not address the underlying causes of the problem. However, there may be

situations where managing the animal is necessary or unavoidable to reduce immediate risks to human health and safety. In many cases, stakeholders may not agree with the actions taken by managers, which we have seen recently in discussions on social media about the 2015 human fatality and lethal removal of a sow grizzly bear and translocation of her cubs from Yellowstone National Park and in the lawsuit brought against NPS related to a human fatality in 2010 from a mountain goat at Olympic National Park. Transparency and ongoing communication will be important aspects of any strategy that involves managing individual animals.

Diagnostic question: What is the relative exposure to management actions vs. visitor behavior?

Management actions intended to change animal behavior often rely on deterrents to induce a flight response. Yet the same animals are often exposed to a high volume of visitors who are prohibited from harassing animals in parks and also may try to get close to them, e.g. for photographs, or to feed them—resulting in neutral or positive outcomes for animals from interacting with people. To be effective, the exposure to negative conditioning from managers must be frequent or intense enough to counteract the neutral stimuli or positive conditioning from accidental or intentional visitor actions. Because NPS staff typically represent only a small percentage of human contacts, attempts at aversive conditioning may simply teach animals to behave differently around NPS staff than visitors. An example of this type of learning took place at Assateague Island National Seashore, where horses learned to avoid the researchers trying to dart them with contraceptives. The researchers had to resort to blinds and disguises. Similarly, when Golden Gate National Recreation Area experimented with aversive conditioning, coyotes learned to avoid NPS trucks and people in NPS uniforms, but their interactions with visitors did not change. Thus, changing animal behavior is complex.

Principle 6: Consider the management context, including the individual animal's history.

An animal's response to people, human food, and infrastructure will vary depending on species, season, landscape, individual animal temperament (e.g., is it a bold or shy individual?), sex (e.g., female with young, and other extenuating circumstances (e.g., was there a recent drought or other extreme weather event resulting in a shortage of natural foods). Similarly, managers must consider the degree and type of human use in the area, as well as the history of the individual animal—what behavior would be expected for its age class and sex? Does it have dependent young and how might that affect its behavior or have repercussions from potential management actions? Does it have a history of interacting with people? Has it been handled before? For these reasons, it will be important to work closely with wildlife biologists, if available, to assess the situation. In addition, the broader management context, including protocols of adjacent management agencies, how local communities view the species, and other socio-cultural factors, will affect which potential management actions are possible. Knowledge of public response to previous management actions, constraints of facilities management (e.g., dumpster design), and other considerations will similarly affect the type of management action that is chosen and indicate the need for interdisciplinary review. A number of parks have successfully implemented an interdisciplinary “wildlife response team” to ensure that the full range of concerns are considered. It is also useful to create a chain of command or phone tree that outlines who to contact in what type of situation.

Clearly, all human-wildlife interactions in the same park or even at the same location within a park would not necessarily warrant the same management response. For example, an individual animal traveling through a campground for the first time but not stopping or actively interacting with people might be ignored, or hazed if possible, while an animal repeatedly entering a campground and seeking food from campers might be more aggressively hazed and possibly removed. Similarly, for situations in which a human injury is sustained or when an animal is perceived as aggressive, managers would need to determine whether the animal was provoked and reacting defensively or whether the animal was acting in an offensive or predatory manner towards people. In other situations, it may be possible to highly control human activity (e.g., at Denali National Park and Preserve where the majority of visitors are in buses, or at Katmai National Park and Preserve where visitors are encouraged to use viewing platforms). In these situations, a broader range of wildlife behavior may be tolerated because there is lower risk to people.

This presents a challenge in creating management plans that provide enough guidance to assist in determining a course of action but do not prescribe specific actions because they may not be appropriate for all possible situations. To help managers consider the range of situations often encountered with species commonly involved in human-wildlife interactions, later sections of this report provide example guidance. Discretion must be used in determining whether and what elements of the guidance are appropriate for use in each specific situation. We also provide resources on the internal websites.

Diagnostic question: Is human safety at risk?

Risks to human safety often are the impetus for considering whether and how to manage animal behavior. A serious human injury or death may require immediate attention, whereas noticing a trend that may eventually increase risks to people could allow more time for monitoring before considering management action, including but not limited to capture or removal. As part of the planning process, parks have found it helpful to develop a step-up process to guide thinking about which situations might indicate which types of management action. In later sections, we have provided this type of matrix for three of the major classes of animals that are often of concern in parks: ungulates, mesocarnivores, and bears. In addition, any animal management must consider safety of the NPS staff involved. NPS RM50B (Section 4.15) provides information on safe work for employees handling wildlife.

Principle 7: Relocation or removal (including lethal removal) may be appropriate in certain cases, but the situation must be evaluated carefully.

Capture and relocation within a park is sometimes used to remove a food-conditioned animal from an area to prevent the behavior from escalating, ideally with preventative measures being addressed at the site before the animal returns. Relocation may be more appropriate for species of conservation concern, where the survival of the individual is critical to the population or cases where the individual is being used to augment a population elsewhere. Relocations can carry risks of transmitting diseases, parasites, and maladaptive genetic and behavioral complexes into recipient populations (i.e., a population-level problem, Craven et al 1998), yet may provide no population-level benefits and often do not even benefit the individual animal being relocated. Relocated animals generally have elevated mortality rates as a result of stress associated with capture/handling,

territorial behavior of conspecifics at release sites, disorientation at release sites and inability to locate food and shelter, unsuitable habitat at release sites, long-distance movements (e.g., homing) that exposes animal to risks like highways, and disease transmission from resident animals (Craven et al. 1998). Thus, relocation of species whose populations are not at risk should generally be avoided.

For an animal that actively seeks out or is aggressive towards people, relocation may only move the problem somewhere else. Recipients of the relocated animals should be made aware of the risks they may be incurring by accepting the animal, since its behavior is not the norm for the species with respect to interactions with people. In addition, relocations would need to be far enough away to prevent the animal from returning to the capture site, which varies by species. For example, bears have regularly been documented moving in excess of 50 miles back to sites where they were captured, in states as varied as Alaska to Florida. In addition, relocated animals sometimes have much lower survival rates due to multiple factors, including the need to establish new territories (interspecific competition), difficulty in finding adequate food resources, and increased mortality from hunting, vehicle strikes, or private landowners as they attempt to return to their home ranges (see Mazur, 2015 for black bears).

Removal to captivity also needs careful evaluation. Accredited zoos and wildlife sanctuaries that can provide adequate level of care have finite space, especially for non-breeding populations of species that are not of conservation concern. For example, facilities accredited by the Association of Zoos and Aquariums (AZA) are already essentially at capacity for black and brown bears and do not hold bears temporarily (AZA Bear Taxon Advisory Group, pers. comm.). Further, moving adult wildlife into captivity may cause excessive distress or injury, either through self-mutilation or difficulty of integration with established groups. Given the space and other constraints, this option should be considered only as a last resort and is likely to be limited to bear cubs whose mothers are candidates for lethal removal.

Lethal removal is often a difficult decision for park managers, yet in some cases may be warranted. For example, once an animal is clearly food conditioned and becoming dangerous to people (e.g., tearing into tents), removing that animal from the population may be warranted. Additionally, if an animal is behaving oddly around humans or if the human-wildlife encounter includes physical contact the animal may need to be removed for disease testing² to protect public health. If an animal must be lethally removed, ideally a euthanasia method (i.e., a pain-free death) should be employed to minimize pain and distress; however, the most humane and appropriate manner to remove an animal will vary based on the situation. In some cases it is more humane to kill a free-ranging animal with a gunshot rather than attempting to capture it to administer euthanasia.

Once the difficult decision to lethally remove an animal has been made, managers will need to be sure to have a communication plan, as there will likely be attention from people both in favor of and against removing the animal. Lethal removal of an adult also may result in orphaned animals. If this

² If there has been physical contact, rabies is the primary disease concern, which can only be tested in dead animals.

is the case, a plan should be in place for any dependent young. The situation also can be used as a “teachable moment” to reduce the need for removal in the future. Sequoia & Kings Canyon National Parks and Katmai National Park and Preserve both offer vivid stories of the series of events that can lead to the end of a bear's life on their websites (see the “Death of #583” at <http://www.nps.gov/seki/planyourvisit/583.htm> and the story of the last bear killed at Brooks Camp at <http://www.nps.gov/katm/blogs/The-Last-Bear-Killed-at-Brooks-Camp.htm>). In both cases, the parks studied the situation to determine how to avoid similar outcomes in the future. Katmai staff implemented measures that have led to a remarkable safety record at Brooks Camp despite increased numbers of visitors and bears. The staff at Sequoia & Kings Canyon implemented a Human-Bear Management Program that uses food storage techniques, education, and aversive conditioning of bears to facilitate safety in areas that humans and bears enjoy (available at http://www.nps.gov/seki/planyourvisit/human_bear_mgt.htm).

Steps 4 & 5: Pilot, Implement & Evaluate

It is important to determine how you will evaluate whether your management actions are successful *before* putting them in place. Typically, this would involve pilot testing management actions at a small scale to ensure desired results before allocating the resources for broad scale implementation. In some situations, it may not be possible to pilot test (e.g., you either implement at an entire campground or not at all). Either way, programs should “begin with the end in mind,” identifying from the outset how success of the program will be evaluated. We have combined the steps of piloting, implementation, and evaluation because they are conceptually linked and rely on the same underlying diagnostic question and principle, namely building the program around evaluation. This approach keeps in the forefront the need to answer questions such as: does your pilot strategy effectively reduce the undesired behavior or the negative interactions resulting from that behavior? If so, when you implement more broadly and continue to evaluate do the chosen management actions remain effective, and for how long?

Diagnostic question: How will success be measured?

Often, people have varying ideas about measures of success. For example, if a visitor was attacked by an animal, one could consider removal of that individual animal successful. This may be appropriate if it was a one-time situation. On the other hand, if an injury investigation revealed an previously unidentified systematic problem, such as lack of wildlife-resistant trash cans or landscape design that resulted in visitor trails with low visibility that cut through prime predator habitat, there may be preventive measures that need to be implemented. Monitoring the type and number of human-wildlife interactions over time is one way to indicate the success of those preventive measures.

Principle 8: Good data helps make good management decisions.

Good record keeping, both to document the logic behind the action taken and to serve as monitoring are critical. Good record keeping can help determine whether the actions taken have affected the source of the problem (i.e., reduced problematic interactions) and can provide a scientific basis for future management decisions.

Periodic data analysis also may help identify research needs to improve management. In addition, research results also can be used for interpretation and education. For example, at Grand Canyon National Park, biologists discovered that deer at Phantom Ranch appeared to be starving but this was because they had eaten food wrappers and other trash that impeded their digestion. Wildlife-resistant trash cans were installed and the trash was used in a display at the visitor center to increase awareness and encourage compliance with proper use of the trash cans.

Part II: Additional guidance for specific groups of animals

While the above framework and principles apply conceptually to all human-wildlife interactions, there are some unique aspects of species biology that must be taken into account in the management response. This section outlines more specific considerations in general and for three groups of animals often involved in human-wildlife interactions in parks.

Proactive Strategies

As described in Part I, proactive strategies aim to prevent the situations that lead to problematic human-wildlife interactions. There are a number of specific activities that could be employed. For example, minimum distances for viewing wildlife could be defined in the park's Superintendent's Compendium and, if necessary, be enforced using verbal warnings followed by citations. At visitor centers, staged landmarks could be used to show visitors how to judge this distance.

Seasonal behaviors of animals lend themselves well to certain proactive strategies. For example, during particular seasons when a species' life history increases potential for aggressive encounters (e.g., establishing territories, breeding, tending to young), wildlife safety messages can be distributed to park visitors, residents, and employees detailing the heightened potential for aggressive animals, how to identify behavioral cues, and the need to keep an appropriate distance from all wildlife at all times. Educational media used could include press releases, Facebook posts, website posts, e-mail posts, posting of warning signs, and increased staff assigned to roving patrols to provide face-to-face verbal messages to visitors. Again, it is important to work closely with communication specialists to design effective messages.

In general, staff and visitors should be made aware that if an animal reacts to their presence (i.e., displays defensive behavior), they are too close. Specific defensive behaviors will vary by species, as will the appropriate response. Park staff could also be trained to recognize potentially problematic wildlife situations and notify appropriate park personnel.

Reactive Strategies

All aggressive interactions between animals and people should be documented to justify reactive management actions that may be taken towards an animal. Five examples of reactive management strategies are included here:

- Increase staff or volunteers assigned to monitor wildlife and implement traffic and crowd control, issuing verbal warnings followed by citations if necessary.
- Train staff on how to recognize potential for negative human-wildlife interactions and assign staff to monitor specific individual aggressive animals, keep visitors at a safe distance from them, and warn visitors of the dangers to themselves or their property.
- Hazing can be effective in certain situations. It can include the use of noise, cracker rounds which are often expensive, paintballs, or other deterrents for short-term behavior modification.
- Aversive conditioning, which is attempting long-term behavior modification.

- Relocation or removal of individuals considered to be a significant threat to human safety. The relocation of these animals is difficult to implement safely for these species and staff, and often not effective.

Considerations for frontcountry vs. backcountry situations

The concepts and principles of managing people, their food and garbage, and wildlife are the same for frontcountry and backcountry areas. However, the ability to implement these strategies is much more difficult in the backcountry due to logistical challenges. There are obvious limitations regarding the type of equipment that can be used (e.g., vehicles, culvert traps, etc.), personnel available, timing of actions, and personnel issues associated with overtime, schedules, and tour of duty can also affect decisions.

The importance of documentation and communication

Thorough, accurate, and timely information is essential regarding management decisions associated with managing animals involved in human-wildlife interactions. One of the biggest challenges is educating park staff about animal behavior and staff roles and responsibilities while working and/or living in the park. To the extent possible, training park staff to recognize and report activity that could escalate to a dangerous situation can improve management decisions.

Adaptive Management

As described in Part I, proactive and reactive management strategies to manage animal behavior will need to be used together in an adaptive management approach, tailored to the specific management context. In addition, management techniques focused on changing or altering human and animal behaviors often will need to be developed simultaneously. For each group of animals, we provide a table that outlines a range of actions to consider in different types of encounters. While this range of actions is relatively straightforward, the decisions associated with choosing among the actions are much more complex. They require an accurate analysis of the overall management context, animal's behavior, and specific situation that led up to the incident. Because each incident has its own unique set of circumstances, it is not possible to develop a rigid management tool that dictates the management action to be taken for different types of human-wildlife interactions. Such an approach could not possibly dictate responses to all possible scenarios, and further, is strongly discouraged as it could result in litigation and affect future wildlife management decisions if not appropriately implemented (Perry and Rusing 2001). Rather, employee discretion will need to be applied in selecting the appropriate course of action from the suite of possible management activities.

Ungulates (e.g., deer, elk, mountain goats)

The number of interactions with ungulates such as bison, moose, elk, bighorn sheep, mountain goats, and deer in developed areas in particular within national parks have increased during the past few decades, presumably due to their (1) attraction to high quality foraging sites (e.g., highly palatable forage areas such as lawns and non-native plant species such as cheat grass along roads or disturbed areas), (2) use of areas where predator densities are reduced or altered due to high human activity, (3) reduced seasonal migration, (4) higher adult and young survival leading to higher growth rates, (5) the neutral influence of humans in the national park setting, allowing ungulates to lose their fear of humans (e.g., no hunting, controlled pets, etc.), (6) food or salt conditioning (e.g., in salt deficient ranges seeking out human derived salts from urine, road salt, or antifreeze), and (7) increased visitation.

Unnatural environments as attractants

Many ungulates may be attracted to unnatural yet high-quality forage provided in developed areas such as lawns, ornamental gardens, agricultural fields, and areas with exotic plant species. Subsequently, these species often are drawn to roadsides, lawns of hotels, restaurants, visitor centers, rest-rooms, administrative buildings, housing, visitor attractions, boardwalk trails, and other areas where preferred forage may be present. This can increase the likelihood of some animals becoming aggressive towards humans and their property, especially during calving (spring) and rutting (fall), resulting in property damage, human injuries, and incidents of animals becoming entangled in anthropogenic items such as swings and hammocks. It is anticipated that as visitation and animal numbers increase, the number and severity of wildlife-human interactions will also increase, triggering more management actions.

Proactive Strategies

Seasonal behaviors of ungulates lend themselves well to certain proactive strategies. For example, each spring and fall, wildlife safety messages can be distributed to park visitors, residents, and employees detailing the heightened potential for danger from aggressive animals during the calving and mating seasons, aggressive behavioral cues, and the need to keep an appropriate distance from all wildlife at all times to keep them wild. Visitors should be instructed to pay attention to behavioral cues while in their vehicles as well, especially during the rut, when large male ungulates, such as bull elk and bison have been known to attack vehicles that try to drive through herds. Educational media should also stress that speed limits be followed and extra caution be used, especially at night, when bison and other large ungulates are difficult to see. Media should stress that visitors be aware of their surroundings because the actions of others could cause ungulates such as bison to react unexpectedly or stampede.

In some parks, bison, moose, and elk in close proximities to roads may need to be monitored to avoid potentially problematic situations. Rutting bulls/rams sometimes mock fight with objects around human developments (e.g., swings, hammocks, fencing, nets, lawn chairs, coaxial cable, etc.). To reduce antler/horn entanglements, staff could be assigned to inspect these areas to reduce the number of objects that ungulates may encounter. To prevent salt conditioning, roadway salting could be

reduced by closing roads, if possible, until hazardous conditions are clear or finding alternative road treatments that do not attract ungulates. Keep in mind, vehicles could still provide a salt source from driving on salted roads outside the park boundaries, which could attract ungulates to the vehicles themselves or to areas where salt drops off vehicles after going over bumps or cattle grates. Ungulates also may be attracted to anti-freeze or other fluids leaking from vehicles in parking lots. Any possibilities to remove those attractants should also be considered. Proactive strategies are often used in front-country developments, roadside habitats, and backcountry habitats.

Reactive Strategies

Reactive strategies may need to be employed when individual animals display aggressive behavior. Examples include, cow elk, bison, and moose charging at visitors from long distances to protect calves in spring and bull elk, bison, or moose charging from long distances and goring vehicles or people in the fall. Reactive strategies in these cases could include reminding visitors to keep their distance, placing warning signs in areas where bulls are actively rutting or cows are raising calves asking people to stay in their vehicles, or closing these areas until the rutting/calving activities have passed. Older bison bulls that are no longer herd bulls are often the most unpredictable and aggressive, and when encountered should be backed away from, slowly.

Yearling bison often run up to humans out of curiosity and can be deterred by waving arms and making loud sounds or throwing rocks. With respect to hazing/aversive conditioning tools, pepper spray does not work well for bison, but frozen paintballs can be successful with persistence.

Staff and visitors should be educated to know how to tell when an ungulate is reacting to their presence (i.e., displaying defensive behavior). For example, bison may paw at the ground, raise their tail to a vertical position, turn to face a threat, lower or swing their head back and forth, urinate and wallow, or bluff charge to assert their dominance. Moose, elk, and deer may lower their head and put their ears back to show agitation. If an ungulate displays any of these behaviors, you are too close and should back away slowly.

Examples of food/salt conditioned behavior includes mountain goats persistently following hikers down the trail and ceasing that action only after the hikers urinate, or goats digging and consuming soils around a campsite, returning to the site immediately after hazing once people are back in the tent. Salt conditioned ungulates may congregate along roadways that are salted in winter and may seek the salt or leaking fluids from parked vehicles and parking lots. Hazing would be a reactive strategy to deter these activities in the short term. Food conditioned ungulates that have received food rewards from humans and from within vehicles may physically enter vehicles seeking a reward. This behavior can be partially resolved if visitors do not allow this activity and keep vehicle windows closed if an ungulate approaches and when the vehicle is not occupied. Bison may be attracted to hay or dung in and around equestrian campsites or demonstration herds of cattle and in these cases some appropriate actions would be to remove the dung to avoid negative interactions between bison, horses and visitors, and manage the availability of hay.

Adaptive Management

Techniques to consider in an adaptive management strategy for ungulates are outlined in Table 4.

Table 4. Management strategies for bison, moose, bighorn sheep, elk, mountain goats, and deer. This table provides an example of the types of management actions that should be considered for various types of interactions between people and ungulates. The appropriate management response will need to be tailored to the specific situation. Ideally, activities directed towards human behavior modification should be informed by NPS/park experience and social scientists/communicators versed in human behavior change theory.

Classification	Actions to Consider Based on Situation	Responsibility ^A
DISTANT SIGHTING <i>Visual observation of ungulate(s) from >25^B yards and mountain goats at >100 yards^B</i>	Provide the public and employees safety information about viewing ungulates	RM, VP, VOL, INT, PIO
	Post "Do Not Approach" warning signs, area warning signs and information about ungulate presence in area	RM, VP, INT, WB, VOL
	Control traffic or human uses in areas such as along roads, or high visitor use areas	RM, VP, VOL
	Recruit volunteers to staff use areas to contact visitors, document incidents, and provide continuity with ongoing problem areas	VOL
	Incorporate messages into interpretive programs and junior ranger programs on problems associated with wildlife feeding	INT
	Prepare press releases and articles as necessary	PIO, RM
	Close sensitive areas (temporarily [specific times of the day] or seasonally) via temporary closures for rutting, calving, or wintering areas as needed	RM, VP, VOL, PM
	Provide information to the public about seasonal closures	PIO, INT, VOL
	Record observations on daily logs and provide to RM when page is full or end of season	ALL
CLOSE SIGHTING <i>Observation of ungulate(s) <25^B yards. Includes unintentional encounters where humans accidentally come into close contact with ungulates.</i> <i>Reports of ungulates not moving off trail as hikers approach until people get within 25 yards</i> <i>Can result in 3 responses from ungulates:</i> 1) flight 2) defensive behavior (e.g., defending young) 3) no reaction (habituation)	<u>In addition to actions listed above, consider:</u>	ALL
	Report sighting to RM or VP personnel and include identifying information about ungulate, if possible, to identify repeat offenders	ALL
	Increase area warning signs and information of ungulate presence in area	RM, VP, INT, VOL
	Educate visitors to be aware of their surroundings in the event they accidentally come into close contact with a male in rut or a female with young, and how to react	RM, VP, INT,
	Investigate the area of interest and determine cause of incident	RM, VP
	Evaluate risk to people, wildlife, and staff. Haze ungulates in area exhibiting habituated behavior. Record hazing actions and ungulate responses.	RM, VP

^A Assignments for actions and responsibilities will be determined by the park. The following are suggestions: RM = Resource Management, including Wildlife Biologist; VP= Visitor Protection (Rangers); INT=Interpretation; MNT=Maintenance; VOL=Volunteers; PIO=Public Information Officer; PM=Park Management; ALL = All employees

^B Previously established acceptable distances between humans and deer vary by NPS unit. NPS units should identify acceptable distances for their respective unit.

Table 4 (continued). Management strategies for bison, moose, bighorn sheep, elk, mountain goats, and deer. This table provides an example of the types of management actions that should be considered for various types of interactions between people and ungulates. The appropriate management response will need to be tailored to the specific situation. Ideally, activities directed towards human behavior modification should be informed by NPS/park experience and social scientists/communicators versed in human behavior change theory.

Classification	Actions to Consider Based on Situation	Responsibility ^A
FOOD/SALT CONDITIONED <i>Ungulate(s) approach humans within 25^B yards seeking food or salt</i> <i>Examples: Mountain goats following people on trail, coming into campsites; not easily chased away; not exhibiting natural behaviors. No aggressive postures in adult males.</i>	<u>In addition to actions listed above, consider:</u>	ALL
	Secure items that may result in bull/ram/buck entanglement (fall season)	RM, VP, MNT, VOL
	Since ungulates (especially mountain goats) can be attracted to salt in human urine, provide advice on urine deposits so as not to attract goats to areas where humans congregate	RM, VP, INT
	Increase staff monitoring of area and/or individual ungulates	RM, VP, VOL
	Enforce separation distances between ungulates and visitors of greater than 25 ^B yards as needed.	RM, VP, VOL
	Uniformed employees responsible for contacting people observed feeding or harassing wildlife. Minimal action will be a verbal warning and educational message. In aggravated cases, law enforcement rangers will issue citations.	RM, VP, INT
	Implement hazing practices as needed	RM, VP, VOL
	Consider marking individuals in order to determine and monitor behavior	RM, VP
	When ungulates are in close proximity seeking salt, educate visitors to stay in groups throw rocks, and make noise to deter them.	INT, RM, VP
	Consider using one or more of the following aversive conditioning techniques depending on situation: 1. pepper spray or mace (except bison) 2. cracker rounds 3. rubber buckshot 4. rubber slugs 5. frozen paintballs 6. slingshot 7. other	RM, VP

^A Assignments for actions and responsibilities will be determined by the park. The following are suggestions: RM = Resource Management, including Wildlife Biologist; VP= Visitor Protection (Rangers); INT=Interpretation; MNT=Maintenance; VOL=Volunteers; PIO=Public Information Officer; PM=Park Management; ALL = All employees

^B Previously established acceptable distances between humans and deer vary by NPS unit. NPS units should identify acceptable distances for their respective unit.

Table 4 (continued). Management strategies for bison, moose, bighorn sheep, elk, mountain goats, and deer. This table provides an example of the types of management actions that should be considered for various types of interactions between people and ungulates. The appropriate management response will need to be tailored to the specific situation. Ideally, activities directed towards human behavior modification should be informed by NPS/park experience and social scientists/communicators versed in human behavior change theory.

Classification	Actions to Consider Based on Situation	Responsibility ^A
OFFENSIVE ENCOUNTER <i>Observation of ungulate behaving outwardly aggressive to humans, pets, or human property such as posturing, charging, kicking, sparring, etc.</i> <i>Aggressive rutting male demonstrating aggressive behavior to stationary objects and possibly causing property damage</i> <i>Ungulate continuously destroying property without provocation.</i> <i>Ungulate has made physical contact with humans that may or may not have resulted in injury or death.</i> <i>Ungulate continuing outward aggression to humans or human property after increased management efforts have been implemented</i> <i>Ungulate attacks human; makes contact or corners people making egress impossible</i>	<u>In addition to actions listed above, consider:</u>	ALL
	Report offensive incidents immediately to RM, or VP.	ALL
	Consider need to escalate management of individual ungulates if behavior continues via hazing or aversive conditioning	RM, PM
	Consider Area closures (when possible) prior to marking, wildlife aversion, or destruction of animals since these activities pose an inherent risk to both park staff and the animals involved	RM, PM
	Consider marking individuals in order to determine and monitor behavior	RM
	Lethal removal of animal(s) and submission for disease testing if management actions do not change behavior	RM, VP
	Patrol closed trail for several days to assess efficacy of aversive conditioning (not in uniform)	RM, VP
	Continue more intensive patrols when trail opened to assess ungulate response to hazing.	RM, VP
	Press release regarding any lethal actions taken	PIO, RM

^A Assignments for actions and responsibilities will be determined by the park. The following are suggestions: RM = Resource Management, including Wildlife Biologist; VP= Visitor Protection (Rangers); INT=Interpretation; MNT=Maintenance; VOL=Volunteers; PIO=Public Information Officer; PM=Park Management; ALL = All employees

^B Previously established acceptable distances between humans and deer vary by NPS unit. NPS units should identify acceptable distances for their respective unit.

Mesocarnivores (e.g., coyotes, raccoons, foxes)

Most interactions between humans and medium-sized carnivores in parks pass without a negative outcome. Animals may pause their activity for a few seconds, at most, before fleeing or continuing their previous activity. They are likely searching for food or cover; they may be moving with their offspring; they may also be dispersing to a new territory. Coyotes, raccoons, skunks, and foxes tend to be species of most concern, most often because of their prevalence around developed areas. Food conditioned raccoons are regularly encountered in NPS campsites in every region in the lower 48 states. While interactions with foxes are less common, they do exhibit food conditioning in some areas, particularly when they develop mange which prevents them from foraging for natural foods. The expansion of coyotes into western, midwestern and eastern urban areas has been a particular area of interest for natural resource agencies and urban governments.

Many of the considerations for sightings are surprisingly similar to those of ungulates. Seasonal aggression is less of a concern with meso-carnivores than ungulates, although there are some seasonal concerns. For example, when coyotes are establishing dens in late winter, or need more food to feed pups in the spring, additional care should be taken to reduce defensive interactions, especially against dogs.

Prevention of food conditioning is especially important for meso-carnivores due to disease concerns. As previously mentioned, mesocarnivores serve as reservoirs for rabies, which can be transmitted to both people and pets. Wildlife displaying abnormal activities, such as acute loss of fear of humans, activity at unusual times of day, or neurological signs warrant management action. Due to concerns over rabies, whenever a wildlife species makes physical contact with a human that results in a bite or scratch, removal of the animal and consultation with public health officials is warranted.

In addition, because they are carnivores, animals that are important to people (e.g., pets, domestic livestock, and poultry) are seen as prey items, leading to the potential for predatory behavior. Predation on people by mesocarnivores would be very rare but could be possible for coyotes. For example, a woman was killed by coyotes in a Canadian National Park in 2009.

Management Strategies

Management strategies for mesocarnivores follow a similar progression as for ungulates, although the specifics of interactions are different. In addition, the category of predatory attacks is added. Table 5 outlines techniques to consider in an adaptive management strategy for mesocarnivores.

Table 5. Management strategies for coyotes, raccoons, skunks, foxes, and other mesocarnivores. This table provides an example of the types of management actions that should be considered for various types of interactions between people and mesocarnivores. The appropriate management response will need to be tailored to the specific situation. Ideally, activities directed towards human behavior modification should be informed by NPS/park experience and social scientists/communicators versed in human behavior change theory.

Classification	Actions to Consider Based on Situation	Responsibility ^A
DISTANT SIGHTING <i>An observation of a mesocarnivore from a distance where the animal is seen moving through an area.</i>	Provide informational material to park staff, visitors, and concessioners.	WB, PIO, VUS
	Ensure attractants in the park are addressed (e.g., unsecured trash).	LE,VUS
CLOSE SIGHTING <i>A direct meeting between a human and a mesocarnivore, resulting in one of three responses: flight, defensive behavior, or no reaction (habituation).</i>	In addition to actions listed above, consider:	ALL
	Increase monitoring in the area.	WB, VUS, LE
	Provide informational material to park staff, visitors, and concessioners.	WB, LE,VUS
	Post areas with precautions, appropriate human encounter behavior, and contact information.	WB, VUS, LE, PIO
	Post areas with precautions, appropriate human encounter behavior, and contact information.	WB, LE
	Coordinate efforts with local and state officials to eliminate or reduce the availability of attractants and the attractiveness of structures or landscaping features to medium-sized non-canid animals.	WB
FOOD CONDITIONED <i>Animals actively seek food in human dominated areas, e.g. raccoons getting into garbage cans, or coyotes approaching people begging for food.</i>	<u>In addition to actions listed above, consider:</u>	ALL
	Increase law enforcement patrols and monitoring in the area.	WB, LE, VUS
	Conduct initial field visit (LE and biologists) immediately after receiving report.	WB, LE
	Inform park visitors and local area of the situation.	WB, LE,PIO
	Post areas with precautions, appropriate human encounter behavior, and contact information.	WB, LE,VUS
	Apply aversive conditioning techniques when appropriate.	WB,LE
	Check all garbage dumpsters and receptacles, food storage bins, and livestock feed areas to ensure they animal-proof and on a regular maintenance schedule.	WB, LE, MGMT. MT, VUS

^A Assignments for actions and responsibilities will be determined by the park. The following are suggestions: LE– Law Enforcement PIO–Public Information Officer WB–Wildlife Biologist VUS-Visitor Use Staff, Maintenance – Maintenance Staff, Mgmt.- Park Management Team

Table 5 (continued). Management strategies for coyotes, raccoons, skunks, foxes, and other mesocarnivores. This table provides an example of the types of management actions that should be considered for various types of interactions between people and mesocarnivores. The appropriate management response will need to be tailored to the specific situation. Ideally, activities directed towards human behavior modification should be informed by NPS/park experience and social scientists/communicators versed in human behavior change theory.

Classification	Actions to Consider Based on Situation	Responsibility ^A
OFFENSIVE ENCOUNTER	In addition to actions listed above, consider:	ALL
<i>Unprovoked behavior directed toward one or more people that requires defensive actions by the person or persons to avoid direct contact. Mesocarnivore likely has been involved (or suspected) in a previous encounter or incident and its behavior continues to be atypical from expected or known behavior.</i> <i>Animal(s) lacks fear, confidently approaches human or pets. May continue with earlier activity (searching for food, etc), but focus is on human.</i> <i>The animal directly approaches a human or human with an attended pet and does not retreat when humans take offensive/aggressive actions (i.e., yelling-loud noises, waving arms, etc.) are directed at animal, or human retreats.</i> <i>Position, behavior, and actions are atypical and threaten the safety of the human(s) then or in future.</i> <i>Fox stays in close proximity (within 50 ft) of humans. It pays close attention to humans and does not engage in typical activity (hunting/foraging, seeking cover, exploring the territory)</i> <i>Coyotes growl or bark at a human or a human with an attended pet and not retreating, or engage in a short charge and retreat sequence Coyote pups may be present.</i> <i>Chasing a human or a human with an attended pet.</i>	Increase law enforcement patrols and monitoring in the area.	WB, LE
	Consider closing the area where the encounter occurred. If dogs are targeted, consider closing the area to dogs, but not all visitors.	WB, LE, VUS
	Conduct initial field visit (LE and biologists) immediately after receiving report.	WB, VUS, LE
	Inform park visitors and local area of the incident.	WB, LE
	Post areas with precautions, appropriate human encounter behavior, and contact information.	LE,VUS,WB
	Find, contain or control animal and remove from area (wild), euthanize if necessary. Save samples for testing. This may be particularly appropriate in those instances when a coyote approaches/chases a human either with or without a pet or when raccoons or skunks display abnormal behavior consistent with disease.	WB, LE
	Offer to meet and discuss the incident with park staff, local and State officials. Seek input and offer recommendations on managing future incidents to the Visitor Use and all park staff. Stress importance of reducing attractants.	WB, LE, MGMT, VUS,PIO,MT
	Implement aversive conditioning in the area to individuals not directly implicated in threatening incident(s).	WB, LE

^A Assignments for actions and responsibilities will be determined by the park. The following are suggestions: LE– Law Enforcement PIO–Public Information Officer WB–Wildlife Biologist VUS-Visitor Use Staff, Maintenance – Maintenance Staff, Mgmt.- Park Management Team

Table 5 (continued). Management strategies for coyotes, raccoons, skunks, foxes, and other mesocarnivores. This table provides an example of the types of management actions that should be considered for various types of interactions between people and mesocarnivores. The appropriate management response will need to be tailored to the specific situation. Ideally, activities directed towards human behavior modification should be informed by NPS/park experience and social scientists/communicators versed in human behavior change theory.

Classification	Actions to Consider Based on Situation	Responsibility ^A
PREDATORY ENCOUNTER ON PETS, DOMESTIC LIVESTOCK AND POULTRY <i>Mesocarnivore closely stalks, attacks, breaks into enclosures, or kills a pet, domestic livestock, or poultry. These situations may not result in removal of the mesocarnivore, if they were displaying normal behavior expected for their species.</i>	<u>In addition to actions listed above, consider:</u>	ALL
	Consider closing the area where the encounter occurred.	WB, LE, VUS
PREDATORY ENCOUNTER ON HUMANS <i>Mesocarnivore closely stalks, attacks or kills a human. This is rare and would likely only be seen with coyotes.</i>	<u>In addition to actions listed above, consider:</u>	ALL
	Conduct initial field visit (LE and biologists) immediately after receiving report.	WB, LE
	Consider immediate, permanent removal of the animal from the wild and submission of the carcass for disease testing, if appropriate.	WB, LE
	Collect visitor contact information for veterinary and/or public health follow up.	WB, LE, VUS
	Increase law enforcement patrols and monitoring in the area, especially for pets off leash.	WB, LE
	Inform park visitors and local area of the incident.	LE, VUS
	Post areas with precautions, appropriate human encounter behavior, and contact information.	WB, VUS, LE
	Examine and consider improvements for design of livestock/poultry enclosures	WB

^A Assignments for actions and responsibilities will be determined by the park. The following are suggestions: LE– Law Enforcement PIO–Public Information Officer WB–Wildlife Biologist VUS-Visitor Use Staff, Maintenance – Maintenance Staff, Mgmt.- Park Management Team

Bears (black, and brown/grizzly)

Bears are an important component of the ecosystem in many National Parks, and potentially dangerous interactions between people and bears have existed throughout the history of the National Park Service (see Mazur, 2015 for a history of bear management in NPS). Minimizing these interactions requires managing both people and bears. Managing people typically involves education of visitors and park staff about bear ecology and behavior; managing visitor use including their food and garbage; and enforcing regulations associated with food storage, and feeding and approaching wildlife. Bears are intelligent, capable of quickly learning, have a strong sense of smell, are omnivorous and will eat a wide variety of foods, and are curious by nature. Some bears are attracted to developed visitor use areas and therefore must be managed individually. The tools used by bear managers range from monitoring to lethal removal, depending on the type of behavior displayed. Thorough, accurate and timely reporting is crucial to responding to human-bear interactions effectively. Employee discretion is also extremely important as wildlife managers have to recognize, understand, and interpret bear behavior and environmental factors, determine levels of risk, and then initiate the proper response.

Understanding bear behavior

The terminology used in this report (wild, habituated, food conditioned, offensive, defensive, and predatory) were adapted from those used to describe bears (Get Bear Smart Society 2007, Hopkins et. al. 2010). In this section, we describe specific behavioral expressions that can help NPS staff recognize each of those categories. For each category, we also seek to identify situations that indicate some form of management is needed, which may range from information or closures, to more extreme measures.

Wild – From a management perspective, the most desirable bear behavior would be one that is afraid of people, and is often referred to as “wild” behavior. Bears that exhibit “wild” behavioral characteristics avoid people and developed areas, and therefore are generally not involved in interactions with people.

Habituation – As described above, habituation is defined as the waning of an animal’s flight response following repeated exposure to inconsequential stimuli (Jope 1985, Whitaker and Knight 1998, Herrero et al. 2005). Glacier National Park Bear Management Guidelines (NPS, 2010) includes more concrete examples and describes habituation as referring “... to a continuum of bear behaviors including one or more of the following circumstances: is tolerant of human presence, has become accustomed to frequenting developed areas, backcountry campgrounds, trails or roadsides, but has retained its natural foraging behavior...habituated bears do not repeatedly and closely approach humans or investigate and physically manipulate human property in the presence of humans.”

Habituation can provide benefits to both bears and people, which are described in detail in Herrero et al. (2005). Individual park units must decide when, where, and under what conditions habituation may be tolerated, but management should always be taken in areas where human-food cannot be secured. For example, the presence of habituated grizzly bears along roadways in Yellowstone and Grand Teton National Parks may be accepted because the situations are highly monitored by park

staff and there is little risk of bears obtaining human food. In contrast, the presence of habituated black bears in the meadows immediately adjacent to campgrounds in Sequoia Kings Canyon is less tolerated because the probability of these bears investigating abundant (and easily available) nearby human food resources is high.

Food Conditioning – Glacier National Park Bear Management Guidelines (NPS, 2010) describes conditioning in bears as “...any one or more of the following: has sought and obtained non-natural foods, destroyed property, torn into tents or backpacks, displayed aggressive (non-defensive) behavior toward humans. Bears which repeatedly and closely approach people or repeatedly touch tents, backpacks or food storage containers in campsites where people are present, may be considered conditioned.” Food conditioned bears may still be wary of people, entering developed areas at night to obtain human food, but often become active during the day and aggressive towards people. As previously described, food conditioned behavior should not be *promoted* in National Parks, with efforts made towards prevention and management of food-conditioned animals as necessary.

Defensive behavior – Defensive behavior occurs when bears are defending themselves, their cubs, or a food source from a perceived threat (e.g., a surprise encounter or humans approaching too closely). Defensive behavior may appear essentially the same as offensive behavior (e.g., bluff-charging, jaw or lip-popping, etc.), yet defensive bears have been provoked and are reacting. For example, these behaviors may be warning signals that people are too close. Thus, depending on the circumstance, defensive behaviors may be considered “natural” and “wild” and not warrant management of that individual. For example, consider the situation of a park visitor who disregards all park-specific bear safety regulations, approaches a bear for a better photo, and the bear charges and/or makes contact with the person resulting in human injury. In this situation the bear was provoked, and likely gave subtle warnings that the person was getting too close prior to displaying defensive behavior. This situation would not indicate the bear was acting differently than would be expected for its species.

Offensive behavior – Offensive behavior occurs in an unprovoked situation, where bears initiate the interaction and may threaten people through "direct approaches to humans, bluff-charging, jaw or lip-popping, front leg stomping, loud vocalizations, circling, intense staring, [and] salivating" (Hopkins et al. 2010). Bears behaving offensively may do so in order to assert dominance over people in perceived "disputes" over space or food-resources. If rewarded, or if no action is taken, the behavior may escalate and eventually these bears may tear into tents, cars or buildings, or they may injure people. Bears that exhibit this type of behavior are likely to repeat it and/or are more likely to be involved in human injuries or attacks (Stephen Herrero, pers. comm.).

Predatory behavior – Predatory behavior generally involves a bear that is looking at a human as potential prey: "searching, following or testing, attacking (capturing), killing, dragging a person, burying, and feeding upon a person" (Herrero and Higgins 2003:46, cited in Hopkins et al. 2010). Predatory bears are usually silent—they rarely vocalize or pop their jaws – and pursue humans with deliberation. Attacks resulting in physical contact with people are rare, but searching, following and testing probably occurs more often than we know.

Additional Considerations

In addition to the general considerations for management in frontcountry verses backcountry situations, the behavior of individual bears may be different in these two contexts. For example, a bear may be more likely to investigate a small backcountry campsite with a few visitors rather than a busy frontcountry campsite because the initial risk to the animal is much lower. However, because of the logistical challenges mentioned above, few actions may be taken to mitigate offensive but non-predatory behavior in the backcountry, especially if the risk to human life is not imminent. Bears that enter frontcountry campsites to obtain human food may be hazed, captured and marked, etc. while bears that enter backcountry campsites may not experience any direct action—the situation may be mitigated solely by managing people (e.g., campsite closures).

As mentioned earlier, one of the most important roles for bear managers is educating park staff about bear behavior, especially how to recognize behavior that should be reported. Significant bear behavior that would warrant a report and possible management response includes: (1) any bear lingering in or near a developed area (day or night) such as a campground, picnic area, backcountry campsite, parking lot, etc., (2) bears that injure or follow people, (3) sick or injured bears, (4) any bear that causes property damage, (5) any bear that receives a food reward, or (6) any other type of unusual bear observation, behavior or encounter.

The ability to recognize, understand and interpret bear behavior requires a tremendous amount of training and most visitors and park staff are generally not qualified. Therefore, information collected about a bear incident should be factual which will enable park biologists and/or bear management specialists to determine the type of bear behavior that was displayed.

Management Strategies

Options for managing bears in a National Park are relatively straightforward; however, the decisions associated with these options are much more complex and require employee discretion. When making decisions about the appropriate action to take in response to a bear incident, there are many factors to consider beyond the behavior displayed by a bear. Just a few examples include the bear's sex and age class, its behavioral history during previous encounters with people, the behavior of the people involved, the location where the incident occurred, the time of year, and the resources available to the NPS for responding. There may be many additional mitigating or aggravating factors as well. Table 6 outlines techniques to consider in an adaptive management strategy for bears.

Table 6. Management strategies for black and brown/grizzly bears. This table provides an example of the types of management actions that should be considered for various types of interactions between people and bears. The appropriate management response will need to be tailored to the specific situation. Ideally, activities directed towards human behavior modification should be informed by NPS/park experience and social scientists/communicators versed in human behavior change theory.

Classification	Actions to Consider Based on Situation	Responsibility ^A
DISTANT SIGHTING <i>Visual observation of a bear >50 yards or >100 yards (50 yards is the threshold of tolerance used by some parks for black bears and 100 yards for grizzly bears, based on viewing distances outlined in the Superintendent's Compendium).</i> <i>Example: A black bear feeding on blueberries in a meadow about 60 yards from a road.</i>	Monitor.	WB, LE
CLOSE SIGHTING WITH FLIGHT RESPONSE Observation of a bear at a close distance (<50 yards for a black bear and <100 yards for a grizzly bear) that resulted in flight response. Example: A park visitor encounters a bear as they walk around a blind curve on the trail. The bear immediately runs away from the visitor into the brush.	Monitor.	WB, LE
CLOSE SIGHTING WITH DEFENSIVE BEHAVIOR <i>Observation of bear at a close distance (<50 yards for a black bear and <100 yards for a grizzly bear) that resulted in a defensive reaction.</i> <i>Example: A park visitor approaches a female bear with cubs, and the bear lays her ears back, pops her jaws, huffs and the quickly charges but stops very close to the visitor.</i>	Monitor. If recurring, control traffic or human uses in areas such as along roads, or high visitor use areas. If recurring and close to a developed area, consider hazing the animal away from the area, patrolling the area to check on food and garbage storage, and increasing messaging about how to store food in bear country	WB, LE, VUS
CLOSE SIGHTING WITH HABITUATION <i>Observation of bear at a close distance (<50 yards for a black bear and <100 yards for a grizzly bear) that resulted in no reaction (habituation).</i> <i>Example: A bear feeding on blueberries about 30 yard from the road does not show any apparent fear of people nor does it approach people.</i>	<u>If recurring, in addition to actions listed above, consider:</u> Mark the bear (e.g., via paint ball, ear tags, radio collars) determine involvement in future interactions and target management actions Area closure with buffer around area where interaction occurred (e.g., 100 meter area closure)	WB, LE, VUS, PIO, Mgmt, Main

^A Assignments for actions and responsibilities will be determined by the park. The following are suggestions: LE– Law Enforcement PIO–Public Information Officer WB–Wildlife Biologist VUS-Visitor Use Staff, Main – Maintenance Staff, Mgmt.- Park Management Team

Table 6 (continued). Management strategies for black and brown/grizzly bears. This table provides an example of the types of management actions that should be considered for various types of interactions between people and bears. The appropriate management response will need to be tailored to the specific situation. Ideally, activities directed towards human behavior modification should be informed by NPS/park experience and social scientists/communicators versed in human behavior change theory.

Classification	Actions to Consider Based on Situation	Responsibility ^A
FOOD CONDITIONED <i>Bear enters a developed area or approaches humans seeking food.</i> <i>Example: A bear walks into a campground and investigates fire rings, picnic tables, food storage lockers, etc.</i>	<u>In addition to actions listed above, consider:</u> Higher level warning signs in campgrounds or other front-country areas, or distributed with permits and posted at trailheads in the backcountry Area closure (may be logistically easier in the backcountry) Implement hazing practices as needed Capture/release on site (night active bears). Relocation Lethal removal	WB, LE, VUS, PIO, Mgmt, Main
OFFENSIVE ENCOUNTER <i>A bear scratches or bites a human, or rips into a tent, car or building while attempting to get human food or garbage.</i> <i>Example: A bear breaks into a car during the night and pulls out a cooler.</i>	<u>In addition to actions listed above, consider:</u> Area closures (when possible). Capture and euthanize the bear, collect biological samples for DNA analysis to confirm the animal's identity	WB, LE, VUS PIO, Mgmt, Main
PREDATORY ENCOUNTER <i>Bear closely stalks, attacks or kills a human.</i> <i>Example: A bear rips through a tent during the night and attempts to drag a person from their campsite.</i>	<u>In addition to actions listed above, consider:</u> Immediate area closures	WB, LE, VUS, PIO, Mgmt, Main

^A Assignments for actions and responsibilities will be determined by the park. The following are suggestions: LE– Law Enforcement PIO–Public Information Officer WB–Wildlife Biologist VUS-Visitor Use Staff, Main – Maintenance Staff, Mgmt.- Park Management Team

Conclusion

Following the framework outlined above and referring to the tables of suggested management actions can help NPS managers consider the range of challenges associated with managing “problem” or “nuisance” animals in parks and develop strategies most appropriate for their unique management situations. Considering the diagnostic questions, principles, and strategies before potentially dangerous human-wildlife interactions occur can help managers by outlining potential plans of actions with contingencies for risk management. In addition, it improves transparency and facilitates communication with the public by demonstrating the logic behind management actions.

In the process of developing the framework and strategies, we identified a number of additional insights. First, the need for management action may not be noticed until “problem” or “nuisance” animals are reported. At that point, managers must move into a reactive mode, which has fewer options for changing the animal’s behavior and is more difficult from a communication and public relations standpoint. Therefore, Principles 2 and 3 (“Be proactive; don’t wait until an animal is conditioned to take action,” and “Consider any parallel actions that must be taken to manage human behavior at the root of the problem”) is highly recommended, even when there is not yet a need to address specific individual animals. This is why we retained suggestions for managing human behavior in Part II, even though we did not provide guidance on those topics.

In addition, while requests for assistance usually are related to how to manage animals, most of the management options that were identified related to managing people, either proactively or as a necessary component of a reactive strategy. Effectively managing and changing human behavior can be challenging; while human behavior is a necessary component of wildlife management, managing human behavior is often outside of a wildlife biologist’s skillset. Interpreters are trained to provide interpretive opportunities that help the public understand natural resources in parks and make their own meanings about them, which is not the same as designing programs to encourage pro-environmental behaviors. Individual parks have worked with universities and practitioners to design “objectives-based programs” that measure changes in human behavior as an outcome, but this approach is not yet widespread. To address this need, the Biological Resources Division Human Dimensions Program and Office of Education and Outreach in NRSS are beginning to examine approaches and resources to help manage the human behavior side of human-wildlife interactions.

The concepts, framework, and suggested strategies outlined in this paper were an important first step to help managers assess situations that may require managing individual animals. To comprehensively address potentially dangerous human-wildlife interactions in parks, these approaches will need to be integrated with proactive efforts to explicitly manage human behavior.

Literature Cited

- Baruch-Mordo, Sharon, Kenneth R. Wilson, David L. Lewis, John Broderick, Julie S. Mao, and Stewart W. Breck. 2014. Stochasticity in natural forage production affects use of urban areas by black bears: Implications to management of human-bear conflicts. *PLoS One* 9(1):e85122. doi:10.1371/journal.pone.0085122.
- Bath, A. J., and J. W. Enck. 2003. Wildlife-human interactions in National Parks in Canada and the USA. *Social Science Research Review* 4 (1):1-32.
- Beckmann, J.P., and J. Berger. 2003. Rapid ecological and behavioural changes in carnivores: the responses of black bears (*Ursus americanus*) to altered food. *Journal of Zoology* 261: 207-212.
- Bernstein, D. A., Penner, L. A., Clarke-Stewart, A., & Roy, E. J. 2006. *Psychology (7th ed.)*. Boston, MA: Houghton Mifflin Company.
- Ciuti S., J. M. Northrup, T. B. Muhly, S. Simi S, M. Musiani, J. A. Pitt, and M.S. Boyce. 2012 Effects of humans on behaviour of wildlife exceed those of natural predators in a landscape of fear. *PLoS ONE* 7(11): e50611. doi:10.1371/journal.pone.0050611
- Conover, M. R. 2002. *Resolving Human-Wildlife Conflicts: The Science of Wildlife Damage Management*. Boca Raton, FL: Lewis Publishers.
- Cornell, D., and J.E. Cornely. 1979. Aversive conditioning of campground coyotes in Joshua Tree National Monument. *Wildlife Society Bulletin* 7: 129-131.
- Craven, S., T. Barnes, and G. Kania. 1998. Toward as professional position on the translocation of problem wildlife. *The Wildlife Society Bulletin* 26: 171-177.
- Ditmer, Mark A., John B. Vincent, Leland K. Werden, Jessie C. Tanner, Timothy G. 2015. Bears show a physiological but limited behavioral response to unmanned aerial vehicles. *Current Biology* 25(17): 2278-2283.
- Garcia, John, Walter G. Hankins, and Kenneth W. Rusiniak. 1974. "Behavioral Regulation of the Milieu Interne in Man and Rat." *Science* 185(4154): 824-831.
- Gabriel, Pia O. and Richard T. Golightly. 2011. Experimental Assessment of Taste Aversion Conditioning on Steller's Jays to Provide Potential Short-term Improvement of Nest Survival of Marbled Murrelets in Northern California. Arcata, CA; Humboldt State University.
- Get Bear Smart Society. 2007. Responding to human-black bear conflicts: a guide to non-lethal bear management techniques. 90pp.
- Herrero, S., and A. Higgins. 2003. Human injuries inflicted by bears in Alberta 1960-1998. *Ursus* 14:44-54.

- Herrero, S., Smith, T., DeBruyn, T. D., Gunther, K., & Matt, C. A. (2005). From the field: Brown bear habituation to people — Safety, risks, and benefits. *Wildlife Society Bulletin* 33(1), 362–373. Available at: <http://www.jstor.org/stable/pdfplus/3784879.pdf>.
- Hopkins et al. 2010. A proposed lexicon of terms and concepts of human-bear management in North America. *Ursus* 21:154-168.
- Hungerford, H. R., and T. L. Volk. 1990. Changing learner behavior through environmental education. *Journal of Environmental Education* 21:8-21.
- Jacobson, S. K. 1999. *Communication Skills for Conservation Professionals*. Island Press, Washington, D.C.
- John B. Hopkins III, Stephen Herrero, Richard T. Shideler, Kerry A. Gunther, Charles C. Schwartz, and Steven T. Kalinowski 2010. A proposed lexicon of terms and concepts for human-bear management in North America. *Ursus* 21(2):154–168. Available at: http://www.nrmssc.usgs.gov/files/norock/products/Ursus_112010.pdf.
- Johnson, H. E., S. W. Breck, S. Baruch-Mordo, D. L. Lewis, C. W. Lackey, K. R. Wilson, J. Broderick, J. S. Mao, J. P. Beckmann. 2015. Shifting perceptions of risk and reward; Dynamic selection for human development by black bears in the western United States. *Biological Conservation* 187: 164-172.
- Joep, K. L. 1985. Implications of grizzly bear habituation to hikers. *Wildlife Society Bulletin* 13:32-37.
- Kellert, Stephen R. 1997. *The Value of Life: Biological Diversity and Human Society*. Washington, DC: Island Press.
- Kloppers, E. L., C. C. St. Clair, and T. E. Hurd. 2005. Predator-resembling aversive conditioning for managing habituated wildlife. *Ecology and Society* 10(1): 31. Available at: <http://www.ecologyandsociety.org/vol10/iss1/art31/>.
- Mazur, R. 2010. Does Aversive conditioning reduce human-black bear conflict? *Journal of Wildlife Management* 74(1):48-54.
- Mazur, R. 2015. *Speaking of Bears: The Bear Crisis and a Tale of Rewilding from Yosemite, Sequoia, and Other National Parks*. Guilford, CT: FalconGuides.
- McCullough, D. R. 1982. Behavior, bears, and humans. *Wildlife Society Bulletin* 10(1):27-33.
- National Park Service. 2002. Director's Guidance Memo, National Park Service response to chronic wasting disease of deer and elk, July 26, 2002.
- Newhouse, N. 1990. Implications of attitude and behavior research for environmental conservation. *Journal of Environmental Education* 22:26-32.

- National Park Service. 2006. Management Policies 2006. Washington, DC: National Park Service.
- National Park Service. 2008. Reference Manual 50B: National Park Service Occupational Safety and Health Program. Washington, DC: National Park Service.
- National Park Service. 2010. Bear management guidelines: Glacier National Park.
- National Park Service. 2010. Director's Order #50 C: Public Risk Management Program.
- Perry, G. L., and M. J. Rusing. 2001. The changing dynamics of bear management: Arizona's experience with litigation from a black bear mauling. Western Black Bear Workshop 7:1-8
- Réale, Denis, Simon M. Reader, Daniel Sol, Peter T. McDougall, and Niels J. Dingemanse. 2007. Integrating Animal Temperament within Ecology and Evolution. *Biological Reviews of the Cambridge Philosophical Society* 82(2): 291-318.
- Shannon, G., L. S. Cordes, A. R. Hardy, L. M. Angeloni, K. R. Crooks. 2014. Behavioral responses associated with a human-mediated predator shield. *PLoS One* 9(4): e94630. doi:10.1371/journal.pone.0094630
- Steen, J. B., G. W. Gabrielsen, and J.W. Kanwisher. 1988. Physiological aspects of freezing behavior in willow ptarmigan hens. *Acta Physiol Scand* 134: 299-304.
- Strasser, Erin H., and Julie A. Heath. 2013. Reproductive Failure of a Human-Tolerant Species, the American Kestrel, is Associated with Stress and Human Disturbance. *Journal of Applied Ecology* 50(4): 912-919. Available at: http://works.bepress.com/julie_heath/26.
- Whittaker, D. and R. L. Knight. 1998. Understanding wildlife responses to humans. *Wildlife Society Bulletin* 26(2):312-317.
- Widner, C. J. and J. R. Roggenbuck. 2000. Reducing theft of petrified wood at Petrified Forest National Park. *Journal of Interpretation Research* 5(1):1-18.
- Wild, M. A. 2002. Use of telemetered heart rate as an indicator of acute stress in bighorn sheep (*Ovis Canadensis*) ewes. Ph.D. dissertation Colorado State University, 95pp.
- Wright, R. G. 1998. A review of the relationships between visitors and ungulates in National Parks. *Wildlife Society Bulletin* 26: 471-476.

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NPS 999/133917, August 2016

National Park Service
U.S. Department of the Interior



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1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

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