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Human-Wildlife Interactions in Bryce Canyon National Park

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HUMAN-WILDLIFE INTERACTIONS IN BRYCE CANYON NATIONAL PARK

by

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ABSTRACT

Human-wildlife Interactions in Bryce Canyon National Park

by

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This study investigated human-wildlife interactions in Bryce Canyon National Park (BRCA), Utah to better understand factors that lead to human-wildlife conflicts and how the attitudes and perceptions of visitors can affect their interactions with wildlife. Human-wildlife interactions were observed in high visitor use areas of BRCA from May to August of 2014. Interaction were scored based on a protocol developed from a pilot study in 2013 to determine if the interactions followed current National Park Service (NPS) guidelines. A generalized linear models approach was used to determine which variable(s) had a significant effect on the probability of a conflict occurring. The strongest model showed location and species to be significant. Specifically, golden-mantled ground squirrels (*Callospermophilus lateralis*; GMGS) were significantly more likely to be involved in a conflict (negative interaction) than any other species and interactions taking place at the Inspiration Point location were significantly less likely to result in a conflict than any other location. Results suggested that while both species and location were significant factors, this is mainly a species driven system.

To investigate the motivations behind human-wildlife interactions, a visitor questionnaire was administered with ten questions regarding demographics, experiences, planning, and human-wildlife interactions from May to August of 2015. In total, 224 questionnaires were completed with slightly more than half of responses coming from U.S. residents and the remainder from fourteen different foreign countries. A question asking respondents to select from a matrix consisting of potential reactions to encountering different wildlife species was used as the response variable.

Findings revealed significant differences between both motivations and understanding of appropriate interactions with wildlife. Visitors who selected that they would enjoy seeing certain species were generally more likely to select inappropriate interactions for those than other species. Finally, visitors who identified seeing and photographing wildlife as important motivations for their visit also selected a higher number of inappropriate responses to questions regarding encounters with wildlife. Combining the interactions I observed with the results about visitors' motivations, this study provides new insight into understanding the causes of human-wildlife conflicts in BRCA and suggestions for efficient strategies to help mitigate the problem.

(91 pages)

PUBLIC ABSTRACT

Human-wildlife Interactions in Bryce Canyon National Park

Chad H. Wildermuth

Public lands such as National Parks protect some of America's most spectacular and iconic natural, cultural, and historic landscapes. These lands are managed with a goal of preserving their unique features for the recreational use of the public. Therefore, it is important to understand the effects, if any, that public visitation has on these natural systems. This study investigated human-wildlife interactions in Bryce Canyon National Park (BRCA), Utah in order to better understand factors that lead to human-wildlife conflicts and how the attitudes and perceptions of visitors affect their actions towards wildlife.

Observations of human-wildlife interactions were observed and measured against current National Park Service (NPS) guidelines. Factors including location, time, wildlife species, outcome, and number of visitors involved were recorded. Analyses were conducted to determine which factors influenced the probability of a human-wildlife conflict occurring. Results showed that golden-mantled ground squirrels (GMGS) were significantly more likely to be involved in a conflict than any other species and interactions taking place at the Inspiration Point location were significantly less likely to result in a conflict than any other location. Ultimately, the data suggest that while both location and species are important factors, this is a species driven system where the specific species involved in a human-wildlife interaction has the most significant effect on whether the encounter results in a conflict.

To better understand the motivations behind human-wildlife interactions, a visitor questionnaire was administered with ten questions regarding demographics, experiences, planning, and human-wildlife interactions from May to August of 2015 in popular stops within the park. In total, 224 questionnaires were completed with slightly more than half of responses coming from U.S. residents and the remainder from fourteen different foreign countries. A question asking respondents to select from a matrix consisting of potential reactions to encountering different wildlife species was used as the response variable.

Findings from our analysis revealed that international visitors were significantly more likely than U.S. visitors to select inappropriate responses regarding interactions with wildlife. Visitors who selected that they would enjoy seeing a certain species were generally more likely to select inappropriate interactions for those than other species. Also, international visitors ranked photographing wildlife as more important than U.S. visitors while U.S. visitors ranked learning about the history of BRCA and learning about nature as more important than international visitors. Finally, visitors who identified seeing and photographing wildlife as important motivations for their visit also selected a higher number of inappropriate responses to questions regarding encounters with wildlife. Combining the interactions, I observed with the results about visitors' motivations, this study provides new insight into understanding the causes of human-wildlife conflicts in BRCA and suggestions for efficient strategies to help mitigate the problem.

“Whatever in creation exists without my knowledge exists without my consent.”

- Cormac MacCarthy

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CHAPTER 1

A REVIEW OF THE LITERATURE REGARDING HUMAN-WILDLIFE INTERACTIONS ON PUBLIC LANDS

Bryce Canyon National Park (BRCA) is famous not only for its scenic vistas and colorful rock formations but also as an excellent place to view, and sometimes interact with, wildlife. While the National Park Service (NPS) aims to protect natural resources and to allow opportunities for visitors to view and enjoy wildlife, there are a number of potential negative consequences of these wildlife interactions for both the visitors and the wildlife involved (Orams 2002). From 2006 to 2014, BRCA recorded a rise in yearly visitation numbers from 890,676 to 1,435,741, an increase of over 5.5% annually (irma.nps.gov/Stats). Evidence suggests that this increase will continue. A 2009 survey found that 40% of BRCA visitors are international, and this proportion is increasing (Holmes et al. 2010). In areas of especially high visitation, there has been an increase in the number of human-wildlife interactions resulting in unacceptable levels of wildlife feeding, wildlife attacks including bites, and the potential for interspecific disease transmission (S. Haas, National Park Service, personal communication). The most prevalent wildlife species involved in human-wildlife interactions at BRCA are golden-mantled ground squirrels (*Callospermophilus lateralis*), least chipmunks (*Tamias minimus*), Uinta chipmunks (*Tamias umbrinus*), Steller's jays (*Cyanocitta stelleri*), Clark's nutcrackers (*Nucifraga Columbiana*), and common ravens (*Corvus corax*).

Bryce Canyon National Park has an interpretive series that includes educational programs and signs to encourage positive human-wildlife interactions and reduce harmful

interactions. However, potentially negative interactions continue to occur. Unknown are the frequency with which interactions take place and the proportion of interactions that do not align with NPS regulations. It is also important to understand the attitudes and perceptions of visitors regarding appropriate interactions with wildlife to better inform and educate visitors. Without this knowledge, it is difficult to gauge which management actions will work best to educate and motivate visitors to be conscious of their effect on wildlife and comply with regulations regarding interactions.

Recreational Effects on Wildlife

National parks are an iconic American ideal, designating protection for areas of natural, cultural, or historical significance. These unique sites are set aside for the use and enjoyment of the general public and therefore inherently managed for both the protection of resources and to provide recreational opportunities for visitors (National Park Service Organic Act 1916). While these two goals are not necessarily mutually exclusive, they can often present a conflict to public land managers (Winks 1996, Cheever 1997). As outdoor recreation continues to increase (Cole 1996), new monitoring processes and management techniques will need to be employed to maintain the health of wildland ecosystems while at the same time providing appropriate outdoor recreation opportunities.

The idea of a recreational carrying capacity was first explored in E.L. Sumner's "The Biology of Wilderness Protection" (1942). Sumner recognized that over-abundant livestock grazing in areas of Yosemite and Kings Canyon National Parks was having a negative ecological impact on the local environment. Based on his findings, Sumner

recommended a limit be placed on the number of visitors allowed to access certain areas by livestock each day to reduce the ecological impact. The strategy of limiting access has been heavily used as one of the most popular management strategies for dealing with recreational overuse which results in ecological degradation. However, further research has suggested that simply limiting the amount of use may not be the most appropriate or effective recreation management action to use for ecological protection (Wagar 1964, Manning 2010). Other actions such as targeted interpretive information, signage, or increased staff presence may also be effective ways to reduce ecological impacts of recreation.

One particular impact of wildland recreation use is the effect on wildlife populations. Visitors' actions not only alter the natural habitat of wildlife but also influence their behavior in a number of different ways over a large spatial and temporal scale. While the lack of research has prevented a better understanding of exactly how recreation use relates to many species (Hammitt and Cole 1998), there are several well-defined effects of human recreation use on wildlife species. Three broad categories of wildlife response to humans are attraction, avoidance, and habituation (Whittaker and Knight 1998). Attraction refers to wildlife that respond positively or move towards a human stimuli, usually due to a rewarding previous experience. Attraction does not necessarily indicate a loss of fear, only a perception on the part of the animal that benefits will outweigh risk. When wildlife modify their behavior on any temporal or spatial scale to avoid encounters with humans, they are utilizing an avoidance behavior. Finally, habituation is the loss of fear of humans and usually occurs as a result of multiple stimuli encounters that do not lead to any negative outcomes (Whittaker and Knight 1998). For

example, many large ungulates in heavily visited areas of national parks no longer flee from vehicles or humans on foot due to the loss of a perceived threat from humans.

Six factors of recreational disturbance to wildlife have been defined: type of activity, recreationist behavior, predictability, frequency and magnitude, timing, and location (Knight and Cole 1995). Each of these factors, as well as the characteristics of different wildlife species, may affect the ultimate outcome of any human-wildlife encounter and resulting behavioral reactions. Animals with very specific habitat and/or food requirements show less tolerance for disturbance and are often more heavily affected by recreation use (Hammitt and Cole 1998). Taylor and Knight (2003) found a strong negative relationship between body size of study species and response to recreation use. In their study of ungulate responses to hikers and mountain bikers on Antelope Island, Utah they found that pronghorn antelope alerted to and fled from recreationists at a significantly further distance than bison. These findings demonstrate how the diverse factors of visitor recreation use affect wildlife and influence the final outcome of an encounter.

One of the resulting effects of increased recreational use of wildlands is an increase in human-wildlife conflicts. A human-wildlife conflict occurs in situations where a disturbance has become chronic and humans, wildlife, or both are being negatively impacted. A disturbance could be deer fleeing from a lone hiker while a conflict could be a landowner building a house in wintering habitat for deer and the deer adapting to eat ornamental or garden plants during cold months. The majority of human-wildlife conflict studies have focused on large mammals, especially carnivores, however small mammals account for the largest number of human-wildlife conflicts recorded in

the United States annually (Conover 2001). While research has shown that social factors play a large role in driving human-wildlife conflicts the relationship has not been adequately studied to date (Dickman 2010).

Conflicts associated with small mammals do not have the same potential to result in immediate serious injury or human deaths as conflicts with large mammals but they can result in minor injuries, infections, and interspecific disease transmission. Historically there has not been wide-spread, organized NPS policies for handling zoonotic diseases (Aguirre et al. 1995). However, recent outbreaks of plague and Hantavirus in Grand Canyon National Park and Yosemite National Park, respectively, have drawn national attention to the potential threat of human interactions with disease infected small mammals and forced NPS managers to develop new practices for dealing with this threat (Daszak et al. 2000).

Habituation in Wildlife Populations

In easily accessible natural areas with high visitation, the potential for habituation of wildlife increases especially if there is an expected benefit such as anthropogenic food sources (Whittaker and Knight 1998). In front country settings (areas with the highest visitation), direct management in national and state parks is often used to regulate visitor behavior through signage or enforcement (Manning 2013) but limited resources make it difficult to effectively control issues such as wildlife feeding. Some studies have shown that fear provoking messages (i.e. the personal dangers of interacting with wildlife) are more effective than moral messages (i.e. long term harm of feeding on wildlife) but

factors such as species and location can influence effectiveness (Schwarzkopf 1984, Hockett and Hall 2007).

In a survey of 640 backcountry visitors to Antelope Island recreation area, Taylor and Knight (2003) found that visitors to wildland recreation areas have been shown to underestimate the effect their use has on wildlife. Previous research has also shown differences in attitudes and perceptions of wildlife along different demographic spectrums including age and gender (Kellert and Westervelt 1984, Kellert and Berry 1987). These attitudes and perceptions of visitors towards wildlife and appropriate interactions with wildlife represent an important aspect of wildland recreation management that has not yet been sufficiently researched to properly inform management decisions regarding the effect of recreation on wildlife.

Human-Wildlife Interactions in Bryce Canyon National Park

Bryce Canyon National Park continues to see an increase in visitation with the vast majority of visitors spending time at a small number of sites within the park. For example, a 2009 survey showed that 2 areas, Sunset Point and Sunrise Point, were visited by 89% and 84% of total visitors, respectively (Holmes et al. 2010). In these highly visited sites the wildlife communities have become heavily habituated to the presence of humans and animals feed opportunistically on anthropogenic food sources (C. Wildermuth, Utah State University, personal observations). A pilot study conducted in 2013 revealed that BRCA visitors are actively feeding wildlife, resulting in less fearful animals and occasional biting of humans (S.N. Frey, Utah State University, unpublished data).

Of the most common wildlife species in BRCA, there is little published literature on the effects of daily interactions with visitors on these species' behavior. Several studies of golden-mantled ground squirrels have taken place at Crater Lake National Park. Huestis (1947) published a report on golden-mantled ground squirrel trapping in Crater Lake that showed above average densities in areas of high human visitation and wildlife feeding, specifically in Rim Village area. A 1992 study investigated whether the intense feeding of golden-mantled ground squirrels during the day also increased densities of nocturnal mammals who scavenged on scraps or dug up squirrel caches (Brandt 1993). Results were inconclusive but suggested an increase in overall small mammal densities due to anthropogenic food sources. Approximately 13 visitors per hour were found to feed ground squirrels in the Rim Village area of Crater Lake National Park. This number decreased by half when signs presenting a moral case for not feeding were present and by half again when fear provoking (disease transmission) signs were present (Schwarzkof 1984).

Due to the previously mentioned gaps in the literature, the goal of this study is to obtain information on the level of human-wildlife interactions occurring at BRCA and the attitudes of visitors toward wildlife that might influence these interactions. Objectives of this study include determining which species show the greatest tolerance for human presence and habituation and, consequently which species may pose the greatest human-wildlife conflict risks. Findings from the study will be presented to the National Park Service in order to allow them to better inform management decisions relating to human-wildlife interactions.

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CHAPTER 2

FACTORS INFLUENCING HUMAN-WILDLIFE INTERACTIONS IN BRYCE CANYON NATIONAL PARK, UTAH

ABSTRACT

U.S. National Parks are experiencing increased visitation which has resulted in increased human wildlife interactions. Interactions were considered conflicts when they resulted in negative consequences for either the humans or wildlife involved. Little is known about the specific causes of these conflicts or which factors may influence the probability of their occurrence. I observed human-wildlife interactions at popular lookouts, picnic areas, and hiking trails of Bryce Canyon National Park (BRCA) from May to August of 2014 (n = 327). Eight locations were randomly paired with one-hour time blocks, and data were collected for each interaction observed using the following variables; day, time, location, species, number of animals, number of visitors, activity of visitors, presence of interpretive sign(s), distance to sign(s), and interaction type. Interactions types were coded based on a protocol developed from a pilot study in 2013 and were split into appropriate and inappropriate interactions based on current National Park Service (NPS) guidelines. A generalized linear models approach was used to determine which variable(s) had a significant effect on the probability of a conflict occurring. The strongest model showed location and species to be significant. Further analysis considering the factor levels within species and location showed golden-mantled ground squirrels (Callospermophilus lateralis) (GMGS) were 5.2 times more likely to be involved in a conflict than any other species. Interactions taking place at Inspiration Point

were 8 times less likely to result in a conflict than any other location. Interestingly, the Navajo Loop location was not found to be significantly different from other location despite 48% of interactions being conflicts compared to less than 25% for all other locations. However, most of interactions that took place at Navajo Loop involved GMGS, which suggests that while both location and species are significant factors, this is mainly a species driven system; specifically, GMGS are far more likely to be involved in conflicts regardless of location. Managers should consider species involved and the location of conflicts when implementing future tactics to reduce human-wildlife conflicts.

National parks are an iconic American ideal, designating protection for areas of natural, cultural, or historical significance. The National Park Service Organic Act states that these unique sites are set aside for the use and enjoyment of the general public and therefore inherently managed for both the protection of resources and to provide recreational opportunities for visitors (National Park Service 1916). While these two goals are not necessarily mutually exclusive, they can often present a conflict for public land managers, such as when large numbers of visitors cause ecological degradation or changes in wildlife behavior (Winks 1996, Cheever 1997). As outdoor recreation continues to increase (Cole 1996), new monitoring processes and management techniques will need to be employed to maintain the health of wildland ecosystems while at the same time providing appropriate outdoor recreation opportunities.

The idea of a recreational carrying capacity was first explored by E.L. Sumner (1942). Sumner recognized that grazing by pack animals used by visitors in areas of Yosemite and Kings Canyon National Parks had a negative ecological impact on the local environment. Based on his findings, Sumner recommended a limit be placed on the

number of visitors allowed to access certain areas by stock each day to reduce the ecological impact. Limiting visitors' access has been widely used and is one of the most popular management strategies for dealing with recreational overuse that results in ecological degradation. However, research has suggested that simply limiting the amount of use may not be the most appropriate or effective recreation management action to use for ecological protection (Wagar 1964, Manning 2013).

One particular ecological impact of wildland recreation use is its effect on wildlife populations. The actions of park visitors not only alter the natural habitat of wildlife but also influence their behavior in a number of different ways over a large spatial and temporal scale. There are several well-defined effects of human use on wildlife species. Three broad categories of wildlife response to humans are attraction, avoidance, and habituation (Hammitt and Cole 1998, Whittaker and Knight 1998). Attraction refers to wildlife that respond positively or move towards a human stimulus, usually due to a rewarding previous experience; attraction does not necessarily indicate a loss of fear, only a perception on the part of the animal that benefits will outweigh risk. Alternatively, when wildlife modify their behavior on any temporal or spatial scale to avoid encounters with humans, they are utilizing an avoidance behavior. Finally, habituation is the loss of fear of humans and usually occurs as a result of multiple stimuli encounters that do not lead to any negative outcomes (Whittaker and Knight 1998). For example, many large ungulates in heavily visited areas of national parks no longer flee from vehicles or humans on foot due to the loss of a perceived threat from humans. A classic case of habituation is the situation at Yosemite National Park in the mid-1900s, where black

bears (*Ursus americanus*) learned to access food in campgrounds, tents, and would even walk up to people in their cars, expecting a food handout (Madison 2008).

The response category an animal exhibits is based on the specific factors of human disturbance experienced by the animal. Six factors influencing the potential for recreational disturbance to wildlife have been defined: type of activity, recreationist behavior, predictability, frequency and magnitude, timing, and location (Knight and Cole 1995). Each of these factors, as well as the characteristics of individual animals, may affect the ultimate outcome of any human-wildlife encounter and resulting behavioral reactions. Animals with very specific habitat and/or food requirements show less tolerance for disturbance and are often more heavily affected by recreation use (Hammitt and Cole 1998). Taylor and Knight (2003) found a strong negative relationship between body size of species and response to recreation use. In their study of ungulate responses to hikers and mountain bikers on Antelope Island, Utah, they found that pronghorn (*Antilocapra Americana*) alerted to and fled from recreationists at a significantly further distance than bison (*Bison bison*).

A disturbance of wildlife from recreationists is considered a human-wildlife conflict when a disturbance becomes chronic and humans, wildlife, or both are being negatively impacted. An example of a disturbance is a deer fleeing from a lone hiker, while a conflict would be a landowner building a house in wintering habitat for deer and the deer adapting to eat ornamental or garden plants. Most human-wildlife conflict studies have focused on large mammals, especially carnivores. However, small mammals account for the largest number of human-wildlife conflicts recorded in the United States annually (Conover 2001). While research has shown that social factors

play a large role in driving human-wildlife conflicts, the relationship has not yet been adequately studied (Dickman 2010).

Even though conflicts associated with small mammals do not have the same potential to result in serious injury or human deaths as conflicts with large mammals, they can result in minor injuries, infections, and interspecific disease transmission. Historically there have not been wide-spread, organized U.S. National Park Service (NPS) policies for handling zoonotic diseases (Aguirre et al. 1995). However, recent outbreaks of plague (*Yersinia pestis*) and Hantavirus Pulmonary Syndrome (*Hantavirus*) in Grand Canyon National Park and Yosemite National Park, respectively, have drawn national attention to the potential threat of human interactions with disease infected small mammals and forced NPS managers to develop new practices for dealing with this threat (Daszak et al. 2000, Center for Disease Control and Prevention 2012).

In light of the lack of published information regarding small mammal interactions with humans, and the recent zoonotic outbreaks, Bryce Canyon National Park (BRCA) staff began investigating human-wildlife interactions to determine what percentage of interactions resulted in conflicts and what factors increased the chances of a conflict occurring. The goal of this study is to determine the percentage of human-wildlife interactions that become conflicts and which factors of those interactions increase the probability of the interaction becoming a conflict. These results will help direct NPS resources more efficiently and potentially reduce human-wildlife conflicts in the park.

STUDY AREA

Bryce Canyon National Park (BRCA) is located in southern Utah, approximately 80 km east of Cedar City. The park encompasses 14,500 ha and ranges in elevation from approximately 2,017 m to 2,775 m. The three climatic zones present are pinyon pine (*Pinus edulis)*/juniper (*Juniperus scopulorum*) forest, ponderosa pine (*Pinus ponderosa)* forest, and spruce (*Picea pungens*)/fir (*Pseudotsuga menziesii*) forest. Pinyon pine and juniper dominate the lower elevations while ponderosa pine and manzanita (*Arctostaphylos patula*) cover most of the higher elevation rim of BRCA. The spruce/fir vegetation community is found at the highest elevations of the southern end of the park. Due to the high elevation, the park usually receives heavy snowfall during the colder months, averaging 226 cm from October to May (National Park Service 2016). Summer highs reach approximately 26° C and lows in January average -15° C. Afternoon thunderstorms are common from late May to September; average annual rainfall was 38.7 cm (Western Regional Climate Center 2016).

There is one main road running from the park entrance in the north to Rainbow Point near the southern end of the park (Fig. 2-1). Small spur roads or loops run off of the main road to lookouts, picnic areas, campgrounds, and other attractions. Although BRCA has over 80 km of trails, most hikers remain within the main amphitheater between Sunrise Point and Bryce Point on the Queen's Garden, Navajo Loop, or Peekaboo Loop trails and connectors. Over 1.5 million people visit BRCA each year, visitation peaks at around 300,000 visitors per month from June to August, and the park

remains busy from April to October (National Park Service 2016). The park experiences low visitation from October through March, when most of the trails are covered in snow.

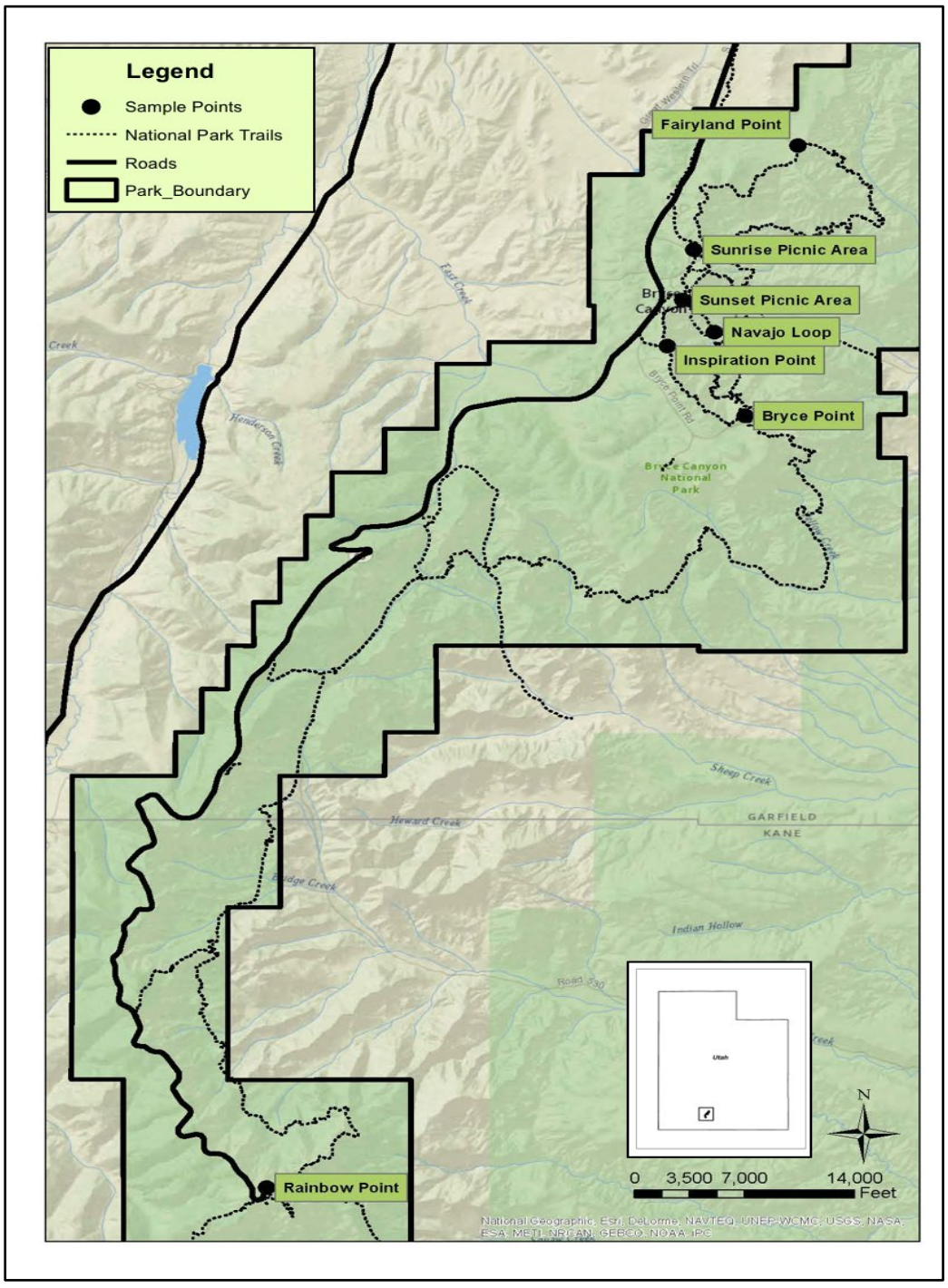

Figure 2-1. Human-wildlife interactions observational study sites in Bryce Canyon National Park, May – August 2014.

METHODS

I recorded data on human-wildlife interactions in BRCA. I selected eight locations throughout the park to sample areas of highest visitation; Fairyland Point, Sunrise Point, Bryce Canyon Lodge, Sunset Point, Navajo Loop, Inspiration Point, Bryce Point, and Rainbow Point. I chose areas of highest visitation based on conversations with NPS staff because these were the areas that were suspected as having the highest rate of human-wildlife interactions and therefore were of human-health concern for BRCA. Eight distinct one-hour time blocks throughout the day were designated as sampling periods. Since wildlife activity often decreases during the middle of the day, two hours at mid-day were not included to account for these crepuscular tendencies. For example, ground squirrels have been shown to display a bimodal daily activity pattern (Hut et al. 1999). The eight locations and eight time blocks were randomly paired to create a sampling schedule. Each time block-location pair was then randomly assigned to one day of the week. The schedule was checked for duplicate time blocks during the same day; duplications were randomly reassigned until no time conflicts existed. Observations were completed weekly from 1 May to 4 August 2014.

Upon arriving at a location, I chose a location to observe visitors, where interactions could be observed without disturbing their experience. For the entire one hour time block, I recorded every interaction between humans and wildlife species, recording the day of week, time, location, species of wildlife, number of animals involved, number of visitors involved, activity, presence of interpretive sign(s), distance to sign(s), interaction type (see below), and qualitative information describing the occurrence. When the same individual visitor or group participated in multiple

encounters with wildlife during the same observation only the first encounter was recorded. I remained anonymous and did not interact with visitors during the study.

I considered an interaction to have taken place when either the animal(s), the person(s), or both acknowledged the presence of the other. For example, visitors kneeling down to photograph a chipmunk or pointing out a bird in the tree above their picnic table were typical interactions where the person(s) acknowledged the wildlife. Conversely, a ground squirrel running from a trail into the brush as visitors approach or a raven flying down to land next to a parked car with visitors eating lunch are examples of wildlife acknowledging the visitors.

I grouped interactions as either food-driven or not food-driven. The different interaction types observed are described as follows:

Non-food Interactions

- **Respect** - both the wildlife and the visitor(s) tolerated each other for a brief time and did not directly approach each other or engage in inappropriate activities.
- **Fear** - the wildlife elicited some level of fearful reaction from the visitor(s) such as yelling at the animal, "shooing" the animal, or running away from the animal.
- **Pursue** - the wildlife was/were pursued by visitor(s) after the initial encounter, the wildlife was avoiding, showing alarm or running away from the human.

Food-interactions

- **Steal** - wildlife stole food from a visitor(s) without provocation from humans.
- **Beg** - wildlife approached a visitor(s) within two meters and displayed begging behavior.

- **Feed** - wildlife were intentionally fed by a visitor(s).
- **Indirect Feed** - wildlife fed on scraps left behind by a visitor(s) who was occupying the location earlier in the observation period.

I used current NPS mandates to distinguish between appropriate and inappropriate interactions between visitors and wildlife. Any interaction other than "respect" was considered an inappropriate interaction. Some of these behaviors occurred without the knowledge of the visitor involved, such as wildlife stealing food or cases of indirect feeding. Although the visitor was not implicitly behaving inappropriately, these scenarios result in wildlife obtaining anthropogenic food sources, which could potentially exacerbate the problems associated with wildlife habituation and health.

ANALYSIS

I conducted summary statistical analyses to determine the proportion of inappropriate interactions occurring and what location had the highest occurrence of inappropriate interactions. The sampling unit for this study was each recorded interaction, the data from which was used to measure the effect of the variables on the outcome. Additionally, a generalized linear model approach in program R was used to determine which variables had a significant effect on the probability of an inappropriate human-wildlife interaction occurring (R Core Team 2014). A generalized linear models approach allowed for the inclusion of variables with both normally and non-normally distributed error and was the most convenient analysis for the generation of models with the best fit for this complicated system (Nelder and Wedderburn 1972). All models within 4 ΔAIC of the top model were evaluated for significant variables. Independent

models were generated based on the significant variables from the top model, to test which factor levels increased the probability of an inappropriate interaction.

RESULTS

A total of 327 observations were recorded from May through August of 2014. After conducting summary statistics, two of the original eight locations and five of the twelve wildlife species were dropped before continuing statistical analysis due to sparse data. This resulted in the removal of eleven observations from the data set leaving 316 observations for analysis. Overall, inappropriate actions occurred in 27.5% of interactions observed. The proportion of inappropriate interactions per site ranged from 12% at Inspiration to 48% at Navajo (Table 2-1). Navajo also had the highest number of human-wildlife interactions (104), with the lowest number of interactions occurring at Sunrise Point (twelve total interactions; Table 2-1).

Table 2-1. Interaction type, total interactions, and percent of inappropriate interactions for each location, Bryce Canyon National Park, May – August 2014.

	Location					
Interaction Type	Navajo	Sunset	Bryce	Rainbow	Inspiration	Sunrise
Respect	54	62	42	37	29	10
Beg	32	3	5	0	0	2
Pursue	10	2	5	3	3	0
Feed	4	2	4	4	1	0
Fear	4	1	0	0	0	0
Indirect Feed	0	3	0	0	0	0
Steal	0	0	0	0	0	0
Total	104	73	56	44	33	12
% Inappropriate	48%	15%	25%	16%	12%	17%

Seven species were recorded interacting with humans at BRCA (Table 2-2). The proportion of human-wildlife interactions varied widely among species (6-49%; Table 2-2). Golden-mantled ground squirrels (*Callospermophilus lateralis*) (GMGS) were involved in the highest number of total interactions with visitors (138), and the highest percentage of inappropriate interactions of any species observed (49%; Table 2-2). Steller's jays (*Cyanocitta stelleri*) were involved in the second highest number of total interactions (77) but the lowest percentage of inappropriate interactions (6%).

Table 2-2. Interaction type, total interactions, and percent of inappropriate interactions for each species, Bryce Canyon National Park, May – August 2014. Species involved in interactions are golden-mantled ground squirrels (*GMGS*), Steller's jays (*S Jay*), common ravens (*Corvus corax*), chipmunks (*Tamias minimus*, *Tamias umbrinus*), Clark's nutcrackers (*Nucifraga Columbiana*), American robins (*Turdus migratorius*), and mule deer (*Odocoileus hemionus*).

	Species						
Interaction Type	GMGS	S Jay	Raven	Chipmunk	C Nutcracker	Robin	Mule Deer
Respect	71	72	35	31	12	5	5
Beg	37	0	0	4	1	1	0
Pursue	15	2	2	3	0	0	1
Feed	9	2	4	0	0	0	0
Fear	4	0	0	0	1	0	0
Indirect Feed	1	1	0	0	1	0	0
Steal	1	0	0	0	0	0	0
Total	138	77	41	38	15	6	6
% Inappropriate	49%	6%	15%	18%	2%	17%	17%

Four models had a ΔAIC of less than 4 (Table 2-3). All four models showed species to be a significant variable, and the top three models showed location to be significant as well. Consequently, the model that used location and species had the best fit for explaining the probability of an inappropriate interaction, or conflict, occurring (Table 2-3). The results from the 'all models' analysis show significance at the variable level but did not test which factor levels within each variable were significantly different from others. Therefore, I ran GLM models post-hoc with differing combinations of species and locations incorporated as independent variables outside of the intercept to find the strongest model (Table 2-4).

Table 2-3. Abbreviated list showing GLM models within four AICc of the best model, generated from all models testing the interaction of variables to explain human-wildlife interactions, Bryce Canyon National Park, May – August 2014.

ID	Factors	n	AIC	AICc	Delta AICc	Intercept	Intercept SE
1	Location, Species	316	332.14	333.17	0	0.15	0.21
2	Location, Species, # of Visitors	316	333.79	335	1.83	0.28	0.31
3	Location, Species, # of Animals	316	334.14	335.35	2.18	0.15	0.45
4	Species	316	335.14	335.51	2.34	-0.09	0.17

Table 2-4. Models within four AIC of the best model produced from post-hoc GLM assessment of factor-level groups for location and species for human-wildlife interactions recorded at Bryce Canyon National Park, May – August 2014.

Model Rank	Factors	AIC	Delta AIC
1	Sunset Point, Inspiration Point, GMGS, S Jay	323.57	0
2	Bryce Point, Inspiration Point, GMGS, S Jay	323.92	0.35
3	Sunset Point, Inspiration Point, GMGS	324.64	1.07
4	Navajo Loop, Inspiration Point, GMGS, S Jay	324.89	1.32
5	Sunset Point, Bryce Point, Inspiration Point, GMGS, S Jay	325.06	1.49
6	Sunset Point, Inspiration Point, GMGS, S Jay, Raven	325.13	1.56
7	Navajo Loop, Sunset Point, Inspiration Point, GMGS, S Jay	325.28	1.71
8	Navajo Loop, Bryce Point, Inspiration Point, GMGS, S Jay	325.51	1.94
9	Inspiration Point, GMGS	325.51	1.94
10	Sunset Point, Inspiration Point, GMGS, S Jay, Raven	325.56	1.99
11	Navajo Loop, Bryce Point, Inspiration Point, GMGS, Raven	325.66	2.09
12	Bryce Point, Inspiration Point, GMGS, S Jay, Raven	325.87	2.3
13	Sunset Point, Bryce Point, Inspiration Point, GMGS, S Jay, Chipmunk	326.86	3.29

The strongest model explaining the probability of an inappropriate interaction included 2 species and 2 locations as factors: GMGS, Steller's jay, Sunset Point, and Inspiration Point (Table 2-4, Table 2-5). Using post-hoc GLM models in an AIC framework to measure the influence of these factors, I determined that a human-wildlife encounter involving a GMGS was more than 5.2 times more likely to result in a conflict

than interactions involving any other species ($P < 0.01$). A human-wildlife interaction at Inspiration Point was more than 8 times less likely to result in a conflict than an interaction taking place at any other location ($P < 0.01$). There was a trend for Sunset Point to be less likely to have a wildlife conflict (probability effect = -0.37), but the effect was not significant ($P = 0.25$). In this model, locations other than Sunset Point and Inspiration Point as well as species other than GMGS and Steller's jays are included in the intercept (coefficient = -1.45, $P < 0.01$, probability effect = -0.77; Fig. 2-2).

Table 2-5. Intercept and variables from highest ranking model. The intercept, Inspiration Point, and golden-mantled ground squirrels had a statistically significant effect on the probability of a conflict occurring (designated by *). Probability Effect represents the percent increase or decrease in probability of a conflict occurring, Bryce Canyon National Park, May – August 2014.

	Coefficient Estimate	P Value	Probability Effect
Intercept	-1.45	<0.01*	-0.77
Sunset Point	-0.46	0.25	-0.37
Inspiration Point	-1.65	<0.01*	-0.81
GM Ground Squirrel	1.64	<0.01*	5.16
Steller's Jay	-0.9	0.1	-0.6

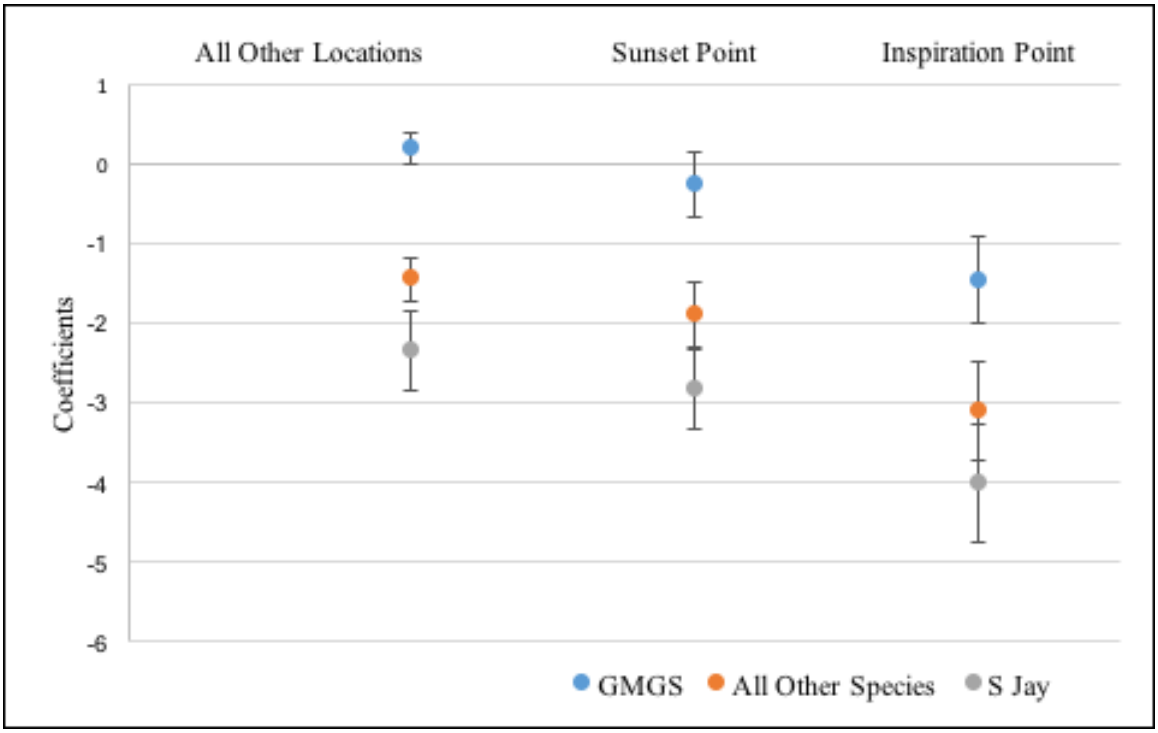

Figure 2-2. Coefficients for combinations of species and locations included in the best fit model. Positive numbers represent an increase in probability of a human-wildlife conflict, Bryce Canyon National Park, May – August 2014.

DISCUSSION

I found that GMGS are involved in a high percentage of human-wildlife conflicts. This coincides with previous studies of the same species in Crater Lake National Park, Oregon, US (Huestis 1947, Schwarzkopf 1984, Brandt 1993). The prevalence of Steller's jays on the landscape coupled with their intelligence suggests that they would be predisposed to begging, stealing, and being fed by visitors. Research has suggested that some corvid species benefit from increased development due to their broad diet and adaptability (Marzluff and Neatherlin 2006). Another study of Steller's jays in Washington state showed that abundance is higher in rural sites than urban sites and the birds show a preference for edge habitat (Vigallon and Marzluff 2005). Bryce Canyon

National Park is a unique environment in that it exists in a very rural setting but entertains approximately 1.5 million visitors per year. Therefore, the rural-edge habitat that Steller's jays have been shown to select for is coupled with ample opportunities to utilize anthropogenic food sources.

The significance of the influence of location on the probability for conflict is possibly due more to the concentration of visitors and consequently, availability of anthropogenic food sources, than to physical characteristics of the locations. Navajo Loop, where the highest number of interactions took place, is at the intersection of the two most popular hikes in BCNP (Holmes et al. 2010). At one point in the hike, there are three benches within 50 m where many hikers stop for a break and/or snack before continuing their hike (C. Wildermuth, personal observation). There are no trash disposal containers in the area, so visitors who are not familiar or not compliant with 'Leave No Trace' practices dispose of food scraps by leaving them in the surrounding area. This behavior may condition wildlife to anthropogenic food sources and habituate them to humans which resulted in more interactions with GMGS and higher rates of conflicts at the Navajo Loop site than any other location.

The Navajo Loop location was not included in the strongest model suggesting that there is some cofounding effect between the location and species variables. The majority of interactions that took place at Navajo did involve GMGS, which were included in the strongest model as significantly more likely to be involved in a conflict. Therefore, I suggest that although both species and location are significant variables, overall species has a stronger effect on the outcome of an interaction than location or, in other words, the system is more species driven than location driven.

Due to the effect GMGS have on the probability of an interaction becoming a conflict, I suggest that efforts to reduce overall conflicts in the park focus on this species. A removal strategy may be necessary in areas of high visitor use where a large percentage of interactions are becoming conflicts, specifically the Navajo Loop area. The National Park Service strives to reduce human-wildlife conflicts by addressing the human behaviors that may be causing the conflicts but does reserve the option to remove wildlife in situations where it is deemed necessary for ecological or safety related reasons (National Park Service 2006). Resources were not available to mark individuals and determine how many animals are involved in these conflicts but I hypothesize that a small number of individual animals have benefitted from the behaviors of begging and stealing and consequently account for the majority of conflicts. This hypothesis is based on my personal observations of apparent differences in the boldness of individual animals within the study sites. Conflicts may likely be reduced in this area if these individuals were removed and strategies were implemented to address human behaviors.

Several factors could have added strength and validity to the study. First, if individual animals could have been identified it would have been possible to determine how many members of a species were involved in interactions and conflicts at specific locations. Without marking individuals, it is impossible to determine if conflicts are caused by just a few individual animals who have become habituated to visitors' present and anthropogenic food sources, or if the behavior is widespread among a species' population. Secondly, additional demographic information about visitor(s) involved in wildlife interactions would have provided data for investigating differences between visitor groups. Finally, a more in depth study of the locations used would allow for better

control of factors such as elevation, vegetation communities, and wildlife densities. These factors were considered but resources were not available to expand the study past the current scale at the time.

MANAGEMENT IMPLICATIONS

The goal of this study was for these findings to be used in formulating management decisions throughout national parks and other public lands. Other national parks including Zion, Capitol Reef, Canyon Lands, Arches and the Grand Canyon, as well as national forests and national monuments in the southern Utah and northern Arizona region could potentially benefit from this study, by determining problem areas and species and targeting them for management. I propose several suggestions for future research into human-wildlife conflicts at national parks. First, a study to determine if begging and stealing are learned behaviors and what percentage of a population engages in these behaviors would be beneficial for determining the best management practices to undertake. A study of wildlife feeding of mountain sheep (*Ovis candensis*) in Colorado showed that in some situations a dominant animal could control access to anthropogenic food sources, causing increased stress and social instability (Lott 1988). Such a study could also attempt to assess if population densities are higher in area of high visitors use and if begging and stealing are learned behaviors. Secondly, an analysis of the health effects of anthropogenic foods on small mammals should be conducted. I suspect that some individual animals within the study site were obtaining a high percentage of their daily food intake through anthropogenic sources. A study to address any health issues or

effects on survival of a diet high in anthropogenic foods would be beneficial to understanding the system.

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CHAPTER 3

VISITOR ATTITUDES AND PERCEPTIONS TOWARDS WILDLIFE IN BRYCE CANYON NATIONAL PARK, UTAH

ABSTRACT

Shifting visitor demographics are causing public land managers to reevaluate best practices for regulating visitor behavior. Bryce Canyon National Park, in southern Utah, initiated a study to measure visitors' attitudes and expectations toward wildlife to assist in managing human-wildlife interactions. I randomly distributed a visitor questionnaire comprised of ten questions regarding demographics, experiences, planning, and human-wildlife interactions from May to August of 2015 in popular stops within the park. In total, 224 questionnaires were completed with most responses coming from U.S. residents (55%, n = 124) and the remainder from fourteen different foreign countries (45%, n = 103). Data analysis was conducted using IBM Corp's Statistical Package for the Social Sciences (SPSS) software package (IBM Corp 2013). Of particular interest was the relationships between attitudes and perceptions of U.S. and international respondents towards wildlife and what constitutes an appropriate interaction with different wildlife species.

One question asked respondents to select from a matrix consisting of reactions to encountering wildlife crossed with multiple wildlife species. The total number of inappropriate responses to this question for each respondent was used as a response variable and measured against responses to other questions to determine relationships and patterns that may help identify visitors who are more likely to be involved in human-

wildlife conflicts. Overall, international visitors were significantly more likely than U.S. visitors to select inappropriate responses regarding interactions with wildlife (2.55 ± .362 and 1.23 ± .218 respectively, $P < 0.01$). Length of stay and visitor group size had no significant effect on the number of inappropriate responses selected. Visitors who selected that they would enjoy seeing pronghorn (*Antilocapra americana*), black bears (*Ursus americanus*), mule deer (*Odocoileus hemionus*), birds (multiple species present), and bats (multiple species present) were significantly more likely to select a higher number of inappropriate responses regarding interactions with the respective species and/or all species than visitors who did not select that they would enjoy seeing the respective species. Visitors from other countries had different objectives than U. S. visitors for their stay in BRCA. International visitors ranked photographing wildlife as more important than U.S. visitors ($X^2 = 10.83$, df = 4, $P = 0.03$) while U.S. visitors ranked learning about the history of BRCA ($X^2 = 20.92$, df = 4, $P < 0.01$) and learning about nature ($X^2 = 25.58$, df = 4, $P < 0.01$) as more important than international visitors. Finally, there was a positive relationship between the amount of importance visitors selected for both "See Wildlife" and "Photograph Wildlife" and selecting a higher number of inappropriate responses, suggesting that visitors who identified seeing and photographing wildlife as important motivations for their visit were more likely to think that inappropriate encounters with wildlife were acceptable.

INTRODUCTION

In easily accessible natural areas with high visitation ("front country") the potential for habituation of wildlife increases, especially if there is an expected benefit

such as anthropogenic food sources (Whittaker and Knight 1998). In front country settings, direct management in national and state parks is often used to regulate visitor behavior through signage or enforcement (Manning 2010) but limited resources make it difficult to effectively control issues such as wildlife feeding. Some studies have shown that fear-provoking messages (i.e. the personal dangers of interacting with wildlife) are more effective than moral messages (i.e. long-term harm of feeding on wildlife) but factors such as species and location can influence the effectiveness of messaging (Schwarzkopf 1984, Hockett and Hall 2007).

In a survey of 640 visitors to Antelope Island Recreation Area in Utah, Taylor and Knight (2003) found that visitors to wildland recreation areas underestimate the effect their use has on wildlife. Previous research has also shown differences in attitudes and perceptions of wildlife along different demographic spectrums including age and gender (Kellert and Westervelt 1984, Kellert and Berry 1987). These attitudes and perceptions of visitors towards wildlife and appropriate interactions with wildlife represent an important aspect of wildland recreation management that has not yet been sufficiently researched to properly inform management decisions regarding the effect of recreation on wildlife.

While the U.S. National Park Service (NPS) aims to protect natural resources, and allow opportunities for visitors to view and enjoy wildlife, there are a number of potential negative consequences of these interactions for both visitors and wildlife, such as wildlife attacks, disease transmission, and changes in wildlife behavior (Orams 2002). There is little published literature on the effects of daily interactions with visitors on small mammal species' behavior, the animals with which visitors most frequently interact.

Several studies of golden-mantled ground squirrels (*Callospermophilus lateralis*) have taken place at Crater Lake National Park. Huestis (1947) published a report on golden-mantled ground squirrel trapping in Crater Lake that showed above average densities in areas of high human visitation with consequent wildlife feeding. Brandt (1993) investigated whether the intense feeding of golden-mantled ground squirrels during the day also increased densities of nocturnal mammals who scavenged on scraps or dug up squirrel caches. Results were inconclusive but suggested an increase in overall small mammal densities due to anthropogenic food sources. In the same study area, the incidents of humans feeding wildlife decreased by half when signs presenting a moral case for not feeding were present and by half again when fear provoking (disease transmission) signs were present (Schwarzkof 1984).

Bryce Canyon National Park, in southern Utah, has an interpretive series that includes educational programs and signs to encourage positive human-wildlife interactions and reduce harmful conflicts. However, potentially negative interactions continue to occur. The frequency with which interactions take place and the proportion of interactions that do not align with NPS regulations was studied in Chapter 2 (Wildermuth and Frey, Utah State University, unpublished data). In addition to knowing this frequency, it is important to understand the attitudes and perceptions of visitors regarding appropriate interactions with wildlife to better inform and educate visitors. Without this knowledge, it is difficult to gauge which management actions will work best to educate and motivate visitors to be conscious of their effect on wildlife and comply with local regulations regarding interactions.

The NPS has seen an annual increase in annual visitation of approximately 1.4% over the past ten years, from 272,623,980 in 2006 to 307,247,252 in 2015. During this same time period, Bryce Canyon National Park (BRCA) experienced a 5.5% increase in annual visitation. Most visitors spent time at a small number of sites within the park (National Park Service Visitor Use Statistics 2016). For example, a 2009 survey showed that two small areas, Sunset Point and Sunrise Point were visited by 89% and 84% of total visitors, respectively (Fig. 3-1; Holmes et al. 2010). In these highly visited sites, the wildlife communities have become habituated to the presence of humans, and animals feed opportunistically on anthropogenic food sources (personal observations). I found that 28% of interactions between visitors and wildlife were inappropriate, meaning that they did not comply with current NPS guidelines (Chapter 2). Two factors were found to significantly increased the probability of an interaction being inappropriate; wildlife species and location (Chapter 2). Furthermore, a pilot study conducted in 2013 revealed that BRCA visitors are actively feeding wildlife, resulting in less fearful animals and occasional biting of humans (Frey, unpublished data) which creates a human health and safety issue.

The goal of this study was to obtain information on the attitudes of visitors toward wildlife that might influence these interactions. Of particular interest is whether perceptions of wildlife differ among the diverse groups of visitors to BRCA.

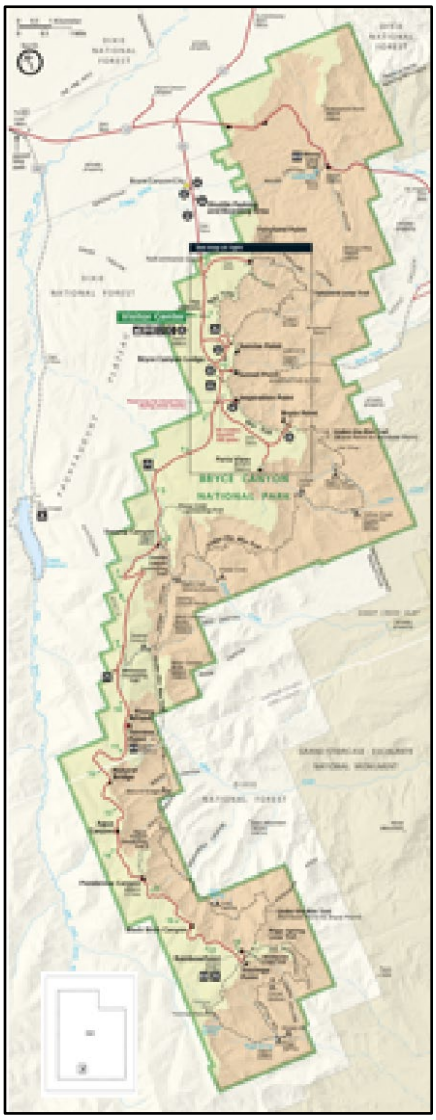


Figure 3-1. Bryce Canyon National Park Map (National Park Service 2016).

STUDY SITE

Bryce Canyon National Park (BRCA) is located in southern Utah, approximately 80 kilometers east of Cedar City. The park encompasses 14,500 hectares and ranges in elevation from approximately 2,017 to 2,775 meters. Three climatic zones are present: pinyon pine (*Pinus edulis)*/juniper (*Juniperus scopulorum*) forest, ponderosa pine (*Pinus ponderosa)* forest, and spruce (*Picea pungens*)/fir (*Pseudotsuga menziesii*) forest. Pinyon

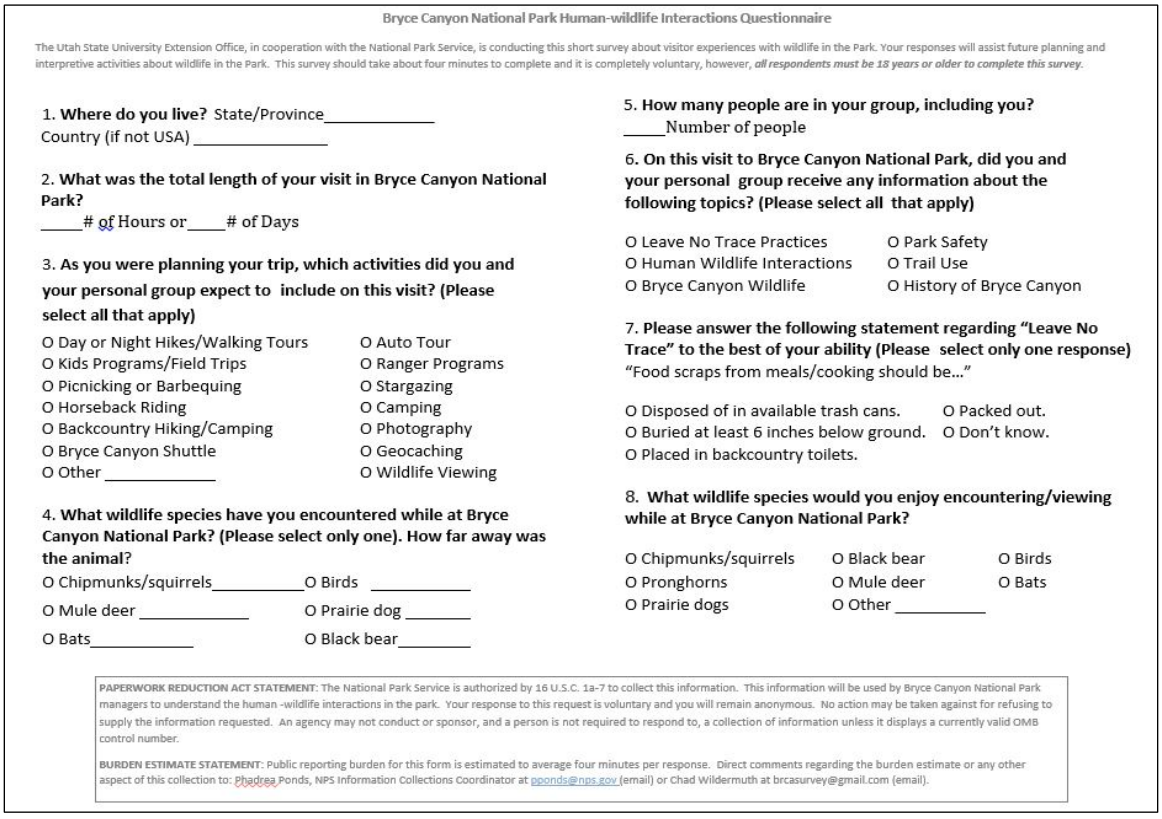
pine and juniper dominate the lower elevations while ponderosa pine and manzanita (*Arctostaphylos patula*) cover the majority of the higher elevation rim of BRCA. The spruce/fir vegetation community is found at the highest elevations of the southern end of the park. The park receives an annual average of 221.7 cm of snowfall with the highest amounts occurring from December to March. Summer highs reach approximately 26° degrees C and lows in January average -15° C. Afternoon thunderstorms are common from late May - September; average annual rainfall is 38.7 cm (Western Regional Climate Center 2016).

There is one main park road running from the park entrance in the north to Rainbow Point near the southern end of the park (Fig. 3-1). Small spur roads or loops run off of the main road to lookouts, picnic areas, campgrounds, and other attractions. Although BRCA has over 80 kilometers of trails, most hikers remain within the main amphitheater between Sunrise Point and Bryce Point on the Queen's Garden, Navajo Loop, or Peekaboo Loop trails and connectors. Over 1.5 million people visit BRCA each year, visitation peaks at around 300,000 visitors per month from June to August and the park remains busy from April to October (National Park Service Visitor Use Statistics 2016). The park experiences low visitation from October to March, when most of the trails are covered in snow.

METHODS

A visitor questionnaire was developed in coordination with the National Park Service to assess the attitudes and perceptions of park visitors towards wildlife at BRCA. The survey consisted of ten questions addressing demographic information, visitor group

characteristics, the level of park information visitors received, and perceptions of human-wildlife interactions. Six of the questions were multiple choice, three were fill in the blank and one used a Likert scale (Fig. 3-2, 3-3). The survey was reviewed by the Utah State University Institutional Review Board and approved under protocol number 5740 on April 8, 2014.



Bryce Canyon National Park Human-wildlife Interactions Questionnaire

The Utah State University Extension Office, in cooperation with the National Park Service, is conducting this short survey about visitor experiences with wildlife in the Park. Your responses will assist future planning and interpretive activities about wildlife in the Park. This survey should take about four minutes to complete and it is completely voluntary, however, ***all respondents must be 18 years or older to complete this survey.***

1. **Where do you live?** State/Province_____
Country (if not USA) _____

2. **What was the total length of your visit in Bryce Canyon National Park?**
_____# of Hours or____# of Days

3. **As you were planning your trip, which activities did you and your personal group expect to include on this visit? (Please select all that apply)**

O Day or Night Hikes/Walking Tours
O Kids Programs/Field Trips
O Picnicking or Barbequing
O Horseback Riding
O Backcountry Hiking/Camping
O Bryce Canyon Shuttle
O Other _____
O Auto Tour
O Ranger Programs
O Stargazing
O Camping
O Photography
O Geocaching
O Wildlife Viewing

4. **What wildlife species have you encountered while at Bryce Canyon National Park? (Please select only one). How far away was the animal?**

O Chipmunks/squirrels_____ O Birds _____
O Mule deer _____ O Prairie dog _____
O Bats_____ O Black bear_____

5. **How many people are in your group, including you?**
_____Number of people

6. **On this visit to Bryce Canyon National Park, did you and your personal group receive any information about the following topics? (Please select all that apply)**

O Leave No Trace Practices
O Human Wildlife Interactions
O Bryce Canyon Wildlife
O Park Safety
O Trail Use
O History of Bryce Canyon

7. **Please answer the following statement regarding "Leave No Trace" to the best of your ability (Please select only one response)**
"Food scraps from meals/cooking should be…"

O Disposed of in available trash cans.
O Buried at least 6 inches below ground.
O Placed in backcountry toilets.
O Packed out.
O Don't know.

8. **What wildlife species would you enjoy encountering/viewing while at Bryce Canyon National Park?**

O Chipmunks/squirrels
O Pronghorns
O Prairie dogs
O Black bear
O Mule deer
O Other _____
O Birds
O Bats

PAPERWORK REDUCTION ACT STATEMENT: The National Park Service is authorized by 16 U.S.C. 1a-7 to collect this information. This information will be used by Bryce Canyon National Park managers to understand the human -wildlife interactions in the park. Your response to this request is voluntary and you will remain anonymous. No action may be taken against for refusing to supply the information requested. An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

BURDEN ESTIMATE STATEMENT: Public reporting burden for this form is estimated to average four minutes per response. Direct comments regarding the burden estimate or any other aspect of this collection to: Phadrea Ponds, NPS Information Collections Coordinator at pponds@nps.gov (email) or Chad Wildermuth at brcasurvey@gmail.com (email).

Figure 3-2. Front side of visitor questionnaire with introductory information and first eight questions. Responses were collected at Bryce Canyon National Park from May to August 2015.

9. **What should you do when you see the following wildlife species? (Please select all that apply)**

	Mule Deer	Pronghorn	Squirrel	Chipmunk	Prairie Dog	Birds	Black Bear
Put some food on the ground because obviously it is hungry	O	O	O	O	O	O	O
Make noise or throw something to scare it away	O	O	O	O	O	O	O
Get as close as you can to get a better view	O	O	O	O	O	O	O
Be quiet and try not to startle the animal	O	O	O	O	O	O	O
Quietly approach the animal to take a photo	O	O	O	O	O	O	O
Try to get it to eat something from your hand	O	O	O	O	O	O	O
Chase it	O	O	O	O	O	O	O
Run as fast as you can to get away from it	O	O	O	O	O	O	O
Scream/yell for help	O	O	O	O	O	O	O
Use the zoom on your camera to take a photo	O	O	O	O	O	O	O
Don't know	O	O	O	O	O	O	O

10. **Below is a list of possible experiences you would like to have while visiting Bryce Canyon National Park. For each item please indicate how important the experience is to you on your visit to the park.**

Experience:	Not at all Important	Slightly Important	Moderately Important	Very Important	Extremely Important
To be close to nature	1	2	3	4	5
To be where things are fairly safe	1	2	3	4	5
To see wildlife	1	2	3	4	5
To view scenic beauty	1	2	3	4	5
To photograph wildlife	1	2	3	4	5
To learn more about the history of BRCA	1	2	3	4	5
To learn more about nature	1	2	3	4	5

Figure 3-3. Backside of the visitor questionnaire with questions nine and ten. Responses Collected May to August 2015

The questionnaire was printed on two-sided, 21.5 x 28 cm notecards. The questionnaire was translated into German and French to increase response rates. These languages were the second and third most used languages by visitor groups, respectively, according to the 2009 visitor survey (Holmes et al 2010). The Visitor Center, Sunrise Point, and Sunset Point were originally chosen as the study locations based on the 2009 visitor survey that found these to be the most visited sites in the park (Fig. 3-4) (Holmes et al 2010). However, the Visitor Center was dropped from the study sites since visitors often stop there before entering the park and participating in recreation. Several of the survey questions refer to visitors' experiences in the park and responses would have been lacking if the survey was administered at the Visitor Center.

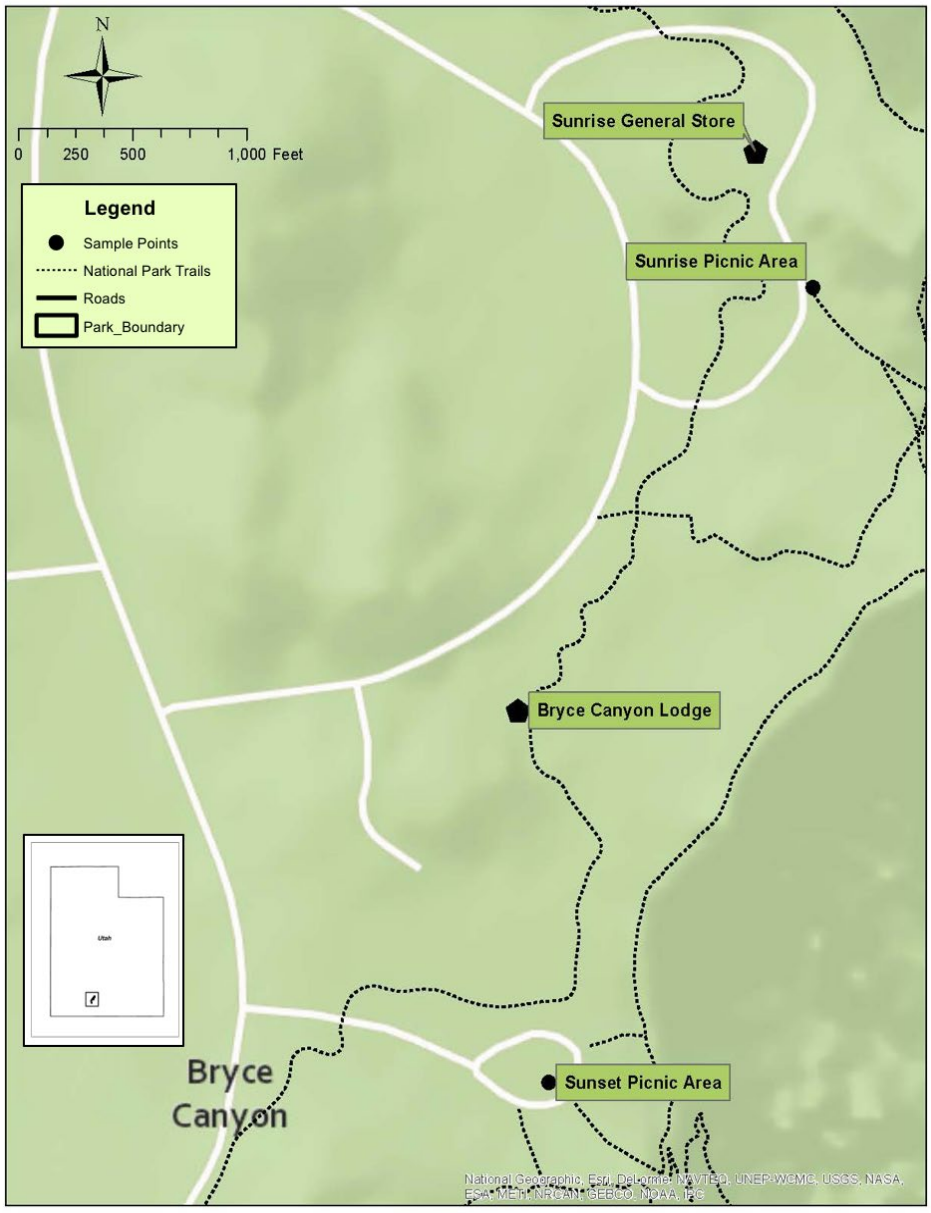


Figure 3-4. Area of Bryce Canyon National Park including both visitor questionnaire sampling sites, the Sunrise General Store, the Bryce Canyon Lodge, and nearby roads and trails. Questionnaires were administered at Sunrise Picnic Area and Sunset Picnic Area, Bryce Canyon National Park, May – August 2015.

Surveys were administered from May to August of 2015. Four-hour time blocks for both the morning and afternoon were randomly paired with days of the week using a random number generator. These were then randomly assigned to survey location. Upon arrival at a given study location, three clipboards were set up, one each for surveys in English, French, and German. At the start of the survey time period, I approached the next visitor or visitor group traveling back towards the parking area and then every fourth visitor or group of visitors thereafter. I asked the visitor or the first person from a group if they would be willing to take a five-minute survey based on their experience at Bryce Canyon; the visitor group selected the clipboard with the survey in their favored language. The survey took approximately 5 minutes to complete but some visitors, especially those in groups, took longer. The respondents were asked to return the questionnaire directly back to me after completing the questionnaire.

Survey Questions - Question 1 asks the country of origin of the respondent. Country of origin is important because different nationalities may have a different viewpoint or expectations of wildlife in U.S. National Parks. In Question 2, I asked the respondent to indicate the length of their stay. Those that are only staying for the day may feel more urgency to get the experiences they were expecting while at BCNP, including encountering wildlife. Questions 3 and 8 gathered information regarding visitors' intended activities and expectations for seeing wildlife. These questions were included to gather information on visitors' motivations and expectations for trips to BRCA. Question 4 collected information about what wildlife species visitors had seen during their stay. This question was used to inform park staff as to the relative frequency of these 'encounters'. Additionally, there may be correlation between what wildlife

visitors wanted to see (Question 8), what they did see (Question 4) and visitors' tendency to engage in unacceptable human-wildlife interactions. In Question 5, I asked visitors how many people were in their group. This information was used to determine if group size had an effect on selecting inappropriate responses to human-wildlife interactions. Questions 6 and 7 related to the ability of interpretive information to help visitors understand ethical actions such as "Leave No Trace". While I did not focus on these questions in my analysis, they were collected to assist park management staff and may be analyzed in the future. Question 10 asked visitors to specify the importance of certain experiences during their visit to BRCA. The lowest measure of importance, “Not at all Important” was recoded as 1 with each increasing level of importance recoded as the next highest whole number up to 5 for “Extremely Important”. Means and standard deviations were calculated based on this numeric scale coded for the seven experiences ranked by respondents. These responses allowed comparisons between visitors’ motivations and potential actions. For the purpose of this study, I focused on the visitor responses to Questions 9, which pertained to appropriate human-wildlife encounters. Visitors were asked to choose from a list of potential actions in response to encountering mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), squirrels (*Callospermophilus lateralis*), chipmunks (*Tamias minimus, Tamias umbrinus*), prairie dogs (*Cynomys parvidens*), birds (multiple species present), and black bears (*Ursus americanus*).

ANALYSIS

I used IBM Corp's Statistical Package for the Social Sciences (SPSS) software package to analyze the survey responses (IBM Corp 2013). This study focused on the ability of visitors to identify appropriate human-wildlife interactions (Question 9) and the importance of viewing wildlife for park visitors (Question 10; Fig. 3-3). In Question 9 I asked respondents to select from a matrix consisting of reactions to encountering wildlife crossed with multiple wildlife species. The total number of inappropriate responses to Question 9 for each respondent was used as the response variable and measured against responses to other questions to determine relationships and patterns that may help identify visitors who are more likely to be involved in human-wildlife conflicts. Questions 10 was based on a five point Likert scale ranking the importance of difference experiences at BRCA (Fig. 3-3).

To begin to understand the motivations of visitors toward human-wildlife interactions, I first determined if there was variability among the respondents regarding which actions were appropriate for the list of species provided in Question 9. Using summary statistics, I measured the variability between the percentage of appropriate and inappropriate responses for each combination of species x interaction. For those combinations that showed at least a 5% or greater variability (e.g. 5% of the respondents incorrectly indicated it was appropriate to feed chipmunks, while 95% did not), I continued analysis. I did not use those that did not have this variability because of the small sample sizes that would be associated with a lower percentage. Next, I evaluated if other aspects of the visitors' group and their experiences influenced the respondents' ability to identify appropriate human-wildlife interactions for the wildlife listed in

Question 9. For matched pairs that showed the variation in response as described, Leven's test for inequality was conducted with nationality, length of stay, wildlife species encountered, interpretive information received, and wildlife species visitors would enjoy seeing. BRCA experience preferences were analyzed using a Cronbach's Alpha reliability test, a Likert scale mean rankings chi square analysis, and Pearson R Correlation test.

RESULTS

The focus of this study was to determine which variables affected participants' selection of responses when questioned on the appropriate behaviors when viewing wildlife. A total of 227 completed questionnaires were collected while 23 visitors declined to participate in the questionnaire.

Influence of Demographics

U.S. residents accounted for 55% of respondents (n = 124) with the other 45% (n = 103) of responses coming from 14 different foreign countries, led by Germany and France. U.S. respondents came from 37 different states with California (20) and Utah (10) respondents the most common. Further results for county and state of origin can be found in Appendix A. The average length of stay in BRCA for respondents was 1.69 (SD = ± 2.89) days and visitor group size averaged 3.27 (SD = ± 2.54) people.

The mean number of inappropriate responses to Question 9 regarding encounters with wildlife for U.S. and international visitors were 1.23 ± 0.29 and 2.55 ± 0.36, respectively. Overall, the mean number of inappropriate responses selected by international visitors was significantly higher than for U.S. visitors (T = -3.14, df = 171,

$P < 0.01$). Length of stay did not have a significant effect on the number of inappropriate responses selected by visitors ($n = 225$, $r = -0.06$, $P = 0.39$). Similarly, visitor group size had no significant effect on the total number of inappropriate responses selected ($n = 227$, $r = 0.09$, $P = 0.21$).

Table 3-1. Percentage of respondents that selected actions as appropriate for each species. All actions represented in this table are considered inappropriate according to current NPS guidelines for all species except black bears. Data collected at Bryce Canyon National Park from May to August of 2015.

	Mule Deer	Pronghorn	Squirrel	Chipmunk	Prairie Dog	Birds	Black Bear
Put some food on the ground because obviously it is hungry	0.00%	0.00%	1.32%	0.88%	0.00%	0.44%	0.00%
Make noise or throw something to scare it away	0.00%	0.00%	0.88%	0.88%	1.32%	0.00%	30.84%
Try to get it to eat something from your hand	0.00%	0.00%	1.76%	0.44%	0.00%	0.00%	0.00%
Chase it	0.00%	0.00%	0.00%	0.00%	0.44%	0.00%	0.44%
Run as fast as you can to get away from it	0.44%	0.88%	0.00%	0.00%	1.32%	0.00%	8.37%
Scream/yell for help	0.00%	0.00%	0.44%	0.44%	0.44%	0.00%	13.66%

For further analysis of Question 9, I looked at only those respondents who selected inappropriate actions. For most combinations of species and actions presented in Question 9, all or nearly all visitors selected the appropriate response, resulting in very

low response variation (Table 3-1). The results for the species black bear are an obvious outlier. The appropriateness of several listed actions towards black bears is very conditionally dependent. For example, the decision to "make noise or throw something to scare it away" and "scream/yell for help" depends on many factors including location, distance from animal, actions of the animal etc. Additionally, there are inconsistencies in official interpretive information provided by public land management agencies on how to behave when encountering a black bear. Therefore, the results for black bear are of note but were not used in further analysis for this paper.

Table 3-2. Frequency of responses to individual actions by species. Only actions with significant (<.05) response variation are shown. Bold percentages show the actions that are appropriate. Data collected at Bryce Canyon National Park from May to August of 2015. See appendix for complete data results.

Get as close as you can to get a better view			Quietly approach the animal to take a photo		
	Selected	Not Selected		Selected	Not Selected
Mule Deer	10	217	Mule Deer	34	193
Pronghorn	8	219	Pronghorn	26	201
Squirrel	29	198	Squirrel	55	172
Chipmunk	30	197	Chipmunk	54	173
Prairie Dog	10	217	Prairie Dog	29	198
Birds	24	203	Birds	47	180
Black Bear	2	225	Black Bear	9	218

Be quiet and try not to startle the animal			Use the zoom on your camera to take a photo		
	Selected	Not Selected		Selected	Not Selected
Mule Deer	163	64	Mule Deer	127	100
Pronghorn	151	76	Pronghorn	123	104
Squirrel	134	93	Squirrel	125	102
Chipmunk	133	94	Chipmunk	122	105
Prairie Dog	139	88	Prairie Dog	122	105
Birds	133	94	Birds	121	106
Black Bear	132	95	Black Bear	121	106

Responses to four actions ("get as close as you can to get a better view", "be quiet and try not to startle the animal", "quietly approach the animal to take a photo", and "use the zoom on your camera to take a photo") showed significant response variation (Table 3-2). For these four actions, enough variation and large enough sample sizes in both groups allowed for further analysis.

For each of the 4 actions with response variability ("get as close as you can to get a better view", "be quiet and try not to startle the animal", "quietly approach the animal to take a photo", and "use the zoom on your camera to take a photo"), I analyzed the species x action combination to determine influences of inappropriate selections. For these actions, visitors selected inappropriate responses most frequently for chipmunk, mule deer, squirrel, and mule deer, respectfully. For all four actions, black bears had the lowest number of inappropriate responses (tied with birds for "use the zoom on your

camera to take a photo") and were consistently an outlier for the other three actions as well (see Appendix A for full results).

Table 3-3. Chi-squared test results for comparison of U.S. and International visitors' selections of two actions when encountering seven wildlife species. Significance is denoted by an *. Data collected at Bryce Canyon National Park from May to August of 2015.

Get as close as you can to get a better view

Species	U.S.	International	X^2 value	df	Sig. (p-value)
Mule Deer	3	7	2.56	1	0.11
Pronghorn	3	5	0.98	1	0.32
Squirrel	9	20	7.47	1	.01*
Chipmunk	12	18	2.98	1	0.08
Prairie Dog	4	6	0.9	1	0.34
Birds	10	14	1.81	1	0.18
Black Bear	2	0	1.68	1	0.2

Quietly approach the animal to take a photo

Species	U.S.	International	X^2 value	df	Sig. (p-value)
Mule Deer	11	23	8	1	0.01*
Pronghorn	8	18	6.74	1	0.01*
Squirrel	22	33	6.26	1	0.01*
Chipmunk	22	32	5.51	1	0.19*
Prairie Dog	12	17	2.35	1	0.13
Birds	19	28	4.82	1	.028*
Black Bear	2	7	3.97	1	.046*

There were some significant difference between U.S. and international visitors choices for appropriate responses for several of the actions listed in question 9. First, I considered visitors' country of origin. For two of the four actions ("get as close as you can to get a better view" and "quietly approach the animal to take a photo") there was a significant difference in the average number of inappropriate actions selected between U.S. and international visitors for at least one species. Analyzing these responses further, a statistically higher number of international than U.S. visitors incorrectly selected "Get as close as you can to get a better view" as an appropriate action when encountering a squirrel ($P = 0.01$), but responses were similar for the other species. U.S. visitors were also statistically less likely than international visitors to select the inappropriate action of "Quietly approach the animal to take a photo" as an appropriate behavior for mule deer ($P = 0.01$), pronghorn ($P = 0.01$), squirrel ($P = 0.01$), chipmunk ($P = 0.02$), birds ($P = 0.03$), and black bear ($P = 0.05$). There was no significant difference in the number of U.S. and international visitors who selected "Quietly approach the animal to take a photo" as appropriate for prairie dogs (Table 3-3).

Animal Encounters

Of the 227 respondents that answered the question of which animals they had seen during their visit, 203 reported viewing chipmunk/squirrels, followed by birds (144 respondents), mule deer (89) and prairie dog (46) observations. The least frequent observations were black bear (1) and bats (13). All 227 respondents also answered the question of which animals they would enjoy seeing. Overall, 137 visitors reported wanting to see black bears, followed by prairie dog (131), mule deer (124), and

pronghorn (119). Less popular selections included bats (64), birds (98), and chipmunk/squirrel (105).

I used the information regarding which species were encountered and which species were desired to inform the rate of inappropriate responses visitors selected for appropriate interactions. There was no relationship among the wildlife species a visitor encountered and the rate of incorrectly selected action for any species (Table 3-4).

Table 3-4. Measure of significance for effect of the wildlife species visitors had encountered on the total number of inappropriate actions they selected for Question 9. Data collected at Bryce Canyon National Park from May to August of 2015.

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means			95% Confidence Interval	
	F	P	t	df	P (2-tailed)	Lower	Upper
Chipmunk/Squirrel Inappropriate Responses	1	0.32	0.45	225	0.65	-0.23	0.37
Mule Deer Inappropriate Responses	1.37	0.24	-0.69	225	0.49	-0.17	0.08
Birds Inappropriate Responses	3.01	0.08	0.84	225	0.4	-0.09	0.23
Prairie Dog Inappropriate Responses	1.65	0.2	-0.75	225	0.46	-0.25	0.11

Influence of Desire to See Wildlife Species

I compared a visitor's desire to see a species with their propensity to select inappropriate actions for those species. There was no significant effect on the number of inappropriate responses selected for chipmunk/squirrel or prairie dog between respondents who would and who would not enjoy seeing those species (Table 3-6). For each other species listed, visitors who selected that they would enjoy seeing a species chose a statistically higher number of inappropriate responses than those who did not select that they wanted to see that species. Visitors who would enjoy seeing pronghorn had a significantly higher average number of inappropriate responses related to encountering pronghorn (0.23) than those who would not enjoy seeing pronghorn (0.08) ($P = 0.01$). The average number of total inappropriate responses selected by visitors who said they would enjoy seeing black bears (2.42) and mule deer (2.27) was significantly higher than those who would not enjoy seeing black bears (0.92) and mule deer (1.30) ($P > 0.01$ and $P = 0.02$, respectively). Average total inappropriate responses for all species (2.45) and average inappropriate responses for birds (.47) from visitors who would enjoy seeing birds were significantly higher than those who would not enjoy seeing birds (1.36, 0.47) ($P = 0.01$ and $P = 0.01$, respectfully). Visitors who would enjoy seeing bats also selected a significant higher total number of inappropriate responses (2.52) than those who would not enjoy seeing bats (1.56) ($P = 0.05$) (Table 3-5).

Table 3-5. T-test results for effect of wildlife species visitors would enjoy seeing on total number of inappropriate responses. First column represents species choices from question eight. Second column represents inappropriate responses for corresponding species from question nine and total inappropriate responses. Significance is denoted by an *. Data collected at Bryce Canyon National Park from May to August of 2015.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	95% Confidence Interval	
							Lower	Upper
Chipmunk/ Squirrel	Total Inappropriate Responses All Species	1.91	0.17	-1.16	225	0.25	-1.3	0.34
	Chipmunk Inappropriate Responses	3.96	0.05	-1.38	206.04	0.17	-0.32	0.06
	Squirrel Inappropriate Responses	0.72	0.4	-0.84	225	0.4	-0.27	0.11
Pronghorn	Total Inappropriate Responses All Species	7.98	0.01	-1.93	219.17	0.06	-1.59	0.02
	Pronghorn Inappropriate Responses	28.28	0	-2.5	182.25	0.01*	-0.25	-0.04
Prairie Dog	Total Inappropriate Responses All Species	4.47	0.04	-1.94	220.76	0.05	-1.59	0.01

	Prairie Dog Inappropriate Responses	7.69	0.01	-1.53	224.81	0.12	-0.24	0.03
Black Bear	Total Inappropriate Responses All Species	39.15	0	-4.05	221.51	<0.01*	-2.23	-0.77
	Black Bear Inappropriate Responses	10.12	0.00	-1.66	224.95	0.1	-0.17	0.02
Mule Deer	Total Inappropriate Responses All Species	12.46	0	-2.41	221.03	0.02*	-1.75	-0.18
	Mule Deer Inappropriate Responses	8.09	0.01	-1.6	223.96	0.11	-0.22	0.02
Birds	Total Inappropriate Responses All Species	13.61	0	-2.54	169.28	0.01*	-1.94	-0.24
	Birds Inappropriate Responses	37.57	0	-3.24	160.48	0.01*	-0.43	-0.11
Bats	Total Inappropriate Responses All Species	6.43	0.01	-2	104.71	0.05*	-1.91	-0.01

Influence of Park Interpretive Information

Visitors were given six options to select regarding information received during their visit: Leave No Trace Practices, Human-wildlife Interactions, Bryce Canyon Wildlife, Park Safety, Trail Use, and History of Bryce Canyon. Respondents had varied experience with park information (n = 227). The most common information received was regarding trail use and the history of Bryce Canyon (120 respondents for each). A similar number of respondents received information pertaining to Bryce Canyon wildlife (104), Leave No Trace practices (107), and park safety (111). Only 77 respondents (34%) said that they had received information about human-wildlife interactions. I compared the level of each type of information received with the number of inappropriate actions selected for each respondent. Only the level of Park Safety and Leave No Trace information correlated to the number of incorrect actions selected by respondents. For Park Safety, only the number of inappropriate actions selected for squirrels and chipmunks were influenced by whether or not a respondent had received this information (Table 3-6). For visitors who responded that they did not receive information regarding park safety, they selected an average of 1.32 and 1.26 inappropriate actions for squirrels and chipmunks, respectively. For visitors who responded that they did receive information regarding park safety, they selected an average of 1.5 and 1.52 inappropriate responses for squirrels and chipmunks, respectively. Therefore, receiving information regarding park safety significantly increased the total inappropriate responses selected by visitors for squirrels and chipmunks ($P = 0.043$ and $P = 0.025$).

Table 3-6. T-test results for effect of information received regarding "Park Safety" on total number of inappropriate responses. Significance is denoted by an *. Data collected at Bryce Canyon National Park from May to August of 2015.

Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means				
	F	Sig.	t	df	Sig. (2-tailed)	95% Confidence Interval	
						Lower	Upper
Mule Deer Inappropriate Responses	0.1	0.75	0	225	>.99	-0.12	0.12
Pronghorn Inappropriate Responses	1.05	0.31	0.49	225	0.62	-0.09	0.14
Squirrel Inappropriate Responses	12.61	0	-2.04	205.09	0.04*	-0.38	-0.01
Chipmunk Inappropriate Responses	17.57	0	-2.26	198.05	0.02*	-0.4	-0.03
Prairie Dog Inappropriate Responses	0.49	0.48	-0.49	225	0.62	-0.18	0.11
Birds Inappropriate Responses	13.19	0	-1.96	225	0.05	-0.31	<0.01
Black Bear Inappropriate Responses	0.69	0.41	0.4	225	0.69	-0.08	0.12
Total Inappropriate Responses	1.63	0.2	-1.33	225	0.19	-1.36	0.27

A total of 221 respondents answered the question addressing specific "Leave No Trace" practices. Some respondents selected more than one answer and most respondents selected acceptable practices; 125 respondents selected "dispose of in available trash cans" while 114 selected "packed out". The response "don't know" was

selected 15 times. Since only three respondents selected the inappropriate practices of "buried at least 6 inches below the ground" and "placed in backcountry toilets", there was not a large enough sample size to compare this group to those who selected the acceptable practices across responses to other questions.

Motivations for Visiting BRCA

I studied the relationship between visitors' objectives for visiting BRCA and the tendency to select inappropriate human-wildlife interactions. I compared U.S. visitor responses to international visitor responses. First, a reliability analysis was conducted, resulting in a Cronbach's Alpha value of 0.7. This surpasses the 0.65 threshold cutoff for an adequate scale and suggests that the response scale is approximately 70% reliable (Vaske 2008).

Table 3-7. Comparison of Likert scale mean rankings for BRCA experiences between U.S. and international respondents. For chi square values (X2), an * denotes significance (alpha = 0.05). Bryce Canyon National Park, May to August of 2015.

	Means		
Experience	U.S.	International	P-value
To be close to nature	4.62	4.52	0.28
To be where things are fairly safe	3.56	3.34	0.08
To see wildlife	4.16	4.14	0.59
To view scenic beauty	4.88	4.87	0.84
To photograph wildlife	3.43	3.59	0.03*
To learn more about the history of BRCA	3.53	3.22	<0.01*
To learn more about nature	3.89	3.65	<0.01*

Chi square analyses were run for each experience to determine significance between responses from U.S. and international visitors. The three motivations, "To photograph wildlife," "To learn more about the history of BRCA," and "To learn more about nature" showed a significant difference between the two groups. International visitors ranked photographing wildlife as more important than U.S. visitors ($x^2 = 10.83$, df = 4, P = 0.03) while U.S. visitors ranked learning about the history of BRCA ($x^2 = 20.92$, df = 4, P < 0.01) and learning about nature ($x^2 = 25.58$, df = 4, P < 0.01) as more important than international visitors (Table 3-7).

There was a positive relationship between "See Wildlife" (P < 0.01) as well as "Photograph Wildlife" (P < 0.01) and the total inappropriate responses selected. Thus, visitors who ranked "See Wildlife" or "Photograph Wildlife" as a higher importance were more likely to select inappropriate responses (Table 3-8).

Table 3-8. Pearson R correlation analysis of effect of relationship between motivations for visiting BRCA and total inappropriate responses selected. Significance at the 0.05 level is signified by an *. Significance at the 0.01 level is signified by **. Data collected at Bryce Canyon National Park from May to August of 2015.

Pearson R Correlations		
		Total Inappropriate Responses
Close to Nature	Pearson Correlation	0.08
	Sig. (2-tailed)	0.24
	N	201
Fairly Safe	Pearson Correlation	0.07
	Sig. (2-tailed)	0.31
	N	194

See Wildlife	Pearson Correlation	.18*
	Sig. (2-tailed)	0.01
	N	197
View Scenic Beauty	Pearson Correlation	0.05
	Sig. (2-tailed)	0.53
	N	201
Photograph Wildlife	Pearson Correlation	.21**
	Sig. (2-tailed)	0
	N	196
Learn History BRCA	Pearson Correlation	0.05
	Sig. (2-tailed)	0.53
	N	197
Learn Nature	Pearson Correlation	0.13
	Sig. (2-tailed)	0.06
	N	196

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

DISCUSSION

Bryce Canyon National Park (BRCA) is one of the smaller national parks in the Southwest and the smallest in Utah, often considered a stopping point while traveling between more well-known destinations (i.e. Grand Canyon National Park, Zion National Park, Arches National Park). This may account for the similarities in length of stay between U.S. and international visitors, because most groups were just stopping over for a day between the drive between other, larger parks. These findings are similar to

previous BRCA visitor survey data that showed an average length of 24 hours (Holmes et al. 2010).

There was a significant difference between U.S. and international visitors in the number of inappropriate responses given to the question regarding appropriate actions when wildlife are encountered. International visitors were more likely than U.S. visitors to select inappropriate actions in response to encountering wildlife in BRCA. This is especially relevant given the rise in international visitation to national parks and other natural areas and suggests that perhaps interpretive information is not reaching theses visitor populations to the same level that it is U.S. visitors.

U.S. and international visitors also showed different motivations for visiting BRCA. The fact that international visitors ranked photographing wildlife as more important than U.S. visitors may explain why a significantly higher percentage of international visitors responded that approaching wildlife to take a photo was an appropriate action for all wildlife species except prairie dogs. Conversely, U.S. visitors ranked learning about the history of BRCA and learning about nature as more important than international visitors. One explanation for these differences could be differing cultural and religious views. Other countries have different systems and institutions in place to manage public lands, many of which differ greatly from the U.S. Manfredo and Dayer (2004) suggest that these factors be taken into consideration when attempting to manage visitor groups.

Initially, the finding that receiving information regarding park safety significantly increased the total number of inappropriate responses selected by visitors for both squirrels and chipmunks is somewhat counterintuitive. However, in breaking down the

six different categories of information that visitors may have received, human-wildlife interactions had the lowest number of responses with only 77. So, overall, visitors answered that they had received the least amount of information pertaining to human-wildlife interactions. Also, it is interesting to note that a related study regarding human-wildlife interactions at BRCA found that ground squirrels and chipmunks were the two most likely species to be involved in human-wildlife conflicts and that the involvement of a golden-mantled ground squirrel(s) in an interaction with a visitor(s) had the most significant effect of all variables measured on the probability that that interaction would become a conflict (Chapter 2). Taken together this information suggests that even when appropriate interpretive information is provided, there is either a lack of understanding or a lack of incorporation of that information regarding interactions with ground squirrels and chipmunks.

The positive correlation between visitors assigning a higher ranking to "see wildlife" and "photograph wildlife" and selecting a higher number of inappropriate interactions is consistent with other studies that suggest motivations influence actions (Lee 2011). Those visitors who were more concerned with seeing and photographing wildlife may have been more likely to disregard NPS regulations in order to get closer to wildlife for better viewing or to get a better photograph. These findings propose that data collected on visitor motivations could be used as an affordable and less intrusive metric for visitor actions.

One improvement to this study would be to administer the questionnaire in a wider range of languages. If a large enough sample size were reached, comparisons could be made in attitudes, perceptions, and desires among individual countries, allowing

an optimal focus of interpretive resources towards groups of visitors who display the highest propensity to act outside of BRCA regulations. For future research, I suggest the investigation of how visitors who enter BRCA as part of a tour group on a large bus differ from other visitor groups. While there were some tour-bus respondents included in this study, it was not recorded as a variable and the small sample size would have been problematic during analysis. These tour buses are a potentially significant factor in uninformed visitors because the tour guide is the only person required to interact with the NPS employee at the entrance station. This puts the tour guide in the unique position of being able to disseminate varying quantities and quality of information to their clients regarding BRCA and NPS regulations.

Another improvement would be to increase sampling sites and use teams of two to three researchers to improve the rate of responses per hour. Only one questionnaire was administered at a time during the study and the next visitor was not approached until that respondent had finished filling out the questionnaire, causing a bottleneck in the rate of questionnaires completed.

A study of off-trail use by visitors in Acadia National Park found a significant difference in the percentage of visitors who *reported* walking off trail and the percentage of visitors who were *observed* walking off trail, revealing the tendencies for questionnaire respondents to underreport known negative behaviors (Park et al. 2008). My study attempted to alleviate this issue by building upon a related observational study of human-wildlife interactions in BRCA. Findings from the two studies combined present a more holistic understanding of visitor attitudes, perceptions, and actions regarding wildlife in BRCA. For example, respondents to the questionnaire were more

likely to select inappropriate interactions for encounters with squirrels than any other species. Analysis of observational data from Chapter 2 revealed that a human-wildlife encounter involving a golden-mantled ground squirrel(s) was significantly more likely to result in a conflict than an encounter with any other species. The obvious question is why these small mammal species rise to the top in both studies. Is it because they are viewed as less threatening by visitors and more easily approachable? Do they become habituated to humans and anthropogenic food sources faster than other species? Hopefully future research can build upon the information from these studies and provide more information to answer these questions.

MANAGEMENT IMPLICATIONS

Findings from this research project show that there are differences in attitudes and perceptions of U.S. and international visitors to BRCA. While not unexpected, these results suggest that differing visitor groups may have different requirements in terms of information provided by the NPS and in understanding the current rules and regulations of the park. Developing materials (i.e. classes, signage, pamphlets) to address the different motivations of park visitors could reduce the number of negative interactions. Development and implementation of new policies may require further research to determine which strategies work best. While indirect management practices are often preferred, research to asses which management practices worked best to encourage visitors to stay on established paths and therefore not damage fragile ecosystems on Cadillac Mountain in Arcadia National Park, found that more aggressive indirect methods were more effective than less aggressive indirect methods while direct methods (i.e.

fencing) were the most successful (Park et al. 2008). A similar study of potential management options at BRCA would be highly beneficial.

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CHAPTER 4

SUMMARY AND CONCLUSIONS

Public lands such as National Parks protect some of America's most spectacular and iconic natural, cultural, and historic landscapes. These lands are managed with a goal of preserving their unique features for the recreational use of the public. Therefore, it is important to understand the effects that public visitation has on these natural systems. This study investigated human-wildlife interactions in Bryce Canyon National Park (BRCA), Utah to better understand factors that lead to human-wildlife conflicts and how the attitudes and perceptions of visitors affect their actions towards wildlife.

For the first chapter, human-wildlife interactions were observed in popular lookouts, picnic areas, and hiking trails of BRCA from May to August of 2014. Interactions types were coded based on a protocol developed from a pilot study in 2013 and were split into appropriate and inappropriate interactions based on current National Park Service (NPS) guidelines. A generalized linear models approach was used to determine which variable(s) had a significant effect on the probability of a conflict occurring. The strongest model showed location and species to be significant factors explaining the frequency of conflicts. Specifically, golden-mantled ground squirrels (GMGS) were significantly more likely to be involved in a conflict than any other species and interactions taking place at the Inspiration Point location were significantly less likely to result in a conflict than any other location. Interestingly, the Navajo Loop location was not found to be significantly different from other location despite a higher proportion of conflicts compared to all other locations. However, the majority of

interactions that took place at Navajo Loop involved GMGS which suggests that while both location and species are significant factors, this is mainly a species driven system. Managers should consider this information when implementing future tactics to reduce human-wildlife conflicts.

For the second chapter, a visitor questionnaire was administered with ten questions regarding demographics, experiences, planning, and human-wildlife interactions from May to August of 2015 in popular stops within the park. In total, 224 questionnaires were completed with slightly more than half of responses coming from U.S. residents and the remainder from fourteen different foreign countries. The response variable was calculated from a question asking respondents to select from a matrix consisting of reactions to encountering wildlife crossed with multiple wildlife species.

Analysis revealed that international visitors were significantly more likely than U.S. visitors to select inappropriate responses regarding interactions with wildlife. Visitors who selected that they would enjoy seeing certain species were generally more likely to select inappropriate interactions for those than other species. Also, visitors from other countries had different objectives than U. S. visitors for their stay in BRCA. International visitors ranked photographing wildlife as more important than U.S. visitors while U.S. visitors ranked learning about the history of BRCA and learning about nature as more important than international visitors. Finally, there was a positive relationship between the amount of importance visitors selected for both “See Wildlife” and “Photograph Wildlife” and selecting a higher number of inappropriate responses, suggesting that visitors who identified seeing and photographing wildlife as important

motivations for their visit were more likely to think that inappropriate encounters with wildlife were acceptable.

Overall, this research added significant knowledge to the issues of human-wildlife interactions in BCNP. By understanding the factors that increase the probability of conflicts occurring, managers can utilize resources more efficiently to reduce the potential for human-wildlife conflicts. In addition, the understanding of visitor attitudes and perceptions as well as how they affect visitors' interactions with wildlife can help develop appropriate interpretive information that can be targeted towards groups or individuals at higher risk of inappropriate behavior. Ultimately, it is my hope that the results of this study are beneficial to the NPS and allow them to better fulfill their objectives of protecting important resources while also providing exceptional public recreation opportunities.

APPENDICES

Table A-1. Total number of questionnaire respondents by country collected at Bryce Canyon National Park from May to August of 2015.

Country	Total Respondents
USA	124
Germany	30
France	23
Netherlands	13
Italy	8
United Kingdom	6
Belgium	5
Switzerland	5
Canada	4
Australia	2
Austria	2
Denmark	1
Japan	1
New Zealand	1
Poland	1

Table A-2. Total number of questionnaire respondents by state collected at Bryce Canyon National Park from May to August of 2015.

State	Total Respondents
California	20
Utah	10
Arizona	8
Colorado	7
Washington	6
Michigan	5
New York	5
Wisconsin	5
Florida	4
Massachusetts	4
Nevada	4
Texas	4
Illinois	3
Minnesota	3
North Carolina	3
Ohio	3
Pennsylvania	3
Idaho	2
Indiana	2
Kansas	2
Missouri	2
New Jersey	2
New Mexico	2

Tennessee	2
Virginia	2
Washington DC	1
Delaware	1
Georgia	1
Iowa	1
Kentucky	1
Maine	1
Maryland	1
Nebraska	1
Oklahoma	1
Oregon	1
Rhode Island	1

Table A-3. Frequency results for responses to question nine interactions options by species. Data collected at Bryce Canyon National Park from May to August of 2015.

Put some food on the ground because obviously it is hungry			Chase it		
	Selected	Not Selected		Selected	Not Selected
Mule Deer	0	227	Mule Deer	0	227
Pronghorn	0	227	Pronghorn	0	227
Squirrel	3	224	Squirrel	0	227
Chipmunk	2	225	Chipmunk	0	227
Prairie Dog	0	227	Prairie Dog	1	226
Birds	1	226	Birds	0	227
Black Bear	0	227	Black Bear	1	226

Make noise or throw something to scare it away			Run as fast as you can to get away from it		
	Selected	Not Selected		Selected	Not Selected
Mule Deer	0	227	Mule Deer	1	226
Pronghorn	0	227	Pronghorn	2	225
Squirrel	2	225	Squirrel	0	227
Chipmunk	2	225	Chipmunk	0	227
Prairie Dog	3	224	Prairie Dog	3	224
Birds	0	227	Birds	0	227
Black Bear	70	157	Black Bear	19	208

Get as close as you can to get a better view

	Selected	Not Selected
Mule Deer	10	217
Pronghorn	8	219
Squirrel	29	198
Chipmunk	30	197
Prairie Dog	10	217
Birds	24	203
Black Bear	2	225

Scream/yell for help

	Selected	Not Selected
Mule Deer	0	227
Pronghorn	0	227
Squirrel	1	226
Chipmunk	1	226
Prairie Dog	1	226
Birds	0	227
Black Bear	31	196

Be quiet and try not to startle the animal

	Selected	Not Selected
Mule Deer	163	64
Pronghorn	151	76
Squirrel	134	93
Chipmunk	133	94
Prairie Dog	139	88
Birds	133	94
Black Bear	132	95

Use the zoom on your camera to take a photo

	Selected	Not Selected
Mule Deer	127	100
Pronghorn	123	104
Squirrel	125	102
Chipmunk	122	105
Prairie Dog	122	105
Birds	121	106
Black Bear	121	106

Quietly approach the animal to take a photo

	Selected	Not Selected
Mule Deer	34	193
Pronghorn	26	201
Squirrel	55	172
Chipmunk	54	173
Prairie Dog	29	198
Birds	47	180
Black Bear	9	218

Don't know

	Selected	Not Selected
Mule Deer	7	220
Pronghorn	10	217
Squirrel	5	222
Chipmunk	6	221
Prairie Dog	8	219
Birds	6	221
Black Bear	5	222

Try to get it to eat something from your hand

	Selected	Not Selected
Mule Deer	0	227
Pronghorn	0	227
Squirrel	4	223
Chipmunk	1	226
Prairie Dog	0	227
Birds	0	227

Black Bear	0	227