

UNDERSTANDING THE NATURE OF INTERACTIONS BETWEEN
VISITORS AND MOUNTAIN GOATS (*Oreamnos americanus*) ON
THE HIDDEN LAKE TRAIL, GLACIER NATIONAL PARK

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ABSTRACT

This study examined interactions between visitors and mountain goats on the most heavily used trail in Glacier National Park. The primary objective was to give park managers a baseline of unbiased, reliable data with which to make informed decisions and improve the quality of interactions between visitors and mountain goats. Secondly, this research was intended to achieve a thorough understanding of both human and wildlife responses during interactions on publically protected lands.

The study was conducted over a two month period during the summer of 2013, and it was purely observational. Observations were recorded five days a week for approximately six hours each day, between the hours of 8 AM and 8 PM. Focal sampling and scan sampling methods were used to collect data on goat and visitor behaviors as well as emotional responses. Information was also collected on setting attributes (e.g. weather, time), the duration of interactions, the distance between mountain goats and visitors and the elevation of mountain goats relative to visitors.

Results show that mountain goats along Hidden Lake Trail exhibited significantly different behaviors during interactions compared to when no interaction was occurring. In addition, the behaviors that mountain goats exhibited more frequently during interactions were more energy costly. Negative interactions occurred 42% of the time, but typically only one negative behavior was observed in these interactions, and the behavior was low in intensity. The likelihood of an interaction occurring was largely influenced by environmental variables such as weather, time of day and the location of mountain goats relative to visitors, while the duration of interactions was affected by the number of mountain goats present and the elevation of mountain goats relative to visitors. Ninety percent of all interactions were emotional experiences for visitors, and 95% of the emotions exhibited were positive in nature. Emotional responses varied based on the distance between mountain goats and visitors, time of day, weather, visitor group composition and the number of mountain goat kids present. Twelve emotional responses (both positive and negative) were also significantly correlated with duration.

These findings illustrate the importance of understanding both wildlife and human responses, including emotional responses during interactions. Without the awareness of both, our knowledge is incomplete and effective management decisions cannot be made.

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CHAPTER 1: INTRODUCTION

Background

Human-wildlife conflict is not a novel topic of debate in the United States. As the nation's population grows, so too does the overlap between wildlife habitats and human infrastructure (humanwildlifeconflict.org). This inevitably creates tensions between people and wild animals, bringing together a plethora of stakeholders and researchers that hold a variety of views and values toward wildlife. The nature of the problem changes when the conflict occurs not on private land, but within publicly owned parks that are set aside not only for preservation purposes, but for human enjoyment as well ("Mission", nps.gov). To complicate matters, interactions with animals in park settings are often not avoided, but rather, sought after by visitors.

One such interaction that occurs on recreation wildlands is that between humans and mountain goats (*Oreamnos americanus*). Few conflicts occur between these two species outside of public lands because mountain goats typically reside in high elevation, subalpine ecosystems that are generally inhospitable for or protected from human infrastructure. Therefore, little research has been conducted on this topic. However, new studies are beginning to shed light on interactions between recreationists and mountain goats in National Forests and Parks, which may be more frequent and intense than previously believed (Festa-Bianchet and Côté, 2008; Wright, 1977; Chadwick, 1983; Holyrod, 1967; Bansner, 1978; Stevens, 1983).

Glacier National Park (GNP), located in northwestern Montana and bordering Alberta, Canada, is one such place where mountain goats and recreationists frequently interact. Within its one million acres, GNP accommodates approximately two million visitors every year, and most of these visitors stay in the park between June and August. Not only are visits concentrated

within three months of the year, but they also occur primarily along the Going-to-the-Sun Road, an engineering feat that bisects the park and attracts millions of visitors every summer (Freimund, 2012). All of these factors combined have created a major management challenge requiring the intense scrutiny of park staff in order to fulfill the park's mission, to "preserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations" ("Mission", nps.gov).

Logan Pass, the point of highest elevation on Going-to-the-Sun Road, is a major tourist attraction in GNP. Two of the most popular hiking trails in the park (Hidden Lake and Highline) have trailheads at Logan Pass, and on a typical summer day, the visitor center parking lot fills up by 10 AM. During August of 2012, the Highline trail registered an average of 606 visitors, while the Hidden Lake trail boasted the highest average number of visitors per day of any other trail in the park (1,145 visitors) (Weinberg, Freimund and Dalenberg, 2012).

Humans are not the only species that find Logan Pass appealing, however. A multitude of wildlife can be found among the visitors near the parking lot and along the trails, including golden-mantled ground squirrels, Columbian ground squirrels, hoary marmots, bighorn sheep, ravens and even the occasional wolverine. One of the most highly sought-after animals at Logan Pass is the mountain goat (Lomax, 2013) . Mountain goats prefer rocky, steep terrain and feed on mosses, lichens, trees and shrubs. At 1,970 meters above sea level, Logan Pass lies just below treeline in the subalpine, and provides the ideal habitat for mountain goats. It is characterized by lush, south-facing slopes that support dozens of vascular plants, mosses and lichen, and these meadows are bounded by precipitous headwalls which provide protection from predators (Rockwell, 2007). If visitors are intent on seeing a mountain goat at close range, Logan Pass is the place to do so.

In 2005, collaborative efforts were initiated between faculty and graduate students from the University of Montana and Glacier National Park to monitor use and survey visitors about their experiences travelling Going-to-the-Sun Road. Reconstruction of the road began two years later, and a free shuttle bus system was introduced in hopes of minimizing short-term disruptions to visitors travelling along the corridor as well as long-term impacts to park values (Freimund, 2012). Since monitoring has begun, much has been learned about visitor use dynamics in this portion of the park. Results suggest that the shuttle is increasing the number of visitors who take longer hikes because the transit system facilitates return trips from geographically separated trailheads. The availability of shuttles also appears to be attracting a slightly different visitor: one who is more interested in experiencing the park by foot, rather than by driving ((Freimund et al., 2006a; Freimund et al., 2006b).

Reconstruction of the road is slated for completion in 2014. Park managers anticipate an increase in travel efficiency for visitors driving cars as well as for visitors riding the shuttles. This will likely mean an increase in the number of people on trails adjacent to the road. At present, GNP is working with the University to develop a visitor management plan for the corridor, with the goal of mitigating any adverse impacts to natural and cultural resources, as well as to the visitor experience that may result from these changes in use patterns.

Significance

Glacier National Park is known by many as the Crown of the Continent. The Blackfeet have given the park a different name - “Backbone of the World” - referring to the striking mountain peaks that shoot up from the prairie on the eastern edge of the park (Rockwell, 2007). These names embody the strong association that people have with GNP, and are indicators of the widespread importance of preserving this wild place.

Glacier National Park is one of the most ecologically intact areas remaining in the temperate regions of the world. It is also one of the few places in the United States that offers relatively accessible spectacular scenery and increasingly rare primitive wilderness experiences (Rockwell, 2007). Thus, the park strives to “preserve and protect the natural and cultural resources for future generations” and “to provide opportunities to experience, understand and enjoy the park consistent with the preservation of resources *in a state of nature*” (“Purpose and Significance Statements”, nps.gov). Because wildlife are inherently valuable to people throughout the world (Manfredo, 2008), it follows that one of the top priorities of GNP should be to preserve wildlife habitat and the viability of populations within the park.

Wildlife-watching is one of the most popular outdoor activities in America. One analysis of North American ecotourism markets suggested that seeing wildlife is one of the top four setting attributes desired in a tourist experience (Wight, 1996), and visitors to U.S. national parks consistently rank viewing wildlife as a top reason for their attendance (Manfredo, 2008). As a result of its increasing popularity, wildlife-viewing has generated large amounts of money in parks throughout the country. In 2006, the U.S. Fish and Wildlife Service (2007) estimated that wildlife viewers spent 45 billion dollars. If this trend continues, wildlife management in parks may see dramatic changes in the future, such as a more intense focus on managing human behavior rather than wildlife populations themselves.

Wildlife encounters also appear to be an important part of the GNP experience for many visitors. A survey of hikers on the Highline trail in 2012 indicated that seeing wildlife was a very important motivating factor for 44% of people when choosing that trail. In addition, approximately 76% of these same hikers said that seeing wildlife added greatly to their experience, and 17% said it added somewhat (Bedoya and Freimund, 2012).

Mountain goats are commonly cited as a motivating factor and highlight for many of the visitors at Logan Pass. They are a flagship and an umbrella species within the park, so their protection confers protection to many other subalpine species as well. Because they are migratory and have relatively large home ranges, their habitat provides for a wide range of wildlife and human resource security benefits. Additionally, mountain goat health and continuity are indicators of healthy alpine ecosystems. They are sensitive to environmental conditions and rely on high, cool, rocky terrain to survive. Because Glacier National Park is near the southern extent of their native range, these mountain goats are likely to feel the effects of climate change earlier than northern populations (Glacier National Park, 2013). All of these factors make mountain goats a vital focal animal for studies of habitat and behavioral disturbance by humans.

Considering the vast numbers of people that use the Hidden Lake and Highline trails every day, as well as those simply using the bathroom or looking around the visitor center, human-wildlife interactions are almost constantly occurring at Logan Pass. As overall visitation in GNP continues to increase, and more people are able to access scenic pullouts and trails along the road, interactions with wildlife will likely increase as well. Park managers receive information about these interactions sporadically through anecdotal stories from visitors and other park staff or by witnessing the interactions directly. Therefore, while they have some idea of the frequency and nature of these interactions, generalizations cannot be drawn and trends cannot be understood because they are only receiving small pieces of the very large picture.

Interactions between humans and wildlife are incredibly dynamic and depend on numerous factors. Accordingly, the outcome of each interaction impacts the participants in different ways (Knight and Cole, 1991). It can be difficult to say whether the long-term impacts are positive, negative or neutral for the parties involved (animals, visitors and park managers)

without a solid foundation of observational data to build upon. Collecting data regarding interactions between visitors and mountain goats will give managers the tools to a) effectively communicate with visitors about their safety and well-being when viewing wildlife, b) provide visitors with outstanding wildlife-watching experiences, c) effectively manage wildlife and people so that animals are not harmed as a result of interactions with people, d) understand the potential long-term impacts to wildlife populations and e) support decisions with sound science and present well-informed proposals and management actions to the public.

Problem Statement and Objective

While park managers know that interactions between visitors and mountain goats are occurring at Logan Pass, they do not currently have a firm grasp on the complexities of these interactions. Additionally, previous research regarding the impacts of hikers on mountain goats and responses of visitors to mountain goat encounters does not exist. The primary duty of managers is to make decisions that will help fulfill the mission of the park. Informed and well-supported decisions cannot be made without a rigorous science-based understanding of the issue at hand. Therefore, the objective of this study is to provide GNP managers with a baseline of observational data regarding interactions between humans and mountain goats. The first step in fulfilling this objective was to develop the fundamental guiding questions to frame the research:

1. What is the nature of visitor-mountain goat interactions on Hidden Lake Trail?
2. Based on this understanding, what, if anything, can park managers do to either maintain or improve the quality of these interactions for both mountain goats and visitors?
3. What can be learned about human-wildlife interactions in protected areas based on these results?

CHAPTER 2: LITERATURE REVIEW

Introduction

To understand human-wildlife interactions fully, both wildlife responses and human responses must be examined. Thus, the conceptual framework for this study was constructed through the analysis of two primary bodies of literature: wildlife responses to recreationists and human responses to wildlife encounters. This framework is shown below (Figure 1).

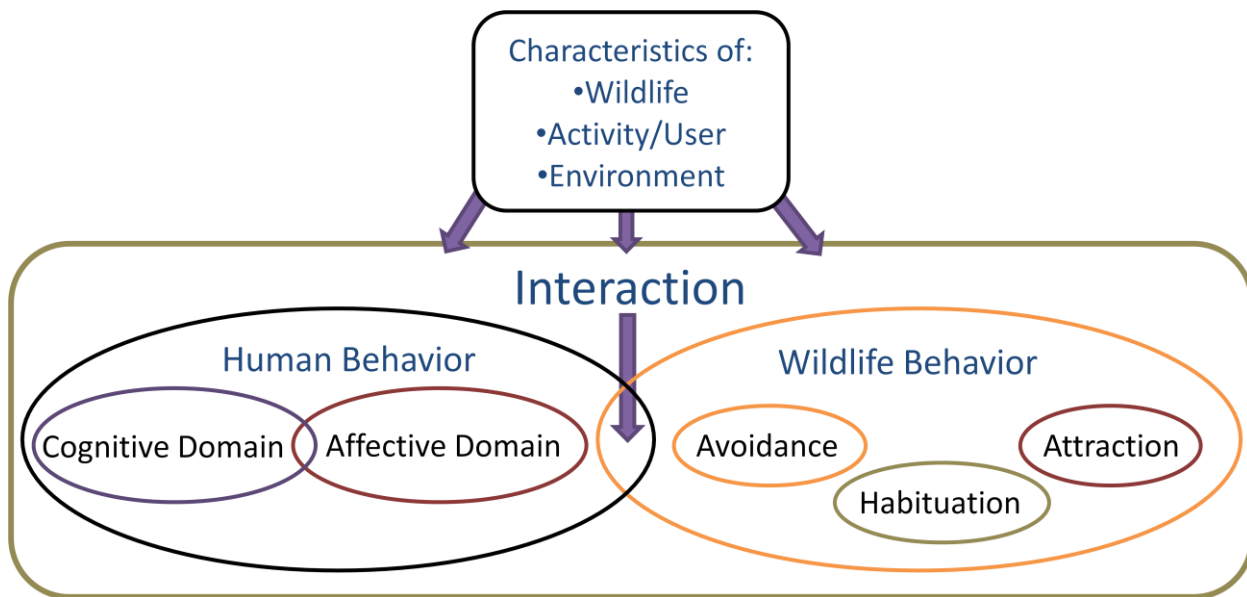


Figure 1 Conceptual Framework for the Study of Human-Wildlife Interactions

This chapter is organized into four major sections. The first section touches briefly on the field of human dimensions of wildlife (HDW) to provide a general foundation for the study. In the second section, human responses to wildlife are explored, with a focus on emotions and social norms elicited by wildlife. Human behavior as a measure of emotion is also discussed.

Next, wildlife responses to recreationists are examined in the literature. The variables that affect the outcome of an interaction for wildlife are analyzed, as well as the potential short and long-term impacts of interactions with recreationists. Finally, section four provides a short natural history of mountain goats and sheds light on studies that have specifically investigated interactions between mountain goats and recreationists.

This study is the direct response to a call for an increased understanding of both mountain goat and human behavior along a heavily used trail in Glacier National Park. Thus, management implications are also presented in two of the sections to provide wildlife professionals with the tools needed to manage a variety of human-wildlife encounters in Glacier National Park.

Human Dimensions of Wildlife (HDW)

“The utility of research can be improved by strengthening the conceptual foundation of investigations. This will enhance our ability to understand human behavior, predict its occurrence, and affect it in achieving conservation goals (Manfredo, 2008).”

The integration of social sciences into wildlife management and conservation has been slow to evolve. It wasn't until the 1970s that the phrase “human dimensions of wildlife” was introduced into wildlife management (Hendee and Schoenfeld, 1973). The increase in use of HDW was largely a result of funding from federal, state and local government agencies that were seeking ways to deal with “people problems” (Manfredo, 2008). It has become widely accepted that while “social science information may not ensure consensus or eliminate controversy, it will help to anticipate and define the nature of problems and guide action in dealing with conflicts” (Manfredo, 2008). In other words, human-wildlife conflict is not a one-dimensional issue. It cannot be looked at solely as a wildlife management problem or as a human management

problem. All aspects of the conflict must be analyzed in order to make informed and effective decisions. Historically, wildlife professionals were largely concerned with managing wildlife and less so on managing human behaviors to prevent conflicts (Manfredo, 2008). As human dimensions of wildlife gain ground, a shift in this paradigm is occurring.

Human Responses to Wildlife

According to Manfredo (2008), “Human response to wildlife is based on a complex mix of emotions and cognitions.” Emotions are feeling states about specific events that last for only short periods of time and occupy conscious thought, while cognitions are a collection of mental dispositions and processes (Manfredo, 2008; Jacobs, Vaske and Roemer, 2012). The cognitive domain describes human thought structurally, building from the basic (values) to specific (attitudes), and includes influences from social group involvement (norms). Contrarily, emotions have an effect on behavior that is independent of thoughtful processing.

Cognitive Domain

The cognitive hierarchy emphasizes that human cognitions exist on different levels of abstraction or specificity and distinguishes stable but general values from more specific cognitions (e.g., attitudes, norms) that people use to evaluate wildlife encounter situations (Jacobs, Vaske and Roemer, 2012). According to Ajzen and Fishbein (1980), values are stable beliefs that there are specific modes of conduct that are preferable to converse modes of conduct. Attitudes, in contrast, are learned predispositions to respond favorably or unfavorably to an object, person, issue or behavior (Ajzen and Fishbein, 1980).

Prominent cognitive theories of behavior include the theory of reasoned action (TRA) and its extension, the theory of planned behavior (TPB). TRA suggests that attitudes and

subjective norms lead people to develop intentions to perform a behavior and that those intentions predict the performance of the behavior (Ajzen & Fishbein, 1980). TBP added the element of perceived behavioral control to the model to address people's perception of their ability to perform a specified behavior (Ajzen, 1991).

Specific attitudinal or normative variables seem to be better predictors of behavior than are general cognitions like values (Jacobs, Vaske and Roemer, 2012). Research has revealed that these cognitive variables can explain approximately half of the variability in behavioral intentions or reported behaviors (Bright, Manfredo and Fulton, 2000; Sijtsma, Vaske and Jacobs, 2012; Teel and Manfredo, 2010; Whittaker, Vaske and Manfredo, 2006).

A new model called the integrative model of behavioral prediction (IMBP) incorporates affective variables into TBP as antecedents to the development of beliefs (Fishbein and Yzer, 2003). For example, suppose a person has previously experienced a highly emotional wildlife encounter. This will likely influence the person's beliefs about future interactions, as well as the behavioral, normative, and efficacy aspects of the model. However, the IMBP also includes environmental constraints which have the potential to induce emotional states that play a more direct role than antecedent affective variables in either facilitating or disrupting planned behavior. Incorporating this into the previous example, if the next time the person encounters the same animal, and the animal behaves differently than it did during the initial experience, it is likely that the associated emotional state will override prior beliefs and disrupt intentions from manifesting as actual behavior (Fishbein and Yzer, 2003). If cognition and emotion are constantly interacting with each other as this model suggests, this begs the question: How much variability in behavior is accounted for by emotions?

Affective Domain

Compared to the cognitive approaches, little empirical research has been conducted regarding the influence of emotion in human-wildlife interactions. Historically, emotions were believed to interfere with more “desirable” forms of human response. Therefore, wildlife professionals have been encouraged to emphasize “science” and exclude emotional considerations from decision-making processes (Manfredo, 2008). Ideas about the centrality of emotion in our personal experiences with wildlife are beginning to shift, however, as more information about human emotions comes to light. As Manfredo (2008) puts it, “From an applied perspective, it is important to realize that emotional responses are at the heart of human attraction to, and conflict over, wildlife.”

Human–wildlife interactions are typically emotionally charged events; individuals may experience worry, excitement, fear, pleasure, or a variety of other highly valenced emotions. These emotions may drive both an individual’s behavior during an interaction and his or her interpretation of the event (Hudenko, 2012). Sudden encounters with wildlife, for example, often evoke strong emotions that a person remembers. Emotion constitutes a potent internal force that drives our motivation to view wildlife (Jacobs, 2009). Individuals with strong emotional dispositions toward wildlife are more likely to identify wildlife in a complex natural scene (Öhman, Flykt, & Esteves, 2001).

In 1980, Plutchik developed a wheel of emotions, comprised of 8 primary bipolar emotions: joy versus sadness; anger versus fear; trust versus disgust; and surprise versus anticipation. In addition, the model makes connections between the idea of an emotion circle and a color wheel. Like colors, primary emotions can be expressed at different intensities and can mix with one another to form secondary emotions (Figure 2).

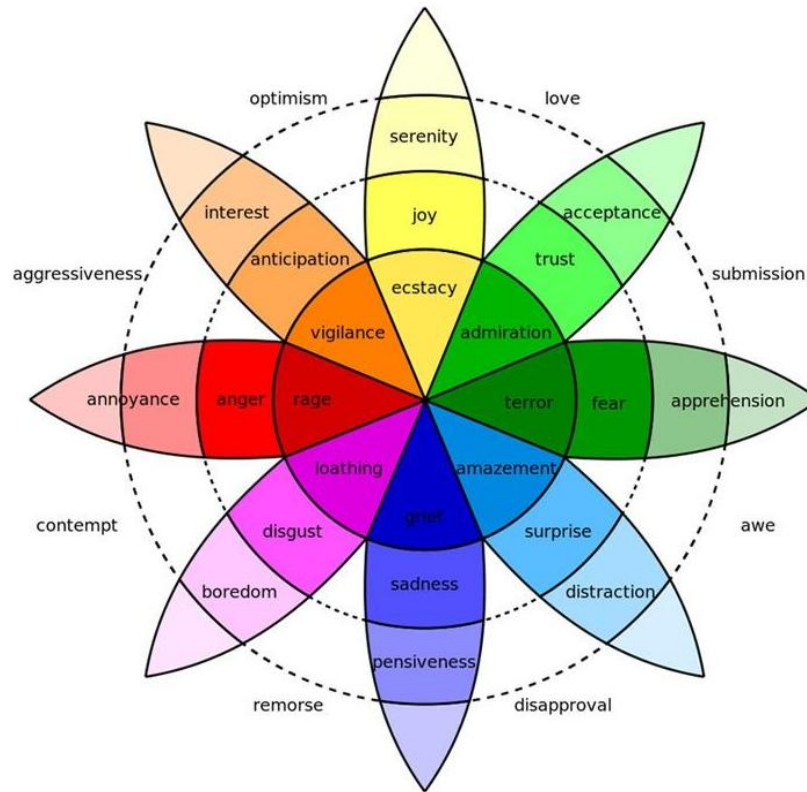


Figure 2 Plutchik's wheel of emotions

This categorization, along with several studies that have been conducted regarding affect displays such as facial expressions, vocalizations, gestures and physiological responses, provided a useful framework with which to observe emotions through behavior.

Theory and research suggest that humans evaluate the emotional relevance of stimuli in terms of five dimensions: (a) novelty (has anything changed), (b) valence (is it good or bad), (c) goals (is it obstructive or conducive to current goals), (d) agency (what is the cause and can it be controlled or predicted), and (e) norms (is it compatible with standards) (Ellsworth & Scherer, 2003; Scherer, 1999; Smith & Ellsworth, 1985). Phrased as questions, these evaluations are as follows: Is there anything new (novelty), is it relevant (valence), are there consequences (goals), can I cope (agency), and is it normatively significant (norms) (Sander et al., 2005)?

Recent reviews of research on emotions reveal that the affective or emotional state of individuals significantly affects the decisions they make (Forgas, 2003; Hudenko, 2012; Isen, 2000; Petty Fabrigar & Wegener, 2003). Human decision making plays a key role in both wildlife habituation and food conditioning processes. These processes in turn may have impacts on the ways in which humans interact with wildlife. Particular variables such as perceived risk and an individual's emotional state are likely to influence human decision making, and therefore behavior, related to habituation and food conditioning (Hudenko, 2012).

Previous research on decision-making has focused primarily on cognitive theories of behavior (e.g. TRA and TPB). It is important to note, however, that many other factors not addressed by strictly cognitive approaches also play a role in decision making. For example, the unconscious use of heuristics and biases can influence decision making, as well as the mental accessibility of information, or the way in which ideas are presented, or framed (Hudenko, 2012).

Optimism bias, or the inclination to overestimate positive outcomes and underestimate negative ones (Gilovich et al., 2002) seems particularly relevant to human–wildlife conflict situations. For example, in situations where people actively seek interactions with wildlife such as in parks, they may feel that they are prepared for an encounter and that a bad experience could happen to others, but not to them. They also may believe that because they simply want to observe wildlife, the animal will not respond negatively (Hudenko, 2012).

While cognitive theories such as TRA and TPB help us to understand the more conscious, reasoned elements of decision making such as attitudes, norms, and control, the various heuristics and biases described above suggest that many processes beyond those that are purely cognitive influence decision making. Many of these unconscious strategies that people rely upon

when encountering wildlife indicate that emotions may be an important factor (Hudenko, 2012). Emotionally laden thoughts are highly salient and more readily encoded than non-emotional thoughts (Bernstein et al., 2006) and therefore are more likely to be accessible when people encounter wildlife. Additionally, when making decisions, humans tend to employ, often automatically, strategies that promote a reduction in cognitive load, thereby decreasing the amount of mental energy required for decision making (Simon, 1990; Wilson, 2008).

Contemporary theorists suggest that cognitive and emotional processing occurs via separate systems in the brain, but that these systems interact concurrently to generate a reaction to stimuli (LeDoux, 2000). Dual process models identify two types of processing that occur when a decision is made (Kahneman, 2003; Sloman, 1996). System 1 is automatic, unconscious, based on affect, and an immediate impression of the stimulus. In contrast, system 2 is controlled, reasoned, and conscious. The processing that occurs through system 1 is moderated by system 2 to produce what is presumed to be the “best” decision. For example, while on a hike, a person might see a bear cub. The system 1 response may be excitement and empathy for what appears to be a baby animal alone in the forest. The behavioral response could be to approach the animal. System 2 might then activate and the person may recall that he or she learned mother bears are likely to be nearby and will protect their cubs fiercely. Therefore, the person may decide to avoid the bear and continue hiking with caution (Hudenko, 2012).

In general, though, when emotional arousal is high, and/or an individual has prior experience to draw from, affective processing will dominate decision making. Since emotions are likely to be intense during interactions with wildlife, models that incorporate emotion as a significant variable that influences decision making seem most appropriate to understand human behavior with respect to human–wildlife interactions (Hudenko, 2012). Therefore, this study

specifically addresses the question, “Do visitors respond emotionally during mountain goat encounters?”

Measures of Emotion

To understand the measurement of emotion, it is important to recognize the difference between the discrete and the dimensional perspectives on the nature of emotions (Gray and Watson, 2007; Mauss and Robinson, 2009). The discrete perspective focuses on specific emotional states such as fear, joy, or anger. Each emotion corresponds to a unique profile in experience, physiology, and behavior (Ekman, 1999; Panksepp, 2007). In contrast, in the dimensional perspective, emotional states consist of a limited number of general dimensions, most notably valence (liking–disliking dimension) and arousal (activation–deactivation dimension). Approach versus avoidance tendencies and submissiveness versus dominance are occasionally mentioned as additional dimensions. The valence dimension contrasts states of pleasure (e.g., happy) with states of displeasure (e.g., sad), and the arousal dimension contrasts states of low arousal (e.g., quiet) with states of high arousal (e.g., surprised). Approach motivation is characterized by tendencies to approach stimuli (e.g., as would likely be facilitated by excitement), whereas avoidance motivation is characterized by tendencies to avoid stimuli (e.g., likely facilitated by anxiety). Some emotion measures tap into discrete emotions, while other measures are sensitive to dimensions (Jacobs, Fehres and Campbell, 2012).

Emotion can be measured using a number of methods including self-report, physiological, brain activity and behavioral measures. A majority of studies that have addressed human emotional responses to wildlife have utilized self-report, single-item measures and have focused on fear. Therefore, there is limited knowledge about the other potential measures of emotion in response to wildlife (Jacobs, Fehres and Campbell, 2012).

Self-report measures are popular instruments to assess emotional responses to wildlife because they are relatively inexpensive and easy to administer. Many self-report assessment instruments for measuring emotions have been developed and tested (Jacobs, Fehres and Campbell, 2012). Typically, the scales used to measure emotion consist of lists of adjectives describing either discrete emotions or emotional dimensions and response categories denoting the extent to which the adjective describes the respondent's experience (Larsen and Frederickson, 1999). Self-report measures of emotion are practical because they can be used to assess past emotions, current emotions, anticipated emotions, and emotions in general (Robinson and Clore, 2002). Additionally, a number of self-report measures have good construct validity, as demonstrated by correlations with personality trait scales and other types of emotion measures (Gray and Watson, 2007). Downfalls of self-report methods include the potential for mental fatigue (Poels and Dewitte, 2006), social desirability bias (Mauss and Robinson, 2009; Welte and Russell, 1993), and the inability to verbalize a specific emotional state (Larsen and Frederickson, 1999; Mauss and Robinson, 2009). Bias may also result from the recall of past experiences or anticipation of future experiences (Robinson and Clore, 2002).

Behavioral measures of emotion have historically been used less frequently in human-wildlife interaction studies because quantifying emotion through behavior is subject to interpretation by the observer. However, it is becoming increasingly apparent that to yield robust results and truly understand human emotions toward wildlife, it is necessary to employ a variety of emotion measures across studies (Jacobs, Fehres and Campbell, 2012). Thus, the study presented here utilized solely behavioral measures of emotion to increase our general understanding of this measure of emotion toward wildlife.

Darwin (1965) suggested that emotions serve an evolved communicative function and thus should prime behaviors that reveal one's emotional state to others (see Ekman, 1992, for a related view). Another set of theories links emotional states to action dispositions, such as the primed tendency toward flight in the case of fear (Frijda, 1986; Lang et al., 1997). According to these theories, it is possible to infer a person's emotional state from vocal characteristics, facial displays, and whole-body behaviors.

The most consistent association between behavior and emotion reported in the literature is between arousal and vocal pitch, such that higher levels of arousal have been linked to higher-pitched vocal samples (Bachorowski, 1999; Kappas, Hess, & Scherer, 1991; Pittam, Gallois, & Callan, 1990). Facial behaviors also appear to reliably indicate the valence of a person's emotional state (Russell, 1994). For example, Duchenne ("non-social") smiles involving wrinkling of the muscles around the eyes have often been linked to experiences of positive emotion (Ekman, Davidson, & Friesen, 1990; Frank, Ekman, & Friesen, 1993; Hess, Banse, & Kappas, 1995; Keltner & Bonanno, 1997). On the other hand, negative emotion inductions are often associated with a visible facial behavior in which the eyebrows are lowered and brought closer together (Kring & Sloan, 2007). Although research on bodily expressions of emotion is sparse (Adolphs, 2002; Van den Stock, Righart, & de Gelder, 2007), the research that does exist indicates that at least certain emotional states may have distinct bodily behavior signatures. In particular, pride and embarrassment have been linked to expansive and diminutive body postures, respectively (Jacobs, Fehres and Campbell, 2012).

Norms

The type of emotion that a person expresses often depends not only on their feelings about the situation, but also on the norms that apply to the situation. For example, the ability for a person to empathize toward animals would dictate the extent to which that person would exhibit helping behavior to alleviate emotional distress. Norms direct us in appropriately revealing our feelings, while emotions ensure that normative behavior is followed (Manfredo, 2008).

Schwartz and Howard (1982) proposed that there are two types of norms: personal and social. They defined personal norms as “situation-specific behavioral expectations generated from one's own internalized values, backed by self-administered sanctions and rewards”. Conversely, social norms are “group expectations backed by externally defined and imposed rewards and punishment”. Personal norms, they contend, are highly influential in making moral decisions, more so than social norms. This is especially true if the individual is aware of the consequences of their actions and feel responsible in the situation. An individual's personal norms depend on whether the value that is being affected is central to one's own self-evaluation. Manfredo (2008) illustrates this by describing a situation in which one individual sees another person feeding wildlife in a park. If the person observing the feeding identifies themselves as a park purist, or someone that views parks as undisturbed natural systems, they are more likely to speak up or take action against the wildlife feeding. If not, they will likely do nothing to stop it.

Another type of norm that commonly exists in places such as national parks, where norms of appropriate behavior may be vague, is a descriptive norm. These are “observable regularities of behavior that would provide cues regarding socially acceptable forms of behavior in a given situation.” When uncertainty exists, people look for guidance in what others are doing

to perform “correctly” (Manfredo, 2008). Cialdini et al. (1990) suggested that this tendency is related to a basic motivation to be effective and competent in our action.

The conceptual structure of norms has been an important component of models used to predict the behavior of individuals. Thus, the ability of wildlife managers to influence human behavior can be enhanced by a better understanding of the operation of norms (Manfredo, 2008).

Management Implications

A basic knowledge of these concepts can have a significant impact on the way that wildlife professionals perceive interactions and make management decisions based on those interactions. Studying emotions might improve our general understanding of human behavior toward wildlife and associated experiences, especially if emotions are examined in relation to cognitions (Manfredo, 2008). Wildlife interactions, and a certain (as of yet undefined or identified) degree of human–wildlife habituation have the potential to create positive conservation impacts. People who enjoy wildlife may seek out encounters, increasing their appreciation for wildlife and thereby support for conservation initiatives (Kretser, Curtis, Francis, Pendall, & Knuth, 2009). It is also possible, however, for human–wildlife interactions to become risky situations that result in harm to people or wildlife. Furthermore, habituation may lead to food conditioning, which in general causes conflict between people and wildlife. Finding a balance between learned approach and avoidance behaviors in both people and animals will be key to the successful management of human–wildlife interactions (Hudenko, 2012).

Knowing the underlying elements that influence the decisions that people make can also have a major impact on management decisions. One of the inherent difficulties associated with finding an appropriate level of habituation from a behavioral decision-making perspective is understanding how to encourage “good” decision making in people (Hudenko, 2012). The

definition of a good decision is debated in the decision-making literature. Decisions may have coherence (i.e., are logical and rational according to the individual decision-maker's goals), and/or they may have correspondence (i.e., is consistent with the reality of the situation) (Reyna & Farley, 2006; Tape, 2009). Finding a balance between coherence and correspondence is a very real problem for wildlife managers. For example, a person who approaches an animal may be acting consistently with his or her beliefs and goals to be close to wildlife, thereby exhibiting coherence. Such behaviors, however, may not constitute a good decision from a manager's perspective because close encounters with wildlife are potentially risk-laden. Investigating people's decision-making processes when they encounter wildlife may help to illuminate some of the issues associated with individuals' decision making in the context of human-wildlife conflict. "If researchers and managers can work toward identifying a sustainable level of human-wildlife habituation that prevents negative outcomes, and fosters positive encounters, an opportunity exists for human-wildlife interactions to help further conservation goals" (Hudenko, 2012).

Knowing that people relate strongly to wildlife at an emotional level is important for natural resource professionals, whom often communicate with the public in a highly factual, cognitive fashion. Developing strategies that evoke emotional reactions could greatly improve how persuasive a manager is when communicating with the public. Managers would benefit from knowing if communication can induce the use of a heuristic that leads to the desired (from a management perspective) behavior or if emotionally charged communications could serve as "emotion markers" that influence behavior (Hudenko, 2012).

Wildlife Responses to Outdoor Recreation

The following discussion addresses the general wildlife responses that can occur as a result of human disturbance. It also examines the different variables that can affect the type of response exhibited by an animal.

General Wildlife Responses

Knight and Cole (1991) present three classes of wildlife responses to humans:

- 1) *Attraction*: The strengthening of an animal's behavior as a result of positive reinforcement (e.g. food, shelter or security). This implies a movement *toward* stimuli.
- 2) *Avoidance*: The opposite of attraction. An aversion to negative consequences associated with a stimulus. In contrast, *escape* is a reaction to aversive consequences rather than the prevention of those consequences (Domjan and Burkhard, 1986).
- 3) *Habituation*: A waning of response to a repeated, neutral stimulus. This term is often misapplied and confused with attraction (Humphrey, 1930; Thorpe, 1956; Eibl-Eibesfeldt, 1970). Habituation has little to do with the word "habit", as it implies disregard for stimuli rather than continuous reaction to it. Conversely, *sensitization* is the opposite of habituation. It is the increased response to a stimulus (Domjan and Burkhard, 1986; Immelmann and Beer, 1989).

Several ideas exist about the basis of these response behaviors. Many wildlife researchers consider attraction, avoidance and habituation to be learned behaviors (Klopfer, 1974; Knight and Cole, 1991), while others suggest genetic roots (Klopfer, 1974; Knight and Temple, 1995). Some believe these responses to be both genetic and learned, which Hailman (1967) termed

“learning an instinct”. This refers to the idea that genetic components of response behaviors can be reinforced through learning (e.g. mountain goats responding to gunshots in a similar way that they respond to rock falls) (Geist, 1971). Still others suggest they may be culturally transmitted across generations (Thurber et al., 1994). This may have important implications for the long-term viability of populations in response to recreation.

It is important to note that different wildlife species do not learn the same responses for all situations. Manning (1992) proposed that animals with greater cognitive abilities and longer rearing periods may respond differently to new settings or additional stimuli. Additionally, one response can often lead to a different response (e.g. attraction leading to habituation (Goodall, 1986) or habituation leading to attraction (Olson et al., 1997)), and responses harmful to one species may be beneficial to another (Shelby and Heberlein, 1986; Bekoff and Jamieson, 1991). Thus, wildlife responses should be treated as continuous, rather than branching, and should be considered in context and in differing magnitudes (Whittaker and Knight, 1998).

Variables Affecting Wildlife Responses

As stated above, wildlife responses to humans are varied and depend heavily upon the context of the situation. Cole (2004) concludes that frequency of use, type of use, season, environmental conditions, and distribution of use are the key physical factors determining the magnitude of disturbance. Steidl and Anthony (1996) describe these variables as the “disturbance context”. These factors have been broken into three categories, and are discussed in further detail below. Also included in these categories are three other factors of considerable importance: recreationist behavior, species characteristics, and animal group type.

- Characteristics of Wildlife

Wildlife characteristics include attributes of the species along with animal group size and composition (i.e. natural history). Knight and Cole (1995) discuss the importance of knowing how recreation impacts can differ by species. They report that species that are specialized in terms of diet and habitat requirements are more vulnerable to disturbance than species with generalized requirements. Further, species residing in stable environments often respond more intensely to disturbances because they haven't evolved mechanisms to respond to rapid changes. Rather, they have been selected for longevity and specialization. On the other hand, species in fluctuating environments that have been selected for rapid reproduction are better able to adjust to unpredictable events (MacArthur and Wilson, 1967; Pianka, 1970). Knowing this, one would also expect native and non-native wildlife species to respond differently to recreation-induced disturbance.

Body size can also determine the specific response of an animal. Several studies have found that larger species flush at greater distances than smaller species (Cooke, 1980; Skagen et al., 1991; Holmes et al. 1993). One explanation for this finding is that larger species are more conspicuous and have historically been persecuted more frequently by humans (Cooke, 1980). Another explanation suggests that it is energetically more costly for small species to flee because their surface area to body weight ratio is greater than for large species. (Hayes and Gessaman, 1980; Koplin et al., 1980; Wasser, 1986).

The group size of animals can also determine the type of response elicited by disturbance. Research has shown that animals feeding in groups tend to respond to humans at greater distances and are less vulnerable to approaching threats than animals that are alone (Rubenstein, 1978; Morse, 1980; Pulliam and Caraco, 1984). Knight and Cole (1995) further

report that as flock or herd size increases, time devoted to vigilance decreases. Group composition also plays a role in response to disturbance. In one study of caribou, herds that were composed of cows and calves were more likely to flee than all-cow groups, while herds composed only of bulls were least likely to flee from threats (Singer and Beattie, 1986).

- Characteristics of the Activity and User

Characteristics of use and the recreationist are also important to understand when examining wildlife responses. First, the activity type, frequency, magnitude and predictability (as described previously) should be identified. Another significant, but often overlooked variable is the behavior of the recreationist. For example, the speed at which a recreationist moves toward an animal can greatly affect how the animal responds. Typically, rapid movement directly toward wildlife is more frightening than movement away from the animal (Knight and Cole, 1995). A study by Richens and Lavigne (1978) showed that white-tailed deer were more alarmed by snowmobiles moving at high speeds than those at low speeds, but when people stopped to view the deer, they always flushed.

Wildlife also exhibit a stronger response to humans that approach them directly and off designated trails (Moen et al., 1982; Knight and Cole, 1995a), and the noise made by recreationists often disturbs wildlife as well. Karp and Guevara (2011) discovered that even average levels of conversational noise can have an impact on wildlife behavior.

- Characteristics of the Environment

The last category of variables that can have an effect on wildlife responses is “environmental conditions”. This category is wide-ranging and includes factors such as season,

weather, time of day, location of animal, cover type, etc. All environmental conditions should be recorded at the time of the observation, so that none of them can confound the results.

Season can refer to either seasons of the year or whether it is breeding season for the species under investigation. The consequences of disturbance during breeding season compared to those outside breeding season are quite different, but can be equally severe (Knight and Cole, 1995). During the breeding season, disturbances can affect an individual's productivity by eliciting the following responses: abandonment of nests or young, altered attentiveness to young, disrupted feeding patterns and exposing young to environmental stress. Outside of the breeding season, the major concern of disturbance is the individual's energy balance rather than productivity. Responses include: reduction in energy acquisition (e.g. foraging) or increases in energy expenditure (e.g. fleeing) (Knight and Cole, 1995).

The location of the animal in relation to the recreationist can assist in determining the response of the animal as well. One aspect of location is elevation. Evidence suggests that wildlife often show more pronounced responses to activities that are occurring above them (Taylor and Knight, 2003). It seems they perceive this as a greater threat to their safety and ability to escape (Hicks and Elder, 1979; Herbert, 1965; Taylor and Knight, 2003). Another factor related to an animal's location is the amount of open distance between themselves and the potential threat. As the distance decreases, the animal's response increases (Skagen et al., 1991; Newton and Campbell, 1973; Madsen, 1985).

In order to gain a deeper understanding of the nature of interactions occurring between visitors and mountain goats on the Hidden Lake Trail, a number of the above variables were recorded during interactions. Therefore, the following questions were addressed: do interactions vary depending on the time of day, weather, and distance/elevation between recreationists and

goats?” and “do mountain goat or visitor behaviors vary based on the time of day, weather, or distance/elevation between recreationists and goats?”

Impacts to Wildlife Following Disturbance

While it is easy to observe and record an animal's response to a specific stimulus, it can be more difficult to determine what kind of impact the stimulus will have on the animal. Impacts can be either positive or negative (although few studies have addressed positive impacts to wildlife as a result of human activity). Negative impacts include energy costs from increased stress levels, decreased foraging time and increased movement due to flight and avoidance. Reproductive costs and displacement are other negative consequences of human disturbance (Knight and Cole, 1991).

Impacts to wildlife from recreation are also either direct or indirect. Direct impacts resulting from recreation include harvest and harassment, while habitat modification is an indirect impact. All three of these impacts can lead to three responses by wildlife. First, the animal may alter its behavior. This could be anything from habituation to migration. Second, the animal may be displaced completely to a new habitat or from the population. Third, the impact may ultimately lead to a reduction in reproduction or survival. No matter what the response, these impacts result in a change in the species composition and the structure of the population (Hammit and Cole, 1987).

Knight and Cole (1991) state that generally, the immediate response of wildlife to disturbance is a change in behavior (e.g. cessation of foraging, fleeing or altering their reproductive behavior). The long-term effects of human presence in wildlife habitat are not as well understood, as they are more difficult to measure and less studied.

Long-term studies on wildlife impacts are of the utmost importance for wildlife managers. Perhaps immediate negative responses by wildlife do not actually have much of an effect on their survival and productivity. On the contrary, maybe the impacts are more far-reaching than can be estimated from a short-term investigation. It is also possible that long-term impacts from recreation may be beneficial for a certain species. Studying individual animals over a period of years can yield a wealth of information that would be difficult to achieve in only a few months. When an animal is disturbed, the short-term effect on its behavior, survival, reproduction and distribution will likely cause long-term reactions for both the individual animal and the animal community (Knight and Gutzwiller, 1995).

One long-term study conducted by Marion et al. (2008) addressed the issue of food-conditioned wildlife. They found that food-conditioned animals can suffer nutritionally and be aggressive toward humans. On a larger scale they claim that these wildlife populations may reach unnaturally high levels, abandon territories, and move to more exposed recreational sites, which increases their susceptibility to predation and vehicle collisions. Another study by Yarmoloy et al. (1988) utilized all-terrain vehicles to harass mule deer. The disturbed deer altered their feeding and spatial use patterns and experienced decreased reproduction the following year, while the undisturbed deer maintained normal usage and reproductive success. Similar results were obtained by Hamr (1988) with chamois being displaced by hikers and skiers from nutritionally important habitats for prolonged periods. During the 1980s wolves in the Great Lakes region retreated entirely from areas with road densities greater than 0.61 km/sq. km. (Thiel, 1985; Jensen, 1986; Mech et al., 1988).

Not all human disturbances result in energy or reproductive costs to wildlife. For example, several studies of birds, deer and red squirrels suggest that generally, walking as a

recreational activity does not have significant long-term impacts on animal behavior (Marzano and Dandy, 2012). Research conducted by Jeppeson (1987a, 1987b) found that orienteering activities displaced roe and red deer from their home ranges, but the animals eventually returned after the disturbances ceased. This illustrates the importance of understanding the relationship between length of activity and intensity of the impact on wildlife. In this case, it was a one-time activity, but in many areas, activities continue for several years.

Mountain Goats

Mountain goats are generalist herbivores, meaning they eat a broad range of forage (e.g. grasses, sedges, forbes, shrubs, ferns, mosses, lichens and conifers) (Hjeljord, 1973). In general, they occupy alpine, rugged terrain, but they will use lower-elevation subalpine or montane terrain to access mineral licks (Shackleton, 1999).

Mountain goats typically occur in small groups of adult females (nannies) and their kids and occasionally a few associated immature males and females. Adult males (billies) are usually solitary or found in small groups except during rut (November-December) (Wright, 1977; Chadwick, 1983; Festa-Bianchet and Côté, 2008). Nannies isolate themselves in late spring (May-June) and give birth in high-elevation, steep and rugged terrain (Lemke, 1999; Shackleton, 1999; Côté and Festa-Bianchet, 2001a). Nannies and kids remain isolated for <2 weeks before returning to spring and summer range (Côté and Festa-Bianchet 2001a).

Mountain goats have an established hierarchy, and therefore there is a fair amount of intra-specific aggression. In most situations, females are dominant to males (Chadwick, 1983; Hutchins, 1984). However, this is not the case at salt and mineral licks, where a dominance structure is less apparent (peak use of these areas is June – July) (Rideout, 1974; Singer, 1977).

In most areas of their range, mountain goats are reclusive and do not allow humans to

approach closely (Festa-Bianchet and Côté, 2008). For example, in a hunted population in the Washington Cascades, the mean closest distance an observer could approach goats on foot was 351 m (nannies with kids) and 213 m for billies (Wright, 1977). However, in areas where unhunted populations come in repeated contact with humans, goats have become habituated to the presence of humans and allow people to approach much closer, some to within 10 feet (Chadwick, 1983; Holyrod, 1967).

Attacks on humans have occurred in Glacier National Park (Gunsight Pass, 1980s), Olympic National Forest (Mt. Ellinor, 1999) and Olympic National Park (Hurricane Ridge, 2010 – fatal). All attacks were a result of goats that had habituated to humans and made a positive association between people and salt. In the Olympic National Park situation, the goat was in rut.

Mountain goats in some protected areas have been observed to abandon home ranges when subjected to stress or disturbance (Chadwick, 1983). In other cases, though, mountain goats in national parks have been observed to be fairly tolerant of human disturbance and readily habituated to backcountry users (Bansner, 1978; Stevens, 1983).

Knowing this, one of the research questions this study explored was how mountain goats behaved during an interaction with humans compared to how they behaved when no humans were present or interacting. This provided insight into the subtle impacts that visitors had on the way mountain goats behaved and how mountain goats may be affected by interactions with people over longer periods of time. Additionally, this research shed light on the frequency of negative interactions, or interactions in which a visitor or mountain goat responded aggressively or aversely during an interaction.

Management Implications

One significant challenge to overcome when dealing with wildlife management problems is that of asking the right question. Whittaker and Knight (1998) address this challenge in terms of wildlife habituation. They say that instead of asking a question like, “Are these animals habituated?” a better question would be “Under what conditions does habituated behavior exist?” or “How long does habituation take to appear?” The first question requires a yes or no answer, and most of the time, the answer is neither yes nor no.

This brings up a second difficulty that managers and scientists must overcome, and that is the problem of terminology and communication. Managers and scientists may apply different definitions to the same words (e.g. habituation, attraction and avoidance). This is not surprising as value judgments are easily and often attached to these words. Remaining unbiased can be particularly difficult when evaluating wildlife responses, but it is imperative that judgments about what is “right” or “natural” be left out of research. There is a time and place for judgments to be made and that is *after* the research has been done, and has been disseminated to managers, stakeholders, interest groups and the public. (Whittaker and Knight, 1998).

In order to communicate effectively and ease the decision-making process, ideals for wildlife responses must be explicit and acceptable standards must be developed (Whittaker and Knight, 1998). Ideals can vary widely based on spatial, situational and temporal factors. A classic example of the dynamic nature of wildlife management is the management of bears in national parks from the early 1900s to present day.

Early on in the history of parks, bears were allowed access to human foods either through direct handouts, public feedings, or unrestricted access to garbage dumps (Schullery, 1992; Wondrack-Biel, 2006). This led to numerous human injuries, and thus, the removal of many

bears. Throughout the 20th century, bears have become more socially and ecologically valued in the United States, and consequently, bear management in parks has shifted from focusing on removal of problem bears to modification of visitor behavior. Glacier National Park implemented their first bear management plan in 1968, utilizing the “new” approach. Evidence has shown that it has been quite effective in reducing bear mortalities, as well as incidents of obtaining food and damaging human property. Results have been similar for other North American national parks that have implemented bear management programs (Gniadek and Kendall, 1998).

This example also stresses the importance of understanding human as well as wildlife behavior when addressing wildlife management problems. Baruch-Mordo et al. (2009) states, “There is a growing recognition among wildlife managers that focusing management on wildlife often provides a temporary fix to human-wildlife conflicts, whereas changing human behavior can provide long-term solutions.” As the number of recreationists in wilderness areas continues to increase, this knowledge has never been more vital for the conservation of wildlife.

Finally, studies such as those presented in this review provide managers with a wealth of knowledge that informs and guides the decisions they make regarding wildlife and visitor management. Knowing how animals respond to various disturbances and the long-term impacts on wildlife populations and communities provides support for controversial management actions.

Filling the Gaps

From the review of existing literature, as well as from concerns brought forth by GNP managers, five specific research questions were developed to better understand human-mountain goat interactions on Hidden Lake Trail and beyond:

1. What constitutes an interaction, and are there differences in how mountain goats behave during an interaction compared to when no interaction is occurring?
2. How often do negative interactions occur?
3. Do the frequency and duration of interactions vary depending on the time of day, weather, and distance/elevation between recreationists and mountain goats?
4. Do the frequency and duration of interactions vary due to visitor or goat group compositions/behaviors?
5. Do visitors respond emotionally during mountain goat encounters? How do emotional responses vary depending on the time of day, weather, distance/elevation between the recreationist and the goats, and goat group composition/ behaviors? Is there an association between emotional responses and the duration of an interaction?

Previous studies have addressed interesting and innovative questions about both human and wildlife responses during encounters. However, a number of gaps remain in the literature. These research questions were the first step in filling these gaps, not only for managers at GNP but for all professionals in the human dimensions of wildlife realm.

CHAPTER 3: METHODS

Introduction

This chapter details the methods that were employed in designing, implementing and executing the study. In the first section, the study site is described and justified. The next section discusses the schedule that was designed for carrying out the data collection. Finally, the sampling methods are described in detail, including the form that was designed for recording observations and descriptions of the variables included in the study.

Study Area

Data was collected at Logan Pass, the highest point on Going-to-the-Sun Road (6,646 ft.) which runs east-to-west and bisects Glacier National Park. Logan Pass is accessible to non-motorized recreationists year-round, and is typically accessible to vehicles from the third week of June to the third week of October. Observations took place specifically along Hidden Lake Trail, which begins behind the Logan Pass Visitor Center. The trail meanders 1.4 miles through exposed and fragile alpine meadows known as the Hanging Gardens to Hidden Lake Overlook. 8,760-foot Clements Mountain dominates the view to the west, and standing to the northwest is 8,180-foot Mt. Oberlin. To the south, 9,125-foot Mt. Reynolds and 8,016-foot Heavy Runner Mountain shoot up from the pass. Just before the overlook, roughly 1.2 miles from the trailhead, hikers reach the Continental Divide where runoff from snow and rain begins flowing towards the Pacific Ocean. Once hikers reach the overlook they can expect extraordinary panoramic views of the lake and surrounding mountains, including Bearhat Mountain which towers over Hidden Lake. The majority of visitors don't travel further than the overlook, but for ambitious hikers and

anglers, the trail continues another 1.4 miles down to the lake, making the total round-trip distance 5.6 miles.

Although Going-to-the-Sun Road and Logan Pass are often cleared of snow before July, Hidden Lake Trail remains buried under snow until mid-July or later. Once the snow melts, wildflowers such as glacier lilies and Indian paintbrush carpet the meadows, and waterfalls can be found all along the trail to the overlook. The first $\frac{3}{4}$ mile of the trail is a boardwalk, and approximately 550 feet of elevation are gained within the 1.4 miles to the Hidden Lake Overlook. Glacier National Park guidebooks and hiking websites rate the Hidden Lake Trail as “easy” in terms of the effort needed to complete the hike. Hidden Lake Trail saw the most visitors of any trail that was monitored in 2012, and the parking lot at Logan Pass is often full between 11 AM and 4 PM in the summer. Therefore, unless visitors arrive early in the morning or later in the evening, they can expect large crowds in the parking lot and on the trail during peak season.

Because of its high elevation and exposed slopes, weather can fluctuate dramatically at Logan Pass. Even during summer months, one must be prepared for all types of weather, as it can be sunny and warm one minute and raining and windy the next. Lightning is a common occurrence at the pass, and snow is not unusual in July and August. A number of wildlife frequent Logan Pass, including bighorn sheep, marmots, ground squirrels, pikas, ptarmigans, coyotes, grizzly bears and even the occasional wolverine. Mountain goats are a major tourist attraction on the Hidden Lake Trail. The steep mountain slopes and abundant forage provide these hardy ungulates with ample food and shelter to make it through even the most difficult of winters at the Pass.

Hidden Lake Trail was recognized by wildlife managers at the Park as a hot-spot for wildlife encounters, specifically mountain goats. Because Hidden Lake Trail is incredibly crowded during peak season in the Park, and because managers believe the mountain goats in this area are becoming increasingly habituated and possibly food-conditioned as a result of frequent interactions with visitors, this trail was the perfect site to understand the impacts of encounters between people and mountain goats.

Sampling Methods

Observations took place throughout the summer season of 2013, from June 28th to August 23rd. Initially it was thought that the trail would be separated into three zones, each being approximately .5 miles. Each zone was to be sampled once a day between the hours of 7 AM and 8 PM, and randomly assigned to a day of the week. Sampling times were also to be randomly assigned per day. Thus, each zone would be sampled an equal number of days, and time periods would also be represented equally.

However, after approximately one week of observations, it became apparent that the zoning method would not be very efficient. Few goats were observed within the first .5 miles of the trailhead, and a number of goats were observed beyond the Hidden Lake Overlook. It was decided that data would be collected based not on zones but on where an interaction was observed at any given moment. This decision was made in the interest of obtaining a large sample size of interactions to provide a solid baseline of data on the nature of the interactions. Thus, the plan essentially became to go wherever the goats were. The observer hiked along the trail until a goat or group of goats were spotted, and observations would then be recorded. Observations ended as soon as: 1) the goat/goat group left, 2) another goat/goat group was

spotted or 3) observations had been recorded for an ample amount of time (20 – 30 minutes) and were deemed sufficient to move on to another interaction.

The sampling schedule also changed upon a review of daily visitation on the Hidden Lake Trail during the summer of 2012 and after one week of pre-test sampling on-site. It was found that visitation levels did not vary significantly from day to day during peak season in 2012, and therefore, a simple Monday through Friday sampling schedule was set up (although this was not always the case). Additionally, sampling times were selected between 8 AM and 8P.M to capture all daylight hours. Sampling periods lasted between five and six hours each day. These periods were chosen randomly, but were not sampled equally. Early and late sampling occurred less frequently because it was found during pre-testing that fewer interactions occurred in the early morning and late evening hours, and the overarching goal of the project was to achieve as many observations as possible.

Observations

Originally, it was determined that observations would be covert so as not to impact visitor or mountain goat responses to an interaction. In other words, the observer would station themselves at a distance from the visitors and mountain goats so as not to be seen. This proved to be extremely difficult during pretesting, even with the assistance of binoculars, as one or more of the visitors and/or mountain goats were often shielded from view by natural features (e.g. trees, rock formations), and it was impossible to hear any vocal responses. Thus, observers recorded observations directly on trail and attempted to blend in with the visitors as much as possible. Because observations were recorded on a Samsung tablet, it was often assumed by visitors that observers were taking photographs or messaging. Observers were instructed to interact with visitors as little as possible, and if a visitor openly asked what the observer was

doing, they were to tell them they were simply counting goats or watching goat behavior.

Nothing was to be mentioned about recording visitor behaviors. In this way, data collection did not interfere with the visitor's responses to a mountain goat encounter.

Two observation techniques were utilized to record behaviors: scan sampling and focal sampling. Scan sampling involves recording behaviors at fixed time intervals. For this study, scan sampling was used to observe mountain goat behaviors and demographics (both during an interaction and outside of an interaction), as well as visitor behaviors and demographics during an interaction. The time interval used was three minutes. Therefore, every three minutes the observer took a mental snapshot of the interaction or non-interaction (if no people were present or interacting with mountain goats), and all desired behaviors and characteristics were recorded for that moment in time. The same process was carried out at the next three-minute mark and so on for a total of three to four hours each day.

The second observation technique, focal sampling, was used to collect data on the emotional responses of visitors to mountain goats. This type of sampling was different from scan sampling in that a specific person or group of people were observed until they moved away. Rather than taking a mental snapshot of the situation at a given moment, all behaviors and characteristics of the focal person/group were recorded until their interaction with the mountain goat(s) ended. As soon as the focal individual/group left and all observations were recorded, the next individual or visitor group that began interacting became the observer's new focus. Focal sampling took place for one to two hours each day. In this way, a more thorough understanding of people's responses as well as the duration of interactions along Hidden Lake Trail was achieved.

All observations were recorded on a Samsung Galaxy Note 10.1 tablet, using the iForm application (Figure 3).

The screenshot displays the 'Interaction Observations' form within the iForm application. The form is organized into sections, each with a header and a text input field. The sections are: Date.Inter (with value '7/15/14'), GPS.Inter (with detailed location and time data), Weather.Inter (with value 'Clear, Hot'), Zone.Inter (empty), Interpretive Signs.Inter (empty), and Habitat.Inter (with descriptive text about the trail and weather). Each input field has a right-pointing arrow icon. The form is set against a green background with a white checkmark in the top right corner.

Section	Value
Date.Inter	7/15/14
GPS.Inter	Latitude=46.87246686804657, Longitude=-113.97960805271727, Altitude=959.6429460363845, Speed=0.0, Accuracy=8.0, Provider=gps, Time=02/15/2014 01:17:32 MST
Weather.Inter	Clear, Hot
Zone.Inter	
Interpretive Signs.Inter	
Habitat.Inter	Most of trail clear of snow. A lot of water runoff on trail and slopes. Helicopter flying overhead.

Figure 3 Setting Attributes Portion of the iForm

The iForm application greatly simplified the data entry process because all information entered into the application was saved and exported directly to Microsoft Excel as long as an internet connection was available. Two data collection forms were created on the iForm Builder website at <https://www.iformbuilder.com/>. One form was used for the scan sampling data and

the other form was used to collect focal sampling data. The first few questions on both forms were related to setting attributes. These included: the date, GPS coordinates, weather, zone (which was ignored after pretesting), interpretive signs (which was also ignored because educational signs about mountain goats were not implemented at any point during data collection), and habitat (Figure 3).

To change the GPS coordinates, the observer would simply touch the space under GPS and click refresh in the new window. Weather was a multi-select variable, meaning there were a number of options from which to choose, and one or more could be selected. The available weather options were:

Clear	Cold
Mostly sunny	Cool
Partly cloudy	Warm
Mostly cloudy	Hot
Overcast	Rain
Windy	Snow

Habitat was a fill-in-the-blank variable, which allowed the observer to type anything into the space. This variable was only intended for habitat characteristics that were unusual or that may have an effect on visitor or mountain goat behaviors.

For the scan sampling portion of the study, the first two variables were time and whether or not an interaction was occurring (Figure 4).

Time.Inter	1:26 PM	>
Interaction Occurring.Inter	Yes	>
Number Visitors Interacting.Inter	10.0	>
Number Children Under 12.Inter	4.0	>
Number Female Visitors.Inter	5.0	>
Visitor Behaviors.Inter	Viewing/watching goats, Photographing, Talking with others (about goats), Off of trail	>
Number of Goats in Group being Viewed.Inter	2.0	>
Number of Kids.Inter	1.0	>
Number Adult Female Goats.Inter	1.0	>
Goat Behavior.Inter	Walking, Foraging, Alert (human), Following (other goat)	>
Other Goat Behavior.Inter		>
Distance between Visitor(s) and Goat(s).Inter	0 - 5 m	>
Goats' Elevation.Inter	Level	>
Ranger Present.Inter	No	>

Figure 4 Scan Sampling iForm (Interaction Occurring)

If an interaction was occurring, iForm would automatically provide the following variables: number of visitors interacting, number of children under 12 that were interacting (this was a judgment call on the part of the observer), number of female visitors, visitor behaviors, number of goats in the group being viewed, number of adult female goats, goat behaviors, distance between the visitor(s) and the goat(s), goats' elevation (above, level with or below the visitors) and whether or not a ranger was present (Figure 4).

The visitor behaviors and goat behaviors portion of the iForm provided numerous options that had been chosen by the lead researcher prior to sampling. Like the weather variable, both of these variables were multi-select. Visitor behaviors are listed below (Table 1).

Table 1 Visitor Behaviors

Notices goat(s), continues
Viewing/watching goats
Photographing
Talking with others (about goats)
Reprimanding someone (about something related to goats)
Walking toward goat(s)
Running toward goat(s)
Throwing object (other than food) at goat(s)
Holding food out to goat(s)
Placing food near/tossing food to goat(s)
Walking nervously away from goat(s)
Running away from goat(s) (scared)
Whispering to others/trying to be quiet
Yelling excitedly
Pointing at goat(s)
Gesturing/yelling at goat(s) to get attention
Off of trail
Other

Goat behaviors were set up in an ethogram which describes each of the behaviors (Table 2).

Table 2 Ethogram of Mountain Goat Behaviors

Mountain Goat Behavior	Description
Walking	Travelling slowly from one place to another
Running	Travelling quickly from one place to another
Lying down	Lying on stomach, not eating, not sleeping
Foraging	Using snout to find edible vegetation
Chewing	Chewing food, can be lying down or standing
Licking rocks	Licking minerals from rocks, dietary supplement
Grooming self	Licking fur to clean themselves
Grooming other	Licking another goat's fur to clean it
Fleeing	Running away from something/someone
Digging	Using hooves to dig into the dirt/snow
Standing alert	Upright, still, gaze focused in one direction
Sleeping	Lying down with eyes closed
Stare threat	Gaze is focused on another goat, aggressive
Horn threat	Lowers head and pulls chin in to show horns off
Rush threat	Walks or trots at another goat and does a horn threat or swipe at the end
Horn swipe	Lowers head and sweeps horns upward
Present threat	Raises high on its legs while arching back and pulling chin in, moves ponderously, circles other goat, may utter harsh roar or do a horn swipe
Pitting	Sit on ground, arched neck, head looking towards ground, pawing with front leg, throwing snow and dirt at belly, hind legs and flanks, creating a rutting pit
Brush rubbing	Rubbing the supraoccipital glands at the base of their horns on twigs or bunches of grass
Sniffing (air, ground, plant, etc.)	Smelling environmental objects
Sniffing (other goat)	Smelling another goat
Feeding (young)	Mother milking young
Being fed	Drinking milk from mother
Following	Moving close behind another goat
Mounting	Male climbs on female to reproduce
Mating	Male and female copulate
Vocalizing	Using mouth to make noise
Urinating	
Defecating	

The distance variable was single-select, meaning the observer would pick one of the provided choices. The unit of measurement for this variable was meters. The choices were:

0 – 5 m	30.1 – 50 m
5.1 – 10 m	50.1 – 70 m
10.1 – 20 m	70.1 – 100 m
20.1 – 30 m	> 100 m

If no interaction was occurring (i.e. no visitors were present near a goat group or they were present but did not see and therefore interact with the goat(s)), the following variables were automatically provided in iForm: total number of goats seen by observer, number of goat groups, number of kids, number of nannies, goat behaviors, distance between the trail and the nearest goat and elevation of the goat(s) from the trail (above, level with or below). The choices for goat behaviors and distance were the same as above.

For the focal sampling portion of the study (i.e. emotional responses), the following variables were given (all variables refer specifically to the focal group, and not necessarily to every person interacting): distance between the visitors and the goat(s), elevation of the goats to the visitors (above, level with or below), number of people, number of female visitors, number of children under 12, number of goats being viewed, number of goat kids, goat behaviors, emotional responses and duration of the interaction. Again, the distance and behavior variables consisted of the same options as in the scan sampling form. The emotional response variable consisted of a number of options pre-selected by the lead researcher prior to sampling and based on Plutchik's wheel of emotions. All emotions exhibited by every person in the focal group during the interaction were recorded. It is important to note that because all people measure

emotion differently, this variable was subjective and dependent on the observer. The complete list of emotions is shown below (Table 3):

Table 3 Visitor Emotional Responses

Anger	Joy
Annoyance	Affection
Disgust	Empathy
Anxiety	Anticipation/eagerness
Embarrassment	Pride
Regret	Satisfaction
Fear	Trust
Shame	Calm
Envy	Relief
Frustration	Interest
Boredom	Surprise
Disappointment	Amazement
Sadness	Politeness
Amusement	Other
Excitement	No Emotion

The duration of the interaction was measured in minutes, with the shorter time periods (< three minutes) rounded to the nearest tenth of a minute (e.g. 0.5 minutes; 1.5 minutes).

Data Analysis

The data were analyzed using frequency distributions, logistic regression and time to event analyses. Data was organized and cleaned in Microsoft Excel and analyzed using primarily SPSS predictive analytics software (for frequencies and logistic regressions), as well as R software (for the time to event analyses) and Microsoft Excel (for some frequency distributions). Assumptions for each statistical test were addressed and validity and reliability were explored prior to analysis.

Measures of Validity and Reliability

Sources of error were reduced as much as possible by utilizing typologies that have been replicated and found to be valid in previous studies. However, the measurement validity was intrinsically compromised because it was an entirely observational study and the operational definitions used to determine the emotional, cognitive and ideological bases of behavior did not fit perfectly. While validity was difficult to control, reliability was increased by using multiple observers. This is referred to as intercoder reliability, and it measures the extent to which different observers using the same ethograms and typologies get equivalent results. In this study, two observers recorded human-mountain goat interactions simultaneously on various observation days throughout the summer. Therefore, if the data from both observers coincided, the intercoder reliability was considered high.

CHAPTER 4: DESCRIPTIVE ANALYSIS

Introduction

This chapter provides a general overview of the data using descriptive statistics and frequency charts in order to illustrate the range of observations in terms of visitor and mountain goat group compositions and behaviors, weather, elevation and distance between mountain goats and visitors, length of interactions and emotional responses.

The Sample

A total of 2,880 observations were recorded throughout the sampling period. 2,100 of the total observations utilized scan sampling, while 780 involved focal sampling (Table 4).

Table 4 Sample Sizes by Type of Observation

	SAMPLE TYPE			
	Scan Sampling		Focal Sampling	
	Interaction Occurring	No Interaction Occurring	Emotional Responses	Interaction Duration
SAMPLE SIZE	1,641	459	465	315
TOTAL BY SAMPLE TYPE	2,100		780	
PERCENT OF SAMPLE TYPE	0.78	0.22	0.60	0.40
TOTAL OBSERVATIONS	2,880			

Observation Locations

Observations of interactions were largely located around the overlook, which is the typical destination on Hidden Lake Trail. Moving away from the overlook in either direction, the number of interactions tended to decrease (Figure 5).



Figure 5 Locations of Interactions on Hidden Lake Trail

Weather

The most common temperature recorded throughout the sampling period was “warm” (43%), followed by “hot” and “cool” (28% and 26%, respectively). It was observed to be “cold” only one time throughout the entire sampling period. Forty percent of observations took place under clear skies, while only 15% occurred when it was mostly cloudy or overcast. Rain was observed only 16 times throughout the sampling period (less than 1% of the time). However, windy weather occurred during almost half of the observations that were recorded (48%) (Figure 6).

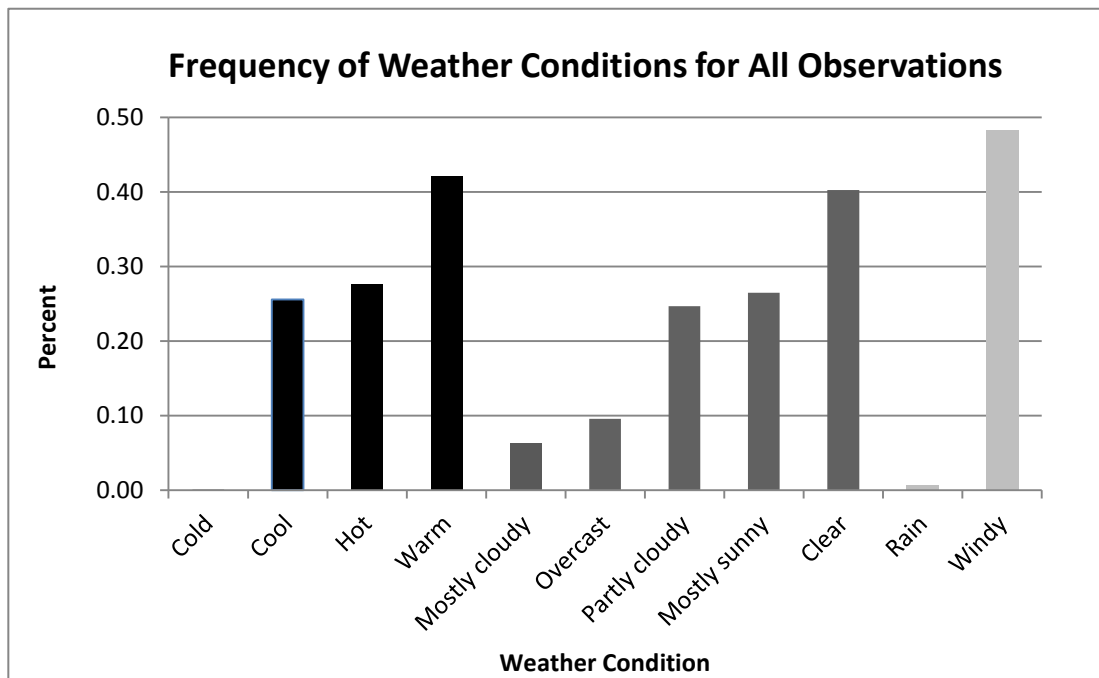


Figure 6 Frequencies of Weather Conditions Occurring throughout the Sampling Period

Visitor and Mountain Goat Group Composition

On average, approximately seven visitors were interacting with mountain goats at a time . The range of the number of visitors interacting was quite large, with a minimum of one visitor and a maximum of 42 visitors. The average number of children interacting at a given moment was less than one (.85), indicating that visitor groups interacting with mountain goats rarely included children. The average number of males interacting with mountain goats was slightly higher than females (3.7 and 3.3., respectively). Table 5 also shows that the average number of people within each visitor group (e.g. groups of friends or couples) was 3.3, and the number of males and females within these groups were very similar (1.7 and 1.6, respectively). The average number of children within a group of visitors was small (.57). The average number of mountain goats per group was two, and the largest number of goats observed within a group was

13. Within each goat group, the average number of kids and the average number of nannies were both 0.57, while the average number of billies was slightly higher (0.84). This indicates that more billy groups were observed during the summer than nanny-kid groups (Table 5).

	N	Minimum	Maximum	Mean	Median	Std. Dev.
Total # of Visitors Interacting	1636	1	42	6.983	6	5.1937
Total # of Children (under 12) Interacting	1640	0	9	.848	0	1.3159
Total # Females Interacting	1640	0	21	3.253	3	2.5682
Total # of Males Interacting	1635	0	27	3.725	3	3.0381
# of People per Visitor Group	504	1	11	3.250	3	1.7500
# of Females per Visitor Group	505	0	7	1.564	1	1.1199
# of Males per Visitor Group	496	1	5	1.700	2	.7891
# of Children per Visitor Group	505	0	7	.570	0	.9736
# of Mountain Goats per Group	2097	1	13	2.054	2	1.3654
# of Kids per Group	2093	0	4	.567	0	.6823
# of Nannies per Group	997	0	3	.571	1	.6260
# of Adult Males per Group	999	0	8	.844	1	.7285

Table 5 Visitor and Mountain Goat Group Composition and Duration of Interactions

Visitor and Mountain Goat Behavior

In terms of visitor behavior, in 83% of interactions, visitors were observed viewing/watching goats. Photographing was a close second at 77%. Fifty-nine percent of visitors were seen talking with others about goats during an interaction. The frequency of other visitor behaviors dropped off sharply after these three. Two behaviors that are highly discouraged by park staff, leaving the trail and approaching mountain goats, were observed 24% of the time and 18% of the time respectively. Many of the other visitor behaviors that managers consider “negative” were observed infrequently during interactions throughout the sampling period (Figure 7; Table 6).

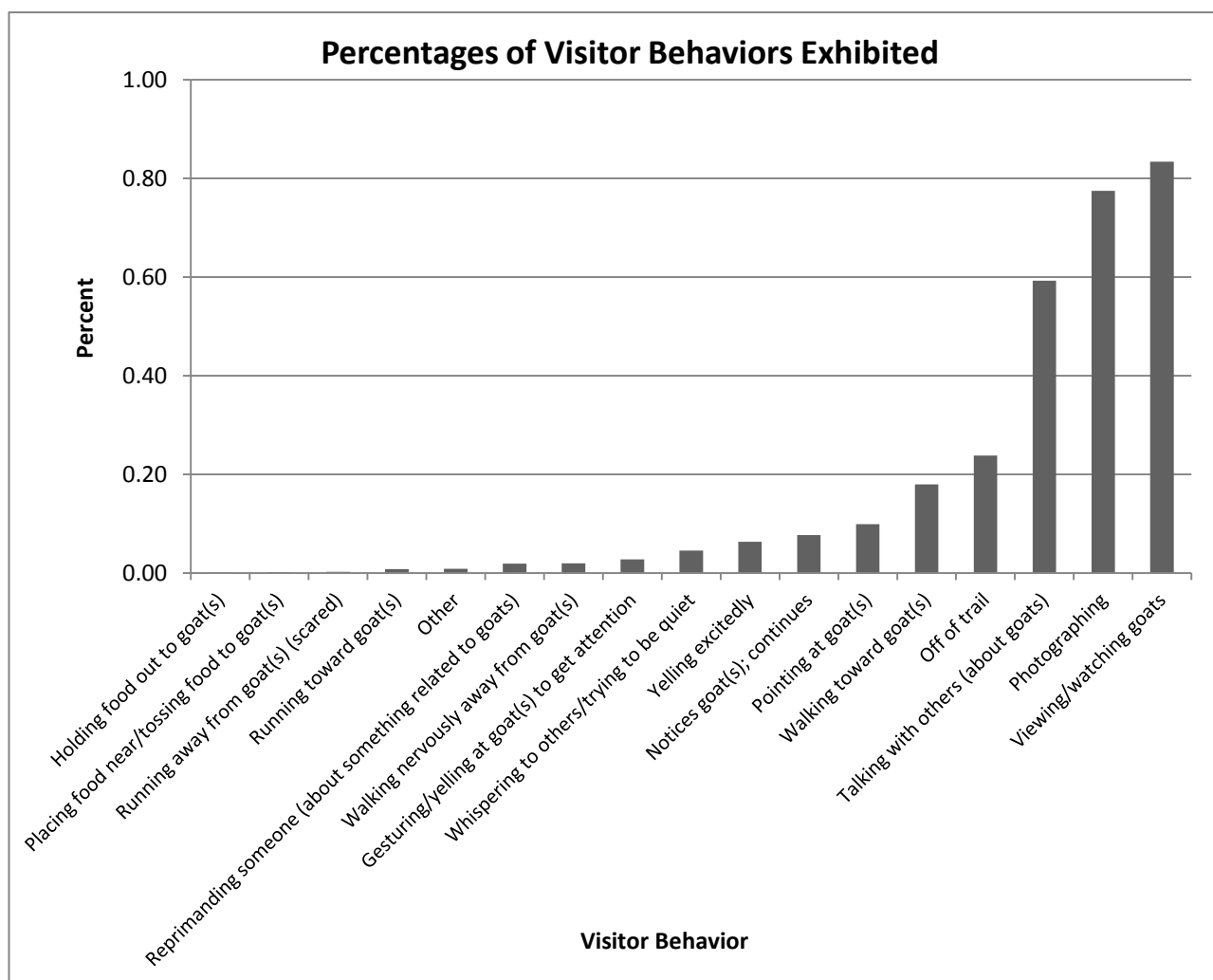


Figure 7 Percentages of Interactions in which Visitors Exhibited Certain Behaviors

Table 6 Ten Most Common Visitor Behaviors during an Interaction

Visitor Behavior	Frequency	Percent
Gesturing/yelling at goat(s) to get attention	46	0.0281
Whispering to others/trying to be quiet	75	0.0458
Yelling excitedly	104	0.0635
Notices goat(s); continues	126	0.0769
Pointing at goat(s)	163	0.0995
Walking toward goat(s)	295	0.1800
Off of trail	365	0.2383
Talking with others (about goats)	971	0.5924
Photographing	1270	0.7749
Viewing/watching goats	1367	0.8340
Total	1639	2.9930

Mountain goat behaviors were analyzed similarly. However, the figure and table below show the frequency of mountain goat behaviors during interactions *as well as* when no visitors were present or interacting. They simply illustrate general goat behavior patterns throughout the summer along Hidden Lake Trail. The four most frequently observed behaviors exhibited by mountain goats on Hidden Lake Trail were walking (38%), foraging (34%), alert to humans (31%) and lying down (29%). Two other behaviors that may be viewed as negative from a management standpoint, licking human-deposited minerals (e.g. urine, food crumbs) and walking away from humans, were observed 6% of the time and 4% of the time, respectively. All of the other “negative” mountain goat behaviors were observed 1% of the time or less throughout the entire summer season (Figure 8; Table 7).

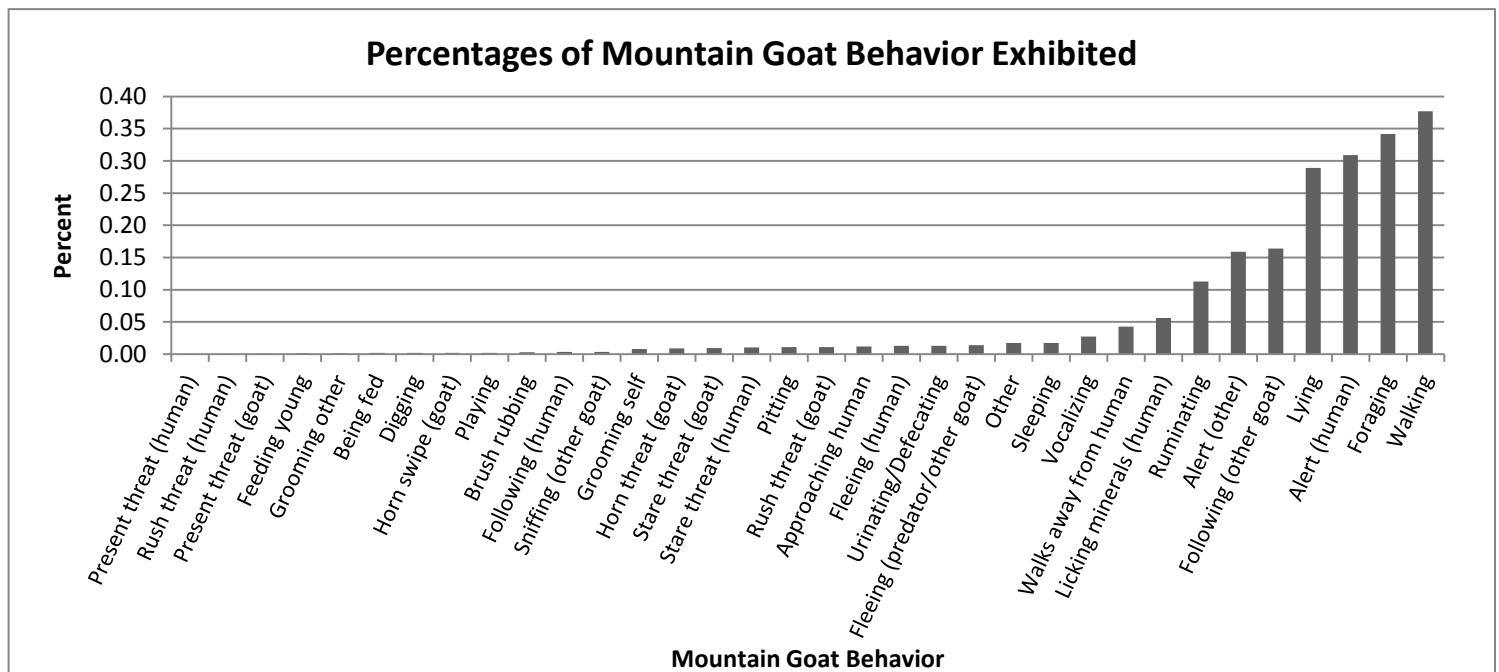


Figure 8 Percentages of Mountain Goat Behavior Observed throughout the Sampling Period

Table 7 Mountain Goat Behavior Frequencies

Goat Behavior	Frequency	Percent
Vocalizing	71	0.0272
Walks away from human	112	0.0429
Licking minerals (human)	146	0.0559
Ruminating	295	0.1129
Alert (other)	415	0.1588
Following (other goat)	428	0.1638
Lying	755	0.2889
Alert (human)	807	0.3088
Foraging	893	0.3418
Walking	985	0.3770
Total	2613	100.0000

Location of Mountain Goats Relative to the Trail/Visitors

The distance and elevation between mountain goats and visitors (during an interaction) or mountain goats and the trail (when no interaction was occurring) were also examined to determine how close mountain goats were staying to high visitor use areas. The most frequently observed relative elevation of mountain goats to either the trail or visitors was neither above nor below, but level. This elevation was recorded in over half of the observations (56%). Goats remained above visitors or the trail 24% of the time, and below visitors or the trail 20% of the time (Figure 9; Table 8).

In terms of distance kept between mountain goats and visitors or the trail, they were within five meters of one another in 45% of all observations. In fact, 85% of the time, mountain goats were observed less than 30 meters from either visitors or the trail (Figure 10; Table 9).

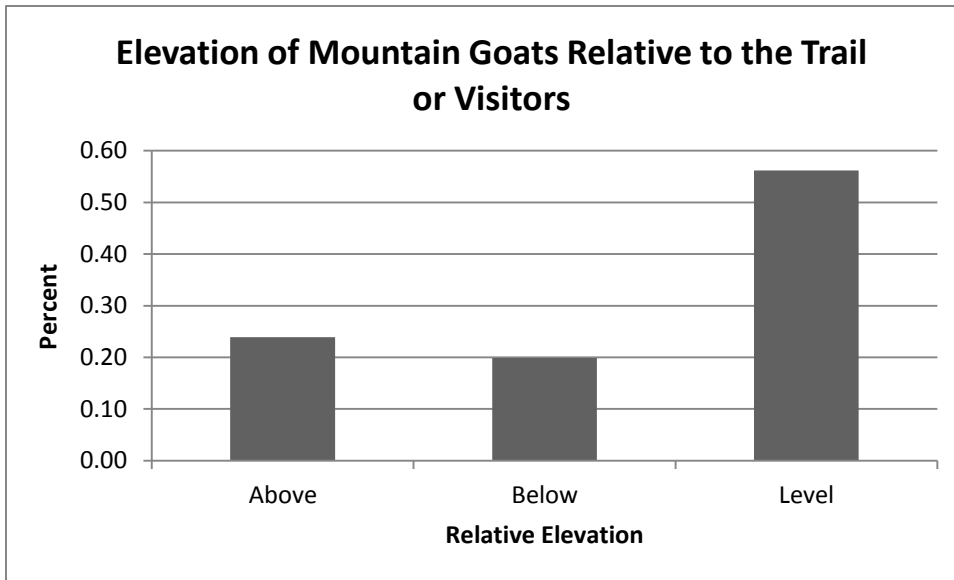


Table 8 Frequencies of Relative Elevations

Elevation	Frequency	Percent
Above	697	23.9%
Below	580	19.9%
Level	1638	56.2%
Total	2917	100%

Figure 9 Relative Elevations of Mountain Goats to the Trail or to Visitors

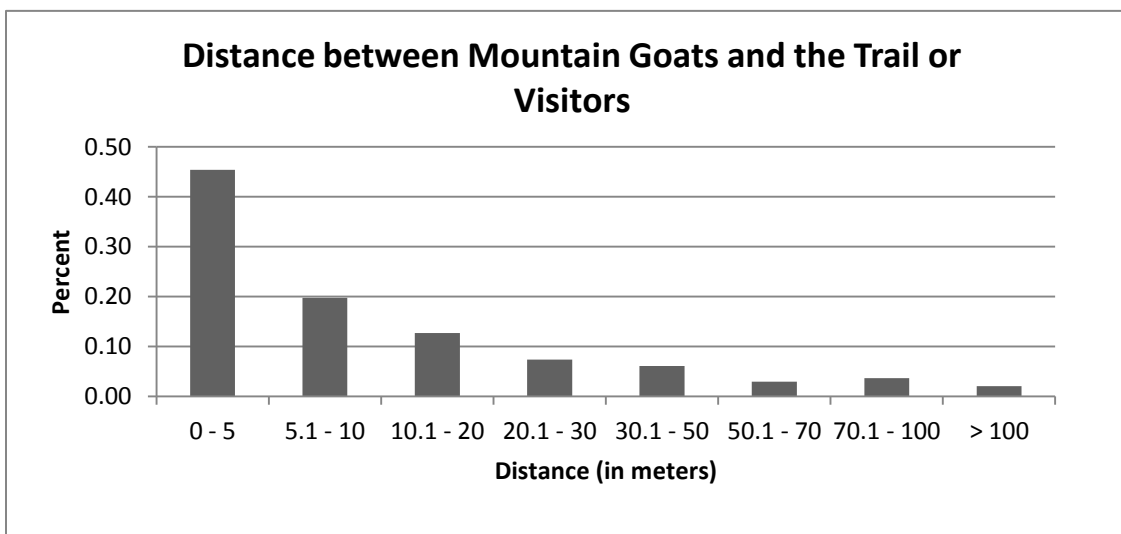


Figure 10 Distances between Mountain Goats and the Trail or Visitors

Table 9 Distance Frequencies

Distance	Frequency	Percent
0 - 5	1324	0.4542
5.1 - 10	576	0.1976
10.1 - 20	370	0.1269
20.1 - 30	215	0.0738
30.1 - 50	178	0.0611
50.1 - 70	86	0.0295
70.1 - 100	106	0.0364
> 100	59	0.0202
Total	2915	1.00

Interaction Duration

The mean duration of an interaction was 2.04 minutes and the median was one minute. The shortest interaction observed was approximately six seconds (0.1 minutes), and the longest interaction observed was approximately 30 minutes (Table 10).

Table 10 Duration Descriptives

Mean	2.0362
Median	1.0000
Std. Deviation	2.69791
Minimum	.10
Maximum	30.00

Results also show a highly right-skewed distribution of duration frequencies (Figure 11), indicating that most interactions were short in duration. This explains why the median duration is 1 minute less than the mean duration. One minute was by far the most frequent duration observed, followed by two minutes and then by 30 seconds. Few interactions lasted longer than seven minutes.

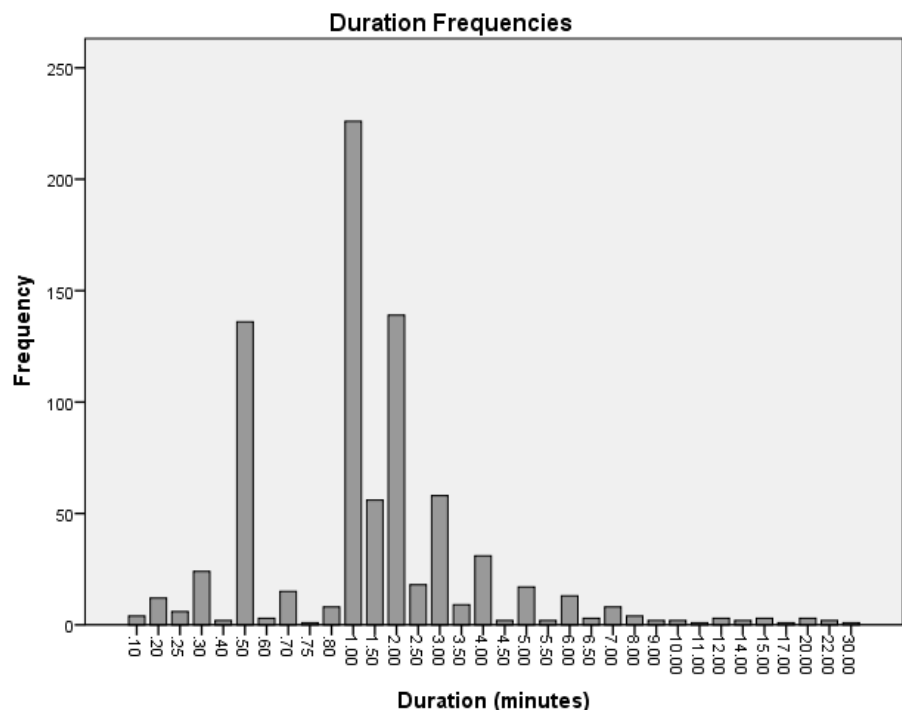


Figure 11 Interaction Duration Frequencies

The generally short durations can be explained by the fact that visitor groups would often encounter the same or different mountain goat groups multiple times during their hike along Hidden Lake Trail. Therefore, after the visitors had seen mountain goats for the first time, they often interacted for short periods of time the next time they ran into a mountain goat group (especially if it was the same group as before).

It should also be noted that mountain goat groups were often travelling from place to place while visitors were interacting. This would shorten the amount of time visitors spent watching because the mountain goats would move in a different direction than the one the visitors were travelling in.

Visitors' Emotional Responses

The most frequently observed emotional response exhibited during an interaction was interest (76%), followed closely by joy (72%). Excitement was the third most frequently observed emotion, but it was still observed less than half of the time (46%). Nine out of the ten most frequently observed emotional responses were positive. Anxiety was the only negative emotion registering in the top ten emotions, and it was observed only 8% of the time. In 11% of interactions, a visitor or visitors exhibited no emotion (Table 11; Figure 12).

It is important to note that all observations reported here were recorded by only one observer. Therefore, these results are somewhat subjective. This issue is discussed in greater detail in Chapter 5.

Table 11 Emotional Responses Exhibited by Visitors during an Interaction

Emotion	Frequency	Percent
Interest	352	0.7570
Joy	334	0.7183
Excitement	215	0.4624
Amusement	113	0.2430
Surprise	95	0.2043
Anticipation	72	0.1548
Affection	54	0.1161
Amazement	50	0.1075
No Emotion	49	0.1054
Anxiety	38	0.0817
Satisfaction	21	0.0452
Empathy	11	0.0237
Annoyance	9	0.0194
Frustration	9	0.0194
Trust	9	0.0194
Calm	8	0.0172
Politeness	8	0.0172
Boredom	6	0.0129
Anger	3	0.0065
Fear	3	0.0065
Pride	3	0.0065
Disappointment	2	0.0043
Relief	2	0.0043
Disgust	1	0.0022
Embarrassment	1	0.0022
Other	1	0.0022
Shame	1	0.0022
Total	465	3.16

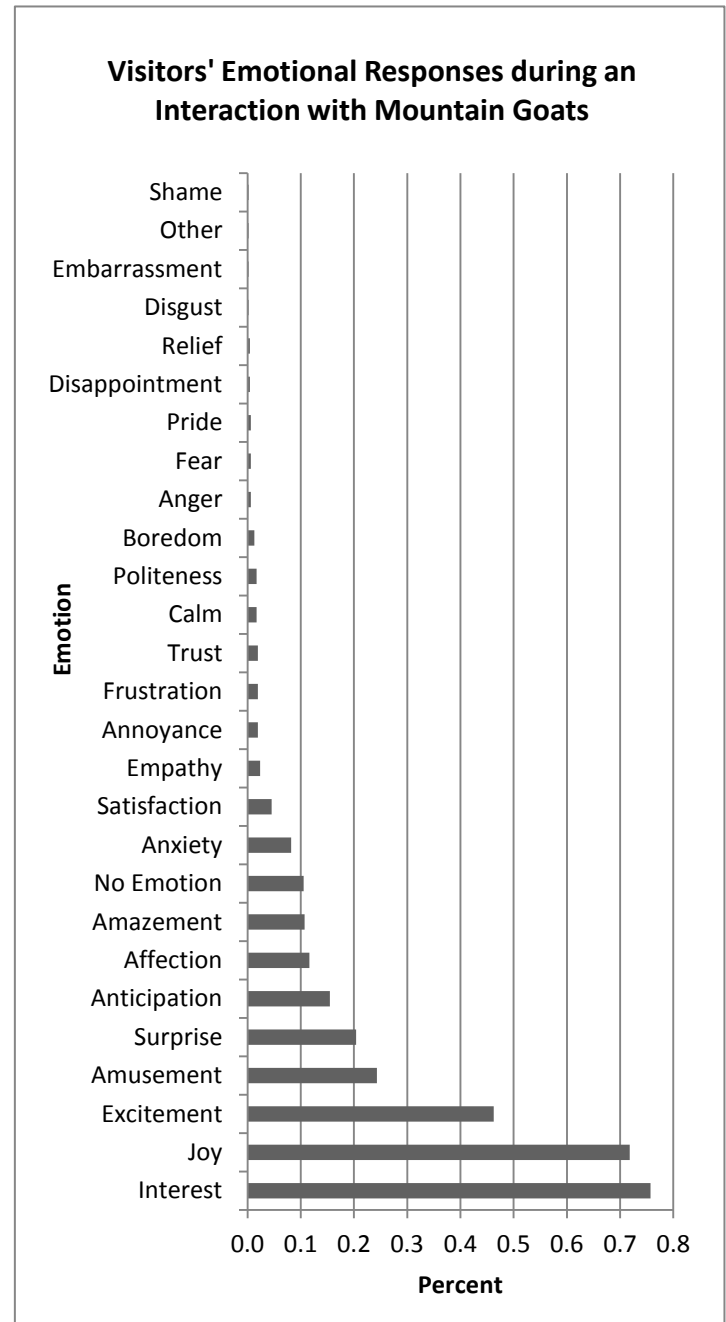


Figure 12 Percentage of Emotional Responses Exhibited

CHAPTER 5: ANALYSIS OF RESEARCH QUESTIONS

Introduction

In this chapter, results from the analyses of each research question are presented. The statistical methods used and the assumptions of each method are also described for each research question. Most of the research questions encompass a number of more specific questions which provide a deeper understanding of the nature of interactions occurring between mountain goats and visitors along Hidden Lake Trail.

Question 1: What constitutes an interaction, and are there differences in how goats behave during an interaction versus when no interaction is occurring?

The definition of an interaction for this study largely determined the data that was collected for each type of observation. Specifically, when visitors were not present or did not notice a mountain goat *or* even if the visitor(s) noticed the mountain goat(s), it was not recorded whether or not the mountain goat(s) noticed the visitor(s). This information was not recorded because it was not central to the primary questions of interest. Therefore, for the purposes of this study, an event in which visitor(s) were present *and* noticed mountain goat(s) was considered an interaction. This was true whether or not the mountain goat(s) noticed the visitor(s). Similarly, an event in which visitor(s) were *neither* present *nor* noticed mountain goat(s) was considered a non-interaction. This was the case whether or not the mountain goat(s) noticed the visitor(s). Simply put, **in order for an interaction to occur, only the visitor(s) needed to be aware of the presence of a mountain goat.**

In the analysis of mountain goat behavior during and outside of an interaction, the dependent variable was mountain goat behavior and the independent variable was a binary

variable, interaction occurring (yes/no). The frequency of certain mountain goat behaviors were hypothesized to be significantly different during an interaction compared to when no interaction was occurring. Frequency tables were created and individual logistic regressions were run for each mountain goat behavior and whether an interaction occurred as a result.

Assumptions

Although the logistic regression was run primarily as a method of data reduction rather than analysis, it was important to address the assumptions of this test prior to running it. First, the dependent variable was measured on a dichotomous scale. In this case the dependent variable, occurrence of an interaction, had two responses: yes or no. Secondly, there was one or more independent variables, which were either continuous (i.e., an interval or ratio variable) or categorical (i.e., an ordinal or nominal variable). For this analysis, the independent variable was the occurrence of a certain mountain goat behavior and each mountain goat behavior was tested individually against the occurrence of an interaction. Therefore, the independent variables were nominal (yes, the behavior occurred, or no, the behavior did not occur). The third assumption addressed whether or not observations were independent and whether or not the dependent variable had mutually exclusive and exhaustive categories. Statistical independence was met because the occurrence of one observation did not affect the probability of another observation. Additionally, the two categories for the occurrence of an interaction were “yes” and “no”, which were mutually exclusive and exhaustive. The final assumption was that there was a linear relationship between any continuous independent variables and the logit transformation of the dependent variable. This was not necessary to test, as all independent variables were categorical rather than continuous.

Results

Table 12 shows the results from the regression, including only those behaviors that were found to be significant at an alpha level of 0.10 or less. The behaviors with a positive β coefficient (e.g. walking, ruminating) indicate that they were more likely to be exhibited by mountain goats during an interaction. Those with a negative β coefficient (sleeping, foraging) were more likely to occur when visitors were not present or interacting.

Table 12 Logistic Regression Results for the Occurrence of an Interaction on the Display of Certain Mountain Goat Behaviors

Mountain Goat Behavior	β	S.E.	Wald	df	Sig.	Exp(β)
Alert (human)	1.403	0.159	78.142	1	0.000	4.068
Walking	0.465	0.116	15.991	1	0.000	1.592
Walking away from human	2.596	0.717	13.12	1	0.000	13.415
Following (other goat)	0.524	0.168	9.723	1	0.002	1.688
Sleeping	-1.074	0.34	9.999	1	0.002	0.342
Ruminating	0.465	0.187	6.166	1	0.013	1.592
Vocalizing	1.069	0.472	5.137	1	0.023	2.912
Approaching human	1.917	1.022	3.517	1	0.061	6.798
Stare threat (human)	1.781	1.025	3.02	1	0.082	5.937
Foraging	-0.191	0.111	2.964	1	0.085	0.826

A frequency distribution was developed for mountain goat behavior to more thoroughly illustrate the differences between behaviors occurring during interactions and outside of interactions (Table 13; Figure 13). The behaviors with asterisks beside them were all found to be significant in the logistic regressions that were run. Those with three asterisks were significant at the 0.01 alpha level, those with two asterisks were significant at the 0.05 alpha level and those with one asterisk were significant at the 0.10 alpha level.

Table 13 Frequencies and Percentages of Mountain Goat Behaviors during and outside of an Interaction

Goat Behavior	Interaction Occurring		No Interaction Occurring	
	Frequency	Percent	Frequency	Percent
***Walking	619	37.7%	124	27.0%
***Alert (human)	549	33.5%	50	10.9%
*Foraging	513	31.3%	164	35.7%
Lying	461	28.1%	134	29.2%
Alert (other)	270	16.5%	89	19.4%
***Following (other goat)	265	16.2%	46	10.0%
**Ruminating	201	12.3%	37	8.1%
Licking minerals (human)	97	5.9%	31	6.8%
***Walking away from	89	5.4%	1	0.2%
**Vocalizing	51	3.1%	5	1.1%
Other	30	1.8%	6	1.3%
Fleeing (predator/other	26	1.6%	0	0.0%
*Approaching human	23	1.4%	1	0.2%
***Sleeping	21	1.3%	16	3.5%
*Stare threat (human)	21	1.3%	1	0.2%
Fleeing (human)	18	1.1%	4	0.9%
Rush threat (goat)	18	1.1%	2	0.4%
Urinating/Defecating	18	1.1%	4	0.9%
Stare threat (goat)	16	1.0%	4	0.9%
Horn threat (goat)	14	0.9%	4	0.9%
Grooming self	13	0.8%	2	0.4%
Pitting	12	0.7%	6	1.3%
Following (human)	7	0.4%	1	0.2%
Sniffing (other goat)	5	0.3%	2	0.4%
Being fed	4	0.2%	0	0.0%
Brush rubbing	4	0.2%	2	0.4%
Playing	4	0.2%	0	0.0%
Digging	3	0.2%	1	0.2%
Horn swipe (goat)	3	0.2%	0	0.0%
Feeding young	2	0.1%	0	0.0%
Present threat (goat)	1	0.1%	0	0.0%
Present threat (human)	1	0.1%	0	0.0%
Rush threat (human)	1	0.1%	0	0.0%
Total	1641	206.0%	459	160.6%

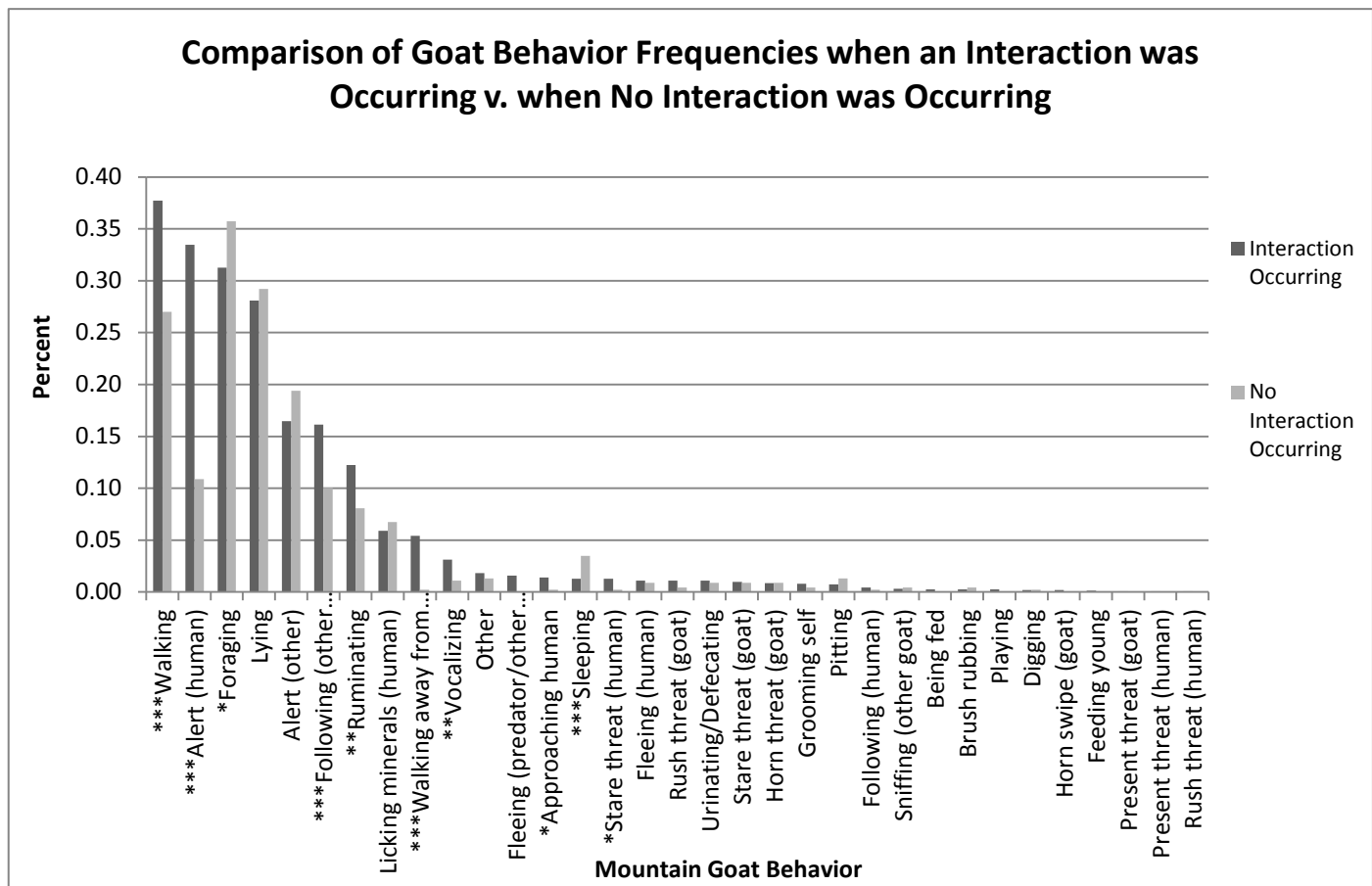


Figure 13 Comparison of Mountain Goat Behaviors when an Interaction was Occurring versus when No Interaction was Occurring

Question 2: How often do negative interactions occur?

In order to answer this question, it was imperative to first define a “negative interaction”. Descriptions of aversive responses were taken from Knight and Cole (1991), and descriptions for harassment and habitat modification were taken from Hammit and Cole (1987) to develop a definition for “negative interaction”. Aversion is an avoidance response to any stimulus that causes stress or physical harm. This definition applies to both humans and other animal species. Harassment refers to an event that *causes* stress, disturbance and physical harm. Habitat modification is the alteration of an animal’s living space, which can result in displacement and

detrimental changes in behavior (Hammit and Cole, 1987). Therefore, for the purposes of this study, a negative interaction was defined as an event in which the following conditions applied:

- a) An interaction was occurring (i.e. visitors and mountain goats were present *and* visitors noticed the mountain goats), **AND**
- b) a visitor was observed harassing a mountain goat, **OR**
- c) a visitor responded aversively to a mountain goat, **OR**
- d) a mountain goat behaved aggressively toward a visitor, **OR**
- e) a mountain goat responded aversively to a visitor.

The next step was to make a list of all of the aversive and aggressive behaviors that were observed for both visitors and mountain goats throughout the sampling period. This list is shown below (Table 14).

Table 13 Negative Behaviors Exhibited by Mountain Goats and Visitors and their Classification

Negative Mountain Goat Behaviors	Classification	Frequency	Percent
Licking minerals (human)	Alteration of Behavior	146	5.6%
Fleeing (human)	Aversion	34	1.3%
Walks away from human	Aversion	112	4.3%
Present threat (human)	Aggression	1	0.0%
Rush threat (human)	Aggression	1	0.0%
Following (human)	Aggression	9	0.3%
Stare threat (human)	Aggression	27	1.0%
Approaching human	Aggression	31	1.2%
Negative Visitor Behaviors	Classification	Frequency	Percent
Holding food out to goat(s)	Habitat Modification	1	0.1%
Placing food near/tossing food to goat(s)	Habitat Modification	3	0.2%
Off of trail	Habitat Modification	365	23.8%
Running away from goat(s) (scared)	Aversion	4	0.2%
Walking nervously away from goat(s)	Aversion	32	2.0%
Running toward goat(s)	Harassment	13	0.8%
Gesturing/yelling at goat(s) to get attention	Harassment	46	2.8%
Walking toward goat(s)	Harassment	295	18.0%

Table 14 also shows the frequencies of each specific negative behavior. It is important to keep these frequencies in mind when examining the following tables because as you can see, a number of the negative behaviors contribute very little to the category they reside under (e.g. holding food out to goat(s) happened only one time, and therefore contributes little to the habitat modification category).

It was hypothesized that negative interactions would occur approximately half of the time. This hypothesis was based purely on anecdotal information provided by visitors, rangers and park managers from the previous field season in GNP.

The frequency of negative interactions was determined first by summing all interactions in which at least one negative behavior was exhibited by either a visitor or a mountain goat and dividing by the total number of interactions. This process was repeated to determine how often a) goats exhibited negative behaviors, b) visitors exhibited negative behaviors, c) aversive behavior occurred, d) harassment or aggression occurred, e) goat habitat or behaviors were altered by human activity and f) negative behaviors were exhibited. To make it more specific, the frequency of interactions was calculated in which: a) mountain goats were aggressive toward visitors, b) goats responded aversively to visitors, c) goats altered their normal behavior because of human activity, d) visitors harassed mountain goats, e) visitors modified mountain goat habitat and f) visitors responded aversively to visitors.

Results

Table 14 Frequencies of Different Types of Negative Interactions

Interaction in which...	Frequency	Percent of Total Negative	Percent of Total
Goat was aggressive	46	6.62%	2.80%
Goat was aversive	105	15.11%	6.40%
Goat altered behavior	97	13.96%	5.91%
Visitor harassed goat	335	48.20%	20.41%
Visitor modified habitat	368	52.95%	22.43%
Visitor was aversive	37	5.32%	2.25%
Goat exhibited negative behavior	239	34.39%	14.56%
Visitor exhibited negative behavior	598	86.04%	36.44%
Aversion was exhibited	135	19.42%	8.23%
Harassment/aggression occurred	371	53.38%	22.61%
Goat habitat/behavior was altered	431	62.01%	26.26%
Negative behaviors were exhibited	695	100.00%	42.35%
Total Interactions	1641		

As Table 15 shows, negative behaviors occurred in 695 out of 1,641 total interactions (42%). In 46 interactions mountain goats exhibited aggression toward visitors (3% of interactions), and their behavior was considered negative in 15% of the total interactions observed. Interactions in which mountain goats displayed aversion or altered their behavior as a result of human activity occurred slightly more frequently than interactions in which aggression was displayed, but still quite rarely (6% of the time for each). On the other hand, interactions in which visitors harassed mountain goats occurred more frequently than interactions in which goats exhibited aggression toward visitors (approximately 20% of the time). Interactions in which visitors modified mountain goat habitat also occurred approximately 22% of the time, but rarely were there interactions in which visitors responded aversively to goats (2% of interactions). In total, 36% of all interactions involved some form of negative behavior on the part of the visitor. Of the three categories of negative behavior used in this analysis (aversion, aggression/harassment, alteration of goat habitat/behavior), the most frequently observed was

alteration of goat habitat/behavior (26% of interactions). Interactions that involved harassment/aggression were the second most frequent at 22%, and interactions involving aversion occurred 8% of the time (Table 15). Refer to Table 14 again, for frequencies of the negative behaviors that contributed to each category.

The following table compares the three categories of negative behavior for both mountain goats and visitors (Table 16).

Table 15 Comparison of the Three Behavior Categories for Mountain Goats and Visitors

	Frequency	Percent of Total
Goat Aggressive	46	19.25%
Goat Aversive	105	43.93%
Goat Altering Behavior	97	40.59%
Total Negative Goat	239	103.77%
Visitor Harassing	335	56.02%
Visitor Modify Habitat	368	61.54%
Visitor Aversive	37	6.19%
Total Negative Visitor	598	123.75%

These results indicate that interactions involving negative mountain goat behaviors were the result of aversive mountain goats more than twice as frequently (44%) as aggressive mountain goats (19%). Interactions in which mountain goats exhibited behaviors that only exist in populations near humans (i.e. licking minerals left behind from humans) also occurred twice as often as interactions involving goat aggression (40%). Contrarily, interactions in which visitors responded aversively to mountain goats occurred more seldom (6%) than those in which visitors harassed a mountain goat or modified their habitat (56% and 62% respectively).

The next table compares the frequency of interactions in which visitors exhibited negative behaviors compared to those in which mountain goats exhibited negative behaviors (Table 17).

Table 16 Comparison of Negative Interactions Involving Mountain Goats versus Visitors

	Frequency	Percent of Total
Goat Aggressive	46	12.40%
Visitor Harassing	335	90.30%
Total Harassing/Aggressive	371	102.70%
Goat Aversive	105	77.78%
Visitor Aversive	37	27.41%
Total Aversive	135	105.19%
Goat Altering Behavior	97	22.51%
Visitor Modify Habitat	368	85.38%
Total Altering Behavior/Habitat	431	26.26%

As indicated by the table, of interactions involving harassment/aggression, the culprit was more often a visitor than a mountain goat (90% compared to 12%). Contrarily, in 78% of interactions in which aversive behavior occurred, mountain goats were the ones exhibiting the behavior. Twenty-seven percent of aversive interactions involved aversive behavior from visitors. Interactions in which visitors modified mountain goat habitat (e.g. step off trail) were more frequent (85%) than interactions in which goats altered their behavior as a result of human activity (23%).

The final table shows the mean number of instances of each type of negative behavior that occurred per interaction (Table 18). The mean for total negative interactions was 0.625, which means in an average interaction, the number of negative interactions exhibited was between 1 and 0, but slightly closer to 1. The mean occurrence of negative goat behaviors per interaction was quite low at 0.16, and goat aggression was especially low (0.033). Negative visitor behaviors had a slightly higher mean of 0.465, and the mean occurrence of interactions in which visitors harassed goats or modified their habitat was also higher (0.217 and 0.225, respectively).

Table 17 Mean Occurrence of Negative Behaviors per Interaction

	Mean # of Instances per Interaction
Goat Aggressive	0.033
Goat Aversive	0.067
Goat Altering Behavior	0.060
Visitor Harassing	0.217
Visitor Modify Habitat	0.225
Visitor Aversive	0.023
Total Negative Goat	0.160
Total Negative Visitor	0.465
Total Aversive	0.090
Total Harassing/Aggressive	0.250
Total Altering Behavior/Habitat	0.283
Total Negative Interactions	0.625

The figure below helps to illustrate the table above by showing how frequently negative behaviors occurred per each interaction. In approximately 58% of interactions, no negative behaviors were exhibited. This isn't surprising, knowing that the number of negative interactions that occurred throughout the sampling period is less than 50%. One instance of negative behavior per interaction is the second most common result, at approximately 28%. In 12% of interactions, 2 negative behaviors were exhibited, and in 5% of interactions 3 or more negative behaviors occurred at once (Figure 14).

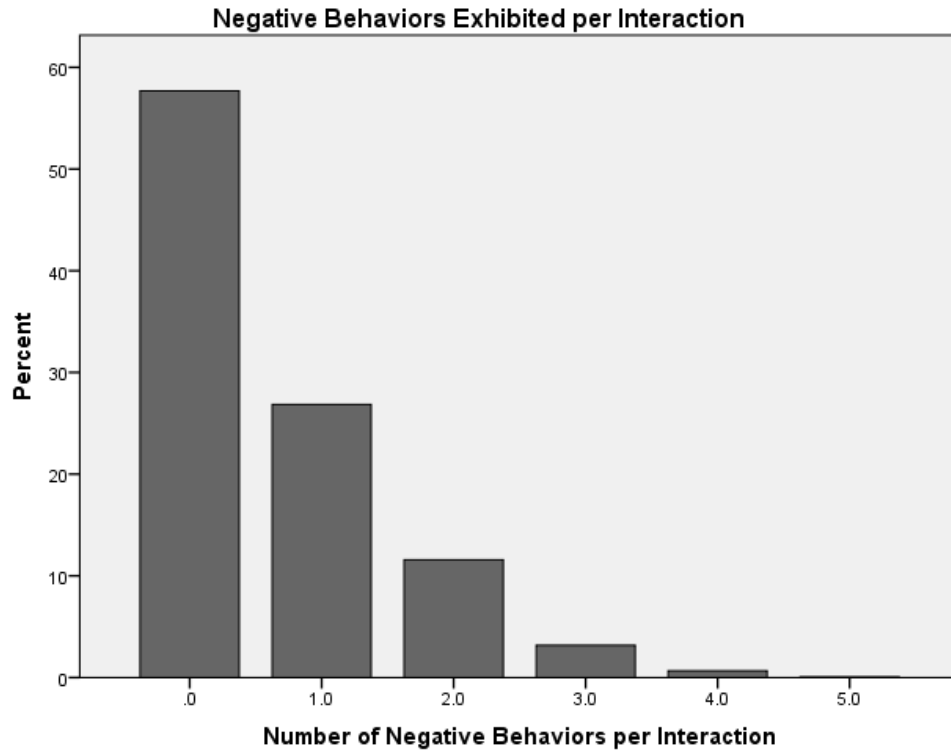


Figure 14 Number of Negative Behaviors Exhibited per Interaction

Question 3: Do interactions vary depending on the time of day, weather, and distance/elevation between recreationists and the goats?

This research question consisted of two dependent variables (whether or not an interaction occurred and the duration of an interaction) and four independent variables (time, weather, distance and elevation). Two predictions were made regarding this question:

1. Time of day, weather, distance between recreationists and goats and elevation between recreationists and goats will directly influence the occurrence of an interaction, and
2. The duration of an interaction will depend on time of day, weather, distance between recreationists and goats and elevation between recreationists and goats.

First, the relationship between the independent environmental variables (time, weather, distance and elevation) and the dependent variable, occurrence of an interaction is discussed. As in Question 1 a binary logistic regression was run to better understand the data and determine which variables to focus on for a more in depth analysis.

Logistic Regression Assumptions

The same assumptions from the logistic regression in Question1 apply to this statistical analysis. In this question, the dependent variable, occurrence of an interaction, had two responses: yes or no. Secondly, there were one or more independent variables, which were either continuous or categorical. For this analysis, the independent variables were all categorical: time of day (ordinal), weather (4 categories, either ordinal or nominal), distance (ordinal) and elevation (ordinal). The third assumption addressed whether or not observations were independent and whether or not the dependent variable had mutually exclusive and exhaustive categories. Statistical independence was met because the occurrence of one observation did not affect the probability of another observation. Additionally, the two categories for the occurrence of an interaction were “yes” and “no”, which were mutually exclusive and exhaustive. The final assumption was that there was a linear relationship between any continuous independent variables and the logit transformation of the dependent variable. This was not necessary to test, as all independent variables were categorical rather than continuous.

Results (dependent variable = occurrence of an interaction)

The logistic regression results are shown below (Table 19). To provide more information about the relationship between setting attributes and the occurrence of interactions, the weather variable was separated further into cloud cover, temperature, wind and rain.

Table 18 Results for the Logistic Regression of all Independent Variables on Whether or Not an Interaction Occurred

Independent Variable	B	S.E.	Wald	df	Sig.	Exp(B)
Temperature	1.828	.153	142.579	1	.000	6.221
Cloud Cover	.065	.060	1.143	1	.285	1.067
Windy	-2.426	.152	254.866	1	.000	.088
Rain	-.989	2.398	.170	1	.680	.372
Time	-.135	.026	26.203	1	.000	.873
Distance	-.410	.035	134.614	1	.000	.664
Elevation	.343	.094	13.185	1	.000	1.409
Constant	4.341	2.436	3.174	1	.075	76.753

As the table illustrates, there is strong evidence to conclude that five of the nine independent variables are associated with the occurrence of an interaction. Temperature, wind, time of day, distance between mountain goats and visitors, and the relative elevation of mountain goats all appear to influence the likelihood of an interaction taking place between mountain goats and visitors ($\alpha < 0.05$).

Cloud cover did not appear to have an influence on the occurrence of an interaction. This variable consisted of five options (clear, mostly sunny, partly cloudy, mostly cloudy and overcast). It is difficult to say whether or not rain influenced the likelihood of an interaction because the sample size was too small to draw conclusions. However, the reason the sample size is so small is not only because there were few rainy days, but also because few goats or visitors

were observed on the trail during rain. Therefore, it would seem that interactions are less likely during rainy events. More data is needed to test this hypothesis.

The two weather variables that appeared to influence the occurrence of an interaction were temperature and wind. The temperature variable consisted of 4 general options (cold = 1, cool = 2, warm = 3 and hot = 4). According to the logistic table the β coefficient for temperature is 1.828. Because it is a positive value, this means that as the temperature increased from 1 (cold) to 4 (hot), the likelihood that an interaction occurred also increased (Table 20; Figure 15).

Table 19 Comparison of Temperature Frequencies during an Interaction and outside of an Interaction

Temperature	Interaction		No Interaction	
	Frequency	Percent	Frequency	Percent
Cold	0	0.0	1	.2%
Cool	395	25.6	123	27.5%
Warm	642	41.7	176	39.3%
Hot	503	32.7	148	33.0%
Total	1540	100.0	448	100%

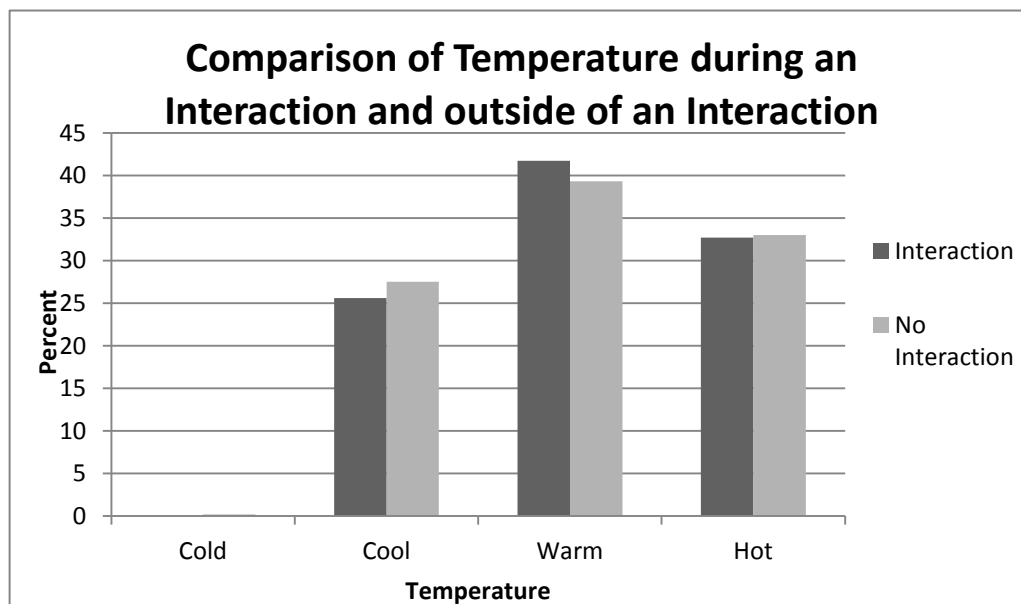


Figure 15 Temperatures during Interactions Compared to Temperatures when No Interaction was Occurring

The previous figures illuminate some nuances that the logistic regression did not explain. Table 20 shows that the percentages of each temperature were similar in interactions compared to when no interaction was occurring. However, Figure 15 gives a clearer picture about the differences in temperature between the two events. Interactions were more likely to take place than non-interactions when it was warm, and contrarily, non-interactions were more likely to occur than interactions when it was cool. The two types of events were equally likely to occur when it was hot. Only one observation of cold weather was recorded, and no interaction was taking place at the time. Overall, the largest number of interactions (41.7%) occurred in warm weather, followed by hot weather (32.7%). The same was true when no interaction was occurring. Warm weather was most frequent (39.3%), followed by hot weather (33%).

The influence of wind on the occurrence of interactions was analyzed next. Windiness was a binary variable. Therefore, if it was not windy, a 1 was recorded, and if it was windy a 2 was recorded. The β coefficient for wind was -2.426, indicating that interactions were less likely to occur when it was windy than when it was not windy. Table 21 below shows the frequency of windy weather for both interactions and non-interactions

Table 20 Comparison of Wind between Interactions and Non-Interactions

	Interaction		No Interaction	
Windy	Frequency	Percent	Frequency	Percent
No	931	56.7%	214	46.6%
Yes	710	43.3%	245	53.4%
Total	1641	100%	459	100%

The percentage of interactions in which it was windy was 43.3%, whereas 56.7% of interactions occurred in which it was not windy. Contrarily, in cases in which no interaction was occurring, it was windy more frequently (53.4%) than it was not windy (46.6%).

Time of day was expected to influence the occurrence of an interaction because the number of people hiking on Hidden Lake Trail varies throughout the day, and the number of people on trail likely influences the probability of an interaction occurring.

To test H_1 , the times of day were first transformed from the hour:minute format to a time range. For example, 8:30 became 8 – 9 AM. This made it simpler to understand the relationship between time and whether or not an interaction occurred. The hourly frequencies of interactions and non-interactions were calculated, as shown below in Table 22.

Table 21 Comparison of Hourly Frequencies for Interactions and Non-Interactions

Time	Interaction		Non-Interaction	
	Frequency	Percent	Frequency	Percent
8 AM - 9 AM	1	0.1%	0	0.0%
9 AM - 10 AM	58	3.7%	25	5.6%
10 AM - 11 AM	133	8.6%	22	4.9%
11 AM - 12 PM	151	9.7%	21	4.7%
12 PM - 1 PM	185	11.9%	56	12.5%
1 PM - 2 PM	213	13.7%	32	7.2%
2 PM - 3 PM	214	13.8%	51	11.4%
3 PM - 4 PM	183	11.8%	68	15.2%
4 PM - 5 PM	173	11.2%	61	13.6%
5 PM - 6 PM	112	7.2%	32	7.2%
6 PM - 7 PM	73	4.7%	38	8.5%
7 PM - 8 PM	55	3.5%	41	9.2%
Total	1551	100%	447	100%

The hourly time ranges were then plotted against the number of interactions and the number of non-interactions. Below is a figure showing the hourly percentages for both interactions and non-interactions (Figure 16).

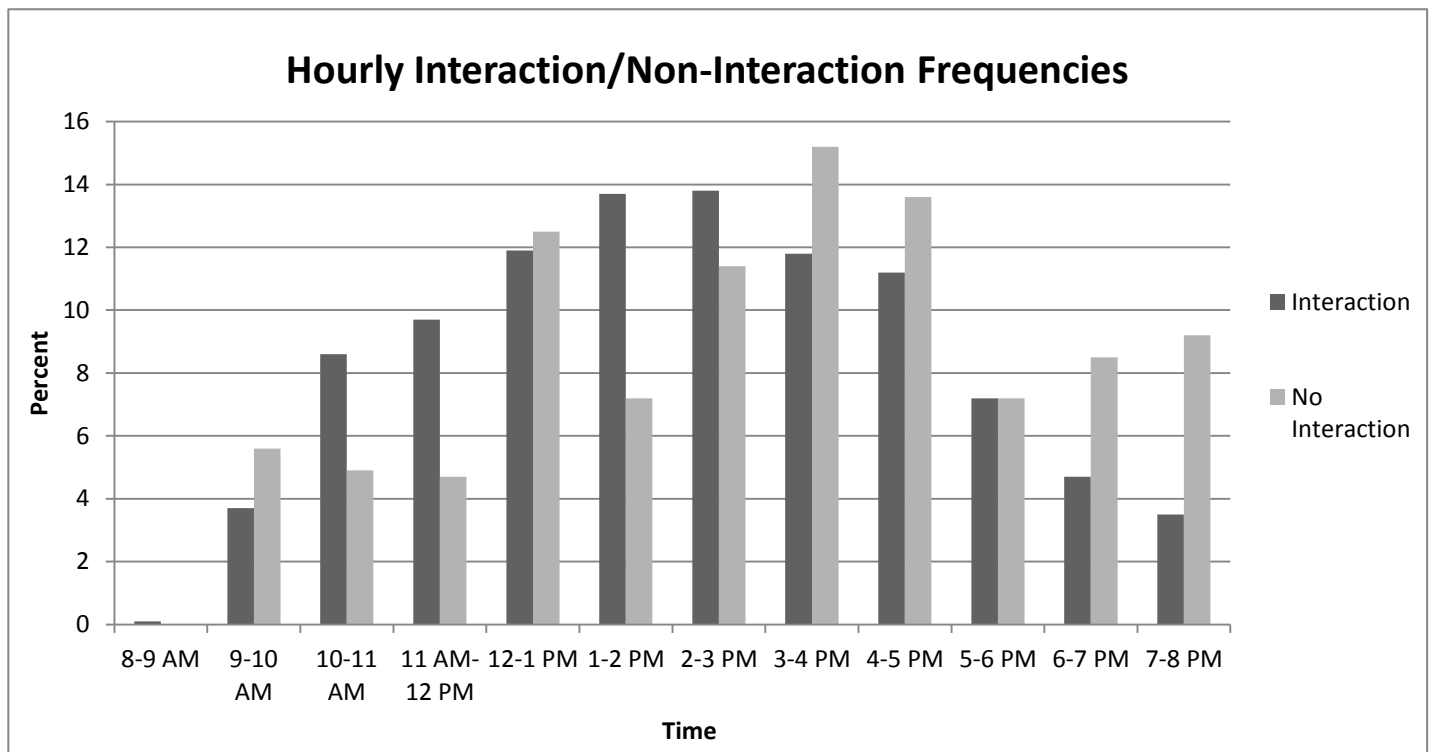


Figure 16 Hourly Percentages of Interactions and Non-Interactions

Figure 16 clearly illustrates the differences between interactions and non-interactions in terms of when they occurred throughout the day. Most notably, between 10 AM and 3 PM, the percentage of interactions that occurred is higher than the percentage of non-interactions (except between 12 and 1 PM). Alternatively, the percentage of non-interactions met or exceeded the percentage of interactions between the hours of 8 AM and 10 PM and 3 PM and 8 PM. This explains the negative β coefficient (-0.135) for time in the logistical analysis. As the day went

on, the likelihood of an interaction occurring tended to decrease, while the likelihood of a non-interaction occurring increased.

A number of factors likely contribute to these trends, but two probable influencers are the number and activity level of mountain goats and visitors at any given time on Hidden Lake Trail. Comparing the normal frequency distribution of interactions in the figure above with the normal frequency distribution of visitors on Hidden Lake Trail in the figure below (Figure 17; taken from Weinberg, Freimund and Dalenberg, 2012) indicates that visitation levels play a large role in the number of interactions that occur per hour.

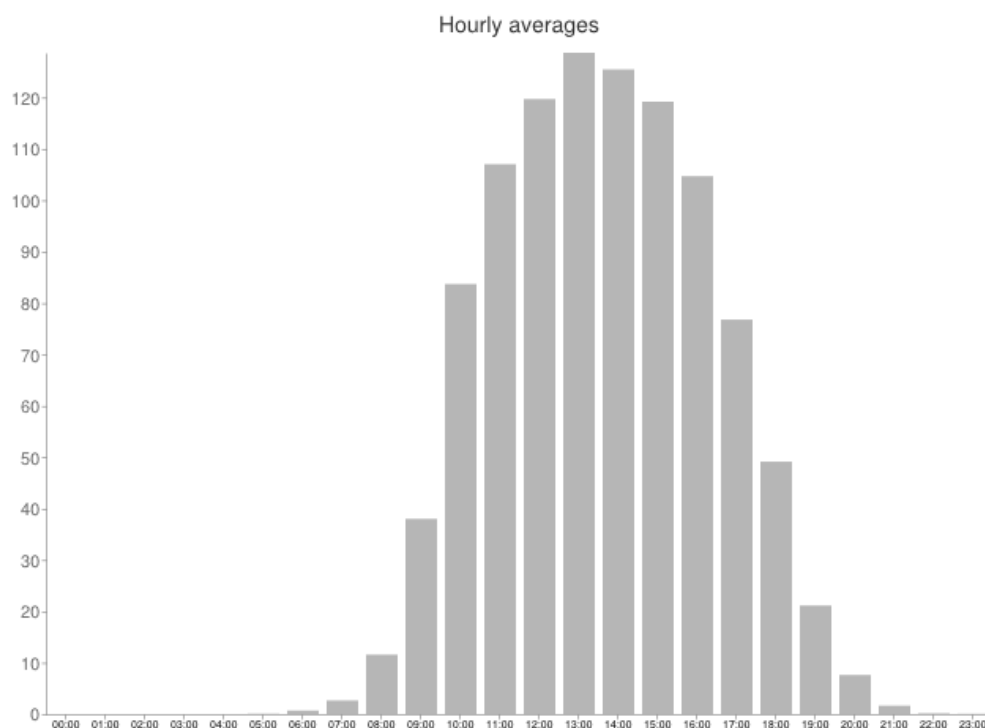


Figure 17 Average Number of Visitors per Hour on Hidden Lake Trail (2012)

Contrarily, the graph of non-interactions follows more of a multi-modal trend. Non-interactions remained low and steady between 9 AM and 12 PM, at which point the occurrences increased until 1 PM. Between 1 PM and 2 PM non-interactions decreased, and then picked

back up again between 2 PM and 5 PM. They decreased again between 5 PM and 6 PM and then began to slowly rise between 6 PM and 8 PM (Figure 16).

The distance between mountain goats and visitors during an interaction was a major concern for park managers prior to conducting this study. Glacier National Park rangers encourage visitors to maintain a minimum distance of 25 yards from mountain goats. However, descriptive statistics from Chapter 4 revealed that this distance is rarely maintained. The question was, then, were mountain goats typically observed 25 yards or further from the trail when an interaction was not occurring? Perhaps visitors have less control over the proximity of mountain goat interactions than rangers believe.

Based on the results from the logistic regression, it appears that there was a difference in the distances between visitors and goats during an interaction and the distances between goats and the trail when no interaction was occurring. The β coefficient for distance was -0.41, indicating that there was a greater likelihood of observing an interaction when goats were closer to the trail/visitors. Table 23 and Figure 18 below show the frequency of interactions and non-interactions in which various distances were maintained between mountain goats and visitors.

Table 22 Distances Maintained between Mountain Goats and the Trail/Visitors during an Interaction versus when No Interaction was Occurring

	Interaction		No Interaction	
Distance	Frequency	Percent	Frequency	Percent
0 - 5 m	811	49.5	126	27.5
5.1 - 10 m	338	20.6	76	16.6
10.1 - 20 m	185	11.3	82	17.9
20.1 - 30 m	113	6.9	53	11.6
30.1 - 50 m	103	6.3	30	6.6
50.1 - 70 m	37	2.3	27	5.9
70.1 - 100 m	37	2.3	37	8.1
> 100 m	16	1.0	27	5.9
Total	1640	100.0	458	100.0

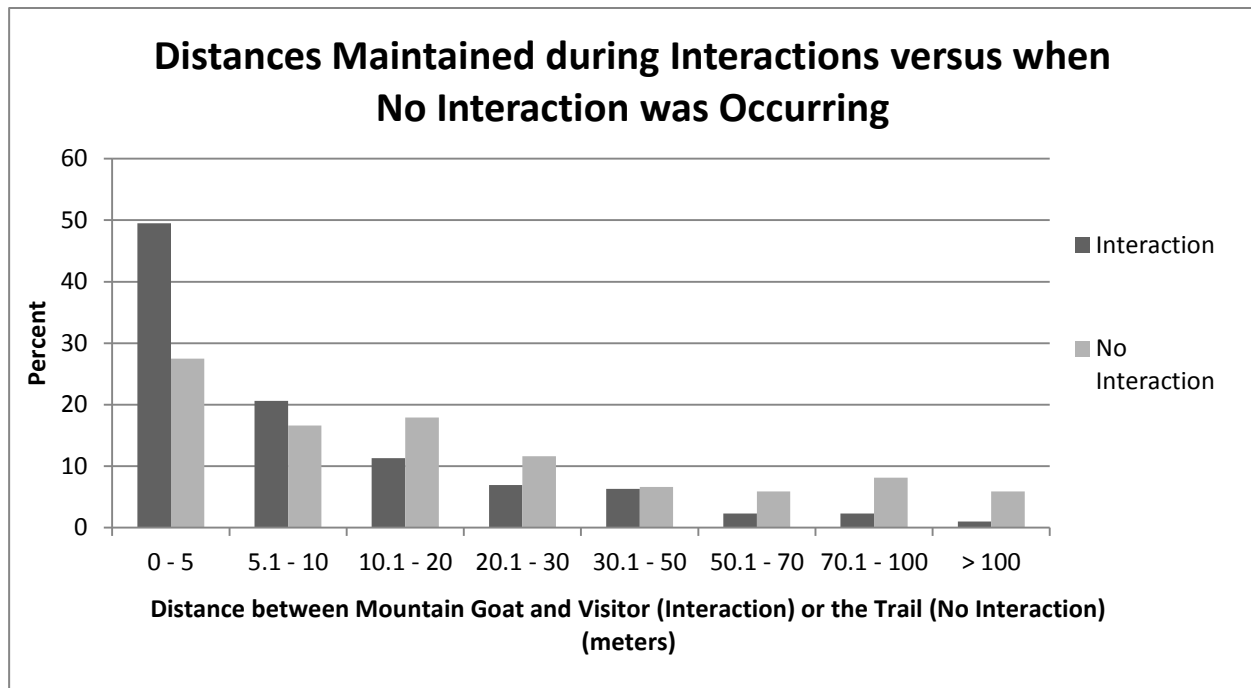


Figure 18 Distances between Goats and the Trail/Visitors during Interactions and Non-Interactions

During almost half (49.5%) of observed interactions, visitors and mountain goats were 0 - 5 meters from one another. On the other hand, in 28% of non-interactions goats and visitors were 0 - 5 meters from one another. The percentage of interactions in which mountain goats and visitors were between 5.1 and 10 meters apart was also larger (21%) than the percentage of non-interactions in which this distance was kept (17%). Non-interactions were more common than interactions at distances greater than 10 meters. These results indicate that goats remain closer to the trail when humans are present and interacting than when humans are absent or are not interacting. However, it is important to note that the general distance trend during non-interactions is similar to the distance trend during interactions. Both events most frequently involve distances less than 5 meters and become less frequent as the distance increases. Thus, no matter whether an interaction is occurring or not, mountain goats are often near the trail. During less than 12% of all recorded interactions and 27% of all recorded non-interactions, 30 or greater

meters of space were observed between mountain goats and visitors or the trail. The box plot below further illustrates these results (Figure 19).

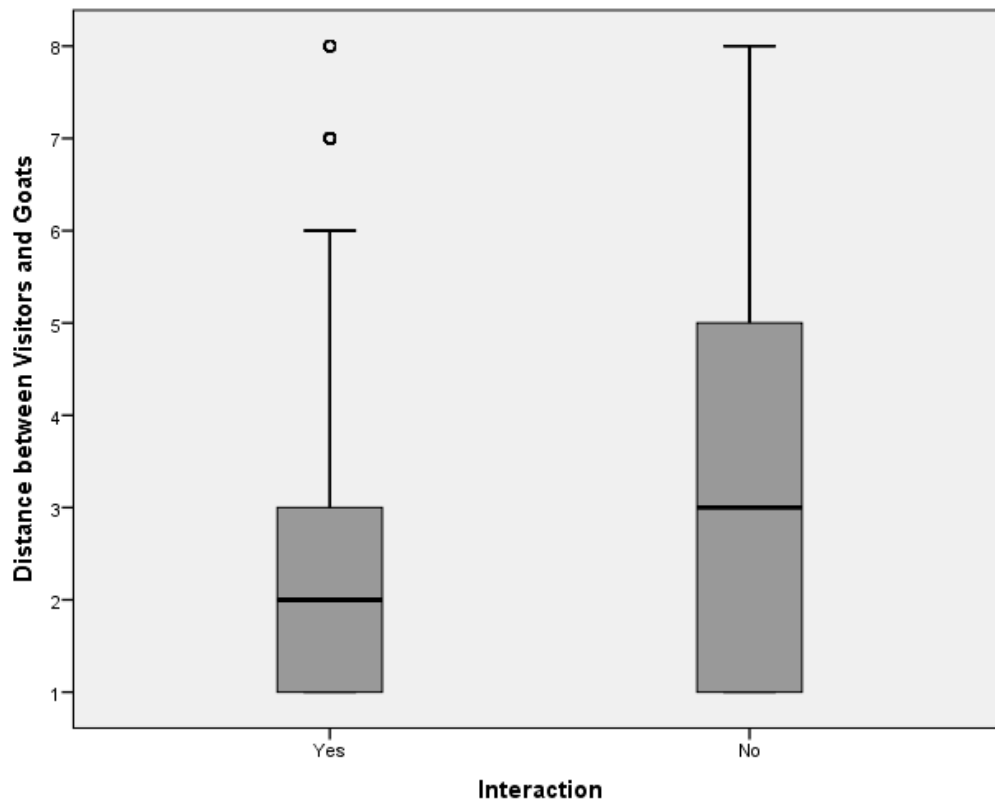


Figure 19 Comparison of Distances during Interactions versus Non-Interactions

Figure 19 shows the average distances between visitors and mountain goats when an interaction is occurring versus when visitors are not present or are not aware of mountain goats' presence. The y-axis labels represent the different distance ranges. For example, 1 represents 0 – 5 m, 2 represents 5.1 – 10 m, and so on up to 8, which represents > 100 m. The interquartile range for distances between mountain goats and the trail when no interaction is occurring is larger (between 0 and 50 m) than when an interaction is occurring (between 0 and 20 m). Additionally, the mean distance is greater when no interaction is occurring (10.1 – 20 m) than when an interaction is occurring (5.1 – 10 m). Both the interaction distribution and the non-interaction distribution are heavily right-skewed (Figure 19).

The final variable that had a significant effect on whether or not an interaction occurred was the elevation of mountain goats relative to visitors or the trail. The β coefficient for elevation from the logistic regression table was positive (0.343), indicating that as a mountain goat's relative elevation increased (below to level to above visitors), the likelihood of an interaction occurring also increased. As Table 24 and Figure 20 show, however, there may be a somewhat different trend occurring.

Table 23 Effect of Elevation on the Occurrence of an Interaction

Elevation	Interaction		No Interaction	
	Frequency	Percent	Frequency	Percent
Above	388	23.7	139	30.3
Below	322	19.6	140	30.6
Level	930	56.7	179	39.1
Total	1640	100	458	100

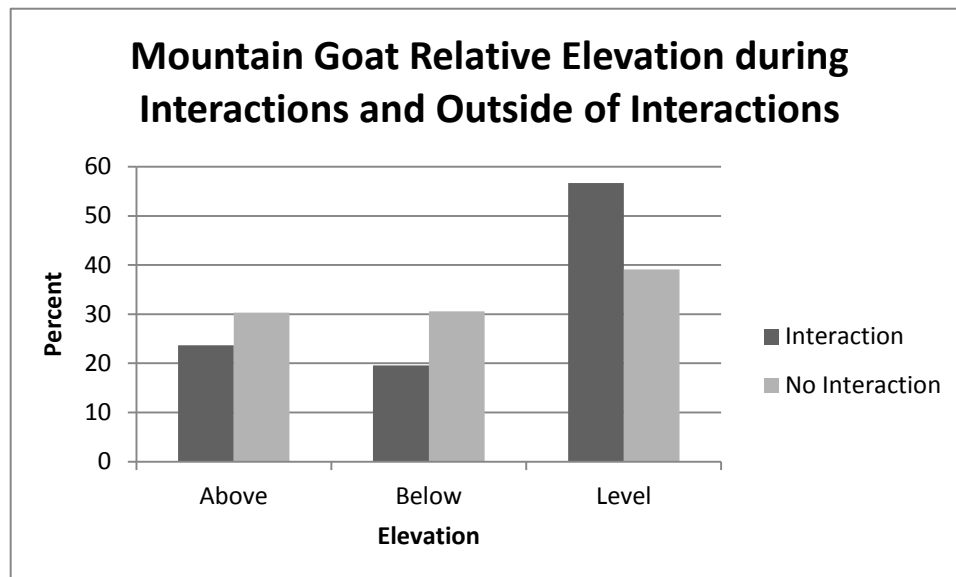


Figure 20 Occurrence of an Interaction as a Function of Elevation

It appears that interactions are more frequent than non-interactions when mountain goats are level with the trail (57% and 39%, respectively). When mountain goats are either above or below the trail, non-interactions are more frequently observed than interactions.

The second part of Question 3 involved a different dependent variable than the previous analyses: duration of an interaction, rather than whether or not an interaction was occurring. It was hypothesized that weather, time of day, distance between mountain goats and recreationists and the elevation of mountain goats relative to recreationists would influence the length of time people would spend interacting with mountain goats (see prediction #2, pg. 69). A multiple regression was run first to determine whether there was significant evidence to conclude that any of the four independent variables were associated with the duration of an interaction.

Time-to-Event Analysis Assumptions

The primary assumption to be met for time-to-event analyses is the issue of *non-informative censoring*. The data satisfied this assumption because the design of the study ensured that the duration of an interaction was defined as the length of time spent from the time visitors began viewing mountain goats until the time visitors stopped watching mountain goats. An observation never ended before an interaction ended.

Results (dependent variable = duration)

The results of the time-to-event analysis are shown below (Table 25). Again, weather was split into four separate categories (cloud cover, temperature, wind and rain) to better understand the subtleties of the variable. Rain was omitted from the analysis because the sample size was too small ($n = 2$) to make any reliable conclusions about its effect on duration.

Table 24 Time-to-Event Analysis of Setting Attributes on the Duration of an Interaction

	Value	Std. Error	z	p
(Intercept)	1.31080	0.2895	4.528	0.000006
Cloud Cover	0.06822	0.0502	1.359	0.174
Temperature	-0.08645	0.1071	-0.807	0.420
Wind	0.05960	0.1145	0.520	0.603
Rain	0.00000	0.0000	NaN	NaN
Time	-0.01849	0.0210	-0.879	0.379
Distance	0.00705	0.0286	0.246	0.805
Elevation	-0.27530	0.0780	-3.529	0.000418
Log(scale)	-0.03374	0.0323	-1.046	0.296

As the table shows, only one of the six variables was found to significantly influence the duration of an interaction. None of the three weather variables were significant. This was somewhat surprising because it was expected that the duration of an interaction would be longer when “pleasant” weather conditions (e.g. warm, few clouds, little wind) were in effect. The time of day and the distance between visitors and mountain goats also did not have a significant relationship with duration. Below is a graph showing the mean interaction durations by hour of the day (Figure 21). While it shows a distinctly non-linear trend, there does seem to be a pattern.

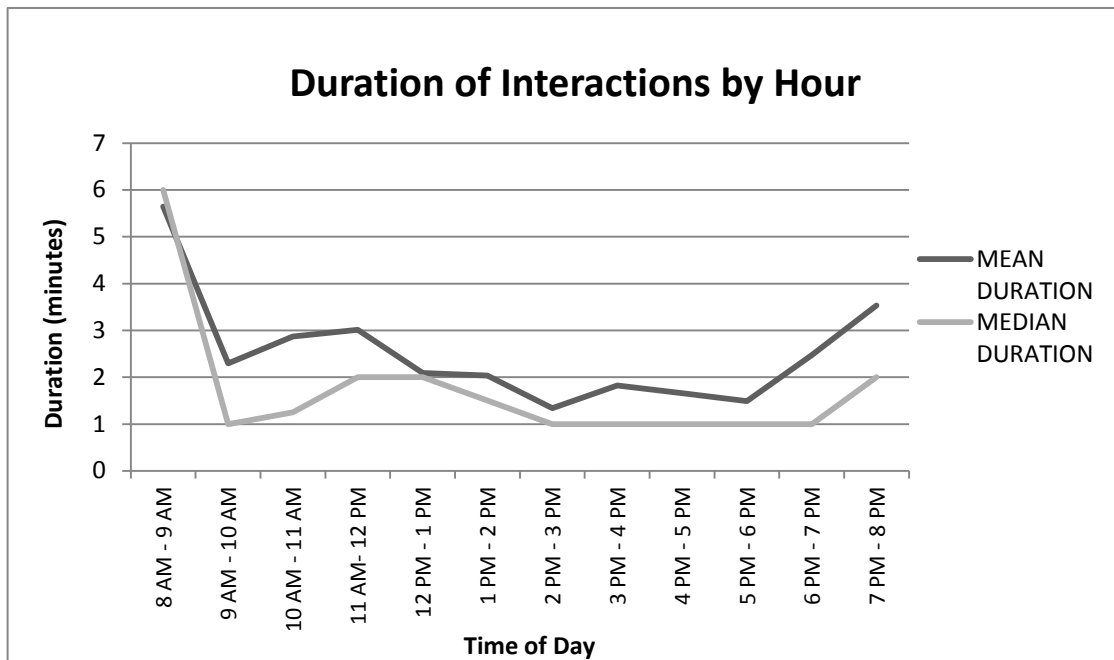


Figure 21 Duration of Interactions by Time of Day

Results show that in the early morning hours, specifically between 8 AM and 9 AM, both the mean and median duration of an interaction was approximately six minutes. The average duration decreased dramatically between 9 AM and 10 AM (mean: 2.3 minutes; median: 1 minute). After 10 AM, the average duration of interactions per hour increased steadily until 12 PM, when it began to decrease slowly until approximately 3 PM. Throughout most of the day between the hours of 9 AM and 7 PM the average hourly duration of an interaction remained between 1 and 3 minutes. After 7 PM, the average duration increased slightly (mean: 3.5 minutes; median: 2 minutes), but never reached the 8 AM to 9 AM level (Figure 21).

The differences between the mean and median durations can be accounted for by large outliers that right-skewed the mean durations. The pattern exhibited in this figure contrasts with the frequency of interactions by time of day (Figure 16) and the average number of visitors on trail per hour (Figure 17). This suggests that the number of visitors and the frequency of interactions may affect how long visitors spend interacting with mountain goats. When there are few visitors on trail and interactions are occurring infrequently, people are more likely to spend longer amounts of time interacting.

There was also little significant evidence to conclude that there was a linear relationship between duration and the distance between mountain goats and visitors. The figure below shows this relationship (Figure 22).

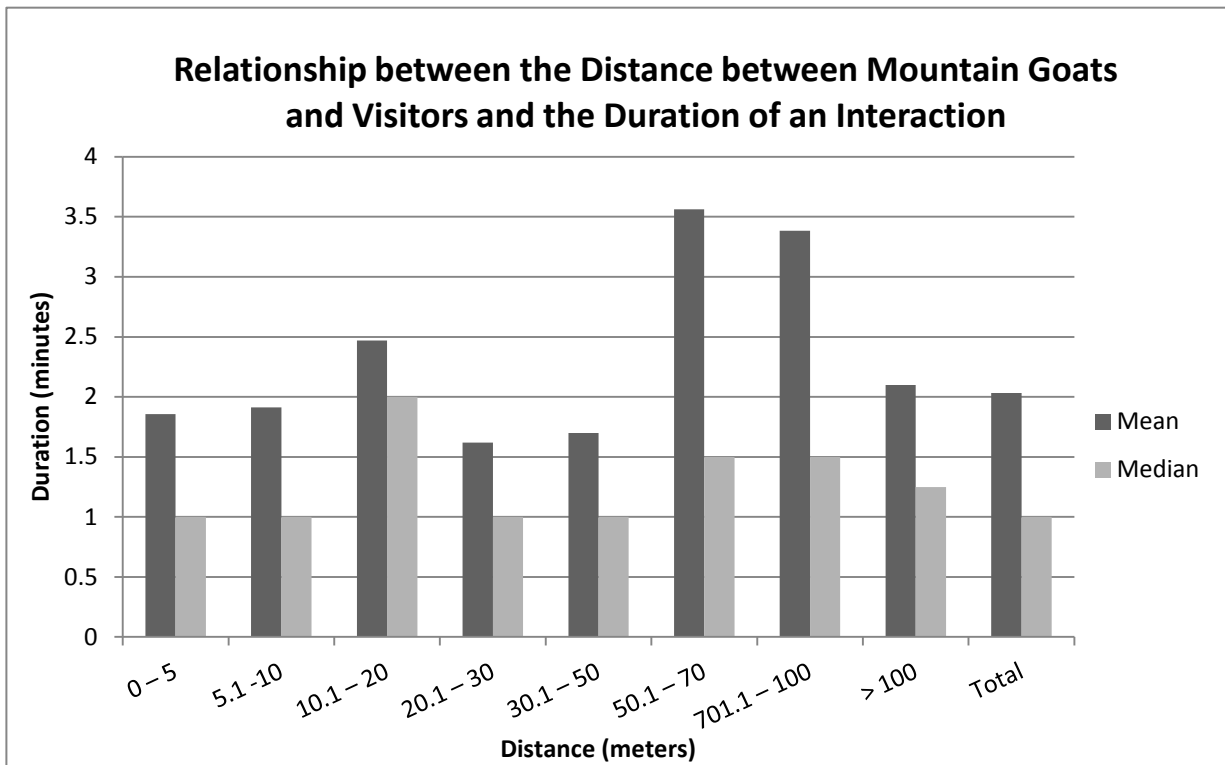


Figure 22 Duration as a Function of the Distance between Mountain Goats and Visitors

Looking at Figure 22, it is difficult to discern a distinct pattern. It does appear that average durations remain short and steady when goats are between 0 and 50 meters from visitors. At distances greater than 50 meters, durations tend to increase slightly. It is important to note that the sample sizes for distances greater than 50 meters were quite low - between 16 and 32 observations. This is illustrated by the large gap between the means and medians for these distances.

The only significant independent variable in the time-to-event analysis was the elevation of mountain goats relative to visitors. The negative unstandardized β for elevation indicates that as a mountain goat's relative elevation increased (went from below to above a visitor), the duration of the interaction decreased. In other words, the duration of an interaction in which a

mountain goat was above a visitor tended to be shorter than an interaction in which a mountain goat was below a visitor.

Below is a comparison of the mean duration of an interaction as a function of mountain goat elevation. The mean duration of an interaction when mountain goats were located below visitors was longer (3.37 minutes) than when mountain goats were either level with or below visitors (1.87 minutes and 1.61 minutes, respectively). On the x-axis in Figure 23, 1 = Below, 2 = Level and 3 = Above (Table 26 and Figure 23).

Table 25 Comparison of Mean Durations as a Function of Mountain Goat Relative Elevation

Elevation	Mean	N	Std. Deviation	Median
Below	3.3653	118	4.49319	2.0000
Level	1.8663	526	2.18579	1.0000
Above	1.6116	168	2.16513	1.0000
Total	2.0314	812	2.69884	1.0000

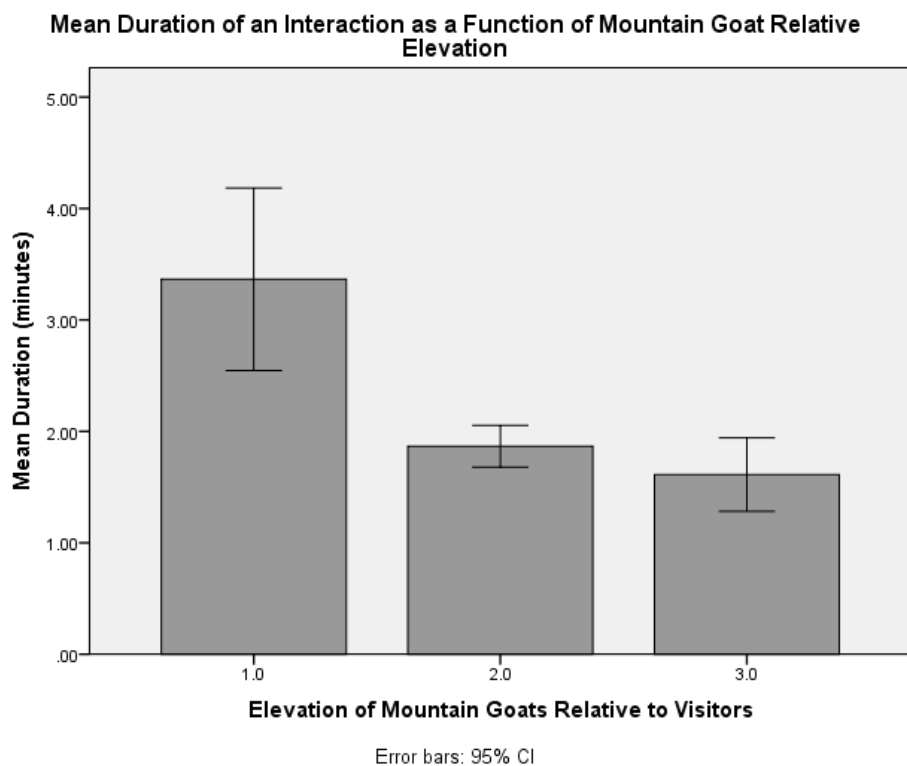


Figure 23 Mean Duration as a Function of Mountain Goat Relative Elevation

Question 4: Do interactions vary depending on visitor/mountain goat group composition/behavior?

Assumptions

Both logistic regressions and time-to-event analyses were run to assist in answering these research questions. Therefore, the assumptions for both tests were addressed as they were in Questions 1 and 3. Again, because these tests were used primarily for data reduction purposes rather than in-depth analysis, great detail is not provided for the assumptions.

For the logistic regression it was first assumed that the dependent variable was measured on a dichotomous scale. In this case the dependent variable, occurrence of an interaction, had two responses: yes or no. Secondly, there were one or more independent variables, which were either continuous or categorical. For this analysis, the independent variable was mountain goat group composition, which consisted of the categories: number of goats being viewed, number of kids and number of nannies. Therefore, the independent variable was continuous. The third assumption addressed whether or not observations were independent and whether or not the dependent variable had mutually exclusive and exhaustive categories. Statistical independence was met because the occurrence of one observation did not affect the probability of another observation. Additionally, the two categories for the occurrence of an interaction were “yes” and “no”, which were mutually exclusive and exhaustive. The final assumption was that there was a linear relationship between any continuous independent variables and the logit transformation of the dependent variable. Using the Box-Tidwell procedure in SPSS, this assumption was met for the independent variable.

For the time-to-event analysis, it was necessary to address the non-informative censoring assumption. The data satisfied this assumption because the design of the study ensured that the duration of an interaction was defined as the length of time spent from the time visitors began viewing mountain goats until the time visitors stopped watching mountain goats. An observation never ended before an interaction ended.

Results

Prior to testing the relationship between mountain goat group composition and occurrence of an interaction, the mountain goat group composition variable was divided into three separate categories. The first category was simply the number of mountain goats in the group being viewed by visitors. Second was the number of mountain goat kids present in the group. And third was the number of nannies present in the group. These categories gave us a general idea of the age and sex structure of interacting mountain goat groups (Table 27).

Table 26 Logistic Regression of Mountain Goat Group Composition on the Occurrence of an Interaction

Independent Variable	B	S.E.	Wald	df	Sig.	Exp(B)
Number of Goats in Group being Viewed	.104	.110	.882	1	.348	1.109
Number of Kids	.186	.269	.479	1	.489	1.205
Number of Nannies	.106	.222	.227	1	.634	1.112
Constant	.692	.149	21.669	1	.000	1.997

Results from the logistic regression provided no significant evidence to conclude that any of the three categories used to describe mountain goat group composition (total number of goats, number of kids and number of nannies) helped predict the likelihood of an interaction occurring. Thus no further analyses were conducted.

For the time-to-event analysis of the relationship between group composition and behavior and the duration of an interaction, the independent variable, visitor group composition, was first separated into similar categories as mountain goat group composition (number of visitors interacting, number of females and number of children under 12). For this analysis, mountain goat group composition did not include the number of nannies. This options was excluded from the focal sampling iForm to make data collection simpler, and therefore, more reliable. The results from the analysis are shown in Table 28 below.

Table 27 Time-to-Event Analysis Results for Mountain Goat/Visitor Group Composition on Duration

	Value	Std. Error	z	p
(Intercept)	0.3378	0.1269	2.662	0.00777
Number of People	0.0875	0.0490	1.784	0.07446
Number of Females	-0.0428	0.0618	-0.693	0.48849
Number of Children	-0.0202	0.0587	-0.345	0.73028
Number of Mountain Goats	0.1123	0.0441	2.545	0.01092
Number of Kids	-0.0805	0.0790	-1.020	0.30790
Log(scale)	-0.0309	0.0316	-0.977	0.32843

As indicated in the table above, there was no significant relationship between the age and sex composition of visitor groups and how long the interaction lasted. Apparently, on Hidden Lake Trail, the length of time spent watching mountain goats did not depend on the number of people, the sex ratio or the age ratio (adult:child) of the visitor group interacting with mountain goats. Therefore, no further tests were conducted for these variables.

However, the duration of an interaction did appear to be affected by the number of goats being watched. This variable exhibited a significance level of 0.01 (Table 28). The β coefficient was positive (0.112), indicating that as the number of mountain goats being watched increased, the length of the interaction increased as well.

Question 5: Do visitors respond emotionally during a mountain goat encounter?

It was hypothesized that in the majority of mountain goat-visitor interactions, all visitors would exhibit an emotional response. To test this hypothesis, the proportion of interactions in which “No Emotion” was recorded in the Emotional Response section of the iForm was examined. Based on these numbers, it was found that 11% of interactions involved one or more visitors responding non-emotionally. Therefore, in well over half of the observed interactions (89%) all visitors exhibited some emotional response (see Chapter 4, Table 11 and Figure 13).

Knowing that mountain goat-human interactions on Hidden Lake Trail were generally emotionally-charged events, the next question was, what are the factors that influence emotional responses during an interaction? First, a logistic regression was run to determine which setting attributes (time of day, weather, distance and elevation) were significant predictors of certain emotional responses.

Assumptions

As before, all assumptions of logistic regression analysis were addressed prior to running the regression. The dependent variable was measured on a dichotomous scale. In this case the dependent variable, occurrence of a certain emotional response, had two responses: yes or no. Secondly, there was one or more independent variables, which were either continuous or categorical. For this analysis, the independent variables were time (ordinal), weather (four categories: either nominal or ordinal), distance (ordinal), elevation (ordinal), visitor and mountain goat group composition (five categories: all interval) and mountain goat behavior (nominal). The third assumption addressed whether or not observations were independent and whether or not the dependent variable had mutually exclusive and exhaustive categories.

Statistical independence was met because the occurrence of one observation did not affect the probability of another observation. Additionally, the two categories for the occurrence of an emotional response were “yes” and “no”, which were mutually exclusive and exhaustive. The final assumption was that there was a linear relationship between any continuous independent variables and the logit transformation of the dependent variable. This was tested for visitor and mountain goat group composition using the Box-Tidwell procedure in SPSS, and the assumption was met for each category.

Results

Prior to running the logistic regression, the weather variable was further split into: cloud cover, temperature, rain and wind. Of the seven independent variables, four were found to have a significant influence on the likelihood of observing at least one emotional response. The distance between visitors and mountain goats was found to significantly influence the occurrence of seven emotional responses: joy, interest, excitement, amusement, surprise, amazement and anxiety. Below are the results from the logistic regression of distance on emotional response (only the emotions that were significantly influenced by distance are shown) (Table 29).

Table 28 Emotions Significantly Influenced by the Distance between Mountain Goats and Visitors

Distance between Mountain Goats and Visitors						
Emotion	B	S.E.	Wald	df	Sig.	Exp(B)
Joy	-0.205	0.064	10.392	1	0.001	0.814
Interest	0.163	0.072	5.09	1	0.024	1.177
Excitement	-0.185	0.061	9.304	1	0.002	0.831
Amusement	-0.373	0.087	18.505	1	0.000	0.689
Surprise	-0.157	0.077	4.133	1	0.042	0.854
Amazement	-0.575	0.17	11.482	1	0.001	0.563
Anxiety	-1.454	0.43	11.401	1	0.001	0.234

Of the seven emotional responses listed above, interest was the only one that was more likely to be observed as the distance between visitors and mountain goats increased ($\beta = 0.163$). In other words visitors expressed interest more frequently when mountain goats were further away. Joy, excitement, amusement, surprise and amazement were all observed more frequently when there was a short distance between mountain goats and visitors. Anxiety was also observed more frequently when visitors were near goats.

Two weather variables (cloud cover and wind) appeared to influence the likelihood of observing certain emotional responses as well (Table 30).

Table 29 Emotions Significantly Influenced by Two Weather Variables (Cloud Cover and Wind)

Cloud Cover						
Emotion	B	S.E.	Wald	df	Sig.	Exp(B)
Joy	0.269	0.117	5.318	1	0.021	1.309
Windy						
Emotion	B	S.E.	Wald	df	Sig.	Exp(B)
Excitement	-0.604	0.254	5.64	1	0.018	0.547
Amazement	-0.848	0.412	4.239	1	0.04	0.428

Cloud cover had a positive association with the expression of joy ($\beta = 0.0.269$). This means that as cloud cover increased, the likelihood of observing joy also increased. Wind had a negative association with both excitement and amazement ($\beta = -0.606$ and -0.848 , respectively). Therefore, the probability of observing excitement and amazement when it was windy was lower than when it was not windy.

Finally, time of day was found to influence the expression of interest and anxiety (Table 31).

Table 30 Emotions Significantly Influenced by Time of Day

Time						
Emotion	B	S.E.	Wald	df	Sig.	Exp(B)
Interest	0.169	0.057	8.643	1	0.003	1.184
Anxiety	-0.295	0.092	10.224	1	0.001	0.745

Time of day had a positive influence on the expression of interest. Therefore, interest was more frequently observed later in the day than early on ($\beta = 0.169$). Oppositely, anxiety was less frequently expressed in the late afternoon and evening than in the morning and early afternoon hours ($\beta = -0.295$).

An important piece of information to keep in mind throughout the following discussions of emotion is that a number of the emotional responses were observed only a few times throughout the sampling period. Therefore, the sample size for many of them is quite small, and so any attempt to make conclusions about trends and patterns is flawed. All emotional responses represented in the logistic regression tables were observed at least 38 times. Table 11 in Chapter 4 shows the frequencies of all emotional responses for reference. Unfortunately, because so many emotional responses were observed infrequently, it is impossible to fully comprehend the nature of these emotions in wildlife interactions.

The next question regarding emotional responses was, how are emotions influenced by the composition of both the mountain goat group and the visitor group that are interacting? Visitor group composition consisted of three categories: number of visitors, number of children and number of females. Mountain goat group composition consisted of number of mountain goats and number of kids. Logistic regression was used once again.

Table 32 below shows the emotional responses that were significantly influenced by visitor group composition.

Table 31 Emotions Significantly Influenced by Visitor Group Composition

Number of Visitors						
Emotion	B	S.E.	Wald	df	Sig.	Exp(B)
Excitement	0.238	0.102	5.442	1	0.02	1.269
Amusement	0.237	0.1	5.658	1	0.017	1.268
Surprise	0.247	0.105	5.529	1	0.019	1.28
Number of Children						
Emotion	B	S.E.	Wald	df	Sig.	Exp(B)
Excitement	0.843	0.159	28.009	1	0	2.323
Amusement	-0.243	0.139	3.051	1	0.081	0.784
Anticipation	0.426	0.152	7.816	1	0.005	1.532
Surprise	0.278	0.135	4.222	1	0.04	1.32
No Emotion	-0.555	0.243	5.202	1	0.023	0.574
Number of Females						
Emotion	B	S.E.	Wald	df	Sig.	Exp(B)
Joy	0.428	0.157	7.476	1	0.006	1.535
Affection	0.333	0.182	3.333	1	0.068	1.395

The number of visitors interacting had a positive association with the expression of excitement, amusement and surprise. Thus, as the number of visitors increased, the probability of observing these three emotions also increased. The number of children in a visitor group had a positive influence on the expression of excitement, anticipation and surprise. In other words, when there were more children involved in an interaction there was a higher likelihood of observing excitement, anticipation and surprise. The number of children also had a negative association with the observation of amusement and no emotion. Therefore, when more children were present, it was likely that one would observe amusement or no emotional responses. Finally, the presence of females affected the expression of joy and affection in a positive direction. So as the number of females in a visitor group increased, the chance of observing joy and affection also increased.

The number of mountain goats interacting did not significantly affect emotional responses. However, the number of kids in a mountain goat group influenced the expression of joy, amusement, surprise and affection (Table 33).

Table 32 Emotions Significantly Influenced by the Number of Mountain Goat Kids in an Interaction

Emotion	Number of Kids					
	B	S.E.	Wald	df	Sig.	Exp(B)
Joy	0.432	0.224	3.728	1	0.053	1.541
Amusement	-0.473	0.243	3.769	1	0.052	0.623
Surprise	-0.431	0.231	3.484	1	0.062	0.65
Affection	0.274	0.162	2.857	1	0.091	1.315

The expression of joy and affection both increased with an increasing number of mountain goat kids, while the expression of amusement and surprise decreased with an increasing number of kids.

Again, no negative emotions were significantly influenced by either mountain goat or visitor group composition. This is because, other than anxiety, negative emotional responses had small sample sizes.

Next, the relationship between mountain goat behaviors and the expression of certain emotional responses was examined. Logistic regression was used once again to test this relationship (Table 34).

Table 33 Emotions Significantly Influenced by Mountain Goat Behavior

Mountain Goat Behavior	Joy			Interest			Excitement			Amusement		
	β	Sig.	S.E.	β	Sig.	S.E.	β	Sig.	S.E.	β	Sig.	S.E.
Alert (human)	0.926	0.000	0.254				0.469	0.025	0.209			
Alert (other)				0.829	0.047	0.417				-0.733	0.090	0.432
Foraging	1.398	0.000	0.383	0.853	0.002	0.276	0.410	0.081	0.234			
Lying							0.799	0.006	0.291			
Sleeping												
Following (other goat)	1.025	0.000	0.289				0.576	0.049	0.293			
Vocalizing										2.671	0.002	0.870
Licking minerals (human)												
Pitting												
Grooming (self)												
Ruminating												
Urinating/Defecating												
Walking away from human							1.361	0.018	0.575			
Fleeing (human)												
Mountain Goat Behavior	Amazement			Affection			Surprise			Anxiety		
	β	Sig.	S.E.	β	Sig.	S.E.	β	Sig.	S.E.	β	Sig.	S.E.
Alert (human)				0.735	0.040	0.357	0.656	0.011	0.259	1.474	0.001	0.444
Alert (other)												
Foraging												
Lying				0.895	0.042	0.441	0.673	0.043	0.333			
Sleeping												
Following (other goat)	1.192	0.019	0.507	1.103	0.017	0.461				-1.200	0.061	0.641
Vocalizing				2.667	0.000	0.765						
Licking minerals (human)				1.247	0.039	0.605						
Pitting				3.017	0.001	0.919						
Grooming (self)	2.174	0.040	1.060									
Ruminating				-1.325	0.090	0.783				1.711	0.005	0.603
Urinating/Defecating	2.509	0.003	0.855									
Walking away from human												
Fleeing (human)										1.450	0.060	0.772

Table 34 shows the eight emotional responses and the 14 goat behaviors that had a significant correlation. The β coefficient, the significance and the standard error are provided for each paired behavior and emotion.

The final question that was addressed regarding emotional responses was how emotional responses varied based on the duration of the interaction. For this question, a basic correlation matrix was run in SPSS (Table 35).

Table 34 Correlations between Duration and Emotional Responses

		Joy	Interest	Excitement	Amusement	Anticipation	Satisfaction
Duration (minutes)	Pearson	.170**	.127**	.125**	.149**	.202**	.152**
	Correlation						
	Sig. (2-tailed)	0.000	0.006	0.007	0.001	0.000	0.001
	N	461	461	461	461	461	461
		Amazement	Relief	Anxiety	Annoyance	Frustration	No Emotion
Duration (minutes)	Pearson	.157**	.124**	.113*	0.125	.092*	-0.125
	Correlation						
	Sig. (2-tailed)	0.001	0.008	0.015	0.007	0.048	0.007
	N	461	461	461	461	461	461

A total of 12 emotional responses were significantly correlated with duration. Eight positive emotions (joy, interest, excitement, amusement, anticipation, satisfaction, amazement and relief) and three negative emotions (anxiety, annoyance and frustration) were positively correlated with duration. In other words, they were more likely to be expressed as the length of an interaction increased. Only one response, the non-emotional response, was negatively correlated with duration. Therefore, non-emotional responses were more likely to be observed in interactions of short duration.

Testing the Reliability of the Emotion Samples

During 40 of the observations involving emotional responses, another observer was present to test the intercoder reliability. In other words, two observers would watch the same interactions and separately record the emotions they observed. In this way, it was possible to

determine how similarly or differently emotion was interpreted and recorded by each observer. The number of emotional responses that were the same in each interaction was divided by the largest number of emotions recorded to determine the accuracy between the two observers. For example, if observer one recorded joy, excitement and anxiety for interaction one, and observer two recorded joy, excitement, interest, surprise and boredom for the same interaction, two (the number of responses that were the same (joy and excitement) was divided by five (the largest number of emotions recorded by one observer). Therefore the accuracy would be $2/5$ or 0.4. These observations occurred over a three day period. Ten interactions were observed on day one and 15 interactions were observed on days two and three ($n = 40$). The accuracies for all interactions on each day were averaged to find the mean daily accuracy. In this way, it was possible to see how the accuracy changed as the two observers spent more time together.

Results

On day one, the mean accuracy was 0.354, on day two the mean accuracy was 0.527 and on day three the mean accuracy was 0.553. Therefore the total average accuracy between the two observers throughout the three day sampling period was 0.478. This means that, on average, approximately 48% of the responses recorded by the two observers during an interaction were the same.

Interestingly, the mean daily accuracy increased between days one and two and between days two and three. This indicates that as the observers spent more time watching interactions together, they tended to have a higher degree of accuracy. One must be cautious with this test, however, because while it may result in more reliable results, it may also increase the bias.

CHAPTER 6: DISCUSSION AND CONCLUSIONS

Introduction

In this chapter the analysis results are discussed in relation to the purpose of the study and the current state of knowledge. Implications for managers of protected areas are described and suggestions for future research are provided. Finally, limitations of the study are examined and a final conclusion statement is made.

Discussion of Results

Descriptive Statistics

Interactions between mountain goats and visitors on Hidden Lake Trail have the potential to occur at every point along the trail. However, few observations of interactions occurred along the first $\frac{3}{4}$ mile of the trail. From that point, the number of interactions increased until reaching the overlook, and then for the last $\frac{1}{4}$ mile past the overlook the number of interactions decreased slightly. It is important to note that only one observer recorded most interactions, and therefore it was difficult to collect data evenly across the entire two miles of trail that were surveyed each day.

In terms of visitor group composition, the male to female ratio was even, but there were typically few children younger than 12 years old during an interaction. Mountain goat group compositions were somewhat unexpected. For example, nanny-kid groups were smaller than those mentioned in a number of previous studies, and most of the time, each nanny-kid pair was found alone. There were also more billies observed in interactions than nannies, which one veteran ranger mentioned was unusual for Hidden Lake Trail.

In general, interactions were short, hovering around the one minute mark, and within that time visitors were well-behaved. For the most part, people would watch and photograph the goats, talk about them with others and then move on. However, almost a quarter of the time, visitors would leave the trail, which is discouraged by park staff. Mountain goats exhibited generally “normal” mountain goat behavior during interactions, other than they were often alert to humans.

Mountain goats were quite close to visitors during most interactions, often maintaining less than 5 meters of distance. This close proximity is highly discouraged by park staff, who tell visitors to remain at least 25 yards from mountain goats at all times. Because of these close distances, mountain goats were also generally level with visitors or the trail rather than above them or below them. These are strong indicators of habituation, as most wild goats prefer to stay far from or at least above, people (Bansner 1978; Stevens 1983).

The large majority of interactions between visitors and mountain goats involved emotional responses. Few interactions occurred in which at least one visitor exhibited no emotions. In addition, most of the observed emotions were positive (e.g. joy, excitement, interest) rather than negative (e.g. anxiety, anger, frustration). These results must be accepted provisionally, however as measurement was somewhat subjective. This will be discussed in further depth later on.

Mountain goat behavior during an interaction versus when no interaction is occurring

The findings from this study suggest that the mountain goats at Hidden Lake do behave differently when visitors are interacting with them compared to when visitors are not present or do not notice them. Interestingly, they are more likely to sleep and forage when no interaction is occurring. In other words, they are more likely to be conserving or obtaining energy. On the

other hand, when people are present and noticing the goats, they are more likely to be expending energy by being alert, walking or moving towards or away from people. Additionally, vocalizing and following another goat, which were typically exhibited by kids that were trying to find or stay near their mother, were observed more frequently during interactions. These results are interesting because they indicate that even mountain goats that are highly desensitized to recreationists exhibit stressful behaviors during interactions more frequently than when no interaction is occurring.

It is important to note that there may be a number of variables at play in this relationship. For example, time of day may play a significant role. Perhaps interactions occur more frequently during the time of day when goats are most active. It is also possible that the animals that are more active in general are the ones that people notice. Also, many behaviors were not found to be significant simply because they occurred so infrequently. This does not mean they are not important. It would be interesting to collect a larger sample for some of these behaviors to determine if they occur more frequently when humans are present or absent.

Negative interactions

Again, it was determined that a negative interaction was one in which a mountain goat exhibited aggression, aversion or altered its “normal” behavior as a result of human activity *or* a visitor harassed or evaded a mountain goat or altered mountain goat habitat in some way.

The majority of mountain goat and visitor behaviors chosen as “negative” behaviors seem fairly obvious because you can see the direct impact to the subject immediately (e.g. a visitor runs toward a goat which results in the stressful act of flight by the goat). However, there are a few whose impacts are more difficult to pinpoint. For example, the act of mountain goats licking minerals left behind by people may be completely benign or even beneficial in some

ways for mountain goats. However, park managers have identified this behavior as negative because it alters the mountain goat's "wild" behavior and brings them in close contact with humans, which has the potential to yield dangerous interactions. The same idea applies to the human act of feeding mountain goats. Stepping off of the trail may also appear to be nonthreatening, but it tramples vegetation and results in interactions of close proximity.

The frequency of negative interactions was smaller than was hypothesized (42% versus 50%), and during a typical negative interaction only one negative behavior was exhibited. More importantly though, were the details of each negative interaction. For example, it was surprising how little aggression was exhibited by mountain goats during interactions, and when they were aggressive, the intensity was typically quite low (e.g. walking versus running toward a person). However, even a low percentage of goat aggression like 3% needs to be understood in the context of Hidden Lake Trail (HLT), as well as in the context of wild animal behavior. Interactions on HLT frequently occurred between visitors and mountain goats that were close to one another. Additionally, while the mountain goats may seem almost domesticated, they are still wild, and their behavior can be difficult to predict. Therefore, the amount of mountain goat aggression should be minimized as much as possible.

While these results provide evidence of mountain goat desensitization to human activity, aversion was exhibited by mountain goats in 15% of negative interactions. However, the most intense aversive mountain goat behavior, running away from humans, was almost never observed. Typically, mountain goats simply walked away from visitors. Mountain goats also occasionally licked minerals left behind by humans (e.g. sweat, urine, food crumbs). Therefore, the Hidden Lake mountain goats, although seemingly unaffected by hikers, are behaving somewhat differently as a result of human activity. The short-term implications do not appear to

be all that negative for these goats, but it remains to be seen whether this is good or bad for their long-term survival and reproduction.

In almost half (48%) of interactions in which negative behaviors were exhibited, the negative behavior(s) observed was visitor harassment of mountain goats. Of the three behaviors included in the harassment category (walking toward goats, running toward goats and gesturing/yelling at goats), walking toward goats was the most frequently observed. In 53% of negative interactions, visitors altered mountain goat habitat, typically by stepping off of the trail. Therefore, while negative visitor behaviors more frequently occur than negative mountain goat behaviors, the majority of them are low in intensity (e.g. walking toward a goat, stepping off of the trail). And although these behaviors are unfortunate, they are easier for managers to control than mountain goat aggression. These results indicate that there needs to be a greater focus on changing hiker behaviors toward mountain goats on Hidden Lake Trail.

Visitors were rarely aversive toward mountain goats. It is important to remember, though, that complacency can often lead to dangerous wildlife interactions. Even though visitors do not appear to be fearful of these mountain goats, this does not mean a goat will never act aggressively. Visitors should be aware of the potential for dangerous interactions with these wild animals, and take all necessary measures to prevent them.

Setting attributes' influence on interactions

A number of setting attributes were found to influence the occurrence of an interaction between mountain goats and visitors on Hidden Lake Trail. In terms of weather, both temperature and wind had an effect on whether or not an interaction occurred. As expected, as the temperature increased from cool to warm, the likelihood of observing an interaction increased. Additionally, when it was windy, interactions were less likely. Perhaps when the

weather is more pleasant (i.e. warm, not windy) mountain goats are more likely to be visible because they are more active and not taking shelter. Or, it could be that visitors are more likely to seek out wildlife during pleasant conditions.

Time of day also appeared to affect whether or not an interaction occurred. As it got later in the day, there was a greater likelihood of observing mountain goats, but not observing an interaction between visitors and mountain goats. This may occur because visitors are less likely to interact with mountain goats (even if they do see them) when they are leaving the trail at the end of the day. This would make sense because they have potentially already interacted with mountain goats on the hike in, and so are less likely to do so when they leave. This may also be the result of daily mountain goat activity patterns. Perhaps mountain goats tend to be more visible or interactive with visitors during the morning/early afternoon hours than in the late afternoon/evening hours. Further information is necessary to test these hypotheses.

Interestingly, the duration of interactions as a function of time followed the opposite trend of visitation. The average length of an interaction was longest early in the morning, and then decreased and stabilized throughout the afternoon. At the end of the day, the average duration increased once again, but never to early morning levels. Because this trend is contrary to hourly visitation, it is likely that the number of visitors negatively influences duration. In other words, people tend to spend more time interacting with a mountain goat group when fewer people are present. When the trail is crowded, people spend shorter periods of time interacting with a mountain goat group.

Unsurprisingly, interactions were more frequent when mountain goats were near visitors than when they were far away. This makes sense because the closer mountain goats are to visitors, the more visible they are, and therefore the more likely visitors are to interact with them.

There was also some evidence to suggest that interactions lasted longer when mountain goats were between 10 and 20 meters or further than 50 meters from visitors. More research is necessary to draw a strong conclusion.

Finally, the duration of an interaction was found to be significantly longer when goats were below visitors compared to when they were level with or above visitors. This was somewhat surprising based on previous findings that ungulates feel more threatened and react more rapidly to recreationists that are above them. However, the mountain goats in this study are highly desensitized to hikers and therefore, studies of other ungulates do not necessarily apply. Perhaps it has to do with visitors' reacting anxiously toward mountain goats that are above or level with them. However, this study also found that visitors rarely respond aversively to mountain goats, and therefore, this should not be the case. This would be an interesting topic for future research of habituated ungulates and recreationists.

Influence of group composition and behavior on interactions

In the test of the relationship between mountain goat group composition (i.e. number of goats, number of nannies and number of kids) and the occurrence of an interaction, it was found that none of the three composition categories had an influence on whether or not an interaction occurred. This was not terribly surprising considering mountain goats are a major Hidden Lake Trail attraction. It doesn't matter whether there are nannies, kids or billies in the group or how many goats there are. If visitors notice them, an interaction is going to occur.

It is likely that mountain goat group composition did not influence the likelihood of an interaction because visitors were apt to interact with mountain goats no matter the number of goats or whether there were babies present. Mountain goats are highly sought after animals in

Glacier National Park, and so visitors are likely to interact with them regardless of group composition.

Alternatively, the duration of an interaction was affected by the number of mountain goats present. As the number of goats increased, the length of the interaction tended to increase as well. There are a couple of potential factors contributing to this trend. The first is that visitors specifically enjoy watching mountain goats interact with one another. When only one mountain goat is present, visitors lose interest more quickly, and ultimately spend less time watching the mountain goat. This would be an interesting subject of future research, not just for mountain goat-watching, but for wildlife-watching in general. The second contributing factor may be the response of mountain goats to recreationists as function of the number of goats in the group. As discussed previously, in ungulates, herd size is often directly related to response rate. When the herd is small, the animal(s) tend(s) to respond more rapidly to recreationists compared to when the herd is large. Although this did not affect whether or not an interaction occurred, it is possible that the Hidden Lake mountain goats move away from visitors faster when there are few of them compared to when there are many.

Emotional responses during interactions

The final research question of interest involved emotional responses during mountain goat encounters. This was a more challenging subject to address as it is quite novel in the human dimensions of wildlife field, making it difficult to find much previous research. Additionally, the observational measurement of emotion is a tricky business because everybody interprets emotional responses differently. However, it was an important topic to tackle, and the results will provide guidance for future research in this field.

The majority of interactions involved emotional responses to mountain goats, and most of these interactions consisted largely of positive emotions (e.g. excitement, joy, interest). Returning to Manfredo (2008) and Hudenko (2012), these results were to be expected. Delving further into the influencers of emotional responses during interactions, it was found that time of day, weather and distance between mountain goats and visitors all affected the frequency of observing certain emotional responses. Specifically, it was found that the closer visitors were to mountain goats, the more likely they were to express joy, excitement, amazement, surprise and amusement. However, there was also a greater likelihood of observing anxiety. These results have some major management implications that will be discussed later on.

A few of the relationships described above make inherent sense. For example, the expression of positive emotions such as joy, excitement, amusement, surprise and amazement were more frequently observed when mountain goats were nearby. This type of relationship was expected because people are better able to see the individual goats' behaviors and make stronger connections with them when they are close.

Many of the findings from this analysis are more difficult to explain, however. For example, why does the expression of interest appear to increase as the proximity between mountain goats and visitors increases? Or, why does increasing cloud cover increase the likelihood of observing joy? It is possible that confounding variables are contributing to these trends. Also, it is important to remember that subjectivity is inherent in the measurement of emotion in an observational study. Therefore, all results must be looked at under a critical lens and replicated, if possible, to be able to make sound claims about emotions in wildlife interactions.

The composition of visitor groups was also quite influential in how frequently certain emotions were expressed. As the number of people increased, the expression of excitement, amusement and surprise all increased as well. The number of females present had a positive influence on the expression of joy and affection, and the number of children had a negative influence on the expression of no emotion. Thus, it seems that children may, in general, respond more emotionally to encounters with mountain goats on Hidden Lake Trail.

Mountain goat behavior and duration were also shown to be significantly correlated with a number of emotional responses. Wildlife behavior and the length of an interaction would be interesting focal variables for future studies of emotion in wildlife interactions.

A test to determine the reliability of measuring emotion in this study was also conducted. From a sample of 40 interactions that were observed by two researchers it was found that, on average, approximately 48% of the responses recorded by the two observers were the same. Although this number is quite low, the average daily accuracy increased slightly each day that the observers recorded emotions together.

This demonstrates the inherent subjectivity in observational measures of emotion, and thus, results from the emotional portion of this study must be viewed with a critical lens. It also provides future researchers with an incentive to improve the methods currently used to understand the role of emotion in human-wildlife interactions. Because emotions play a large role in the way people view wildlife, this is a noble scientific endeavor.

Comparisons with Existing Literature

This study demonstrated the importance of including environmental, activity/user and wildlife characteristics (natural history) in observations of mountain goat responses to hikers. As Cole (2004) and Steidl and Anthony (1996) illustrated in previous studies, the disturbance

context plays a large role in determining the ways that wildlife will react to certain human activities. The findings from this study show that environmental characteristics (time of day, weather, location of mountain goats in relation to hikers), activity/user characteristics and mountain goat characteristics (group composition and behavior) all influenced the frequency and duration of interactions, as well as emotional responses expressed by visitors during interactions. This is interesting because not only were these characteristics significant in understanding wildlife responses to hikers, but also visitor responses to wildlife, and the nature of interactions in general.

Based on the wildlife response typology from Knight and Cole (1991), the mountain goats at Hidden Lake Trail (HLT) appear to be desensitized (habituated) to hikers. While they were alert to humans a fair amount of the time, mountain goats rarely exhibited behaviors indicative of attraction or avoidance. This indicates that they are not sensitized to humans themselves. However, they do appear to have made a connection between the trail and salt, as they remain very close to the trail and sometimes lick minerals left behind by visitors. According to Festa-Bianchet and Côté (2008), across most of their range, mountain goats are reclusive and don't allow humans to approach closely. This was not the case with the mountain goats on Hidden Lake Trail.

Utilizing the model developed by Hammit and Cole (1991) to describe impacts to wildlife from recreation, it appears that the HLT mountain goats are experiencing the direct impact of harassment and the indirect impact of habitat modification. In response, the mountain goats are altering their behavior by remaining very close to people (in terms of both elevation and distance), licking minerals left behind by hikers from sweat, urine and food, and potentially foraging and sleeping less. However, because this study lasted for only one season of the year,

it is difficult to speculate about whether these goats are being displaced or suffering from reduced reproduction as a result. Ultimately though, the structure and composition of this group of mountain goats will change as a result of heavy visitation, and it is important that Glacier National Park managers monitor these changes to ensure the population is not negatively impacted.

The aspect of this study that sets it apart from many of the existing human-wildlife conflict studies is that it attempts to understand the immediate responses of humans to wildlife encounters. Although social science is increasingly being incorporated into wildlife management issues, surveys are the primary instrument utilized to understand public viewpoints on wildlife. Until recently, emotional responses during wildlife encounters were pushed to the wayside, while cognitive approaches such as the Theory of Reasoned Action were the focus of human dimensions of wildlife research. The findings presented here clearly illustrate the importance of incorporating both the cognitive and the affective domain into human-wildlife conflict studies.

Results show that visitors' interactions with mountain goats on Hidden Lake Trail frequently involve positive emotions such as interest, excitement and joy. Recent research by Jacobs (2009) and Hudenko (2012) suggests that not only do emotions affect an individual's behavior during a wildlife encounter, but also their interpretation of the event and their future motivations to view wildlife. It is likely then, that positive emotional encounters with mountain goats on Hidden Lake Trail will affect the memories visitors have of the park and their desired experiences and expectations in similar outdoor settings.

Additionally, a number of recent studies indicate that emotions significantly affect the decisions people make (Forgas, 2003; Hudenko, 2012; Isen, 2000; Petty Fabrigar & Wegener, 2003). Decision-making plays a large role in food conditioning and habituation in wildlife

populations, which in turn affects the way people interact with wildlife. Perhaps then, the most effective method for influencing the decisions visitors make when they encounter mountain goats is to communicate with them using positive emotions.

Plutchik's Wheel (1980) was the primary emotional typology used to categorize emotions that were observed during mountain goat encounters throughout the summer. The Wheel utilizes the discrete perspective on the nature of emotions rather than the dimensional perspective. There are advantages and disadvantages to using this particular model of emotion for observational studies such as this one. The primary advantage for this study was that the results provided a very rich body of information about emotional responses because the observer recorded the exact emotion displayed by a visitor. A major disadvantage to this approach however, is that the data depends heavily on the judgment of the observer, and it can be difficult to distinguish between certain emotions such as excitement, amazement and surprise. Therefore, one observer's interpretation of an emotion can easily be different from another person's even if the emotions they recorded are similar to one another. The dimensional perspective, on the other hand uses more broad categories, such as liking-disliking and activation-deactivation. This approach would likely result in greater consistency across observers, but provide less detailed information about the visitor's experience. Perhaps the most effective method for observational studies such as this one would be to have multiple observers recording discrete emotions that have been categorized more broadly prior to data collection. Then, once comparisons are made between all of the observers' data, a balance between data richness and consistency can be reached by either broadening or narrowing the categories.

Implications for Managers

The impetus for this study was the concern expressed by Glacier National Park (GNP) management that mountain goat-visitor interactions on Hidden Lake Trail were becoming negative for both parties. Thus, a primary objective was to provide managers with essential information that would guide decision-making related to this matter.

The National Park Service mission is to “preserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment, education, and inspiration of this and future generations.” So how does the information presented here facilitate the achievement of this goal? Specifically, it gives GNP managers a baseline of information with which to compare the nature of wildlife interactions before and after Going-to-the-Sun Road reconstruction. On a more broad level, this information gives managers the tools to prevent negative outcomes and cultivate positive encounters. As a result, the park will be better able to recognize and further conservation goals.

In regards to the preservation of national park resources and values, this research specifically provides managers with knowledge of conditions that foster mountain goat desensitization, aggression, aversion and alteration of behavior following human activity on Hidden Lake Trail. It also illuminates influential factors in negative interactions, as well as positive interactions for mountain goats. Knowing how the mountain goats at Hidden Lake respond to frequent and close interactions with visitors can be used to get an idea of causes of human-induced stress in the species, and ultimately guides our understanding about the resulting long-term impacts (both positive and negative) to mountain goats in Glacier National Park. Not only does it teach us about mountain goat responses to recreationists in GNP, but we can also learn a great deal about how other related ungulate species may respond to recreationists in other

areas of the United States. In the end, managers will be better able to protect the quality of life for the mountain goats in GNP and other wildlife species throughout the nation.

The other side of the coin involves providing “enjoyment, education and inspiration” to the public. Preservation and visitor inspiration are not necessarily mutually exclusive, and in fact, they are often congruent with one another. Thus, the preservation of wildlife automatically preserves the visitor experience. The visitor experience in Glacier National Park would be different, and potentially less outstanding if there were no chance of seeing wild mountain goats in their natural habitat. The same would be true if managers restricted visitors from being anywhere near mountain goats in the park. Although the observation of emotional responses in this study was somewhat subjective and is still in need of refinement, it gives managers an idea of the generally positive emotional responses people have toward mountain goats in GNP. Is this something that should be eliminated because mountain goats are becoming desensitized? At its core, this is a purely ethical issue, but the data collected in this study at least help managers weigh the pros and cons of each decision more intelligently. Managers now have an increased awareness of how to improve the quality of the experience for people, both in terms of enjoyment and safety. We now know the types and frequencies of negative behaviors exhibited by visitors, as well as the conditions they are likely to occur in. We also have a better understanding of the underlying elements that influence visitors’ decisions in encounters with mountain goats. As a result, managers are better equipped to move forward and improve the quality of interactions for both visitors and mountain goats.

The following list details useful knowledge and specific suggestions for Glacier National Park staff resulting from the findings of this study:

1. Mountain goats near the trail can be a good and a bad thing. While there is a higher chance of a dangerous situation occurring, interactions with nearby mountain goats result in more positive emotional experience for visitors.
2. Mountain goats remained near the trail even when people weren't present. Therefore, rather than attempting to change mountain goat behavior (which can be difficult), focus on changing human behavior to indirectly influence goat behavior. This could be accomplished by encouraging visitors *before* they begin their hike to stay on trail, contain any food items, use the restrooms and refrain from following goats. Additionally, interpreters and rangers can inform visitors about how human disturbance can cause mountain goats to eat and sleep less and expend more energy.
3. Restrictions on the number of visitors allowed on Hidden Lake Trail will likely be less effective in mitigating negative interactions than changing visitor behavior. In fact, more visitors actually seem to influence the emotionality of the experience in a positive way.
4. Getting rangers and interpreters on the trail between peak interaction hours – 10 AM and 3 PM will be the most efficient way to effectively communicate with visitors.
5. Inform visitors that by hiking early in the morning or late in the afternoon they are more likely to avoid crowds and experience more intimate wildlife interactions.
6. Focus on educating visitors using positive emotions (e.g. joy, excitement). Negative emotional appeals (e.g. fear, anxiety) will likely be ineffective in changing behavior.
7. Target children for both marketing the park and interpretation, as few were present during interactions, and when they were present they tended to increase the emotionality of the experience in a positive way.

Ultimately, this study provides wildlife professionals in protected areas with the tools to help them a) make management decisions, b) support these decisions when presenting them to the public, c) eliminate bias, d) effectively educate visitors and e) predict scenarios. More specifically, Glacier National Park managers now have a better idea of the most effective and unbiased actions to take to preserve mountain goats and the visitor experience at Hidden Lake Trail. No longer must they rely on sporadic and biased anecdotal data to make these decisions. They also have solid quantitative data to support whatever action they decide to take, which is especially important for this heavily debated and strongly valued issue. When making decisions about how to communicate with visitors about mountain goat encounters, managers now have a clearer idea of what generally goes on during interactions in terms of both visitor and mountain goat behaviors. Additionally, they will be more persuasive in their messaging with increased awareness of emotional responses. Finally, knowing the factors that influence visitor and mountain goat responses will enable the park to predict and prepare for future scenarios.

Recommended Future Research and Limitations of This Study

Exploration of the subject of wildlife-human interactions is far from complete, and the research conducted here only reinforces this claim. While this study answered a number of questions, it also generated a great many more. These questions, as well as the limitations that emerged throughout the process are addressed in the following discussion.

Mountain Goat Responses to Recreational Activities

As human populations continue to grow and encroach on the remaining wild areas of the world, it is imperative that we proactively investigate the potential impacts to species that are currently unaffected. Mountain goats are one of those species that are just beginning to see the

impacts of increased human activity throughout parts of their range. Therefore, in order to prevent negative long-term impacts to this vital species, a more thorough understanding of their responses to human activity is required. Three specific questions related to mountain goat behavioral patterns and responses to recreationists that were not answered by the data collected in this study were:

1. What are the daily activity patterns of the mountain goats on Hidden Lake Trail during peak visitor use, and how do they compare to activity patterns of mountain goats in areas that receive lower use in GNP?
2. Do mountain goat behaviors/habitats that are altered due to human activity (e.g. licking minerals left behind by humans; maintaining close proximities to humans) affect their long-term survival and reproduction?
3. Is mountain goat predation higher in populations that are not desensitized to human activity?

Unfortunately, due to time and funding constraints, the first question regarding daily activity patterns could not be explored in this study. While comparisons were made between mountain goat behavior during interactions and mountain goat behavior outside of interactions, this does not necessarily elucidate whether their daily activity patterns are consistent with other groups of mountain goats. It would also be interesting to compare goats within park boundaries to goats just outside of the park.

The second question is potentially even more difficult to answer because it requires years of observation. It would also require a comparison between mountain goat groups that exhibit altered behaviors regularly and live in human-altered landscapes and mountain goat groups that never exhibit these behaviors and live in unaltered landscapes.

Question three gets at the idea that rather than only seeking out humans for food or salt, mountain goats in GNP may also be seeking refuge from predators. Although mountain goats were observed licking minerals left behind from humans, no instances of mountain goats taking actual food from visitors was observed throughout the summer. This indicates that there may be other reasons for remaining so close to large groups of people. Perhaps they are trying to insert themselves into a larger “herd” to decrease their chances of becoming food for a grizzly bear or mountain lion.

All three of these questions would be incredibly valuable in further determining how mountain goats are impacted by human activities, and whether or not more protection is actually necessary to maintain the health of mountain goat populations on public recreation lands.

Visitor Responses to Mountain Goat Encounters

Visitor responses to mountain goats are more novel even than mountain goat responses to humans. In general, the response of humans to wildlife is a fairly new area of study, and so there are many gaps that still need to be filled in the literature. This is especially true when it comes to the affective or emotional component of wildlife encounters. Therefore, while this study provides some insight into the role emotions play, it is just the tip of the iceberg. Five specific questions for further inquiry emerged from this study:

1. How does crowding influence the quality of wildlife interactions for visitors?
2. Do people tend to spend more time watching wildlife when more than one animal is present?
3. How can emotion be more reliably measured through observation?
4. Does age influence the amount of emotion expressed during wildlife interactions?

5. Is emotionally charged messaging an effective method for changing visitor behavior on protected public lands?

The first two questions spawned from the correlation that was found between group composition and the duration of an interaction. Results showed that duration was inversely related to hourly visitation on Hidden Lake Trail. However, the hourly visitation data was taken from a study from 2012, and this was not a primary interest of the study, so it was not examined any further. This would potentially be of interest to visitors because if they want to spend more time watching mountain goats in a more intimate setting, the early morning or late evening hours would be the best times to hike. Similarly, as the number of mountain goats increased, the time spent watching them increased. It would be interesting to examine whether this is true in a variety of wildlife-watching settings.

The last three questions are all related to the emotional aspect of human-wildlife interactions. The first question addresses the primary limitation of this study. While emotion has been measured in a number of highly controlled, experimental settings, it is a more difficult thing to measure purely through observation. Through replication, intercoder reliability and further refinement of observational methods, researchers will be able to more accurately understand the affective domain in human-wildlife interactions. The second of the emotion questions came from the analysis of the effect of visitor group composition on the expression of emotion. It was found that as the number of children increased, it became less likely that no emotion was expressed. An examination of this question would be especially relevant for interpretive staff when determining how to communicate with young people compared to adults. On a related note, the final question addresses the effect of emotional communication as a method of changing human behaviors. This was initially intended to be a part of this study, but

signs were never installed by park staff as expected. It would be interesting to conduct an experimental study comparing the nature of human-wildlife interactions when emotion-based communication techniques are used compared to cognitive-based techniques.

Other Limitations

Observational studies such as this one are advantageous for a number of reasons, but they are also fraught with difficulties. One advantage is that they provide direct and practically unambiguous evidence of overt behavior without subjects being aware that scientific research is occurring. They also increase external validity and are effective for applied research. However, observational studies lack control over extraneous variables, as well as over the manipulation of the independent variable. Thus, internal validity is sacrificed and causation cannot be inferred. Therefore, in order to better control sampling and measurement error and permit stronger generalizations and checks on reliability and validity, observations in this study used explicit and preset plans for selection, recording and encoding of data.

Conclusion

This study is the first step in what will hopefully be a larger effort to understand both sides of human-wildlife interactions. As the field of human dimensions of wildlife grows, and the human population continues to expand into previously wild areas, research such as this will become increasingly necessary. Managers are beginning to focus their efforts more on changing human behaviors than controlling wildlife, and to achieve this goal, an understanding of the nature of interactions is indispensable. Not only do we need to recognize what is going on during an interaction, but to really get at the root of the issue we need to know how and why humans and wildlife are interacting. Without this knowledge, the management decisions that are made will be intrinsically compromised.

The research presented here is very focused and applied in nature, but much can be gleaned from an understanding of visitor-mountain goat interactions in Glacier National Park. Perhaps the most valuable lesson to be learned from this study is the importance of scientifically and systematically monitoring interactions, rather than taking anecdotal evidence at face value. While much can be learned from visitor and ranger experiences, it can be risky to use this information to make unbiased decisions. Additionally, this study has shed some light on the piece of the interaction that is often overlooked by wildlife managers: visitor responses. It is imperative for wildlife professionals to understand both sides of the interaction in order to make decisions that positively impact both the people and the animals involved.

There is still much to be learned about human-wildlife interactions in protected areas. Future studies on this topic will be a vital part of the effort to conserve biodiversity and reconnect people with the natural world.

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