

This article was downloaded by: [Marion, Jeff]

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Publisher Routledge

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## Human Dimensions of Wildlife

Publication details, including instructions for authors and subscription information:

<http://www.informaworld.com/smpp/title-content=t713666717>

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Jeffrey L. Marion <sup>a</sup>; Robert G. Dvorak <sup>b</sup>; Robert E. Manning <sup>c</sup>

<sup>a</sup> USDI U.S. Geological Survey, Virginia Tech Field Station, Virginia Tech, Forestry (0324), Blacksburg, Virginia, USA <sup>b</sup> College of Forestry and Conservation, University of Montana, Missoula, Montana, USA <sup>c</sup> Rubenstein School of Environment and Natural Resources, University of Vermont, Burlington, Vermont, USA

Online Publication Date: 01 November 2008

**To cite this Article** Marion, Jeffrey L., Dvorak, Robert G. and Manning, Robert E. (2008) 'Wildlife Feeding in Parks: Methods for Monitoring the Effectiveness of Educational Interventions and Wildlife Food Attraction Behaviors', *Human Dimensions of Wildlife*, 13:6, 429 — 442

**To link to this Article:** DOI: 10.1080/10871200802270158

**URL:** <http://dx.doi.org/10.1080/10871200802270158>

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# Wildlife Feeding in Parks: Methods for Monitoring the Effectiveness of Educational Interventions and Wildlife Food Attraction Behaviors

JEFFREY L. MARION,<sup>1</sup> ROBERT G. DVORAK,<sup>2</sup>  
AND ROBERT E. MANNING<sup>3</sup>

<sup>1</sup>USDI U.S. Geological Survey, Virginia Tech Field Station, Virginia Tech, Forestry (0324), Blacksburg, Virginia USA

<sup>2</sup>College of Forestry and Conservation, University of Montana, Missoula, Montana, USA

<sup>3</sup>Rubenstein School of Environment and Natural Resources, University of Vermont, Burlington, Vermont, USA

*Opportunities to view and interact with wildlife are often an important part of high quality recreational experiences. Such interactions frequently include wildlife feeding, resulting in food-conditioned behaviors that may cause harm to both wildlife and visitors. This study developed and applied efficient protocols for simultaneously evaluating wildlife feeding-related behaviors of visitors and related foraging behaviors of chipmunks along a trail in Zion National Park. Unobtrusive observation protocols permitted an evaluation of educational messages delivered, and documentation of wildlife success in obtaining human food and the strength of their food attraction behavior. Significant improvements were documented for some targeted visitor behaviors and human food available to chipmunks, with minor differences between treatments. Replication of these protocols as part of a long-term monitoring program can help protected area managers evaluate and improve the efficacy of their interventions and monitor the strength of food attraction behavior in wildlife.*

**Keywords** wildlife feeding, efficacy of management actions, information/education, human-wildlife interactions, wildlife monitoring, food-attraction behavior, Zion National Park

## Introduction

Wildlife feeding, intentional or unintentional, is common in many national parks and protected areas. Federal law prohibits the feeding of wildlife in all national parks and wildlife refuges (36 C.F.R. § 2.2), although visitors are often unaware or choose to ignore the law, and enforcement is difficult. Visitors frequently seek out protected natural areas expressly for the wildlife watching and the human-wildlife interactive experiences they provide. Wildlife viewing and associated interactions with wildlife are important elements of high quality outdoor recreation experiences (Manfredo, 2002). Such interactions can result in

The authors acknowledge and are thankful for the contributions and support of several Zion National Park staff, including Jeff Bradybaugh, Sharon Kim, Cindy Purcell, and non-park project staff, including Wayne Freimund, Amy Manning, Emily Bennet, and Laura Hanson.

Address correspondence to Jeffrey L. Marion, USDI U.S. Geological Survey, Virginia Tech Field Station, Virginia Tech, Forestry (0324), Blacksburg, VA 24061, USA. E-mail: jmarion@vt.edu

wildlife obtaining human food, leading to food attraction behavior that can ultimately harm both wildlife and visitors (Orams, 2002). In highly visited park areas, numerous animals have developed strong food attraction behaviors to human food sources that can lead to human injury and property damage (Larson, 1995). Food-conditioned wildlife suffer nutritionally, become dependent on unreliable food sources, and are susceptible to predators and vehicle collisions (Orams, 2002).

Nearly a third of Americans age 16 and older participate in wildlife-associated recreation; 66.1 million people reported that they fed, photographed, and observed wildlife in 2001 (USDI *et al.*, 2001). This represents more participants than hunting (13 million) and fishing (34 million) combined. Although hunting and fishing participation has declined, wildlife watching has increased. Wildlife viewing connects visitors with wildlife and provides opportunities to learn about wildlife in natural environments. Such learning can increase concern for wildlife preservation and their habitats (Manfredo, 2002; Vaske & Donnelly, 1999). The economic impact of wildlife watching generated an estimated \$38.4 billion in 2001 (USDI *et al.*, 2001).

On the negative side, 7.1 million visitors reported feeding wildlife on trips away from home where the primary purpose was watching wildlife (USDI *et al.*, 2001). The potential for problems associated with wildlife-feeding are rarely recorded or tracked by park staff. Observing, viewing, and feeding wildlife have historically been considered “non-consumptive” activities because the animals are not caught or killed. Increased participation in these non-consumptive activities, however, suggests negative wildlife impacts such as disruption of behavioral patterns, food dependencies on humans, and loss of ability to forage for natural foods (Higginbottom, Green, & Northrope, 2003; Larson, 1995; Shaw & Mangun, 1984; Taylor & Knight, 2003).

Park managers facing this situation must consider how to (a) communicate to visitors that feeding wildlife is an inappropriate and harmful activity, (b) develop effective educational efforts that discourage intentional or unintentional wildlife feeding, (c) monitor visitors’ wildlife feeding and wildlife food attraction behaviors, and (d) modify visitor behaviors. This study used unobtrusive observation protocols to simultaneously evaluate wildlife feeding behaviors of visitors and wildlife. Protocols were developed to evaluate the effectiveness of printed and verbal educational contacts intended to discourage wildlife feeding in Zion National Park.

Located in southwestern Utah, Zion National Park is comprised of nearly 150,000 acres of high desert canyons. The park attracts over 2.5 million visits annually. Wildlife feeding has been a problem at the park for several decades. Managers have had difficulty managing food-conditioned animals and associated negative impacts, such as begging animals that become a nuisance, animal bites, traffic congestion, damage to personal property, and decline in wildlife health. In response, park managers have conducted an educational program to reduce visitor feeding of wildlife, using messages in the visitor center, inside park buses, in the park newspaper, and on roadside, trailhead, and trailside signs.

### **The Problem of Wildlife Feeding**

Park managers are challenged to find effective ways to enable human-wildlife interactions while protecting both visitors and wildlife from potential negative consequences. Behavioral changes in wildlife attracted to human food can increase their risk of injury or death. For example, they may abandon their pre-existing territories, moving from protective habitats to more exposed recreation sites where they are vulnerable to predators, hunters,

poachers, dogs, or collisions with vehicles (Edington & Edington, 1986; Newsome, Dowling, & Moore, 2005). A ready supply of human food may cause populations of small mammals to reach unnaturally high and unsustainable levels that promote disease transmission or starvation during the off-season, generally during the winter when natural food is already scarce (Roe, Leader-Williams, & Dalal-Clayton, 1997). Artificial food provided by divers in the Cayman Islands has led stingray to feed during the day rather than at night and such foods represented a large portion of their diet (Shackley, 1998). The cessation of long-term artificial feeding in the Galapagos Islands left some animals with an inability to locate natural food (Boo, 1990). Such food provisioning quickly increases an animal's food dependency on humans because they lose their ability and skills to forage for natural foods (Orams, 2002). The young of provisioned adult animals may never learn the skills necessary to forage for natural foods.

Food-attracted wildlife can pose a threat to human health and safety (Newsome et al., 2005). Animals that receive human food rewards lose their fear of humans and can become nuisances to visitors, aggressive, and cause human injury and death (Orams, 2002). Individuals have been killed by food-conditioned deer in Yosemite National Park and food-conditioned dingoes in Australia's World Heritage-listed Fraser Island. Bites from small mammals are common injuries in parks, and disease transmission to humans can occur from bites or close contact (e.g., rabies and Hantavirus, respectively).

Although wildlife may readily learn to eat and be attracted to human foods, such foods often do not constitute a healthy diet. In Florida and Australia, dolphin health risks have been noted when fed unnatural foods such as potato chips and marshmallows (Byrant, 1994; Wilson, 1994). Food-attracted animals can chew through packaging and ingest both food and plastic or foil wrappings. At Grand Canyon National Park, managers killed 22 food-attracted deer that became aggressive and dangerous (Leslie, 1995). Autopsies revealed underweight and malnourished animals with up to five pounds of plastic and foil food packaging obstructing digested matter from passing through their intestines. Even though these animals were eating, they were starving to death in a condition known as "cachexia."

### **Deterring Wildlife Feeding**

Resolving the problem of wildlife feeding requires altering human behavior—visitors who feed wildlife, improperly store or dispose of trash, leave food unattended at campgrounds and picnic areas, or leave food scraps behind. Low impact outdoor practices that address food storage and wildlife viewing have been developed and communicated by organizations such as Leave No Trace ([www.LNT.org](http://www.LNT.org)) and the Center for Wildlife Information. These practices are informed by a small but growing literature describing studies that test the potential efficacy of alternative educational messages and their methods of delivery (Manning, 2003; Marion & Reid, 2007).

### ***Conceptual Models of Visitor Management***

Management practices can be classified according to their strategic purpose (Chavez, 1996; Gilbert, Peterson, & Lime., 1972; Manning, 1979; Peterson & Lime, 1979). Direct management practices act directly on visitor behavior, leaving little or no freedom of choice. Indirect management practices attempt to influence decision factors on which visitors base their behavior. For example, a direct management practice to reduce wildlife feeding would prohibit the activity through enforcement of regulations. An indirect

management practice might include educational programs that informed visitors of potential wildlife feeding impacts and encouraged visitors to refrain from this activity. Research suggests that indirect management practices are generally favored by visitors and managers (Hendee & Dawson, 2002; McCool & Christensen, 1996; Peterson & Lime, 1979).

Types of problem visitor behavior can be classified along a spectrum. At the two ends of the spectrum, problem behaviors can be seen as either deliberately illegal (e.g., theft of cultural artifacts) or unavoidable (e.g., disposal of human waste). In these instances, information/education may have limited effectiveness. Other problem behaviors (e.g., careless, unskilled, or uninformed actions), however, may be more amenable to the behavioral-change purposes of information and education programs (Hendee & Dawson, 2002). Wildlife feeding by visitors falls into these types of problems.

The effectiveness of education programs designed to change behavior depends on visitor-associated variables, and message content and delivery (Manfredo & Bright, 1991; Manfredo, 1992; Marion & Reid, 2007; Roggenbuck, 1992; Roggenbuck & Ham, 1986; Stankey & Schreyer, 1987; Vander Stoep & Roggenbuck, 1996). For example, visitor behavior is at least partially driven by attitudes, beliefs, and norms. Education programs aimed at "connecting" with or modifying relevant attitudes, beliefs, or norms may be successful in guiding or changing visitor behavior, substituting high impact behaviors like feeding wildlife, with behaviors that avoid or minimize impacts. The substance of messages and the media of message delivery may also influence effectiveness of education programs (Marion & Reid, 2007).

### *Efficacy of Visitor Management*

Research suggests that education programs can improve visitor knowledge and minimize visitor-caused environmental and social impacts (Fazio, 1979a; Kernan & Drogan, 1995; Stewart et al., 2000; Cole, Hammond & McCool, 1997; Confer, Mowen, Graefe & Absher, 2000; Fazio 1979b; Ross & Moeller, 1974; Brown & Hunt, 1969; Cockrell & McLaughlin, 1982; Fazio & Ratcliffe, 1989). Hockett (2000), for example, evaluated the effectiveness of moral- and fear-appeal messages in deterring Shenandoah National Park visitors from feeding deer in a picnic area. The moral-appeal message explained the potential harm to wildlife associated with human foods; the fear-appeal message suggested that even deer that appeared tame were unpredictable, could become aggressive, and could injure visitors who attempted to feed them. Both forms of the message were effective for reducing feeding of deer, from 63% of picnickers when no message was present to 25% who read the moral appeal and 39% who read the fear appeal. Message efficacy depended on visitor motivations and knowledge and both educational messages successfully addressed uninformed and unintentional actions by describing various harmful consequences associated with feeding deer (Hockett, 2000). Lower efficacy of fear appeals was attributed to visitors discounting the true threat of being injured by deer. Message effectiveness was enhanced by posting messages directly on picnic tables, providing clear guidance at the location and time when visitors were most likely to consider feeding deer.

At Crater Lake National Park, the feeding of golden-mantled ground squirrels in the Rim Village area has been a persistent problem leading to substantially increased squirrel population levels. Schwarzkopf (1984) conducted a study designed to reduce ground squirrel feeding in this area after routinely observing 8–12 squirrels begging for food. Both moral-appeal and fear-appeal messaging was designed and evaluated. The moral-appeal message explained that natural foods were better for squirrels than human food and reduced feeding by 50%. The fear-appeal described the danger of contracting

bubonic plague or other diseases from squirrels and reduced feeding by 72%, compared to control conditions.

### ***Monitoring Visitor and Wildlife Behaviors***

Although research has documented the efficacy of management interventions, monitoring protocols that provide objective information on visitor behavior related to wildlife feeding, or the relative strength of food attraction behavior in wildlife could not be identified in the literature. A survey of 93 units of the National Park System with substantial backcountry visitation found no reported monitoring devoted to wildlife feeding or food attraction behavior, yet 74% of the parks employed messaging asking visitors not to feed wildlife (Marion, Roggenbuck, & Manning, 1993). We sought to develop efficient, unobtrusive observation protocols that managers could apply to document visitor and wildlife behaviors related to feeding. Observation has been effectively used in wildlife studies to investigate the effects of different hiking activities on marmots (Mainini, Neuhaus, & Ingold, 1993), and to record behavioral response categories to understand how birds respond to a variety of recreation activities (Klein, 1993).

### **The Study**

Our overall purpose was to develop and apply efficient protocols for evaluating feeding-related behaviors of visitors and wildlife at Zion National Park. The target wildlife selected was the least chipmunk (*Tamias minimus*). The study area was a popular recreation site known as Scout's Lookout located along the Angels' Landing Trail. Using an experiment design, visitors were exposed to two management treatments designed to deter wildlife feeding. Unobtrusive observation protocols were used to evaluate educational messages delivered personally and by sign, and document wildlife success in obtaining human food and the strength of their food attraction behavior. Because Zion National Park already had a regulation against feeding wildlife, the study treatments emphasized information/education programs designed to communicate this regulation and the reasons for it. Visitors and chipmunks were observed during the treatment and control periods to measure feeding and foraging behavior, respectively. A visitor survey examined if management treatments increased visitor awareness, knowledge, and associated behavior. The study was conducted from July 16 to September 18, 2003.

### ***Treatments and Control***

Treatment 1 was a sign posted along the trail as hikers approached the study site. The text of the message was "Help protect wild animals by not feeding them. Human food is unhealthy and teaches them to become aggressive beggars. We need your help to keep wildlife wild in their native habitat." Treatment 2 was a personal message to hikers at the study site delivered by uniformed park staff. The staff delivered the same message included in the sign. During both treatments, visitor wildlife feeding behavior and associated variables were observed by research staff (as described later).

The study Control was designed to measure treatment effectiveness on deterring wildlife feeding by visitors. Wildlife feeding behavior of visitors and associated variables were measured (as described later) during an initial period in which neither of the treatments (sign or personal message) were present at the study site.

### ***Observation of Visitor Wildlife Feeding Behavior***

Visitor wildlife feeding behavior and associated variables were unobtrusively observed and measured by field researchers posing as park visitors during treatments 1 and 2 and the control. The study site was a trailside area approximately 200 × 200 feet. Field staff located groups who appeared to be taking a break from hiking. When possible, groups who were or appeared likely to eat were preferentially selected. The observation period was initiated when a chipmunk approached within five feet of any member of the group, with the observation period continuing for five minutes. This distance was selected as a proximity that was reasonably beyond a chance encounter; however, it was biased toward chipmunks already comfortable approaching humans. Five minutes was determined to be a sufficient amount of time for observing relevant visitor and chipmunk behaviors without attracting undue attention to the observers. The following variables were observed and recorded: (a) whether or not chipmunks were intentionally fed, (b) visitors intentionally attracting chipmunks with food, wrappers, or non-food items (to tease, get photo, etc.), (c) visitors unintentionally dropping crumbs while eating, (d) visitors unintentionally feeding chipmunks by leaving food out or in unattended packs, (e) visitors intentionally scaring away chipmunks, (f) visitors moving to avoid contact with chipmunks, and (g) whether or not visitors consumed food.

During treatment 1, research staff unobtrusively observed how visitors reacted to the study sign. Each visitor observed passing the study sign was recorded as (a) appeared not to notice the sign (did not look at the sign), (b) noticed the sign, but did not pause to read it, or (c) stopped to read the sign.

### ***Observation of Chipmunk Foraging Behavior***

Chipmunk foraging behavior was observed and recorded concurrently with visitor feeding behavior during observation periods. To assess chipmunk behavior, all chipmunks approaching within 10 feet of the group were observed during a 5-minute period. The following variables were recorded: (a) maximum number of chipmunks within 10 feet of the group at any given time, (b) closest distance that any chipmunk approached to any group member, (c) dropped human food present on the ground, and (d) chipmunks eating any dropped food. This distance provided a range of foraging behaviors in individual animals across an observation period instead of biasing observations toward the most aggressive chipmunks.

Concerns regarding potential differences in visitor behaviors related to eating prompted inclusion of an additional assessment method and separate observation periods to test chipmunk behavior under standardized conditions at the study site during the treatments and control. Teams of two research staff posed as visitors by adopting a standardized behavioral protocol. For 5-minute periods, the research staff acted like they were eating and rattled a food wrapper for 5 seconds every 30 seconds. This protocol fixed human behaviors associated with the attraction of wildlife, including the appearance of food and noises of food wrappers, the amount of time food eating behaviors were evident and specific subject behaviors toward the chipmunks. Chipmunk foraging behavior was observed during these periods.

### ***Visitor Survey***

A short questionnaire was administered to visitors after they had been observed during treatments 1 and 2. Respondents were asked (a) if and where they had seen or heard

messages in the park about feeding wildlife and (b) if they had seen the study signs or park staff member included in the study treatments. They were also asked if they had noticed chipmunks present at the study site and whether the presence of chipmunks had enhanced or detracted from their experience. Finally, they were asked if any group members had fed wildlife during their current park visit.

## Results

### *Visitor Wildlife Feeding Behavior*

A total of 98 visitor groups were observed across the control and treatments 1 and 2 (Table 1). Visitor observation data revealed that both treatments substantially altered visitor behavior, resulting in a reduction in human food available to chipmunks. The percentage of visitor groups that intentionally attracted chipmunks declined from 24% (control) to 3% for both treatments. More importantly, the number of groups that intentionally fed chipmunks declined from 11% to 3%. Those who dropped food unintentionally declined from 41% before treatments to 10% for treatment 1 and 6% for treatment 2. Those contacted personally also more frequently intentionally scared the chipmunks away.

Changes in attracting chipmunks ( $\chi^2 = 10.239$ ,  $df = 2$ ,  $p = .006$ ) and dropping food ( $\chi^2 = 14.990$ ,  $df = 2$ ,  $p = .001$ ) were significant. The declines in chipmunk feeding, from 11% in the control to 3% in treatments 1 and 2, were not statistically significant (Table 1), but were in expected direction. Finally, the percentage of observation periods in which chipmunks ate dropped human food declined during the treatment periods and food present on the ground also declined. Values were lower for both these variables for the personal contact treatment compared to the sign treatment. Chipmunks eating dropped food ( $\chi^2 = 11.853$ ,  $df = 2$ ,  $p = .003$ ) and food present on the ground ( $\chi^2 = 15.898$ ,  $df = 2$ ,  $p < .001$ ) were significant.

### *Chipmunk Foraging Behavior*

Although study treatments significantly improved some targeted visitor behaviors and reduced human food available to chipmunks, observation of chipmunks in association with visitors ( $n = 98$  groups) showed either no change or a slight increase in their food attraction behavior (Figure 1a). Data gathered when visitors were observed showed no differences in the number of chipmunks present ( $F = .250$ ,  $df = 2$ ,  $p = .779$ ) or in the minimum distance of chipmunks ( $F = 2.504$ ,  $df = 2$ ,  $p = .087$ ) for either the control or treatment groups.

Trends were quite different when research staff were the subjects (Figure 1b). When staff posed as visitors ( $n = 86$  observation periods), the mean number of chipmunks at one time increased from 1.4 during the control to 1.7 during treatment 1 to 1.8 during treatment 2. Mean minimum distance for the boldest chipmunk stayed about the same from the control to treatment 1 but dropped during treatment 2. Analysis of variance, however, showed no significant differences in the number of chipmunks present ( $F = 2.734$ ,  $df = 2$ ,  $p = .071$ ) or in the minimum distance of chipmunks ( $F = 1.460$ ,  $df = 2$ ,  $p = .240$ ).

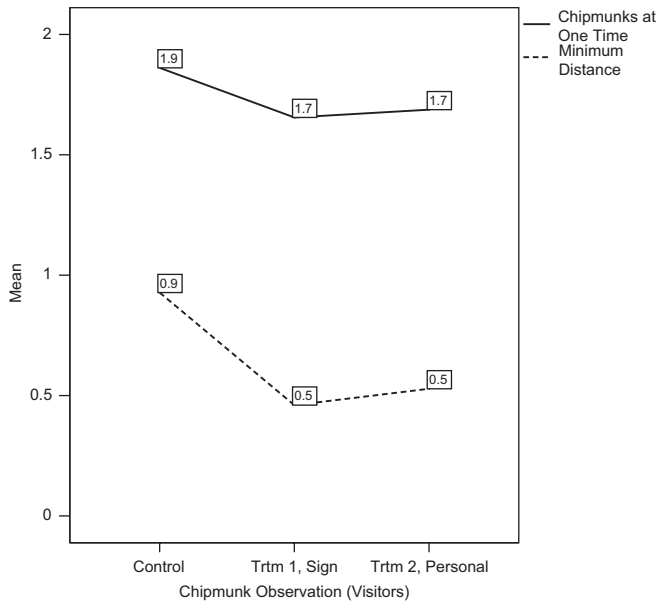
### *Visitor Survey*

Visitor survey data highlighted the efficacy of the information/education program about wildlife feeding. During the study treatments, 97% of the visitors had seen or heard a

**Table 1**  
Unobtrusively observed actions of visitors at Scout's Lookout, Zion National Park,  
related to chipmunks<sup>a</sup>

Control/Treatment	Visitors attracted chipmunk	Visitors fed chipmunk	Visitors dropped food	Scared chipmunk away	Visitors moved to avoid chipmunk	Chipmunk ate dropped food	Food present on ground
Control ( <i>n</i> = 37 groups)	24	11	41	43	5	32	41
Treatment 1 Sign ( <i>n</i> = 29 groups)	3	3	10	38	3	7	14
Treatment 2 Personal Com. ( <i>n</i> = 32 groups)	3	3	6	59	6	3	3

<sup>a</sup>Values refer to the percentage of groups observed.



**Figure 1a.** Observed food attraction behavior in chipmunks for trials with visitors. Mean minimum distance (in feet) from chipmunks to humans and mean maximum number of chipmunks at one time during the five-minute study periods is shown.

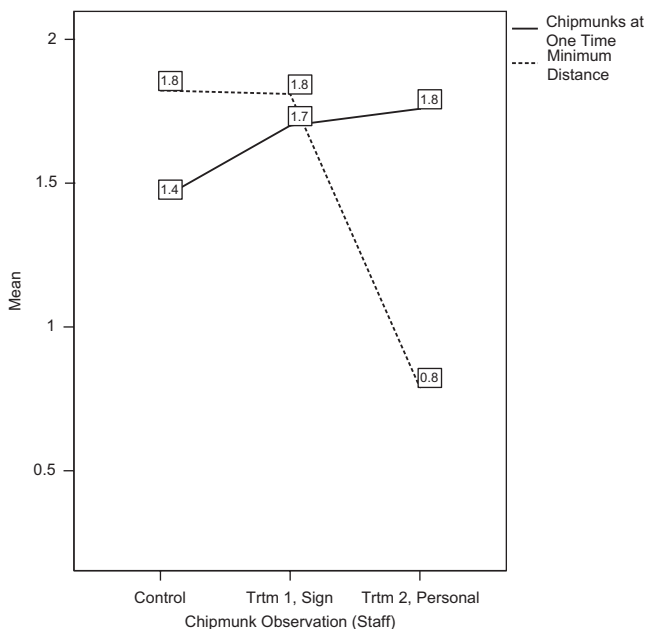
message in the park about feeding wildlife. Primary sources include the park shuttle bus, trailhead signs, and the visitor center. Information from park staff was reported by 18% of respondents during treatment 1, but rose to 100% during treatment 2. Between 77 and 85% of visitors recalled the wildlife-related messages.

During treatment 1 at least one person in 86% of the groups recalled seeing a “sign along this trail” that pertained to wildlife feeding. However, when asked specifically about the study sign and its location on the study trail, at least one person in 97% of visitor groups reported seeing the sign and at least one person in 93% of the groups reported reading the sign. Unobtrusive observation of visitors passing the study sign (treatment 1) found that 80% of visitors either glanced at (36%) or stopped to read (44%) the sign.

Visitors reported receiving messages about not feeding wildlife from more than one source. Over three-quarters (79%) received such messages from two or more sources. These data suggest that the park-wide information/education campaign regarding wildlife feeding is reaching visitors who hike backcountry trails. Only 3%, however, admitted to feeding wildlife. Multiple messages may be necessary to effectively alter visitor behavior.

## Discussion

Differences between the visitor-based and staff-based data are likely attributable to differences in the behavior of visitors versus staff. Staff numbers and behavior were standardized, whereas visitor observations and behaviors were more variable. The data, however, suggest that chipmunks will not rapidly lose interest in visitors once the associated food



**Figure 1b.** Observed food attraction behavior in chipmunks for trials with field staff. Mean minimum distance (in feet) from chipmunks to humans and mean maximum numbers of chipmunks at one time during the five-minute study periods are shown.

supply is reduced. Neither this study nor a review of relevant literature suggest how long chipmunks or similarly food-attracted wildlife require to lose such behaviors. Even small or infrequent food rewards may be sufficient to sustain food attraction behavior. With a reduced human food supply, chipmunks may have compensated by increasing their activity and aggressiveness in obtaining human food in competition with other chipmunks for a limited food source.

Some study limitations may have contributed to the findings. The Control ran from July 16 to August 12, treatment 1 from August 18 to September 9, and treatment 2 from September 10 to 18. The short two-month study duration may be insufficient to measurably alter chipmunk food attraction behavior. As cold weather returned in September, the chipmunk's food attraction behavior may have increased as visitation declined and they sought to gain weight for the impending colder fall and winter seasons.

Although we kept the study area small, chipmunks are territorial so differences in observation locations could mean that different chipmunks were being observed. Sample sizes ranged from 29 to 37 observation periods—these appeared to be sufficiently large for evaluating visitor behavior, but many need to be increased to evaluate more variable chipmunk behavior.

## Conclusions and Recommendations

Study findings documented a substantial amount of unintentional and intentional wildlife feeding and attraction behaviors by visitors at the site under control conditions. This occurred even though messages discouraging wildlife feeding were posted in several

locations throughout the park. Observations revealed that both study treatments were effective in reducing intentional and unintentional wildlife feeding by visitors. Incidence of feeding, purposefully attracting chipmunks, and unintentionally dropping food on the ground, all showed clear reductions from the control during both treatment periods. Other message delivery attributes, such as the timing and location of message delivery relative to the targeted visitor behavior, and source credibility, may be as or more important than whether messages are delivered personally or in print (Marion & Reid, 2007). Mixed results were also apparent in the literature, with some studies reporting the greater effectiveness of personally delivered messages whereas others found printed messages to be as effective. In this study, there were reductions in food left on the ground and chipmunks seen eating human food when message delivery was by personal contact or signs in comparison to the control.

Surveys of visitors revealed that they had received park messages about not feeding wildlife and that they could recall such messages. The placement of an informational/educational sign and/or delivery of a personal message at locations where wildlife feeding occurs are effective in improving some visitor behaviors related to wildlife feeding and reducing the amount of human food available to wildlife. It is unclear, however, whether this level of reduction in wildlife feeding is sufficient to substantially reduce food attraction behavior by wildlife over the long term. This is a critical topic for future research. For example, even small amounts of food, food odors, or trash occasionally left behind by visitors may be sufficient to initiate or sustain food attraction behaviors in wildlife.

The information/education approach represented by the treatments (a) utilized the strategy of reducing the impacts of visitor use (rather than reducing the amount of visitor use, which may be less effective in the case of wildlife feeding), (b) represented an indirect management practice (which is generally favored by both visitors and managers, and which complements the existing park regulation against feeding wildlife—a direct management practice), and (c) capitalized on the “uninformed,” “careless,” and “unskilled” nature of most wildlife feeding and its potential susceptibility to information/education.

Reductions in food attraction behavior of chipmunks occurred under treatment conditions. When research staff posed as visitors, the numbers of chipmunks and the strength of their food attraction behavior slightly increased, although not significantly over the study period. We believe that chipmunks became increasingly active and aggressive in pursuing human food as the food supply diminished, due to conditioning of less feeding and fewer visitors, and possibly to the need to gain weight to survive the winter season.

Relatively few parks have implemented an aggressive visitor information/education program aimed at wildlife feeding comparable to the one at Zion National Park. No national park has implemented a permanent monitoring program to evaluate the efficacy of management on either visitors or wildlife related to wildlife feeding. In particular, evaluating the relative strength of food attraction behavior in wildlife is a new and challenging topic that could benefit from additional research and monitoring work. Zion park staff may want to consider extending this study for several years, or permanently as part of a wildlife monitoring program. The protocols developed provide an efficient yet objective example for protected area staff interested in monitoring wildlife food attraction behavior or evaluating the efficacy of management interventions.

Future research should focus on multi-year evaluations or permanent monitoring programs to investigate the level of food reduction and length of time required to wean chipmunks (and other species) from human foods and return them to natural food sources. A larger sample size of observation periods stratified throughout the summer season is recommended. Interventions might focus on educational signs. Visitor observation

protocols were effective and yielded sufficient data such that they could be discontinued, unless made a part of an ongoing monitoring program. Further research is also recommended to evaluate the inclusion of wildlife feeding-related indicators and observational protocols in recreation management frameworks such as the Limits of Acceptable Change (Stankey, Cole, Lucas, Petersen & Frissell, 1985) and Visitor Experience and Resource Protection (National Park Service, 1997).

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