Integrated Approach to Transportation and Visitor Use Management at Rocky Mountain National Park

Submitted to:
The Department of Interior
National Park Service

Submitted by:
Peter Newman
Colorado State University

Steve Lawson
Resource Systems Group

Chris Monz
Utah State University

Contents

Chapter 1: PROJECT OVERVIEW

1.1 Introduction

Increasingly, the National Park Service (NPS) is relying on alternative transportation systems to provide visitors access to the national parks in a manner that potentially reduces traffic congestion, enhances visitors' experiences, and more effectively protects park resources. Rocky Mountain National Park (ROMO) was one of the first national parks to adopt an alternative transportation system, initiating a shuttle bus system in the Bear Lake Road corridor in 1978 that continues to operate during the peak visitor use season. In 1999, ROMO initiated a transportation study to assess existing visitor use, transportation-related problems and potential solutions (Parsons, et al. 2000). This study concluded that the shortage of parking spaces to meet visitor demand was the most significant transportation problem in the park. The study found that about 46% of summer visitors who would like to park at certain trailheads cannot do so legally. Furthermore, the study findings suggest that when parking lots are full, visitors often park illegally in spaces designated for disabled visitors, on road shoulders, or on alpine tundra, which results in safety concerns and resource damage.

To address the issue of parking lot shortages and related impacts to visitors' experiences and park resources, while accommodating growing numbers of park visitors ROMO implemented an improved 10-vehicle shuttle bus service from the main shuttle parking lot (Park & Ride) off Bear Lake Road in 2001. The shuttle operates from early June through early October and provides service to the Bear Lake and Fern Lake trailheads and several points in between. Prior to 2001, approximately 156,000 people rode the Bear Lake and Fern Lake shuttles annually. Transit service has increased every year since then. In 2006, ridership increased to around 270,000 passengers.

With an increasing percentage of visitors accessing the Bear Lake area via the shuttle bus, rather than in private vehicles, the constraint to visitor use levels associated with parking lot capacities has been effectively eliminated. Thus, recreation sites and trails serviced by the park's shuttle bus system have witnessed increased visitor use levels and associated impacts to the quality of visitors' experiences and park resources. These issues are potentially compounded by the fact that the park's shuttle bus system is expected to undergo further expansion as set forth in the park's 2006 Draft Transportation Plan.

The purpose of this project is to assist the NPS in refining the design of RMNP's shuttle bus system in a manner that optimizes the operational efficiency of the transportation system, and protects the park's resources and the quality of visitors' experiences.

Chapter 2: Visual Based Standards

2.1 Introduction

This component of the larger four-part integrated project involves analyzing visitor perceptions of crowding, potential problems associated with visitor experiences and opinions of travel in the park related to both personal vehicle and park shuttle.

Conceptual Approach

Carrying capacity related decision-making can be very challenging when trying to meet legal mandates, and the diverse tastes and preferences of park visitors. However, the literature suggests that these challenges may be addressed through the development of explicit management objectives and associated indicators and standards of quality (Manning, 1999). *Management objectives* are broad narrative statements outlining the recreation experience to be provided and the desired condition of the resource. *Indicators of quality* are measurable, manageable variables reflecting the essence of management objectives. *Standards of quality* define the minimum acceptable condition of indicator variables (Manning, 1999). Once indicators and standards of quality have been formulated, indicator variables are monitored and management action is taken to ensure that standards of quality are maintained. This "management-by-objectives" approach is at the heart of contemporary protected areas management frameworks including Limits of Acceptable Change (LAC) (Stankey et al., 1985), Visitor Impact Management (Graefe, Kuss, and Vaske, 1990) and Visitor Experience Resource Protection (VERP) (Hoff and Lime, 1997).

Over the last three decades, research in protected areas have informed approaches to carrying capacity management. A study by Shelby et al. (1996) began by distinguishing differences between descriptive and evaluative information. Manning, Valliere, Wang, Lawson, & Newman (2003) describe carrying capacity as having these two components. Objective and factual data are the focus of the descriptive component, whereas subjective evaluations comprise the evaluative component. For example, the question of how visitors perceive higher levels of use refers to the evaluative component of carrying capacity. The relationship between crowding and visitor use levels is an example of the descriptive component (Manning & Lawson, 2002).

Estimating Visitor Use

Estimating visitor use is critical to the management of natural areas in order to inform how visitor use levels affect natural resources and social conditions. However, many land management agencies have insufficient visitor monitoring programs and little baseline data about visitor use patterns and trends (Watson, Cole, Turner, & Reynolds, 2000). A survey of wilderness managers reported that 63% of managers relied on best guesses to estimate visitor use (McLaran & Cole, 1993). Lack of funding, logistic problems resulting from size of area, number of access points, lack of personnel time, and lack of knowledge and training about available methods to collect and analyze data have been identified as some reasons why wilderness use has not been examined adequately (Watson, Cole, Turner, & Reynolds, 2000).

Recently, new technologies, such as mechanical visitor counters, have been developed that allow managers to gather visitor counts with minimal to no disturbance to visitors. These devices collect counts of visitors as they pass the device but results need to be calibrated to ensure accuracy (Watson, Cole, Turner, & Reynolds, 2000). Calibration is necessary to compensate for different types of visitor use patterns such as visitors walking side by side or milling about in an area. For example, infrared monitors were used in RMNP in previous studies and results were inflated due to missed counts (Bates, Wallace, & Vaske, 2006).

Mechanical counters are calibrated through regular direct observation (Watson, Cole, Turner, & Reynolds, 2000). These observed counts are then used to correct the mechanical counters and accurate statistical estimations of the population can be calculated (Watson, Cole, Turner, & Reynolds, 2000).

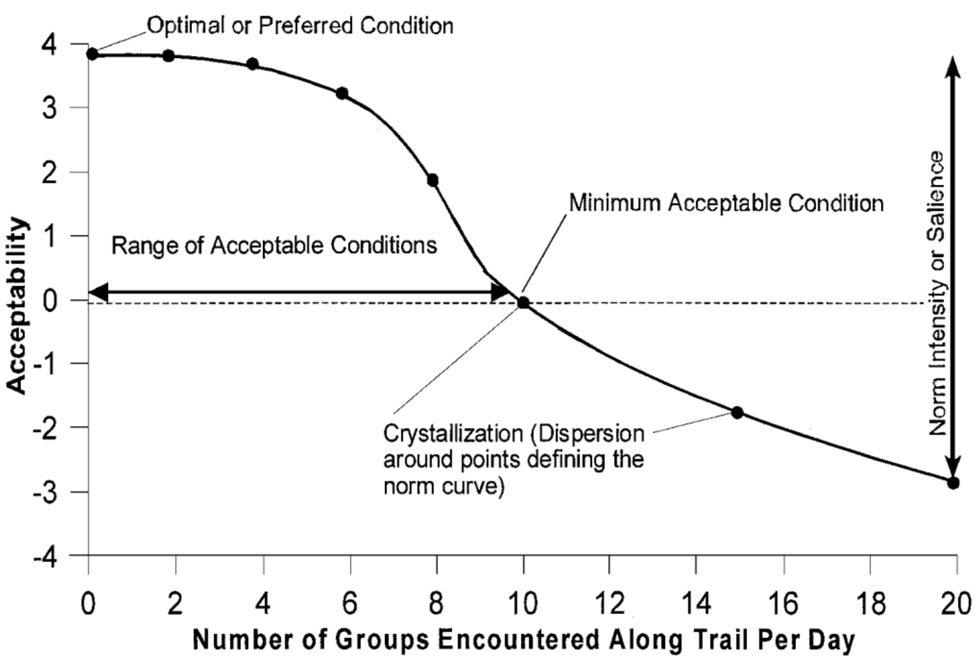
Estimating visitor use, as described above, provides managers with information to better understand the descriptive component of visitor use carrying capacity. However, how can the NPS set visitor use standards when visitors have different ideas for what should be appropriate or desirable in a park setting? Past researchers have used the normative approach to better understand subjective standards (Shelby, Vaske, & Donnelly, 1996).

The question of how many visitors lead to feelings of crowding, comprises the evaluative component of carrying capacity. The component can be measured with subjective terms such as acceptability of people at one time. Shelby et al. (1996) suggest that the evaluative component is the more challenging element for making management decisions. Normative models such as Jackson's return potential curves are suggested to help inform and describe management decisions regarding visitor preferences (Shelby et al., 1996).

In 1965, social psychologist Jay Jackson developed the return potential model, also called an impact acceptability curve, or norm curve. In this model, individual norms are averaged and graphically illustrated to explain social norms (Manning, Lime, Freimundt, & Pitt, 1996; McDonald, 1996; Heywood, 1996; Shelby, Vaske, & Donelly, 1996). In other words, social norms are inferred from what is known about personal norms (see Figure 1). Norms have been defined by Manning, Lawson, Newman, Laven,& Valliere (2002) as "standards that individuals and groups use for evaluating behavior and social and environmental conditions"

Figure 2.1. Hypothetical Norm Curve

(Manning et al., 1999)



The norm curve in Figure 1 describes the acceptability of encounters on a trail, with the number of encounters on the horizontal axis and acceptability on the vertical axis. Encounters increase from left to right, and acceptability has a neutral point in the middle, with positive assessments at the top and negative assessments on the bottom. The highest point on the curve is the most acceptable number of encounters, whereas the lowest point on the curve is the least acceptable number of encounters. Norm intensity is illustrated by the distance of the curve above or below the neutral line. Greater distance above or below the line illustrates higher intensity (Shelby et al., 1996). Intensity has been defined as “the strength with which a norm is held”. In comparison, crystallization refers to the amount of agreement about the norm (Inglis, Johnson, & Ponte, 1999).

Shelby et al. (1996) describe a variety of ways in which normative information can be used in a management setting. First, norms can help establish desired management goals. Second, norms help define the characteristics for a preferred recreation setting. Third, standards can be defined by gaining information about acceptable levels of impact. Fourth, minimal and optimal conditions can be characterized through the use of norm curves. Fifth, we can understand how strongly people hold norms through norm intensity. As a final point, normative information signifies how much consensus for norms is held among different user groups (Shelby et al., 1996). Based on the previous conceptual background, the following study was conducted in the Bear Lake corridor of Rocky Mountain National Park.

2.2 Methods

Visitors in the Bear Lake corridor were asked to complete a questionnaire at four different trailhead areas including Alberta Falls, Dream Lake, Emerald Lake and Glacier Gorge from June 15 to August 28, 2008. Visitors were asked if they would be willing to stop for about 10-minutes and complete an on-site trail opinion survey. At Alberta Falls, 203 participants completed the survey, while at Dream Lake 201, Emerald Lake 199 and finally at Glacier Gorge, 208 visitors completed the questionnaire. These trailheads were chosen to represent typical use in the Bear Lake corridor. Using a random start, the surveyors approached the first eligible group or visitor to pass the site and asked them to participate in the survey. After completing this contact, the surveyor asked the next eligible group or visitor to participate in the survey. This process continued throughout the sampling day. Only one individual or one group was asked to participate at a time. Instructions for the visitor survey were posted on the front page of the survey; however the surveyors also explained these instructions before distributing the survey (Appendix A). A total of 811 completed surveys were collected, yielding a response rate of 73%.

Data entry was completed in Excel and analysis was conducted in SPSS 17.0. Descriptive statistics were run to explore the data and build tables and figures found in this report.

2.3 Study Sites

The purpose of this study is to model visitor use and estimate user capacities along two popular trails and attraction sites in the Bear Lake Corridor of Rocky Mountain National Park. One selected trail and corresponding attraction site is the Glacier Gorge Trail and Alberta Falls. The second selected trail and attraction site is the Dream Lake Trail and Emerald Lake. These two sites were selected for this study because they are among the most popular destinations in the Bear Lake Corridor, are thought to be important to the quality of visitors’ experiences of the area, receive intensive amounts of visitor use during the summer, and are accessed by both private vehicle and shuttle bus modes of transportation.

Researchers from Colorado State, Virginia Tech and Utah State Universities consulted with the NPS to define the geographic boundaries of each study site for the purposes of data collection and modeling. Schematic diagrams of each study site were developed and used to guide the selection of sampling locations. Within this study, there were four sampling locations where field staff were stationed to conduct visitor surveys. One was an access point, (Glacier Gorge) and the other three were attraction site boundaries (Emerald, Dream Lake and Alberta Falls). Access points are places where visitors enter and exit the study sites (i.e., trailheads and trail junctions), while attraction site boundaries are places where visitors enter and exit specific attraction areas *within* the study sites (e.g., the trail segment that includes the viewing area around Alberta Falls). All sampling locations for the larger project are marked on the schematic diagrams of the study sites with text boxes numbered X1-XN (Figure 2 and 3). For this particular study, access point study site Glacier Gorge (X1) and attraction site Alberta Falls (X3) can be seen in Figure 2.2. Dream Lake (X3) and Emerald Lake (X4) can be seen in Figure 2.3.

Figure 2.2. Glacier Gorge Trail and Alberta Falls Study Site Schematic Diagram

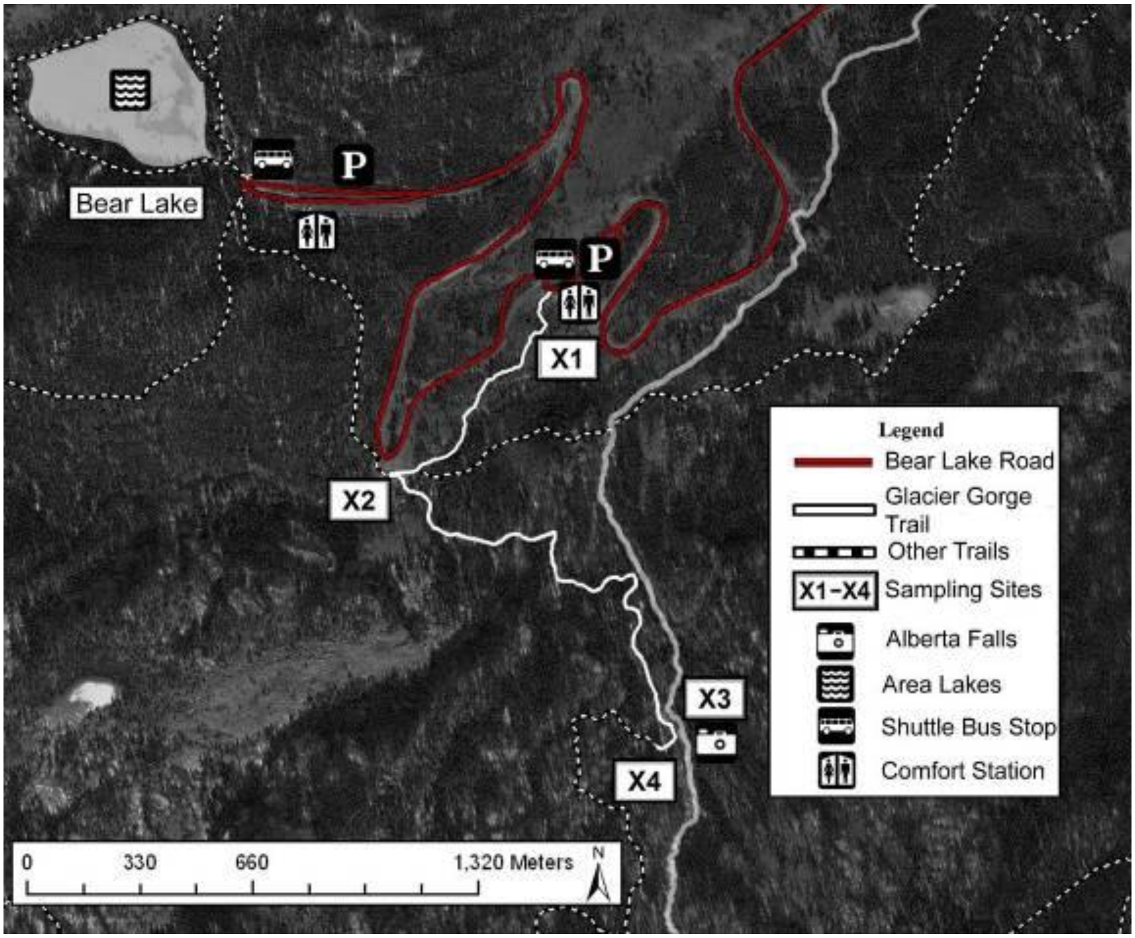
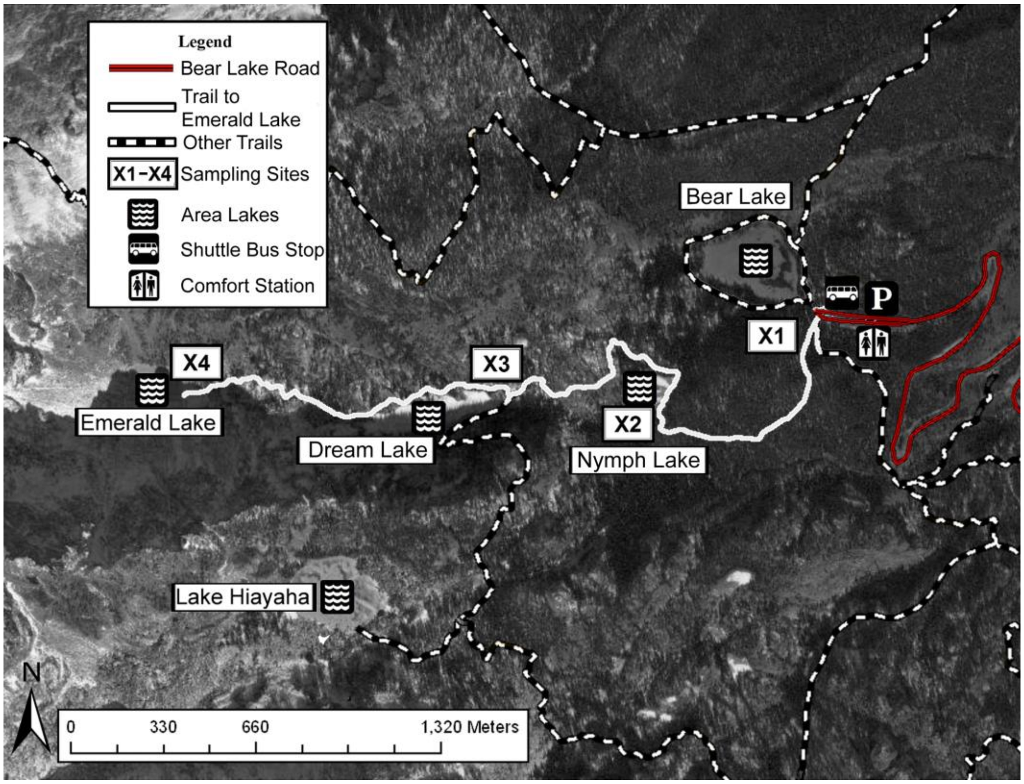


Figure 2.3. Dream Lake Trail and Emerald Lake Study Site Schematic Diagram



2.4 Data Collection

Visitor surveys and visitor counts were administered during the summer of 2008 at each of the four study sites along the Bear Lake Corridor to collect information about visitor use and behavior needed to construct simulation models of visitor use at the study sites. This chapter of the report describes the visitor survey and visitor counting methods used in this study, beginning with the visitor survey methods.

2.4.1 Visitor Surveys

Visitor surveys were administered to random samples of visitors at each of the four study sites along the Bear Lake Corridor during the summer of 2008. The purpose of the visitor surveys was to collect information needed to develop site-specific visitor use models, including: 1) visitor demographics; 2) familiarity with the area and percentage of repeat visitors; 3) perceptions of crowding; 4) potential problems associated with visitor experience in the area; 5) opinions concerning personal vehicle and park shuttle. Site-specific surveys were designed by researchers at Colorado State and Virginia Tech, in consultation with Rocky Mountain National Park, and were reviewed and approved by the Office of Management and Budget. Appendix A. contains a copy of the surveys administered at each of the study sites, and Appendix C. contains a copy of the survey log used to record information about survey response rates.

Colorado State, Virginia Tech and Utah State University surveyors were stationed at access points recruited groups arriving to the study site to participate in the visitor survey. Each time a surveyor at an access point recruited a visitor for the survey, the surveyor asked the visitor to if they would be willing to participate in a park visitor opinion survey. If a visitor declined to participate, surveyors recorded the time in which they spoke to the individual or group, the total number in their party and what mode of transportation they used to travel to the study site, and finally thanked for their consideration.

The survey log data were intended to be used to examine whether those who refused to participate were systematically different than those visitor groups who did participate in the study (i.e., whether the survey data may be subject to non-response bias). However, the overall response rate was ~73% (Table 2.1). Thus, there were too few refusals to conduct robust statistical tests for non-response bias. The high response rates suggest that the visitor survey data are not likely to be biased due to systematic differences between study participants and visitor groups who did not participate in the study.

Table 2.1 Overall Visitor Survey Response Rate

	Overall
Acceptance Rate	72.7%
Refusal Rate	27.3%

2.5 Visitor Demographics and Familiarity Results

This section of the chapter describes the data and result tables pertaining to respondent demographics and familiarity with the Bear Lake area, segmented by the sampling locations including Alberta Falls, Dream Lake, Emerald Lake and Glacier Gorge.

2.5.1 Visitor Survey Site Specific Demographics

Gender varied depending upon the trailhead (Table 2.2). However, the majority of participants were female, with the exception of respondents at Glacier Gorge, which had 105 males and 97 female respondents. Alberta Falls respondents differed the most with 106 female respondents and 87 male respondents. Dream Lake respondents were very close with 100 females and 99 males. Emerald Lake respondents were similar to the demographics found at Alberta Falls, with 102 females and 88 males.

Table 2.2 Gender of Respondents by Trail Site

	Frequency							
Location	Male	Female	Mean	SD.	Median	25^{th}%	75^{th}%	N
Alberta Falls	87	106	.55	.5	1	0	1	193
Dream Lake	99	100	.5	.5	1	0	1	199
Emerald Lake	88	102	.54	.51	1	0	1	191
Glacier Gorge	105	97	.48	.5	0	0	1	202

Participants were asked what race they were and were given the opportunity to check one or more of the following categories including *American Indian* or *Alaskan Native*, *Asian*, *Black* or *African American*, *Native Hawaiian* or *other Pacific Islander* and *White*. The majority of participants at all four trailheads indicated that they were *White* (Table 2.3). The second largest demographic found during analysis included those individuals that indicated their race was *Asian*, followed by *American Indian* or *Alaskan Native, Black* or *African American*, and *Pacific Islander* or *Native Hawaiian.*

Table 2.3. Ethnicity of Respondents by Trail Site

	Percentage					
Location	American Indian/Alaskan Native	Asian	Black/African American	Pacific Islander/Native Hawaiian	White	N
Alberta Falls	1	1.5	.5	0	87.2	203
Dream Lake	.5	3	.5	.5	94	201
Emerald Lake	.5	1.5	1	0	94	199
Glacier Gorge	.5	1.9	.5	1.4	93.8	208

Using a separate indicator, respondents were asked specifically whether or not they were *Hispanic* or *Latino*. Analysis indicates that the majority of respondents were not (Table 2.4). However, at Alberta Falls 7 respondents, 3% specified that they were *Hispanic* or *Latino*. At Dream Lake 5 respondents, (2%), and Glacier Gorge, also 5 respondents, (2%), indicated that they were *Hispanic* or *Latino*. 3 respondents, (1.5%), at Emerald Lake indicated that they identified as *Hispanic* or *Latino*.

Table 2.4 Frequency and Percentage of Participants that Identified as Hispanic/Latino by Trail Site

	Frequency		Percentage				
Location	Yes	No	% Yes	% No	Mean	Std. Dev.	N
Alberta Falls	7	196	3.44	96.55	.03	.18	203
Dream Lake	5	196	2.48	97.51	.02	.16	201
Emerald Lake	3	196	1.5	98.49	.02	.12	199
Glacier Gorge	5	200	2.46	97.56	4.83	.16	205

Respondent age varied slightly by trailhead (Table 2.5). However, the average age of respondents of at Alberta Falls resulted in the oldest average demographic at 49 years of age. Glacier Gorge respondents were very similar with an average age of 48. Dream Lake and Emerald Lake respondents were slightly younger with an average of 45 at Dream Lake and an average of 44 years of age found at Emerald Lake.

Table 2.5 Visitor Age by Trail Site

Location	Average Age	Std. Dev.	Median	25^{th}%	75^{th}%	N
Alberta Falls	48.5	13.22	49	57	39	190
Dream Lake	45.3	13.09	47	54	33	198
Emerald Lake	44.4	13.7	44	55	34	193
Glacier Gorge	47.7	13.62	49	58	37	199

Visitors were asked to indicate their highest level of completed education (Table 2.6). 37%, of respondents at Alberta Falls had completed a masters or doctoral degree. Similarly, many respondents, 40%, at Dream Lake had completed a masters or doctoral degree. At Emerald Lake 39% of respondents were college or trade school graduates. Many respondents at Glacier Gorge, 43%, were masters or doctoral graduates. Overall, respondents in the Bear Lake corridor indicated that they were highly educated.

Table 2.6 Visitor Formal Education Levels by Trail Site

	Percentage										
Location	Some High School	High School Graduate or GED	Some College/ Trade School	College/ Trade School Graduate	Some Graduate School	Master's/ Doctoral	SD	Med.	25th%	75th%	N
Alberta Falls	.5	5.26	17.89	30.52	7.36	37.36	1.4	4	3.75	6	190
Dream Lake	0	3.53	11.11	36.36	9.09	39.89	1.2	4	4	6	198
Emerald Lake	0	5.15	11.34	38.65	7.73	37.11	1.2	4	4	6	194
Glacier Gorge	.49	2.46	9.35	32.01	12.31	43.34	1.2	5	4	6	203

Country of origin percentages varied very little between trail sites (Table 2.7). Respondents at all four of the areas were largely from the United States. The highest percentages of United States citizens were respondents from Glacier Gorge, which represented 97%. The smallest amount of respondents from the United States was found at Dream Lake with 95%.

Table 2.7 Percentage of Visitor Geographic Origin by Trail Site

	Percent						
Location	United States	Canada	UK	W. Europe	E. Europe	Other	N
Alberta Falls	96.6	0	1	1.5	.5	.5	203
Dream Lake	95	.5	0	3	.5	0	201
Emerald Lake	95.5	.5	1.5	2.5	0	0	199
Glacier Gorge	97.1	.5	0	1	0	0	208

The majority of visitors to the Bear Lake corridor were from the state of Colorado, with a total of 218 respondents, 45 at Alberta Falls, 56 at Dream Lake, 48 at Emerald Lake and 69 at Glacier Gorge (Table 2.8). The second largest demographic of visitors came from Texas with a total of 66 respondents, 18 at Alberta Falls, 18 at Dream Lake, 16 at Emerald Lake and 14 at Glacier Gorge. The third largest demographic came from Illinois with a total of 52 respondents, 15 at Alberta Falls, 13 at Dream Lake, 11 at Emerald Lake and 13 at Glacier Gorge. Other states including Kansas with 36 visitors, California with 28 visitors, Missouri with 27 visitors, Iowa with 26 visitors, Nebraska with 23 visitors, and Wisconsin with a total of 20 respondents also indicated a large demographic of visitors.

Table 2.8 Frequency of Visitors to the Four Trail Sites Separated by State

	Frequencies			
State	Alberta Falls	Dream Lake	Emerald Lake	Glacier Gorge
AK	0	0	1	0
AL	4	0	1	0
AR	0	1	0	2
AZ	0	7	1	3
CA	3	6	8	11
CO	45	56	48	69
CT	0	1	1	0
DC	2	0	1	2
DL	0	0	0	0
FL	6	4	4	2
GA	0	1	0	1
HW	0	0	1	0
ID	0	0	0	0
IL	15	13	11	13
IN	4	1	1	2
IW	8	6	8	4
KA	12	6	11	7
KT	2	0	0	0
LA	3	0	1	1
MA	1	1	3	1
MD	1	3	0	1
ME	0	0	0	2
MI	3	5	6	5
MN	4	4	5	2
MO	10	6	6	5
MS	0	1	0	0
MT	0	0	0	0
NB	7	7	5	4
NC	1	0	0	2
ND	0	0	0	0
NH	1	0	1	1
NJ	2	1	3	1
NM	0	0	2	3
NV	0	1	1	0
NY	3	2	4	3

State	Frequencies			
	Alberta Falls	Dream Lake	Emerald Lake	Glacier Gorge
OH	3	3	4	4
OK	2	3	0	1
OR	0	0	1	2
PA	0	2	5	1
RI	1	0	0	0
SC	1	1	0	1
SD	0	2	0	1
TN	0	4	2	1
TX	18	18	16	14
UT	1	0	2	0
UT	0	0	0	0
VA	0	4	3	2
WA	1	0	1	1
WI	5	3	6	6
WV	1	0	1	1
WY	0	0	0	1
Total	170	173	175	183

2.5.2 Respondent Demographic Results Overall

There was only a slight difference in gender of respondents in the Bear Lake Corridor area (Table 2.9). The majority of respondents were female, 52%, while males represented 48% of the sample population.

Table 2.9 Gender of Respondents

Percentage							
% Male	% Female	Mean	SD.	Median	25^{th}%	75^{th}%	N
48	52	.52	.5	1	0	1	785

The majority of respondents, (~92%), in the Bear Lake Corridor were Caucasian (Table 2.10). Those respondents indicating Asian ethnicity was the next largest demographic which was represented by 2% of the total sample.

Table 2.10 Ethnicity of Respondents

Race	Percent	Mean	SD	Median	25th%	75th%	N
American Indian/AK Native	.6	36.99	607.39	0	0	0	811
Asian	2	37.01	607.39	0	0	0	811
Black/African American	.6	36.99	607.39	0	0	0	811
Pacific Islander/Hawaiian Native	.1	36.99	607.39	0	0	0	811
White	92.2	37.91	607.34	1	1	1	811

Respondents were specifically asked if they were *Hispanic* or *Latino*. Results indicate that 2% of the sample population identified as *Hispanic* or *Latino* (Table 2.11).

Table 2.11 Frequency and Percentage of Participants that Identified as Hispanic/Latino

	Percentage							
	% Yes	% No	Mean	Std. Dev.	Median	25th%	75th%	N
Hispanic Visitors	2.47	97.52	.02	.16	.0	.0	.0	808

The average age of most respondents was 46 (Table 2.12).

Table 2.12 Visitor Age

	Average Age	Std. Dev.	Median	25th%	75th%	N
Age	46.23	13.46	47	56	36	789

The majority of respondents were highly educated (Table 2.13). Of respondents, 40% had completed masters or doctoral degrees, and 34% had completed college or trade school degrees. In total, 74% of respondents had completed a college degree.

Table 2.13 Visitor Formal Education Levels

Percentage										
Some High School	High School Graduate or GED	Some College/ Trade School	College/ Trade School Graduate	Some Graduate School	Master's/ Doctoral	SD	Med.	25th%	75th%	N
.3	4.1	12.4	34.4	9.2	39.5	1.4	4	3.75	6	785

The majority of respondents, (~97%), were from the United States (Table 2.14).

Table 2.14 Percentage of Visitor Geographic Origin

Percent						
United States	Canada	UK	W. Europe	E. Europe	Other	N
96.6	.3	.6	1.9	.2	.4	811

The largest percentage of visitors to the Bear Lake corridor were from the state of Colorado, with a total of 31% of respondents (Table 2.15). The second largest demographic of visitors came from Texas with a total of 9% of respondents, while the third largest demographic came from Illinois with a total of 7% respondents.

Table 2.15 Frequency and Percentage of Visitors Separated by State

State	Frequency	Percent
AK	1	.14
AL	5	.71
AR	3	.43
AZ	11	1.57
CA	28	4
CO	218	31.1
CT	2	.29
DC	5	.71
DL	0	0
FL	16	2.28
GA	2	.29
HW	1	.14
ID	0	0
IL	52	7.42
IN	8	1.14
IW	26	3.71
KA	36	5.14
KT	2	.29
LA	5	.71
MA	6	.86
MD	5	.71
ME	2	.29
MI	19	2.71
MN	15	2.14
MO	27	3.85

State	Frequency	Percent
MS	1	.14
MT	0	0
NB	23	3.28
NC	3	.43
ND	0	0
NH	3	.43
NJ	7	1
NM	5	.71
NV	2	.29
NY	12	1.71
OH	14	1.2
OK	6	.86
OR	3	.43
PA	8	1.14
RI	1	.14
SC	3	.43
SD	3	.43
TN	7	1
TX	66	9.42
UT	3	.43
UT	0	0
VA	9	1.28
WA	3	.43
WI	20	2.85
WV	3	.43
WY	1	.14
N	701	

2.5.3 Visitor Familiarity and Frequency of Visit by Site

Mean visits to the Park varied considerably by the four different trailheads analyzed (Table 2.16). The largest mean number of visits to the Park occurred from visitors at Glacier Gorge with an average of approximately 80 previous visits. Emerald Lake respondents indicated that they had visited the Park approximately 38 previous visits. Alberta Falls respondents indicated that they had visited the Park on average approximately 21 times previously, while at Dream Lake, visitors indicated averaging only 2 previous visits to the Park.

Table 2.16 Average Number of Visits to Rocky Mountain National Park

Location	Mean	Std. Dev.	Median	25^{th}%	75^{th}%	N
Alberta Falls	21.27	100.1	3	1	10	202
Dream Lake	2	26.0	3	2	12	201
Emerald Lake	38.07	222.9	3	1	10.3	198
Glacier Gorge	79.48	508.4	5	2	25	208

Respondents were asked to indicate the number of times they had visited the specific trailhead at which they were given the questionnaire (Table 2.17). Again, the largest mean occurred at Glacier Gorge with an average of 26 visits. Respondents at Alberta Falls and Emerald Lake both indicated an average of approximately 10 visits. Emerald Lake had the lowest average with approximately 6 visits to that area.

Table 2.17 Average Number of Visits at the Trail Site

Location	Mean	Std. Dev.	Median	25^{th}%	75^{th}%	N
Alberta Falls	9.75	23.1	3	2	8	102
Dream Lake	6.13	13.2	2	1	5	122
Emerald Lake	9.96	9.6	3	2	8	92
Glacier Gorge	26.29	111.0	3	1.5	15	129

Visitors were asked at which trailhead they began their hike (Table 2.18). With the exception of Glacier Gorge, the majority of respondents began their hike at Bear Lake. Analysis indicates that 105 visitors that completed the questionnaire at Alberta Falls, began their hike at Bear Lake, as opposed to 89 respondents that began at the Glacier Gorge Trailhead. At both Dream Lake and Emerald Lake, the vast majority of visitors began their hikes at Bear Lake Trailhead. Only at Glacier Gorge did the majority of respondents begin their hike at the Glacier Gorge Trailhead. However, 84/198 respondents still began their hike at the Bear Lake Trailhead. This indicates that Bear Lake Trailhead is the most popular starting location for the four trail destinations analyzed in this study.

Table 2.18 Initial Trailheads in which Visitors Began Their Hikes by Trail Site

	Frequency						
	Glacier Gorge	Bear Lake	SD	Med.	25^{th} %	75^{th} %	N
Alberta Falls	89	105	.63	2	1	2	194
Dream Lake	8	191	13.2	2	2	2	199
Emerald Lake	3	191	.20	2	2	2	194
Glacier Gorge	114	84	.67	1	1	2	198

Respondents were asked to indicate the frequency of their visits to particular trail areas (Table 2.19). Alberta Falls respondents frequented Alberta Falls for the majority of hike, with a total of 192/203 respondents. Similarly, respondents at Dream Lake with 161/201 and Emerald Lake with 187/199 indicated that they had visited the destinations at which they were given the questionnaire. This indicates that several respondents may have been unaware of the destinations they visited. Interestingly 39 respondents at Alberta Falls visited Mills Lake, 21 visited Loch Vale, 18 visited Nymph Lake, 14 at Dream Lake, 9 at Emerald Lake and 6 visited Bear Lake and Sky Pond. The majority of Dream Lake respondents visited Nymph Lake with a total of 173. However, 115 also visited Emerald Lake, 22 visited Alberta Falls, 6 visited Mills Lake, 4 visited Loch Vale and 1 indicated visiting Bear Lake and Sky Pond. The majority of Emerald Lake respondents visited Dream Lake with a total of 190. However, 172 also visited Nymph Lake, 16 visited Alberta Falls, 5 visited Mills Lake, 2 visited Bear Lake and 1 visited Loch Vale. Perhaps the most informative analysis was gathered at Glacier Gorge because it was the only trailhead in which respondents were given the questionnaire. The other three areas were destinations within the Bear Lake corridor. The majority of Glacier Gorge respondents visited Mills Lake and Loch Vale with a total of 46 visitors. Glacier Gorge respondents also visited Alberta Falls, with a total of 40 respondents. 19 respondents from Glacier Gorge visited Dream Lake while 17 indicated visiting Nymph Lake. There were 12 respondents from Glacier Gorge who had visited Emerald Lake, and 9 visited Bear Lake.

Table 2.19 Frequency of Destination Visits by Trail Site

	Frequency									
Trailhead	Alberta Falls	Mills Lake	Bear Lake	Loch Vale	Sky Pond	Dream Lake	Emerald Lake	Nymph Lake	None	Unaware of Location	N
Alberta Falls	192	39	6	21	6	14	9	18	2	5	203
Dream Lake	22	6	1	4	1	161	115	173	0	1	201
Emerald Lake	16	5	2	1	0	190	187	172	1	0	199
Glacier Gorge	40	46	9	46	17	19	12	17	1	0	208

The percentage of starting hike time varied for respondents depending upon the trail area (Table 2.20). 35% of respondents at Alberta Falls began their hike between 8am-10am. 30% began their hike between 10am-12pm. 14% indicated that they began their hike between 12pm-2pm, but only .5% stated that they began after 2pm. Only 5% began their hike prior to 8am. Dream Lake had similar results as many of the respondents, 37%, began their hike between 8am-10am. 34% began their hike between 10am-12pm. 14% indicated that they began their hike between 12pm-2pm, and only 5% stated that they began after 2pm. Only 7% began their hike before 8am. At Emerald Lake, 44% began their hike between 8am-10am, and 35% began their hike between 10am-12pm. Only 8% began their hike between 12pm-2pm, and no one indicated starting after 2pm. Glacier Gorge respondents were slightly different than the other trail areas. At Glacier Gorge, 13% of respondents, a greater percentage than found in the other areas, began their hike prior to 8am. This can most likely be attributed to Glacier Gorge being an actual trailhead, whereas the other three areas are trail destinations. 32% began their hike between 8am-10am, but a larger percentage, 35%, began between 10am-12pm. Only 10% began their hike between 12pm-2pm, and 5% began after 2pm.

Table 2.20 Beginning Hike Time by Trail Site

	Before 8AM	8AM-10AM	10AM-Noon	Noon-2PM	After 2PM	Don't Know	
Locations	%	%	%	%	%	%	N
Alberta Falls	5.4	35	30	13.8	.5	4.4	203
Dream Lake	7	37.31	33.83	13.93	4	4	201
Emerald Lake	7.54	44.22	34.67	8	0	3.52	199
Glacier Gorge	12.5	31.73	35.1	10.1	5.3	5.3	208

A 9-point indicator scale was used to analyze visitor familiarity with the specific trail area. Mean computations across all four locations yielded similar results (Table 2.21). Respondents at all four study sites averaged a mean of approximately 5, which indicates that respondents were *somewhat familiar* with each of the areas in question.

Table 2.21 Visitor Familiarity by Trail Site

Location	Frequency														
	Not Familiar						Very Familiar								
	1	2	3	4	5	6	7	8	9	Mean	Std. Dev.	Median	25th%	75th%	N
Alberta Falls	20	28	34	21	27	23	24	17	9	4.53	2.33	4	3	6	203
Dream Lake	14	28	27	23	25	27	28	14	15	4.84	2.35	5	3	7	201
Emerald Lake	22	28	26	26	19	21	27	13	17	4.66	2.49	4	2	7	199
Glacier Gorge	16	22	28	23	23	20	34	19	23	5.13	2.49	5	3	7	208

2.5.4 Visitor Familiarity and Frequency of Visit Overall

The average number of visits for visitors in the Bear Lake Corridor was approximately 39 (Table 2.22).

Table 2.22 Average Number of Visits to Rocky Mountain National Park

	Mean	N
# of Visits	38.52	809

The majority of visitors to the Bear Lake Corridor began their hikes at Bear Lake (Table 2.23). Of the total, 571 respondents, (71%), began at Bear Lake, while 271 respondents, (27%) began at Glacier Gorge.

Table 2.23 Initial Trailheads in which Visitors Began Their Hikes

	Frequency									
	Glacier Gorge	Bear Lake	Don't Know	Other	Mean	SD	Med.	25^{th}%	75^{th} %	N
Trailhead	214	571	9	12	1.78	.54	2	1	2	806

Many respondents, 398 visited Alberta Falls (Table 2.24). Dream Lake was also visited by a large portion, 384, of visitors surveyed. Nymph Lake, with 380 and Emerald Lake with 323 respondents were also heavily visited. Mills Lake, with 96 and Loch Vale, with 72 respondents were less heavily visited. Sprague Lake received the least visitation with 24 respondents.

Table 2.24 Frequency of Locations Visited

	Frequency									
	AF	ML	BL	LV	SP	DL	EL	NL	None	Don't Know	N
Locations	398	96	18	72	24	384	323	380	4	6	811

Overall 40% of respondents began their hike between 8am and 10am (Table 2.25). Also, 10am to noon was a frequent time of use as 33% of respondents indicated beginning their hike during this time. 7% of respondents began their hike before 8am and 2% began after 2pm.

Table 2.25 Beginning Hike Time

	Percent						
	Before 8AM	8AM-10AM	10AM-Noon	Noon-2PM	After 2PM	Don't Know	N
Start Times	7.2	39.5	33.1	11.3	2.4	.5	811

Based upon a 9-point scale, (1 = Not Familiar, 9 = Very Familiar), respondents were asked how familiar they were with the park. The average was near 5, indicating that respondents were *moderately familiar* with the park (Table 2.26).

Table 2.26 Visitor Familiarity with Area

	Percent											
	Not Familiar							Very Familiar				
	1	2	3	4	5	6	7	8	9	Mean	S.D.	N
Familiarity	8.9	13.1	14.2	11.5	11.6	11.2	13.9	7.8	7.9	4.79	2.42	811

2.6 Visitor User Capacities

This section of the chapter describes the data and result tables pertaining to respondent demographics and familiarity with the area.

2.6.1 Perceptions of Crowding by Study Site

Visitors were asked to indicate how encounters with other people at the four specific trail areas affected their overall enjoyment during their hiking experience in the Park. Very few respondents indicated that other people *greatly reduced* their experience Table 2.27). The greatest percentage of respondents indicating that other people *greatly reduced* their experienced occurred at Dream Lake with slightly more than 3% of respondents. Those respondents indicating that other people *somewhat reduced* their experience yielded greater percentages, particularly at Glacier Gorge and Dream Lake, both with approximately 22%. A large percentage of respondents indicated that other people had *no effect* upon their experience, particularly at Alberta Falls with 41%. Analysis indicates that a large portion of respondents believe that other people either *somewhat added* or *greatly added* to their experience in the Park. At each of the four trail areas, nearly 30% of the respondents indicated that other people *somewhat added* to their experience, while at Emerald Lake, 17% of the respondents indicated that other people *greatly added* to their experience.

Table 2.27 Visitor Encounters and the Relationship to Overall Enjoyment by Trail Site

	Percentage									
Location	Greatly Added	Somewhat Added	No Effect	Somewhat Reduced	Greatly Reduced	SD	Mean	25th%	75th%	N
Alberta Falls	12.80	29.06	40.88	15.76	1.47	.946	2.6	2	3	203
Dream Lake	15.92	30.34	28.35	21.89	3.48	1.09	2.7	2	4	201
Emerald Lake	17.25	29.94	32.99	18.27	1.52	1.03	2.6	2	3	197
Glacier Gorge	14.49	28.98	32.85	22.22	1.44	1.02	2.7	2	3	207

During this study the visitor-based standards concerning crowding were assessed using a visual approach. In particular, a series of computer edited photographs was prepared for each study site showing a range of visitor use levels (varying numbers of visitors on the trail or at a park destination). Respondents were asked to rate the acceptability of each photograph on a scale that ranged from +4 ("very acceptable") to -4 ("very unacceptable") and included a neutral point of 0, ultimately resulting in a 9 point scale. The descriptions and tables below describe the results for each study site.

Photos 1 through 5 were shown in order to respondents at Alberta Falls. Photo 1 contained approximately 0 people, Photo 2 contained approximately 7 people, Photo 3 contained approximately 10 people, Photo 4 contained approximately 15 people and Photo 5 contained approximately 25 people. Analysis indicates that mean scores were highest in Photo 1 and began to decrease as Photos and people increased (Table 2.28). Photo 1 mean scores were 3.8, and Photo 2 dropped slightly to 2.9. Photo 3 mean scores decreased to less than 1, and Photo 4 means dropped below acceptability to -1. Photo 5 resulted in the lowest mean scores at nearly -3.

(Alberta Falls Crowding Photos Visible in Appendix C)

Table 2.28 Visitor Perceived Crowding Based Upon Photos at Alberta Falls

	Percentage													
	Very Unacceptable					Very Acceptable								
Photo	-4	-3	-2	-1	0	1	2	3	4	Mean	S.D.	25th%	75th%	N
Photo 1	.5	.5	.5	0	1	0	1	3.1	93.3	3.8	.99	4	4	194
Photo 2	0	0	1	1	4.7	5.2	16.2	30.9	40.8	2.9	1.32	2	4	191
Photo 3	1.6	5.8	7.9	13.2	17.5	7.9	19.6	19.6	6.9	.8	2.08	-1	3	189
Photo 4	17	16	18.6	6.9	11.7	9.6	13.3	2.7	4.3	-.99	2.36	-3	1	188
Photo 5	51.3	12.2	10.1	5.3	9	6.9	3.2	0	2.1	-2.46	2.07	-4	-1	189

A 9-point scale was used to determine the level of crowding experienced at Dream Lake as well (Table 2.29). Photos 1 through 5 were shown in order to respondents at Dream Lake. Photo 1 contained approximately 0 people, Photo 2 contained approximately 4 people, Photo 3 contained approximately 8 people, Photo 4 contained approximately 13 people and Photo 5 contained approximately 16 people. Analysis indicates that mean scores were highest in Photo 1 and began to decrease as Photos and people increased. Photo 1 mean scores were approximately 4, and Photo 2 dropped slightly to nearly 3. Photo 3 mean scores decreased below acceptability to ~1, and Photo 4 means dropped below acceptability at nearly -1. Photo 5 resulted in the lowest mean scores at ~-2.5.

Table 2.29 Visitor Perceived Crowding Based Upon Photos at Dream Lake

Photo	Percentage: Very Unacceptable -4	-3	-2	-1	0	1	2	3	Very Acceptable 4	Mean	S.D.	25th%	75th%	N
Photo 1	0	1.5	1.0	1.5	.5	1.0	2.1	7.2	85.1	3.59	1.3	4	4	194
Photo 2	1.6	3.1	5.2	4.7	8.3	14.5	25.9	20.2	16.6	1.63	1.95	1	3	193
Photo 3	9.6	11.2	16.5	18.1	14.4	15.4	7.4	5.3	2.1	-.68	2.05	-2	1	188
Photo 4	43.5	18.3	15.7	13.1	4.7	2.1	2.1	.5	0	-2.65	1.58	-4	-2	191
Photo 5	79.7	10.9	4.2	1.6	2.1	1.6	0	0	0	-3.58	1.07	-4	-4	192

Similarly, a 9-point scale was used to determine the level of crowding experienced at Emerald Lake (Table 2.30). Photos 1 through 5 were shown in order to respondents at Emerald Lake. Photo 1 contained approximately 0 people, Photo 2 contained approximately 7 people, Photo 3 contained approximately 14 people, Photo 4 contained approximately 21 people and Photo 5 contained approximately 27 people. Analysis indicates that mean scores were highest in Photo 1 and began to decrease as photos and people increased. Photo 1 mean scores were approximately 4, and Photo 2 dropped slightly to around 2. Responses from Photo 3 decreased below acceptability (-.68), and Photo 4 means dropped below acceptability at ~-3. Photo 5 resulted in the lowest mean scores at ~-4.

Table 2.30 Visitor Perceived Crowding Based Upon Photos at Emerald Lake

Photo	Percentage: Very Unacceptable -4	-3	-2	-1	0	1	2	3	Very Acceptable 4	Mean	S.D.	25th%	75th%	N
Photo 1	0	1.0	.5	1.0	1.5	1.0	2.0	3.1	89.8	3.68	1.14	4	4	196
Photo 2	2.1	1.0	1.6	3.6	5.7	6.2	19.2	30.6	30.1	2.38	1.8	2	4	193
Photo 3	8.2	7.7	9.7	6.7	17.9	13.3	18.5	14.4	3.6	.26	2.27	-2	2	195
Photo 4	22.6	13.3	16.4	13.8	8.2	13.8	6.7	4.6	.5	-1.34	2.18	-3	1	195
Photo 5	48.7	15	11.4	7.8	5.2	6.2	2.6	1.6	1.6	-2.48	2.02	-4	-1.5	193

A 9-point scale was also used to determine the level of crowding experienced at Glacier Gorge (Table 2.31). Photos 1 through 5 were shown in order to respondents at Glacier Gorge. Photo 1 contained approximately 0 people, Photo 2 contained approximately 4 people, Photo 3 contained approximately 8 people, Photo 4 contained approximately 12 people and Photo 5 contained approximately 16 people. Analysis indicates that mean scores were highest in Photo 1 and began to decrease as Photos and people increased. Photo 1 mean scores were approximately 4, and Photo 2 dropped slightly to ~2. Photo 3 mean scores decreased a level below acceptability to -1, and Photo 4 means also dropped below acceptability at -3. Photo 5 resulted in the lowest mean scores at approximately -4.

Table 2.31 Visitor Perceived Crowding Based Upon Photos at Glacier Gorge

Photo	Percentage									Mean	S.D.	25th%	75th%	N
	Very Unacceptable				Very Acceptable									
	-4	-3	-2	-1	0	1	2	3	4					
Photo 1	.5	.5	.5	0	1.0	0	2.5	3.9	91.2	3.8	.99	4	4	204
Photo 2	4.5	3.0	6.9	3.5	10.4	9.9	17.3	27.2	17.3	1.51	2.24	.0	3	202
Photo 3	14.3	13.8	17.2	16.7	11.8	8.9	11.8	3.9	1.5	-1	2.14	-3	1	203
Photo 4	52.5	20.7	12.1	8.1	2.0	3.5	.5	0	.5	-2.98	1.45	-4	-2	198
Photo 5	87.9	5.6	2.5	2.0	1.0	.5	.5	0	0	-3.74	.86	-4	-4	198

Respondents were asked to indicate which photo looked like the number of people they saw at the survey site during their visit (Table 2.32). At Alberta Falls many of the respondents, (~47%), indicated that they experienced a scene similar to that found in Photo 3, which contained approximately 10 people in a view area. At Dream Lake the majority of respondents, (63%), indicated that they experienced a scene similar to that found in Photo 2, which contained approximately 4 people in a view area. At Emerald Lake the many respondents, (42%), indicated that they experienced a scene similar to that found in Photo 3, which contained approximately 14 people in a single view shed. At Glacier Gorge, the majority of respondents, (66%), indicated that they experienced a scene similar to that found in Photo 3, which contained approximately 8 people in a view area.

Table 2.32 Percentage of Photographs that Looked Similar to the Number of People Seen by Trail Site

Location	Percentage					Mean	S.D.	Median	25th%	75th%	N
	Photo #										
	1	2	3	4	5						
Alberta Falls	3.46	30.19	46.53	12.37	7.42	2.9	.93	3	2	3	202
Dream Lake	2.5	63	29.5	4.5	.5	2.38	.64	2	2	3	200
Emerald Lake	1.01	28.28	42.42	17.17	11.11	3.09	.97	3	2	4	198
Glacier Gorge	1.44	66.34	27.40	2.88	1.92	2.38	.66	2	2	3	208

At Alberta Falls, the slight majority of respondents, 43%, indicated that they would prefer to experience Photo 1, which contained approximately 0 people (Table 2.33). Additionally, 43% indicated that they would prefer Photo 2, which contained approximately 7 people. At Dream Lake, results were similar as 49% indicated that they would prefer Photo1 while 48% indicated that they would prefer Photo 2. At Emerald Lake, 46% preferred Photo 2, while 41% preferred Photo 1. At Glacier Gorge 51% of respondents indicated that they would prefer that their immediate view shed would look like the scene in Photo 2.

Table 2.33 Percentage of Photographs that Looked Like the Number of People They Would Prefer to See by Trail Site

	Percentage										
	Photo #										
Location	1	2	3	4	5	Mean	SD	Median	25th%	75th%	N
Alberta Falls	43.06	42.57	11.38	1.98	.99	1.75	.81	2	1	2	202
Dream Lake	49	47.5	3	.5	0	1.55	.58	2	1	2	200
Emerald Lake	41.2	46.23	10.55	1.5	.5	1.74	.75	2	1	2	199
Glacier Gorge	45.1	50.5	3.9	0	.5	1.6	.61	2	1	2	206

A 9-point scale was used to determine the level of crowding experienced at the four trail areas (Table 2.34).

Table 2.34 Level of Crowding Experienced by Trail Site

	Percentage												
	Not Crowded							Extremely Crowded					
Location	1	2	3	4	5	6	7	8	9	Mean	S.D.	Median	N
Alberta Falls	9.95	15.42	21.89	15.42	10.44	12.93	10.44	2.48	.99	4	1.1	4	201
Dream Lake	4.5	16.5	22	18.5	10.5	14	10.5	2.5	1	4.17	1.88	4	200
Emerald Lake	6.03	13.56	21.6	12.06	11.05	15.07	13.56	4.52	2.51	4.46	2.1	4	199
Glacier Gorge	4.36	17.96	23.78	14.07	13.1	13.1	8.73	4.36	.48	4.13	1.9	4	206

2.6.2 Perceptions of Crowding Overall

Overall, the many respondents, (34%), indicated that encounters with other people had *no effect* upon their enjoyment in the area (Table 2.35). In fact, (30%) indicated that other people *somewhat added* to their enjoyment. Perhaps most important for management, (20%) of respondents indicated that other people *somewhat reduced* their enjoyment.

Table 2.35 Visitor Encounters and the Relationship to Overall Enjoyment

	Percentage									
	Greatly Added	Somewhat Added	No Effect	Somewhat Reduced	Greatly Reduced	Mean	S.D.	25^{th} %	75^{th}%	N
Enjoyment	15.1	29.6	33.8	19.6	2	2.64	1	2	3	808

Visitors were asked to look at a series of five photos that demonstrated areas in the Bear Lake corridor. Each photo sequentially increased the amount of visitors seen in the immediate view shed. The visitors were given these photos sequentially and were asked to indicate how many other people they could encounter without feeling too crowded. Respondents were asked to rate their acceptability for each photo based upon a scale, -4 indicating very unacceptable to 4 indicating very acceptable. As respondents were shown the photos sequentially, acceptability ratings decreased. As mean scores indicate, when respondents saw photo 3, in which mean scores dropped below 0, their acceptability concerning the amount of people in the photos decreased below the acceptable level (Table 2.36).

Table 2.36 Visitor Perceived Crowding Based Upon Photos

	Percentage													
Photo	-4	-3	-2	-1	0	1	2	3	4	Mean	S.D.	Median	25^{th}%	75^{th}%	N
Photo 1	.3	.9	.6	.6	1	.5	1.9	4.3	89.8	3.71	1.11	4	4	4	788
Photo 2	2.1	2.1	3.5	3.2	7.3	9.0	19.6	27.2	26.1	2.1	1.95	3	1	4	779
Photo 3	8.5	9.7	12.9	13.7	15.4	11.4	14.3	10.7	3.5	-.17	2.25	.0	2	2	775
Photo 4	34.1	17.1	15.7	10.5	6.6	7.3	5.6	1.9	1.3	-2	2.1	-3	4	-1	772
Photo 5	67.1	10.9	7	4.1	4.3	3.4	1.9	.4	.9	-3.07	1.7	-4	4	-3	772

Respondents were asked to indicate which photo looked like the scenario in which they experienced in the park during their visit (Table 2.37). Many, (47%), reported that photo 2. However, 36% of respondents indicated that their experience in the park was most like photo 3. Over 9% of respondents felt like they experienced photo 4 and 5% felt like they experienced photo 5.

Table 2.37 Percentage of Photographs that Looked Similar to the Number of People Seen

	Percent										
Photos 1-5	1	2	3	4	5	Mean	S.D.	Median	25^{th}%	75^{th}%	N
	2.1	47.2	36.4	9.2	5.2	2.68	.87	3	2	3	808

Respondents were also asked to indicate the photo that represented the amount of people they would prefer to see (Table 2.38). 45% indicated that they would prefer to see approximately no other people, as seen in photo 1, while 47% of respondents stated that they would prefer to see approximately 7 people, as seen in photo 2. These two groups equate to approximately 91% of respondents. As photos increase sequentially, again, the percentage of individuals finding the level of people acceptable, decreases.

Table 2.38 Percentage of Photographs that Looked Similar to the Number of People They Would Prefer to See

	Photos 1-5										
	1	2	3	4	5	Mean	S.D.	Median	25th%	75th%	N
Percent	44.6	46.7	7.2	1	.5	1.66	.7	2	1	2	807

Respondents were ultimately asked the level of crowding they experienced during their visit, based upon a 9-point scale (1 = Not at all Crowded, 9 = Extremely Crowded). The average equated to ratings exceeding 4, which indicate that on average, respondents were more than *slightly crowded* (Table 2.39). Analysis indicates that only 22% of respondents were *not at all crowded*, while 37% were *slightly crowded*, 11% felt somewhere between *slightly crowded* and *moderately crowded*, nearly 25% were *moderately crowded* and nearly 5% were *extremely crowded*. Of respondents, 78% indicated experiencing some level of crowding during their visit.

Table 2.39 Level of Crowding Experienced

	Percent										
	Not at all Crowded		Slightly Crowded			Moderately Crowded		Extremely Crowded			
	1	2	3	4	5	6	7	8	9	Mean	S.D.
Crowding	6.2	15.9	22.3	15	11.3	13.8	10.8	3.5	1.2	4.19	1.97

2.7 Potential Problems Associated with Visitor Experience

This section of the chapter describes and demonstrates visitor perceptions of potential problems associated with the visitor experience in the area.

2.7.1 Potential Problems Associated with Visitor Experience by Study Site

Analysis concerning perceived problems experienced by visitors at Alberta Falls yielded varying results (Table 2.40). Very few individuals had problems finding their desired trailhead. Only 1% found this to be a *small problem*. Of the total, 26% had a *small problem* with the lack of parking, but 14% found this to be a *big problem*. Of the respondents, 8% had a *small problem* and 2% had a *big problem* concerning the lack of information about trail preparation, but 86% had *no problem*. *These measures are representative of onsite respondents and do not reflect visitors who may have been displaced because of site conditions.*

Of the respondents, 27% had a *small problem* and 4% of respondents had a *big problem* concerning the lack of signs about natural and cultural information, but 65% had *no problem*. At Alberta Falls 91% of respondents had *no problem* with directional signs along the trail, but 8% had a *small problem,* and 1% had a *big problem*. Most respondents, 96% had *no problem* with the width of the trails in the area, but 3% indicated having a *small problem*. However, 10% indicated that they had a *small problem* with the level of trail erosion. Very few respondents, 4%, indicated having a *small problem* with litter along the trail, and even fewer, .5% indicated having a *small problem* with improperly disposed human waste on or near the trail.

Interestingly, 47% of respondents indicated having a *small problem* and 7% had a *big problem* with the amount of people on the trail. Results indicate that more respondents had a problem with the amount of people on the trail than the 47% that had *no problem*. Of the respondents, 23% had a *small problem* and nearly 5% had a *big problem* with the amount of off-trail trampling found at Alberta Falls. Only 6% of respondents indicated having a *small problem* with the sound from aircraft. However, 29% of respondents indicated having a *small problem* and nearly 4% had a *big problem* with the sound from large groups of visitors. Of the respondents, 28% also indicated having a *small problem* and nearly 2% indicated having a *big problem* with sound from other visitors. Very few respondents, 1%, indicated having a *small problem* with sound from NPS maintenance. However, over 8% indicated having a *small problem* with sound from vehicles such as cars, buses and motorcycles.

Table 2.40 Percentage of Perceived Problems Visitors Experienced at Alberta Falls

	Percentage									
Location	% No Problem	% Small Problem	% Big Problem	% No Opinion	Mean	S.D.	Median	25^{th}%	75^{th}%	N
Difficulty Locating Trailhead	98.44	1	0	.5	1.03	.24	1	1	1	193
Lack of Parking at Trailhead	52.38	26.45	14.28	6.87	1.76	.94	1	1	2	189
Information for Hike Preparation	86.38	7.85	1.57	4.18	1.24	.68	1	1	1	191
Not Enough Signs for Natural and Cultural Info.	65.44	27.22	4.18	4.18	1.48	.76	1	1	2	193
Not Enough Directional Signs Along Trail	91.14	7.81	1.04	0	1.1	.33	1	1	1	192
Trails Are Too Wide	95.74	3.19	0	1.06	1.06	.35	1	1	1	188
Trails Are Too Eroded	88.54	10.4	0	1.04	1.14	.42	1	1	1	192
Litter Along Trail	96.35	3.65	0	0	1.04	.19	1	1	1	192
Improperly Disposed Human Waste Evident	98.96	.51	0	.5	1.02	.23	1	1	1	193
Too Many People	46.63	46.63	6.73	0	1.6	.61	2	1	2	193
Off-Trail Trampling	68.75	23.43	4.68	3.12	1.42	.73	1	1	2	192
Sound From Aircraft	92.18	6.25	0	1.56	1.11	.44	1	1	1	192

Location	Percentage				Mean	S.D.	Median	25th%	75th%	N
	% No Problem	% Small Problem	% Big Problem	% No Opinion						
Sound From Large Groups of Visitors	66.32	29.01	3.62	1.03	1.39	.61	1	1	2	193
Sound From Other Visitors	69.94	27.97	1.55	.51	1.33	.53	1	1	2	193
Sound from NPS Maintenance	95.85	1	0	3.1	1.1	.53	1	1	1	193
Sound From Vehicles	90.1	8.33	0	1.56	1.13	.46	1	1	1	192

Analysis concerning perceived problems experienced by visitors at Dream Lake yielded similar results (Table 2.41). Very few individuals had problems finding their desired trailhead. Nearly 4% found this to be a *small problem*. Although 23% had a *small problem* with the lack of parking, 7% found this to be a *big problem*. Of the respondents, 7% had a *small problem* and 0% had a *big problem* concerning the lack of information about trail preparation, but 89% had *no problem*. Of respondents, 34% had a *small problem* and nearly 2% of respondents had a *big problem* concerning the lack of signs about natural and cultural information, but 63% had *no problem*. At Dream Lake approximately 86% of respondents had *no problem* with directional signs along the trail, but nearly 13% had a *small problem* and 1% had a *big problem*. Most respondents, 94% had *no problem* with the width of the trails in the area but 5% indicated having a *small problem*. However, 18% indicated that they had a *small problem* with the level of trail erosion. Very few respondents, 10%, indicated having a *small problem* with litter along the trail, and even fewer, 4% indicated having a *small problem* with improperly disposed human waste on or near the trail.

The majority, nearly 55% of respondents indicated having a *small problem*, and nearly 9% had a *big problem* with the amount of people on the trail. Results indicate that more respondents had a problem with the amount of people on the trail than the 36% that had *no problem*. Of the respondents, 25% had a *small problem* and 4% had a *big problem* with the amount of off-trail trampling found at Dream Lake. Only 12% of respondents indicated having a *small problem* with the sound from aircraft. However, nearly 43% of respondents indicated having a *small problem* and 7% had a *big problem* with the sound from large groups of visitors. 35% also indicated having a *small problem* and 4% indicated having a *big problem* with sound from other visitors. Very few respondents, 1%, indicated having a *small problem* with sound from NPS maintenance. However, nearly 9% indicated having a *small problem* with sound from vehicles such as cars, buses and motorcycles.

Table 2.41 Percentage of Perceived Problems Visitors Experienced at Dream Lake

Location	Percentage				Mean	S.D.	Med	25th%	75th%	N
	% No Problem	% Small Problem	% Big Problem	% No Opinion						
Difficulty Locating Trailhead	96.39	3.6	0	0	1.04	.19	1	1	1	194
Lack of Parking at Trailhead	67.87	22.79	6.73	2.59	1.44	.73	1	1	2	193
Information for Hike Preparation	88.6	6.73	0	9	1.21	.67	1	1	1	193

Location	Percentage				Mean	S.D.	Med	25th%	75th%	N
	% No Problem	% Small Problem	% Big Problem	% No Opinion						
Not Enough Signs for Natural and Cultural Info.	63.4	33.5	1.54	1.54	1.41	.61	1	1	2	194
Not Enough Directional Signs Along Trail	85.56	12.88	1.03	.51	1.16	.44	1	1	1	194
Trails Are Too Wide	94.3	5.18	.51	0	1.06	.26	1	1	1	193
Trails Are Too Eroded	80.92	18.04	1.03	0	1.2	.43	1	1	1	194
Litter Along Trail	89.69	9.79	.51	0	1.11	.33	1	1	1	194
Improperly Disposed Human Waste	94.32	4.12	1.03	.51	1.08	.35	1	1	1	194
Too Many People	35.75	54.92	8.8	.51	1.74	.63	2	1	2	193
Off-Trail Trampling	45.02	25.13	4.18	25.65	2.1	1.23	2	1	4	191
Sound From Aircraft	83	12.37	.51	4.12	1.26	.67	1	1	1	194
Sound From Large Groups of Visitors	50	42.78	6.7	.51	1.58	.64	1.5	1	2	194
Sound From Other Visitors	60.1	34.71	4.14	1.03	1.46	.63	1	1	2	193
Sound from NPS Maintenance	94.32	1.03	0	4.63	1.15	.64	1	1	1	194
Sound From Vehicles	87.62	8.76	0	3.6	1.2	.61	1	1	1	194

Analysis concerning perceived problems experienced by visitors at Emerald Lake yielded varying results (Table 2.42). Very few individuals had problems finding their desired trailhead. Only .5% found this to be a *small problem*. While 25% had a *small problem* with the lack of parking, and virtually no one found this to be a *big problem*. Only 3% of respondents had a *small problem* concerning the lack of information about trail preparation. Although 30% of respondents had a *small problem,* no one had a *big problem* concerning the lack of signs about natural and cultural information. At Emerald Lake 95% of respondents had *no problem* with directional signs along the trail. Similarly, most respondents, 94% had *no problem* with the width of the trails in the area but 4% indicated having a *small problem*. However, 8% indicated that they had a *small problem* with the level of trail erosion. Very few respondents, 5%, indicated having a *small problem* with litter along the trail, and even fewer, nearly 4% indicated having a *small problem* with improperly disposed human waste on or near the trail.

Nearly 54% of respondents indicated having a *small problem*, and 6% had a *big problem* with the amount of people on the trail. Results indicate that 60% of respondents had at least some problem with the amount of people on the trail. Almost 20% had a *small problem* and nearly 1% had a *big problem* with the amount of off-trail trampling found at Emerald Lake. Only 7% of respondents indicated having a *small problem* with the sound from aircraft. However, 34% of respondents indicated having a *small problem* and 6% had a *big problem* with the sound from large groups of visitors. 33% of respondents indicated having a *small problem* and 5% indicated having a *big problem* with sound from other visitors. 52% of respondents indicated having a *small problem* with sound from NPS maintenance. However, only 2% indicated having a *small problem* with sound from vehicles such as cars, buses and motorcycles.

Table 2.42 Percentage of Perceived Problems Visitors Experienced at Emerald Lake

	Percentage									
Location	% No Problem	% Small Problem	% Big Problem	% No Opinion	Mean	S.D.	Med	25th%	75th%	N
Difficulty Locating Trailhead	99.46	.53	0	0	1.01	.07	1	1	1	188
Lack of Parking at Trailhead	60.84	24.86	11.1	3.17	1.57	.81	1	1	2	189
Information for Hike Preparation	92.06	3.17	0	4.76	1.17	.66	1	1	1	189
Not Enough Signs for Natural and Cultural Info.	66.13	30.15	0	3.7	1.41	.68	1	1	2	189
Directional Signs Along Trail	94.7	5.29	0	0	1.05	.22	1	1	1	189
Trails Are Too Wide	94.11	4.27	1.06	0	6.4	73	1	1	1	187
Trails Are Too Eroded	91.53	7.93	.52	0	1.09	.31	1	1	1	189
Litter Along Trail	93.65	5.29	1.05	0	1.07	.3	1	1	1	189
Improperly Disposed Human Waste	93.65	3.7	1.58	1.05	1.1	.43	1	1	1	189
Too Many People	39.89	53.72	6.38	0	1.66	.59	2	1	2	188
Off-Trail Trampling	75.53	19.68	.53	4.25	1.34	.70	1	1	1	188
Sound From Aircraft	90.42	6.91	1.59	1.06	1.13	.46	1	1	1	188
Sound From Large Groups of Visitors	59.25	34.39	5.82	.52	1.48	.63	1	1	2	189
Sound From Other Visitors	62.23	32.97	4.78	0	1.43	.59	1	1	2	188
Sound from NPS Maintenance	98.41	.52	.52	.52	1.03	.27	1	1	1	189
Sound From Vehicles	97.87	1.59	0	.53	1.03	.25	1	1	1	188

Analysis concerning perceived problems experienced by visitors at Glacier Gorge yielded varying results (Table 2.43). Very few individuals had problems finding their desired trailhead. Only 1% found this to be a *small problem*. While 34% had a *small problem* with the lack of parking, 11% found this to be a *big problem*. Of the respondents, 8% had a *small problem* and .5% had a *big problem* concerning the lack of information about trail preparation with 88%, but had *no problem*. 20% had a *small problem* and 6% of respondents had a *big problem* concerning the lack of signs about natural and cultural information. 94% of respondents at Glacier Gorge had *no problem* with directional signs along the trail, but 4% had a *small problem*. Most respondents, 94% had *no problem* with the width of the trails in the area but 4% indicated having a *small problem*. However, 20% indicated that they had a *small problem* with the level of trail erosion. Very few respondents, 8%, indicated having a *small problem* with litter along the trail, and even fewer, .5% indicated having a *small problem* with improperly disposed human waste on or near the trail.

Perhaps most alarming were the 54% of respondents that indicated having a *small problem*, or the 10% that had a *big problem* with the amount of people on the trail. Results indicate more than 60% of the respondents had at least a small problem with the amount of people on the trail. Of the respondents, 34% had a *small problem* and 12% had a *big problem* with the amount of off trail trampling found at Glacier Gorge. Only 11% of respondents indicated having a *small problem* with the sound from aircraft. However, 43% of respondents indicated having a *small problem* and 5% had a *big problem* with the sound from large groups of visitors. Of respondents, 35% also indicated having a *small problem* and 3% indicated having a *big problem* with sound from other visitors. Very few respondents, 3%, indicated having a *small problem* with sound from NPS maintenance. However, 20% indicated having a *small problem* with sound from vehicles such as cars, buses and motorcycles.

Table 2.43 Percentage of Perceived Problems Visitors Experienced at Glacier Gorge

	Percentage									
Location	% No Problem	% Small Problem	% Big Problem	% No Opinion	Mean	S.D.	Med	25th%	75th%	N
Difficulty Locating Trailhead	98.53	1.46	0	0	1.01	.12	1	1	1	205
Lack of Parking at Trailhead	51.74	33.83	10.94	3.48	1.66	.81	1	1	2	201
Information for Hike Preparation	88.29	7.8	.48	3.41	1.19	.61	1	1	1	205
Not Enough Signs for Natural and Cultural Info.	70.24	20	6.34	3.41	1.43	.76	1	1	2	205
Directional Signs Along Trail	93.62	4.41	1.47	.49	1.09	.37	1	1	1	204
Trails Are Too Wide	94	3.98	.49	1.49	1.09	.43	1	1	1	201
Trails Are Too Eroded	76.47	20	2.45	.98	1.28	.56	1	1	1	204
Litter Along Trail	90.73	7.8	.97	.48	1.11	.39	1	1	1	205
Improperly Disposed Human Waste	97.54	.49	.98	.98	1.05	.36	1	1	1	204
Too Many People	35.64	53.96	10.39	0	1.75	.63	2	1	2	202
Off-Trail Trampling	48.27	33.99	12.31	5.41	1.75	.87	2	1	2	203
Sound From Aircraft	84.80	10.78	2.45	1.96	1.22	.58	1	1	1	204
Sound From Large Groups of Visitors	52.21	42.85	4.92	0	1.53	.59	1	1	2	203
Sound From Other Visitors	61.88	35.14	2.97	0	1.41	.55	1	1	2	202
Sound from NPS Maintenance	95	2.94	0	1.96	1.09	.45	1	1	1	204
Sound From Vehicles	78.1	20.39	.49	.99	1.24	.51	1	1	1	201

2.7.2 Potential Problems Associated with Visitor Experience Overall

Of the respondents, 38% indicated that they had a problem with the lack of parking at the trailhead, and 31% stated that they had a problem with the lack of informational signs about natural and cultural history (Table 2.44). Not surprisingly, 60% of respondents indicated that they had a problem with the number of people they experienced on the trail. About a third, 31%, had a problem with off-trail trampling, and 43% indicated having a problem with sounds from large groups of people, while 36% indicated having a problem with sounds from other people.

Table 2.44 Percentage of Perceived Problems Visitors Experienced

	Percent									
Issues	No Problem	Small Problem	Big Problem	No Opinion	Mean	S.D.	Med	25th%	75th%	N
Difficulty Locating Trailhead	98.2	1.7	0	.1	1.02	.17	1	1	1	780
Lack of Parking at Trailhead	58.2	27.1	10.8	4	1.61	.83	1	1	2	772
Information for Hike Preparation	88.8	6.4	.5	4.2	1.2	.65	1	1	1	778
Enough Signs for Natural/Cultural Info.	66.2	27.5	3.1	3.2	1.43	.71	1	1	2	781
Directional Signs Along Trail	91.3	7.6	.9	.3	1.1	.35	1	1	1	779
Trails Are Too Wide	94.5	4.2	.5	.7	2.37	36	1	1	1	769
Trails Are Too Eroded	84.2	14.2	1	.5	1.18	.45	1	1	1	779
Litter Along Trail	92.6	6.7	.6	.1	1.08	.31	1	1	1	780
Improperly Disposed Human Waste	96.2	2.2	.9	.8	1.06	.35	1	1	1	780
Too Many People	39.4	52.3	8.1	.1	1.69	.62	2	1	2	776
Off-Trail Trampling	59.2	25.7	5.6	9.6	1.66	.96	1	1	2	774
Sound From Aircraft	87.5	9.1	1.2	2.2	1.18	.55	1	1	1	778
Sound From Large Groups of Visitors	56.9	37.4	5.3	.5	1.49	.62	1	1	2	779
Sound From Other Visitors	63.5	32.7	3.4	.4	1.41	.58	1	1	2	776
Sound from NPS Maintenance	95.9	1.4	.1	2.6	1.09	.49	1	1	1	780
Sound From Vehicles	88.3	9.9	.1	1.7	1.15	.48	1	1	1	775

2.8 Visitor Opinions Concerning Personal Vehicle or Park Shuttle

The following section describes the data and result tables pertaining visitor opinions concerning the use of personal vehicle or park shuttle.

2.8.1 Perceptions towards Transportation by Study Site

The method of transportation to the trailheads varied between personal vehicle and Park shuttle vehicle depending upon the four trail areas analyzed (Table 2.45). At Alberta Falls, 49% traveled to their desired trailheads by shuttle bus while 46% traveled by personal vehicle. At Dream Lake the majority, 63%, traveled by personal vehicle while only 37% traveled by shuttle vehicle. Similarly, at Emerald Lake, 60% of respondents traveled by personal vehicle while only 38% traveled by shuttle bus. At Glacier Gorge, a slight majority of respondents, 53%, traveled to their desired trailhead via shuttle bus while 45% traveled by personal vehicle.

Table 2.45 Mode of Transportation to Trailhead by Trail Site

	Percentage								
Location	Personal Vehicle	Shuttle Bus	Other	Mean	S.D.	Median	25^{th}%	75^{th}%	N
Alberta Falls	45.78	49.47	4.73	1.59	.58	2	1	2	190
Dream Lake	62.81	36.68	.5	1.38	.47	1	1	2	199
Emerald Lake	60	38.46	1.53	1.42	.524	1	1	2	195
Glacier Gorge	45.27	52.73	1.99	1.57	.54	2	1	2	201

Two 4-point scales were used to analyze visitor perception about personal vehicle and Park shuttle bus use. Respondents were given the same statements for both personal vehicle and shuttle bus and asked to rate their level of agreement or disagreement with the statement. Respondents rated their level of agreement or disagreement by circling 1 for *strongly agree*, 2 for *agree*, 3 for *disagree* and 4 for *strongly disagree*. Table 2.46 – 2.49 demonstrate the results for each of the study sites.

Table 2.46 Visitor Perceptions Concerning the Use of Personal Vehicle or Park Shuttle at Alberta Falls

Statement	Personal Vehicle						Park Shuttle					
	Mean	S.D.	Median	25%	75%	N	Mean	S.D.	Median	25%	75%	N
Easy access to personal belongings	1.37	.66	1	1	2	172	2.47	.96	3	2	3	150
Opportunity to learn about the park while traveling	2.18	.92	2	1	3	168	2.03	.88	2	1	3	148
Travel is affordable/low cost	2.10	.86	2	1	3	172	1.24	.51	1	1	1	152
Opportunities to see wildlife	1.67	.79	1.5	1	2	168	1.97	.82	2	1	3	147
Easy to find your way around the park	1.48	.64	1	1	2	172	1.46	.61	1	1	2	151
Pleasant interactions with other visitors	7.78	7.58	2	1	2	173	1.62	.63	2	1	2	151
It takes too long to get where you want to	3.03	.88	3	3	4	174	2.62	.87	3	2	3	151
You feel safe	1.37	.65	1	1	2	172	1.39	.58	1	1	2	151
You have little impact on park natural environment	2.39	.92	2	2	3	172	1.78	.79	2	1	2	149
You connect with the natural environment	1.76	.81	2	1	2	172	8.93	.81	2	2	3	150
You hear natural sounds	1.72	.87	1	1	2	173	2.52	.95	3	2	3	149
Easy access to different areas of the park	1.48	.64	2	1	3	172	2.01	.83	2	1	3	147
You hear sounds of traffic	2.36	.90	2	2	3	172	2.31	.81	2	2	3	147
Easy to get to scenic overlooks/visits	1.45	.66	1	1	2	172	2.27	.95	2	2	3	147
You experience a sense of freedom	1.39	.65	1	1	2	173	2.60	.93	3	2	3	147
You feel stressed while traveling through park	3.08	.95	3	3	4	173	3.01	.85	3	3	4	148
Trouble finding park	2.17	.92	2	1	3	171	3.42	.84	4	3	4	147

Statement	Personal Vehicle						Park Shuttle					
	Mean	S.D.	Median	25%	75%	N	Mean	S.D.	Median	25%	75%	N
You can go "where you want, when you want"	1.56	.73	1	1	2	171	2.70	.91	3	2	3	145
Conflict with visitors using other transportation	3.09	.87	3	3	4	170	3.19	.81	3	3	4	148
You avoid traffic congestion	2.47	.85	3	2	3	172	1.76	.81	2	1	2	151
You feel crowded by others	2.73	.80	3	2	3	173	2.35	.83	2	2	3	150

Table 2.47 Visitor Perceptions Concerning the Use of Personal Vehicle or Park Shuttle at Dream Lake

Statement	Personal Vehicle						Park Shuttle					
	Mean	S.D.	Median	25%	75%	N	Mean	S.D.	Median	25%	75%	N
Easy access to personal belongings	1.28	.59	1	1	1	186	2.52	.95	3	2	3	165
Opportunity to learn about the park while traveling	1.97	.83	2	1	2	185	1.96	.83	2	1	2	166
Travel is affordable/low cost	2	.78	2	1	2	180	1.33	.59	1	1	2	165
Opportunities to see wildlife	1.61	.77	1	1	2	184	2.07	.85	2	1	3	166
Easy to find your way around the park	1.5	.66	1	1	2	187	1.55	.69	1	1	2	166
Pleasant interactions with other visitors	2.02	.91	2	1	3	182	1.79	.75	2	1	2	166
It takes too long to get where you want to	3.04	.85	3	3	4	183	1.32	.59	2	2	3	165
You feel safe	1.32	.59	1	1	2	185	1.42	.59	1	1	2	165
You have little impact on park natural environment	2.33	.96	2	2	3	183	1.69	.79	2	1	2	163
You connect with the natural environment	1.82	.84	2	1	2	187	2.42	2.6	2	2	3	163

Statement	Personal Vehicle						Park Shuttle					
	Mean	S.D.	Median	25%	75%	N	Mean	S.D.	Median	25%	75%	N
You hear natural sounds	1.94	.91	2	1	3	188	2.66	.88	3	2	3	164
Easy access to different areas of the park	1.42	.59	1	1	2	186	2.18	.83	2	2	3	166
You hear sounds of traffic	2.31	.89	2	2	3	185	2.18	.79	2	2	3	163
Easy to get to scenic overlooks/visits	1.46	.66	2	2	3	183	2.34	.92	2	2	3	163
You experience a sense of freedom	1.43	.64	1	1	2	187	2.6	.87	3	2	3	165
You feel stressed while traveling through park	3.17	.89	3	3	4	186	3.07	.83	3	3	4	161
Trouble finding park	2.43	.89	2	2	3	182	3.1	.94	3	3	4	162
You can go "where you want, when you want"	1.41	.66	1	1	2	186	2.8	.88	3	2	3	162
Conflict with visitors using other transportation	3.01	.92	3	3	4	187	3.06	.81	3	3	4	161
You avoid traffic congestion	2.42	.85	2	2	3	187	1.88	.82	2	1	2	164
You feel crowded by others	2.79	.81	3	2	3	187	2.35	.81	2	2	3	165

Table 2.48 Visitor Perceptions Concerning the Use of Personal Vehicle or Park Shuttle at Emerald Lake

Statement	Personal Vehicle						Park Shuttle					
	Mean	S.D.	Median	25%	75%	N	Mean	S.D.	Median	25%	75%	N
Easy access to personal belongings	1.37	.74	3	1	2	183	2.58	.95	3	2	3	167
Opportunity to learn about the park while traveling	1.98	.87	2	1	3	181	1.99	.82	2	1	2	168
Travel is affordable/low cost	2.08	.94	2	1	3	180	1.42	.67	1	1	2	169
Opportunities to see wildlife	1.62	.71	2	1	2	178	2.02	.84	2	1	3	166
Easy to find your way around the park	1.46	.61	1	1	2	182	1.54	.66	1	1	2	169
Pleasant interactions with other visitors	2	.96	2	1	3	176	1.73	.71	2	1	2	166

Statement	Personal Vehicle						Park Shuttle					
	Mean	S.D.	Median	25%	75%	N	Mean	S.D.	Median	25%	75%	N
It takes too long to get where you want to	3.16	.79	3	3	4	181	2.45	.91	2	2	3	166
You feel safe	1.35	.62	1	1	2	181	1.49	.68	1	1	2	170
You have little impact on park natural environment	2.3	.91	2	2	3	181	1.72	.74	2	1	2	167
You connect with the natural environment	1.84	.85	2	1	2	179	2.21	.93	2	1.25	3	168
You hear natural sounds	2	1	2	1	3	179	2.63	.96	3	2	3	169
Easy access to different areas of the park	1.44	.64	1	1	2	181	2.1	.86	2	1	3	167
You hear sounds of traffic	2.45	.97	2	2	3	180	2.33	.88	2	2	3	168
Easy to get to scenic overlooks/visits	1.45	.62	1	1	2	181	2.22	.82	2	2	3	167
You experience a sense of freedom	1.37	.59	1	1	2	182	2.58	.94	3	2	3	168
You feel stressed while traveling through park	3.21	.81	3	3	4	180	3.02	.86	3	3	4	168
Trouble finding park	2.4	.94	2	2	3	182	3.35	.83	4	3	4	164
You can go "where you want, when you want"	1.38	.63	1	1	2	181	2.76	.82	3	2	3	164
Conflict with visitors using other transportation	3.1	.78	3	3	4	181	3.09	.71	3	3	4	164
You avoid traffic congestion	2.4	.84	2	2	3	182	1.9	.87	2	1	2	168
You feel crowded by others	2.73	.82	3	2	3	180	2.34	.83	2	2	3	165

Table 2.49 Visitor Perceptions Concerning the Use of Personal Vehicle or Park Shuttle at Glacier Gorge

Statement	Personal Vehicle						Park Shuttle					
	Mean	S.D.	Median	25%	75%	N	Mean	S.D.	Median	25%	75%	N
Easy access to personal belongings	1.39	.69	1	1	2	187	2.44	1.1	2	1	3	166
Opportunity to learn about the park while traveling	2.03	.89	2	1	3	182	2.01	.81	2	1	2	161
Travel is affordable/low cost	2.21	.85	2	2	3	182	1.29	.53	1	1	2	167
Opportunities to see wildlife	1.64	.71	2	1	2	179	1.64	.708	2	1	3	160
Easy to find your way around the park	1.45	.68	1	1	2	184	1.41	.64	1	1	2	163
Pleasant interactions with other visitors	2.07	1	2	1	3	177	1.69	.69	2	1	2	159
It takes too long to get where you want to	3.04	.89	3	3	4	179	2.65	.89	3	2	3	159
You feel safe	1.36	.62	1	1	2	181	1.42	.61	1	1	2	161
You have little impact on park natural environment	2.29	.93	2	2	3	182	1.64	.82	1	1	2	163
You connect with the natural environment	1.87	.89	2	1	2	180	2.25	.91	2	2	3	158
You hear natural sounds	1.87	.92	2	1	2	181	2.6	.89	3	2	3	159
Easy access to different areas of the park	1.53	.74	1	1	2	181	2.06	.82	2	1	3	160
You hear sounds of traffic	2.13	.77	2	2	3	180	2.18	.84	2	2	3	158
Easy to get to scenic overlooks/visits	1.44	.59	1	1	2	180	2.37	.88	2	2	3	158
You experience a sense of freedom	1.41	.64	1	1	2	181	2.6	.92	3	2	3	159
You feel stressed while traveling through park	3.09	.91	3	3	4	179	3.1	.91	3	3	4	156
Trouble finding park	2.21	.95	2	1	3	179	3.26	.86	3	3	4	155
You can go "where	1.48	.70	1	1	2	183	2.75	.83	3	2	3	158

Statement	Personal Vehicle						Park Shuttle					
	Mean	S.D.	Median	25%	75%	N	Mean	S.D.	Median	25%	75%	N
you want, when you want"												
Conflict with visitors using other transportation	2.89	.94	3	2	4	180	3.17	.75	3	3	4	155
You avoid traffic congestion	2.41	.86	2	2	3	180	1.83	.88	2	1	2	157
You feel crowded by others	2.79	.84	3	2	3	180	2.37	.84	2	2	3	161

2.8.2 Perceptions towards Transportation Overall

The majority of respondents, nearly 54% indicated that they drove their personal vehicles to the trailhead. 44% indicated that they took the park shuttle to their trailhead (Table 2.50).

Table 2.50 Mode of Transportation

	Percentage			
	Personal Vehicle	Shuttle Bus	Other	N
Transportation	53.5	44.3	2.2	785

Visitors were questioned concerning their attitudes towards various statements pertaining to traveling in their personal vehicle and in the park shuttle (Table 2.51). The attitudinal statements were asked for both personal vehicle and park shuttle and rated on a scale of 1 – 4 (1 = Strongly Agree to 4 = Strongly Disagree). Personal vehicles were rated slightly better with regard to having *easy access to personal belongings*, *opportunities to see wildlife*, *feeling safe*, connecting *with the natural environment*, *hearing natural sounds*, *easy access to different areas of the park*, *easy access to overlooks/vistas*, *experiencing a sense of freedom*, and *going "where you want, when you want"*. The Park Shuttle was rated slightly better with regard to *travel is affordable/low cost*, *pleasant interactions with other visitors*, *having little impact on the natural environment*, and *trouble finding parking*, and *avoiding traffic congestion*. Interestingly, slightly more respondents indicated that by traveling in the Park Shuttle, it took *too long to get where you want to go*, *you hear sounds of traffic*, *you feel stressed while traveling through the park*, you *experience conflict with visitors using other kinds of transportation*, and *you feel crowded by other visitors*.

Table 2.51 Visitor Perceptions Concerning the Use of Personal Vehicle or Park Shuttle

Statement	Personal Vehicle						Park Shuttle					
	Mean	S.D.	Median	25%	75%	N	Mean	S.D.	Median	25%	75%	N
Easy access to personal belongings	1.35	.68	1	1	2	728	2.5	.99	3	2	3	648
learn about the park while traveling	2.04	.88	2	1	3	716	2.0	.83	2	1	2	643

Statement	Personal Vehicle						Park Shuttle					
	Mean	S.D.	Median	25%	75%	N	Mean	S.D.	Median	25%	75%	N
Travel is affordable/low cost	2.1	.86	2	1	3	714	1.32	.58	1	1	2	653
Opportunities to see wildlife	1.64	.75	2	1	2	709	2.01	.83	2	1	3	638
Easy to find your way around the park	1.47	.65	1	1	2	725	1.49	.65	1	1	2	649
Pleasant interactions with other visitors	3.44	37.48	2	1	3	708	1.71	.7	2	1	2	642
It takes too long to get where you want to	3.07	.85	3	3	4	717	2.55	.91	3	2	3	641
You feel safe	1.35	.62	1	1	2	719	1.43	.62	1	1	2	647
You have little impact on park natural environment	2.33	.93	2	2	3	718	1.7	.78	2	1	2	642
You connect with the natural environment	1.82	.85	2	1	2	718	3.85	39.46	2	2	3	639
You hear natural sounds	1.88	.93	2	1	2	721	2.61	.92	3	2	3	641
Easy access to different areas of the park	1.47	.65	1	1	2	720	2.09	.84	2	1	3	640
You hear sounds of traffic	2.31	.89	2	2	3	717	2.25	.83	2	2	3	638
Easy to get to scenic overlooks/vistas	1.45	.63	1	1	2	716	2.3	.89	2	2	3	635
You experience a sense of freedom	1.4	.63	1	1	2	723	2.59	.91	3	2	3	639
You feel stressed while traveling through park	3.14	.89	3	3	4	718	3.05	.86	3	3	4	633
Trouble finding parking	2.3	.93	2	2	3	714	3.28	.88	3.5	3	4	628
You can go "where you want, when you want"	1.45	.68	1	1	2	721	2.76	.86	3	2	3	629
Conflict with visitors using other transportation	3.02	.88	3	3	4	718	3.12	.77	3	3	4	628
You avoid traffic congestion	2.42	.85	2	2	3	721	1.85	.85	2	1	2	640
You feel crowded by others	2.76	.82	3	2	3	720	2.35	.83	2	2	3	643

2.9 Summary

Visitor Demographics:

Overall, there were slightly more female respondents, (52%), than male, (48%). Most respondents, (92%), were Caucasian and from the United States. The largest amounts of visitors from a single state were from Colorado, with a total of 31% of respondents. The second largest demographic of visitors came from Texas with over 9% of respondents, while the third largest demographic came from Illinois with over 7% of respondents. Respondent age varied slightly depending upon the trail site, but overall, the average age of most respondents was 46. Most respondents were highly educated, with nearly 40% having completed a masters or doctoral degree, while 74% of respondents had completed some sort of college degree.

On average, the respondents had visited the Park nearly 39 times, and were somewhat familiar with the area. The majority, (71%), of visitors to the Bear Lake corridor began their hikes at Bear Lake. Additionally, 40% began their hike between 8am and 10am. Another timeframe, 10am to noon, was also a frequent time of use as 33% of respondents indicated beginning their hike during this time. The most heavily visited areas were Alberta Falls, Dream Lake and Nymph Lake.

Perceived Crowding:

Perhaps most importantly, park managers should be aware of the perceived levels of crowding indicated by respondents. This study evaluated perceived crowding using several indicators. First, respondents were asked to look at a series of five photos that demonstrated popular areas in the Bear Lake corridor. Each photo sequentially increased the amount of visitors seen in the immediate view shed. The visitors were given these photos sequentially and were asked to indicate how many other people they could encounter without feeling too crowded. Respondents were asked to rate their acceptability for each photo based upon a scale, -4 indicating very unacceptable to 4 indicating very acceptable. As respondents were shown the photos sequentially, acceptability ratings decreased. As mean scores indicate, when respondents saw photo 3, (mean equals approximately -.2), their acceptability concerning the amount of people in the photos decreased below the acceptable level.

Additionally, respondents were asked to indicate which photo looked like the scenario which they experienced in the park during their visit. The largest percentage, (47%), reported that photo 2 most resembled their experience. Interestingly, as seen in photo 2 was also rated as a mean = 2, which indicated that the number experienced in the photo was acceptable. However, 36% of respondents indicated that their experience in the park was most like photo 3, which fell below the level of acceptability with a mean below 0, or unacceptable. Interestingly, 9% felt like they experienced photo 4 and 5% felt like they experienced photo 5, both of which were rated as unacceptable. Results indicate that nearly 51% of respondents felt that they experienced levels of crowding similar to photo 3, 4 or 5. When paired with the results from Table 36, it is apparent that over half of the respondents experienced levels of crowding beyond their level of acceptability.

Respondents were also asked to indicate the photo that represented the amount of people they would prefer to see. Nearly 45% of respondents indicated that they would prefer to see approximately no other people, as seen in photo 1, while 47% of respondents stated that they would prefer to see approximately 7 people, as seen in photo 2. These two groups equate to 91% of respondents.

Finally, level of perceived crowding was addressed by asking respondents specifically how crowded they felt during their visit. Overall analysis indicates that only 22% of respondents were *not at all crowded*, while 78% of respondents indicated experiencing some level of crowding during their visit.

Problems Visitors Experienced:

Interestingly, over 60% of respondents indicated that they had a problem with the number of people they experienced on the trail. Similarly 43% indicated having a problem with sounds from large groups of people, while 36% indicated having a problem with sounds from other people. 38% indicated that they had a problem with the lack of parking at the trailhead, and nearly 31% stated that they had a problem with the lack of informational signs about natural and cultural history, while 31% had a problem with off-trail trampling.

Personal Vehicle and Park Shuttle:

Overall, approximately 54% of respondents arrived to the study sites by personal vehicle, and slightly more than 44% by Park Shuttle Bus. Respondent attitudes toward traveling in their personal vehicle and in the park shuttle varied. However, overall personal vehicles were rated slightly better with regard to having easy access to personal belongings, opportunities to see wildlife, feeling safe, being able to connect with the natural environment, hearing natural sounds, easily accessing areas of the park and experiencing an overall sense of freedom. The Park Shuttle was rated slightly better with regard to travel being affordable or of low cost, experiencing pleasant interactions with other visitors, having little impact on the natural environment, and avoiding traffic and parking concerns. However, slightly more respondents indicated that by traveling in the Park Shuttle, it took too long to get where they wanted to go, they more frequently heard sounds of traffic, felt stressed while traveling, experienced conflict with visitors using other kinds of transportation, and felt crowded by other visitors.

2.10 Literature Cited

Heywood, J. L. (1996). Social regularities in outdoor recreation. *Leisure Sciences, 18*(1), 23-37.

Hof, M., & Lime, D. (1998). Visitor Experience and Resource Protection Framework in the National Park System: Rational, Current Status, and Future Direction. *Proceedings- Limits of Acceptable Change and related planning processes: progress and future direction;* 1997 May 20-22; Missoula MT. Gen. Tech. Rep. INT-GTR-371. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Inglis, G. J., Johnson, V. I., & Ponte, F. (1999). Crowding norms in marine settings: A case study of snorkeling on the Great Barrier Reef. *Environmental Management, 24*(3), 369-381.

Lawson, S. R., Manning, R. E., Valliere, W. A., & Wang, B. (2003). Proactive monitoring and adaptive management of social carrying capacity in Arches National Park: An application of computer simulation modeling. *Journal of Environmental Management, 68*(3), 305-313.

Manning, R. E., & Lawson, S. R. (2002). Carrying capacity as "informed judgment": The values of science and the science of values. *Environmental Management, 30*(2), 157-168.

Manning, R. E., Lime, D. W., Freimund, W. A., & Pitt, D. G. (1996). Crowding norms at frontcountry sites: A visual approach to setting standards of quality. *Leisure Sciences, 18*(1), 39-59.

Manning, R. E., Valliere, W., Wang, B., Lawson, S., & Newman, P. (2003b). Estimating Day Use Social Carrying Capacity in Yosemite National Park. *Leisure, 27*(1-2), 77-102.

Manning, R., Lawson, S., Newman, P., Budruk, M., Valliere, W., Laven, D., et al. (2004). Visitor Perceptions of Recreation-related Resource Impacts. In R. Buckley (Ed.), *Environmental Impacts of Ecotourism* (pp. 261-273). Griffith University, Australia: CABI Publishing.

Manning, R., Lawson, S., Newman, P., Laven, D., & Valliere, W. (2002). Methodological issues in measuring crowding-related norms in outdoor recreation. *Leisure Sciences, 24*(3-4), 339-348.

Manning, R., Valliere, W., & Wang, B. (1999). Crowding Norms: Alternative Measurement Approaches. *Leisure Sciences, 21*(2), 97-115.

McDonald, C. D. (1996). Normative perspectives on outdoor recreation behavior: Introductory comments. *Leisure Sciences, 18*(1), 1-6.

National Park Service. (2000). *Management Policies 2001.* Washington, D.C. National Park Service.

National Park Service. (2000a). *Director's Order no. 47: Soundscape Preservation and Noise Management.* Washington, D.C., National Park Service.

Newman, P., Manning, R., Dennis, D., & McKonly, W. (in press). Informing Capacity Decision Making in Yosemite National Park, USA Using Stated Choice Modeling. *Journal of Park & Recreation Administration.*

Nilsen, P., & Tayler, G. (1998). A Comparative Analysis of Protected Area Planning and Management Frameworks. *Proceedings- Limits of Acceptable Change and related planning processes: progress and future direction;* 1997 May 20-22; Missoula MT. Gen. Tech. Rep. INT-GTR-371. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Shelby, B., Vaske, J. J., & Donnelly, M. P. (1996). Norms, standards, and natural resources. *Leisure Sciences, 18*(2), 103-123.

Vaske, J. J., & Donnelly, M. P. (2002). Generalizing the encounter - norm - crowding relationship. *Leisure Sciences, 24*(3-4), 255-269.

Wang, B., & Manning, R. E. (1999). Computer simulation modeling for recreation management: A study on carriage road use in Acadia National Park, Maine, USA. *Environmental Management, 23*(2), 193-203.

Chapter 3: Assessment of Visitor Perceptions of Resource Impacts

3.1 Introduction

Visitor Perceptions

Recreation research suggests that visitors may have thresholds of acceptability in relation to perceived recreation impacts (Hammitt & Cole 1998). Perceived impacts have the potential to affect the quality of visitor experiences. Perception studies have examined how visitors believe impacts influence the attributes, such as solitude or scenic appeal, of the setting in which they are recreating. Perceptions may also examine whether or not visitors view recreation impacts as desirable (Leung and Marion 2000).

Two lines of thought have emerged about visitor perceptions of recreation impacts. One line of thinking is that visitors do perceive recreation impacts, they form judgments about these impacts, and their experience is affected by impacts (Lynn & Brown 2003, Roggenbuck et al. 1993). The second line of thought is that visitor experiences are not significantly affected by impacts, with the exception of impacts resulting from obvious inappropriate behavior such as litter and vandalism (White et al. 2001). White and colleagues (2008) have suggested that the divergent findings in the perceptions research may be contributed to methodological differences between recent studies.

Studies of visitor perceptions have provided support for both lines of thought concerning visitor perceptions of recreation impacts. The methodological differences have made comparisons across perceptions studies difficult. Monz (2009) was successful in showing that the stratification of resource impacts by type and location can provide detailed indications of the types of impacts climbers perceived. Although some visitor perceptions research has shown that visitors do in fact perceive certain recreation impacts and do make value judgments about them, few studies have been successful in finding factors which influence visitor perceptions. White et al. (2008) were able to demonstrate that experience use history did influence visitor perceptions. However, in other studies, experience was shown to have no significant influence on visitor perceptions of impacts (Lynn & Brown 2003; Monz 2009).

Recent research examining the attitudes of visitors towards naturally occurring disturbances in parks and protected areas has taken a slightly different methodological approach to examining visitor perceptions (Kaczensky et al. 2004; Muller et al. 2009). Such studies have explored the influence of independent variables such as subjective knowledge of the topic, national park affinity, and experience use history (Hammitt et al. 2004; Muller et al. 2009). In conservation research, perceptions and attitudes are often evaluated using scales which measure the degree to which visitors agree or disagree with statements related to impacts (Kaczensky et al. 2009; Muller et al. 2009). The scales which have been used in recreation research, ranking the magnitude of the problem or the level of offensiveness, may imply that visitors should be viewing recreation impacts as problematic or as offensive. The application of attitudinal statement scales in visitor perceptions of recreation impacts may provide a better reflection of visitor perceptions by eliminating this bias. Visitor perceptions research can provide an understanding of the types of impacts that visitors find acceptable and unacceptable; these results can highlight potential management problems and provide background for management decisions.

Normative Theory and Visitor Standards

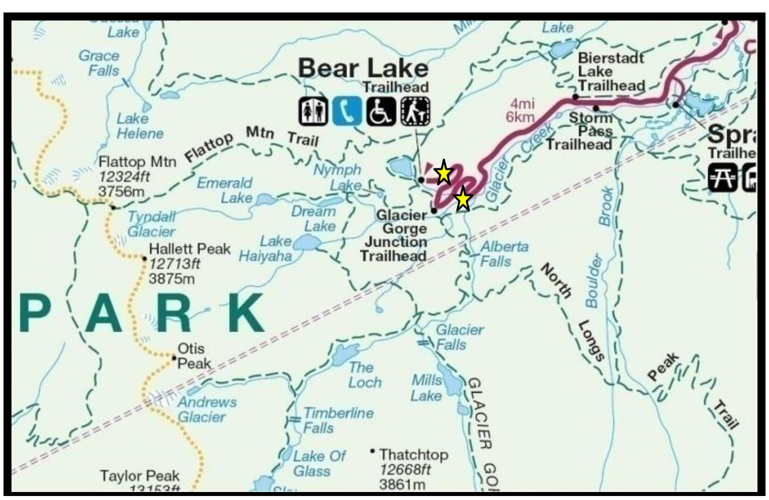
Normative theory was developed in the fields of sociology and socio-psychology; however, recently norm theory has been applied to recreational settings (Manning 1999). Norms can be evaluated at an individual level or a social level. In general, managers of parks and protected areas are most concerned about the social norms for their user group (Manning 2007). Social norms for a particular condition or issue are often measured for individuals and then the results are aggregated for members of the user group. The result is what is known as a social norm curve (Manning 2007). The resulting social norm curve provides a variety of information valuable to managers. The top of the curve represents the optimal preferred condition by the user group (Manning 1999). Each social norm curve contains a neutral line, conditions below this line are considered unacceptable to the user group. The point at which the social norm curve intersects the neutral line is the minimum acceptable condition. Points which are above the neutral line are considered within the range of acceptable conditions (Manning 1997). Overall, the methodologies used to assess social norms and the resulting curve can provide managers with information related to visitor standards; informing managers about what conditions visitors find acceptable in a recreation experience.

This study investigated visitor perceptions of recreation resource impacts of day use visitors to the Bear Lake Road Corridor in Rocky Mountain National Park, CO. Due to the elimination of parking constraints to visitor use along Bear Lake Road Corridor through the implementation of a shuttle bus system, the Bear Lake Road Corridor trail system has seen increased visitor use levels, especially day use. Increased day use can lead to increases in associated experiential and resource impacts. Specifically this study explores the relationship between day use visitor characteristics and day use visitor perceptions of specific resource impacts in the Bear Lake Corridor and examines how visitor perceptions of resource impacts influence day use visitors' experiences at the Bear Lake Corridor. Additionally the study uses visual survey methods to examine visitor standards for specific recreation resource impacts; vegetation cover loss and the proliferation of visitor created trails. The results of this study are intended to highlight the recreation resource impacts that visitors are perceiving and how these impacts influence the visitor experience to better manage for quality visitor experiences along the Bear Lake Corridor.

3.2 Study Site

The purpose of this study is to investigate visitor perceptions of recreation resource impacts in the Bear Lake Road Corridor. Two popular trails within the Bear Lake Road Corridor were selected for data collection using a self-administered visitor survey; the Bear Lake trailhead and the Glacier Gorge trailhead (Figure 3.1). Both trailheads are serviced by the Bear Lake Road shuttle bus and provide access to the majority of the Bear Lake Corridor trail system. The Bear Lake trailhead provides access to popular hiking destinations such as Bear Lake, Emerald Lake, and Lake Hiayaha. The Glacier Gorge trailhead provides access to Alberta Falls, Mills Lake, and Sky Pond. Visitors were approached for participation in the study as they exited the Bear Lake or Glacier Gorge trailheads. At Glacier Gorge a survey station was set up approximately halfway between the trailhead and the first bridge along the designated trail. At the Bear Lake trailhead a survey station was set up behind the visitor interpretive sign at the junction of the Bear Lake trail, Dream Lake trail, and the connector trail to Glacier Gorge.

Figure 3.1 Study area with sampled trailheads, Bear Lake and Glacier Gorge, marked with stars.



3.3 Data Collection

In order to collect data about visitor perceptions of recreation resource impacts and establish visitor standards for specific resource impacts, visitor surveys were administered during July and August of the summer of 2009 in the Bear Lake Road Corridor at the Bear Lake trailhead and the Glacier Gorge Trailhead. The survey was designed by researchers at Utah State University with assistance from colleagues at Colorado State University and Rocky Mountain National Park. The survey was reviewed and approved by Rocky Mountain National Park and the Utah State University Internal Review Board. (see Appendix D for a copy of the survey instrument used at both trailheads and Appendix E for copies of the photographs used for the visual survey techniques).

Each trailhead was sampled for eight days and, in order to collect a representative sample, sampling days were stratified by week days and weekend days as well as morning and afternoon sampling time periods (Table 3.1 and Table 3.2). Morning sampling occurred between approximately 8:30am – 1:30pm while afternoon sampling occurred between approximately 1:30pm and 6:30pm. Sampling continued until a daily quota of 25 surveys was collected. Sampling only occurred at one trailhead per sampling period. Visitors were intercepted at random time within a 10 minute interval; intervals were spaced evenly over an hour for an even distribution of surveys through the overall sampling period. Visitors were intercepted at the completion of their hike and asked to voluntarily participate in the study.

Table 3.1 Sampling effort at the Bear Lake trailhead.

Date	Day of the Week	Time of Day	Solicited	Accept	Reject	Unusable
7.16.2009	Thursday	am	50	26	22	2
7.17.2009	Friday	pm	53	26	24	3
7.22.2009	Wednesday	am	46	26	20	0
7.23.2009	Thursday	pm	42	26	16	0
7.26.2009	Sunday	pm	34	25	5	4
7.29.2009	Wednesday	am	35	26	8	1
8.01.2009	Saturday	am	46	26	18	2
8.03.2009	Monday	pm	45	26	18	1
Total			351	207	131	13

Table 3.2 Sampling effort at the Glacier Gorge trailhead.

Date	Day of the Week	Time of Day	Solicited	Accept	Reject	Unusable
7.21.2009	Tuesday	am	47	25	22	0
7.25.2009	Saturday	pm	34	25	9	0
7.27.2009	Monday	am	35	26	9	0
7.28.2009	Tuesday	pm	39	26	13	0
7.31.2009	Friday	am	39	25	13	1
8.02.2009	Sunday	am	54	25	28	1
8.05.2009	Wednesday	am	36	25	10	1
8.06.2009	Thursday	am	39	24	13	2
Total			323	201	117	5

Survey logs were used each sampling period to track response rate and the total number of surveys completed during the sampling period. For each visitor approached for participation, the survey identification number, time of day, whether the visitor accepted or refused to participate in the survey, and any additional comments were recorded (see Appendix C for a copy of the survey log form). The response rates were similar at both trailheads with an overall response rate of 60% (Table 3.3).

Table 3.3 Survey response rate at Bear Lake and Glacier Gorge trailheads.

Sampling Location	Acceptance Rate	Refusal Rate
Bear Lake	62%	38%
Glacier Gorge	59%	41%
Overall	60%	40%

The survey instrument collected data on various user characteristics which could potentially influence visitor perceptions of recreation resource impacts (see Appendix D). Experience used history was measured by asking visitors to report the total number of visits that they have made to Rocky Mountain National Park, the Bear Lake Road Corridor, and to their primary hiking destination (Hammitt et al. 2004; White et al. 2008). National park affinity (Muller et al. 2009) was measured on a five point Likert-scale of the importance of Rocky Mountain National Park to the visitor. Visitors were also asked to self-rate their knowledge of the natural history and management issues of Rocky Mountain National Park as a measure of local ecological knowledge. Knowledge of low impact practices was measured using multiple choice questions formulated from the frontcountry principles of Leave No Trace. In order to measure visitor perceptions of recreation resource impacts visitors responded to attitudinal statements related to specific types of impacts on a five point Likert-scale (1=strongly disagree, 5 = strongly agree). The recreation resource impacts examined in this study were: erosion, trampled vegetation, visitor created trails, off trail use, tree damage, and solitude/degree of crowding. Visitors answered questions regarding the impact of recreation resource conditions on their overall experience and whether or not they felt that certain recreation resource impacts were a problem in Rocky Mountain National Park. Finally, visual research methods were utilized in order to establish standards for vegetation cover at visitor sites as well as standards for the proliferation of visitor created trails. The degree of vegetation cover and density of visitor created trails used in the photographs was set using condition classes and observations from a recreation ecology study performed by Utah State University during the summer of 2008 to reflect actual conditions visitors would experience in the Bear Lake Road Corridor. Visitors were asked to rate the photos on a nine-point scale from -4 (very unacceptable) to 4 (very acceptable).

3.4 Data Analysis Section

Frequencies and means of responses were calculated using SPSS version 18 for all variables.

3.5 Summary of Findings

3.5.1 Socio-demographic Profile

During the sampling period 408 usable surveys were collected. The socio-demographic profile of respondents is presented in Table 3.4. The average age of respondents was 47 years of age and males comprised 52% of the participants. The majority of respondents had a college degree with 35.6% of the participants having an advanced degree and 32.4% having a Bachelor’s degree.

Table 3.4 Socio-demographic profile of respondents.

Respondent Characteristic	**Frequency (%)**
Education Level	
High school or GED	6.6
Some college	12.8
College (BS Level)	32.4
Some graduate school	12.5
Advanced degree	35.6
Gender	
Male	52.5
Female	47.5

3.5.2 Experience Use History, National Park Affinity, Local Ecological Knowledge, and Knowledge of Leave No Trace

On average visitors had been to Rocky Mountain National Park 37.75 times with 32.3% visiting the park for the first time and 28% of the visitors having visited the park 10 or more times (Table 3.5). For 45.9% of visitors it was their first visitor to the Bear Lake Corridor with 21.9% having visited 10 times or more; the average number of reported visits to Bear Lake Corridor was 17.82. Over half, 68.9%, of the participants were visiting their primary hiking destination for the first time with the average number of previous visits to their primary hiking destination being 7.21. All survey respondents felt that Rocky Mountain National Park was important or highly important to them with the highest percentage, 70%, rating the park as highly important (Table 3.6).

Table 3.5 Experience Use History response frequencies

	Frequency (%)				
Experience Use History	1st Visit	2nd Visit	3 - 10 visits	>10 visits	Mean +/- SE
Total number of visits to Rocky Mountain NP	32	16	24	28	37.75 +/- 7.75
Total number of visits to Bear Lake Corridor	46	11	21	22	17.82 +/- 2.21
Total number of visits to primary hiking destination	69	7	17	7	7.21 +/- 2.29

Table 3.6 National Park Affinity response frequencies

	Frequency (%)			
	Unimportant	Important	Highly Important	Mean +/- SE
National Park Affinity	0	30	70	4.56 +/- 0.036

Visitor knowledge of natural history topics (wildlife, plant life, insects, water, geology, and alpine ecology) as they relate to Rocky Mountain National Park was self-rated by participates (Table 3.7). Visitors were most knowledgeable about wildlife and plant life. Visitors indicated that they had some knowledge about water, geology, and alpine ecology but were least knowledgeable about insects. Visitors also self-ranked how informed they were of management topics or issues in Rocky Mountain National Park; elk management, vegetation management, fire management, air quality issues, water quality issues, mountain pine beetle, and non-native species (Table 3.7). Visitors were most informed about mountain pine beetle. Management topics and issues that visitors were somewhat informed of included elk management, vegetation management, and fire management. Visitors were least informed about air quality issues, water quality issues, and non-native species.

Table 3.7 Frequencies of responses related to self-rated local ecological knowledge.

	Frequencies (%)			
	No Knowledge	Some Knowledge	Proficient Knowledge	Mean +/- SE
Knowledge of Natural History				
Wildlife	10	75	15	2.06 +/- 0.025
Plant life	22	71	7	1.85 +/- 0.26
Insects	39	57	4	1.64 +/- 0.027
Water	24	65	11	1.88 +/- 0.029
Geology	24	66	10	1.85 +/- 0.28
Alpine ecology	29	63	8	1.78 +/- 0.28
Knowledge of Management Issues				
Elk management	58	30	12	1.53 +/- 0.034
Vegetation management	54	39	7	1.53 +/- 0.031
Fire management	42	47	11	1.69 +/- 0.033
Air quality issues	52	40	8	1.56 +/- 0.032
Water quality issues	51	40	9	1.59 +/- 0.033
Mountain pine beetle	31	50	19	1.88 +/- 0.035
Non-native species	66	29	5	1.39 +/- 0.029

Visitors were quizzed on their knowledge of Leave No Trace practices for frontcountry settings (Table 3.8). Slightly more than half of all visitors answered all Leave No Trace questions correctly and 40% missed only one question. The question that visitors most often answered incorrectly was related to low impact practices when resting during a hike. Almost all visitors answered the questions relating to picking wildflowers, frontcountry campfires, interacting with wildlife, and trail etiquette correctly. About 5% of visitors answered the questions related to the following topics incorrectly; trip preparation, staying on the designated trail, and disposal of trash (Table 3.9).

Table 3.8 Frequencies of total questions answered correctly for knowledge of Leave No Trace practices.

	Frequency (%)						
Number answered Correctly	1	2	3	4	5	6	7
Leave No Trace Total Score	0	0	0	1	7	40	52

Table 3.9 Frequencies of correct and incorrect answer by Leave No Trace practice

	Frequency (%)	
	Correct	Incorrect
Leave No Trace Questions		
Trip preparation	95	5
Stay on designated trail	96	4
Disposal of trash	95	5
Leave what you find	99	1
Frontcountry campfires	99	1
Interacting with wildlife	99	1
Trail etiquette	57	43

3.5.3 Visitor Perceptions of Recreation Resource Impacts

Attitudinal statements were used to gauge visitor perceptions of recreation resource impacts. The impacts examined were erosion, trampled vegetation, visitor-created trails, off trail use, tree damage, and solitude/degree of crowding. Statements were framed around whether visitors noticed, expected to see, and were affected by the specific recreation resource impact. Statements were also stratified by perceptions during the visitor's hike and while the visitor was at their primary hiking destination.

Overall, visitors seemed to be less perceptive of almost all resource impacts, with the exception of solitude, at their primary hiking destination than while hiking. The percentage of visitors in agreement with the attitudinal statements was less for when visitors were at their primary hiking destination than while hiking (Table 3.10 and Table 3.11). While hiking, the most noticed recreation resource impacts were visitor created trails, off trail use, and tree damage. The same impacts were also the most noticed impacts at the visitor's primary hiking destination. Both while hiking and at their primary hiking destination, visitors were less aware of erosion, trampled vegetation, and a lack of solitude. While hiking, visitors expected to experience visitor created trails, off trail use, a lack of solitude, and tree damage; erosion and trampled vegetation were the least expected types of impacts. At their primary hiking destination visitors most expected to experience a lack of solitude. At their primary hiking destination, less than half of the respondents expected to experience erosion, trampled vegetation, visitor created trails, off trail use, or tree damage. Both while hiking and while at their primary hiking destination, visitors were most affected by tree damage and crowding. Visitors were least affected by erosion, trampled vegetation, visitor created trails, and off trial use.

Table 3.10 Frequencies of responses to attitudinal statements related to impacts perceived while hiking

Perceptions while hiking	Frequency (%) Strongly Disagree/Disagree	Neutral	Strongly Agree/Agree	Mean +/- SE
Perceptions of erosion				
Noticed erosion	37	20	43	3.00 +/- 0.060
Expected to see erosion	31	26	43	3.09 +/- 0.060
Affected by erosion	55	31	14	2.36 +/- 0.056
Perceptions of trampled vegetation				
Noticed trampled vegetation	38	17	45	3.00 +/-0.061
Expected to see trampled vegetation	41	23	36	2.89 +/- 0.060
Affected by trampled vegetation	48	28	24	2.57 +/- 0.058
Perceptions of visitor created trails				
Noticed visitor created trails	19	9	72	3.70 +/- 0.056
Expected to see visitor created trails	26	22	52	3.28 +/- 0.062
Affected by visitor created trails	38	31	31	2.81 +/- 0.060
Perceptions of off trail use				
Noticed off trail use	35	12	53	3.22 +/- 0.066
Expected to see off trail use	29	21	50	3.21 +/- 0.062
Affected by off trail use	46	27	27	2.68 +/- 0.062
Perceptions of tree damage				
Noticed tree damage	21	9	70	3.76 +/- 0.062
Expected to see tree damage	28	21	51	3.31 +/- 0.063
Affected by tree damage	30	22	48	3.25 +/- 0.067
Perceptions of solitude				
Experience solitude	42	14	44	3.04 +/- 0.068
Expected to experience solitude	34	16	50	3.25 +/- 0.064
Affected by crowding	30	25	45	3.17 +/- 0.058

Table 3.11 Frequencies of responses to attitudinal statements related to impacts perceived while at primary hiking destination

Perceptions at primary hiking destination	Frequency (%) Strongly Disagree/Disagree	Neutral	Strongly agree/agree	Mean +/- SE
Perceptions of erosion				
Noticed erosion	47	23	30	2.90 +/- 0.060
Expected to see erosion	35	31	34	2.90 +/- 0.060
Affected by erosion	55	32	13	2.30 +/- 0.055
Perceptions of trampled vegetation				
Noticed trampled vegetation	43	20	37	2.85 +/- 0.060
Expected to see trampled vegetation	40	30	30	2.81 +/- 0.058
Affected by trampled vegetation	48	31	21	2.52 +/- 0.058
Perceptions of visitor created trails				
Noticed visitor created trails	23	17	60	3.46 +/- 0.060
Expected to see visitor created trails	29	25	46	3.16 +/- 0.061
Affected by visitor created trails	39	32	29	2.77 +/- 0.058
Perceptions of off trail use				
Noticed off trail use	34	16	50	3.20 +/- 0.067
Expected to see off trail use	30	23	47	3.18 +/- 0.062
Affected by off trail use	46	31	23	2.65 +/- 0.061
Perceptions of tree damage				
Noticed tree damage	30	13	57	3.43 +/- 0.069
Expected to see tree damage	32	22	46	3.16 +/- 0.065
Affected by tree damage	35	26	39	3.06 +/- 0.067
Perceptions of solitude				
Experience solitude	41	15	44	3.04 +/- 0.070
Expected to experience solitude	31	16	53	3.31 +/- 0.064
Affected by crowding	33	27	40	3.04 +/- 0.060

3.5.4 *Effect of Recreation Resource Impacts on Visitor Experience*

Visitors were asked whether the specific recreation resource impacts examined in this study detracted from their experience, added to their experience, or had no effect on their experience in the Bear Lake Road Corridor of Rocky Mountain National Park (Table 3.12). The majority of visitors felt that eroded trails, trampled vegetation, visitor created trails, and off trail use did not effect this visitor experience. For tree damage, approximately half of the visitors reported it having no effect on their experience and slightly less than half, 45%, reporting that tree damage detracted from their experience. The degree of crowding experience was reported by 60% of participants as detracting from their experience.

Table 3.12 Frequencies of responses to the effect of resource impacts on visitor experience

	Frequency (%)			
Effect on Experience	Detracted	No effect	Added	Mean +/- SE
Resource Conditions				
Eroded trails	19	78	3	1.84 +/- 0.022
Trampled vegetation	36	63	1	1.65 +/- 0.025
Visitor created trails	34	57	9	1.75 +/- 0.030
Off trail use	36	63	1	1.66 +/- 0.025
Tree damage	45	51	4	1.59 +/- 0.028
Degree of crowding	60	38	2	1.41 +/- 0.026

3.5.5 Perceptions of Recreation Resource Problems

Visitors were asked to rate whether or not they agreed or disagreed with statements saying that specific recreation resource impacts were problems in Rocky Mountain National Park (Table 3.13). In general, visitors felt that erosion was not a problem or reported a response of 'neutral'. For trampled vegetation, the proliferation of visitor created trails, and people hiking off trail responses were almost evenly split between disagreeing that these impacts are a problem, reported neutral, or agreeing that these impacts are a problem. Half of the visitors felt that tree damage was a problem in Rocky Mountain National Park with the other half of responses being split between disagreeing and neutral. Approximately 45% of visitors felt that the lack of opportunities for solitude was a problem in Rocky Mountain National Park with the remaining responses being split between disagreement and neutrality.

Table 3.13 Frequencies of responses to questions asking if specific resource impacts were a problem in Rocky Mountain National Park

	Frequency (%)			
	Strongly Disagree/Disagree	Neutral	Strongly agree/agree	Mean +/- SE
Problem				
Erosion of trails	38	37	25	2.85 +/- 0.047
Trampling of vegetation	36	34	30	2.91 +/- 0.048
Proliferation of visitor created trails	33	32	35	3.02 +/- 0.050
People hiking off trail	33	31	36	3.04 +/- 0.051
Tree damage	24	25	51	3.45 +/- 0.057
Lack of opportunities of solitude	28	27	45	3.25 +/- 0.055

3.5.6 Visitor Standards

Visual survey methods were used to determine visitor standards for vegetation loss on visitor created sites and the proliferation of visitor created trails (Table 3.14 and Table 3.15). Results indicated that for both vegetation cover and the proliferation of visitor created trails, increasing levels of impacts are found to be increasing unacceptable. For vegetation cover, the minimum acceptable level of vegetation cover was 42%; in the photos this level of vegetation cover corresponded to 53% cover loss (Photo 3 was the first photo rated unacceptable; see Appendix E). Therefore, any vegetation loss greater than 53% is considered unacceptable to visitors to the Bear Lake Road Corridor. For the proliferation of visitor created trails, the minimum acceptable condition was 5.7% of the area in the photo being impacted by visitor created trails. Therefore, any areas in which more than 5.7% of the area is impacted by visitor created trails would be considered unacceptable by visitors to the Bear Lake Road Corridor; 5.7% of the are corresponded to approximately two, average sized visitor created trails in the photo area (Photo 2 was the first photo to be rated unacceptable; see Appendix E).

Table 3.14 Results for visual research methods for vegetation loss on visitor sites

Photo Number	Percent Vegetation Cover	Mean Rating	Percent Veg Loss	Agreement	SD
Photo 1	88	3.45	0%	0.86	1.08
Photo 2	62	0.89	30%	0.21	2.37
Photo 3	38	-0.18	57%	0.17	2.31
Photo 4	22	-1.43	75%	0.36	2.26
Photo 5	10	-2.6	89%	0.64	2.02

Table 3.15 Results for visitor research methods for proliferation of visitor created trails

Photo Number	Percent Area Impacted	Mean Rating	Number of Trails in Photo	Agreement	SD
Photo 1	0	2.88	1	0.71	1.47
Photo 2	6	-0.15	2	0.21	2.23
Photo 3	10	-1.76	7	0.44	1.84
Photo 4	16	-2.84	13	0.71	1.51
Photo 5	20	-3.47	15	0.86	1.27

A measure of agreement, and standard deviation, for each photo used in the visual survey methods was calculated (Table 3.14 and Table 3.15). For both photo sets, there was high agreement (>50%) for photos 1 and 5 which showed the extreme conditions for recreation resource impacts. For the proliferation of visitor created trails photo set there was also high agreement for photo 4. As is typical with visual survey methods, agreement was lower for the middle photos where the changes from condition to condition were more subtle.

Figure 3.2 Social norm curve for percent vegetation cover on visitor sites

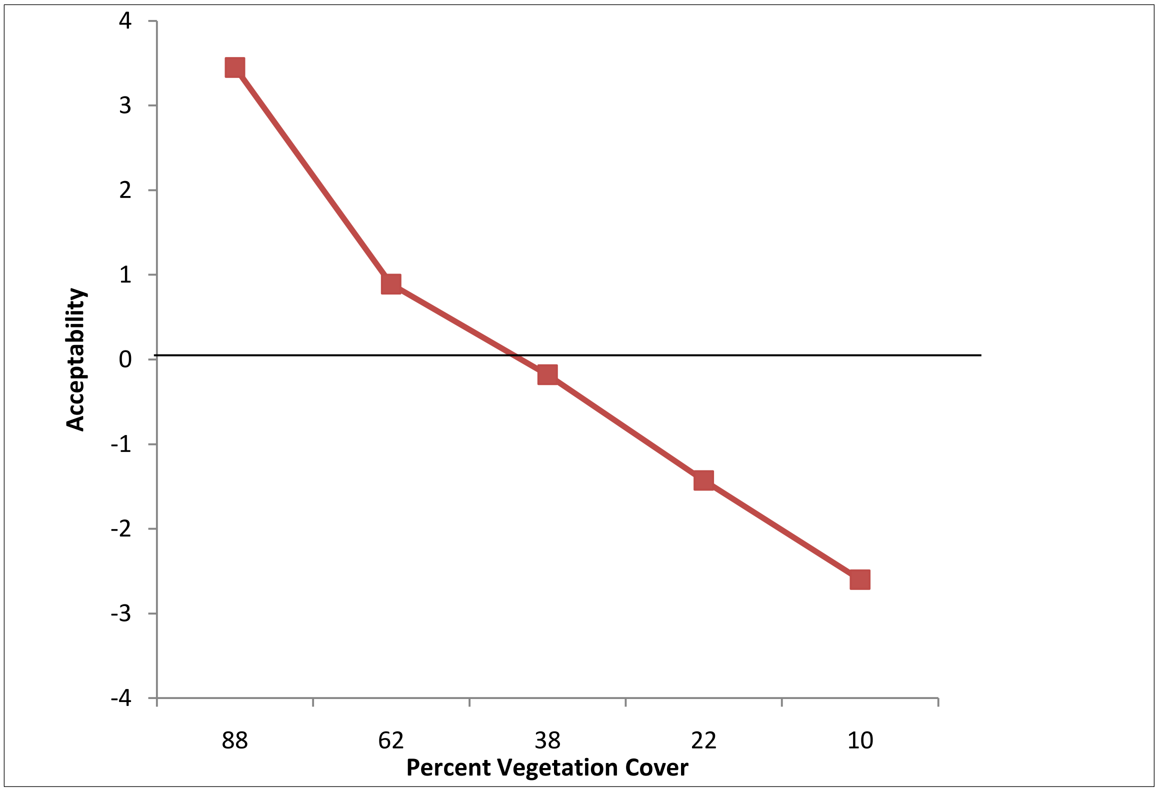
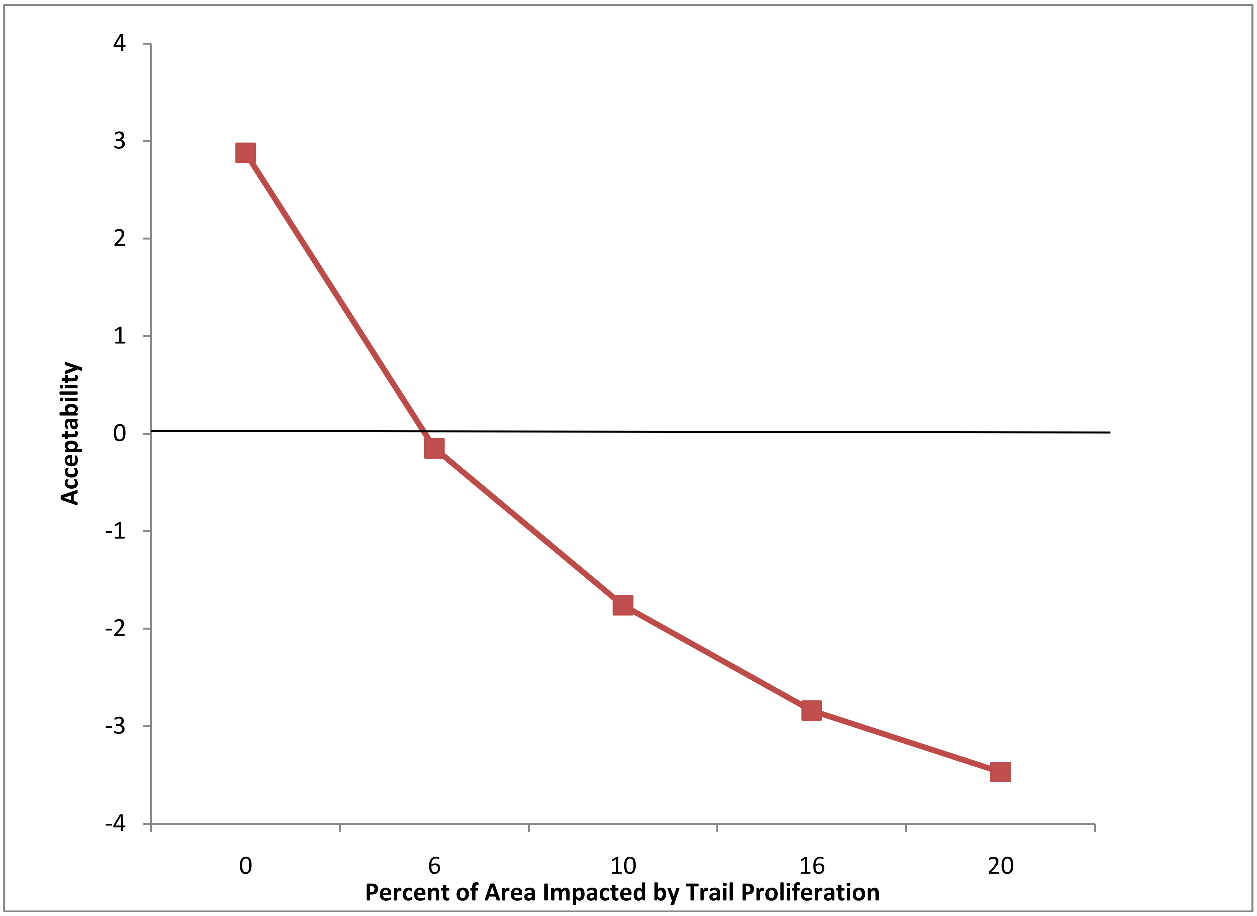


Figure 3.3: Social norm curve for proliferation of visitor created trails



3.6 References

Hammitt, W.E., & D.N. Cole. (1998). *Wildland Recreation: Ecology and Management*. New York: John Wiley & Sons.

Hammitt, W.E., Backlund, E.A, & Bixler, R.D. (2004). Experience use history, place bonding, and resource substitution of trout anglers during recreation engagements. *Journal of Leisure Research, 36*(3), 356 – 378.

Kaczensky, P., Blazic, M., & Gossow, H. (2004). Public attitude towards brown bears (Ursus arctos) in Slovenia. *Biological Conservation*, *118*, 661–674.

Leung, Y. & Marion, J.L. (2000). Recreation impact and management in wilderness: a state-of-knowledge review. In: Cole, D.N., McCool, S.F., Borrie, W.T., and O'Loughlin, J. (comps.) *Wilderness Science in a Time of Change Conference.* Vol. 5. *Wilderness Ecosystems, Threats and Management.* Proceedings RMRS-P-15-VOL-5. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, Utah, 23-48.

Lynn, N. A. & Brown, R. D. (2003). Effects of recreational use impacts on hiking experiences in natural areas. *Landscape and Urban Planning, 64*, 77-87.

Manning, R.E. (1999). Studies in Outdoor Recreation: Search and Research for Satisfaction. Corvallis OR: Oregon State University Press.

Manning, R.E. (2007). Parks and Carrying Capacity: Commons without tragedy. Washington, D.C.: Island Press.

Monz, C.A. (2009). Climbers' attitudes toward recreation resource impacts in the Adirondack Park's Giant Mountain Wilderness. *International Journal of Wilderness, 15*(1), 26 – 33.

Muller, M. & Job, H. (2009). Managing natural disturbance in protected areas: Tourists' attitude towards the bark beetle in a German national park. *Biological Conservation, 142*, 375-283.

Roggenbuck J. R., Williams, D. R., & Watson, A. E. (1993). Defining acceptable conditions in wilderness. *Environmental Management, 17*, 187-197.

White D. D., Hall, T. E. & Farrell, T. A. (2001). Influence of ecological impacts and other campsite characteristics on wilderness visitors' campsite choices. *Journal of Park and Recreation Administration*, *19*, 83-87.

White D. D, Virden, R. J. & van Riper, C. J. (2008). Effects of place identity, place dependence and experience-use history on perceptions of recreation impacts in a natural setting. *Environmental Management, 42*, 647-657.

Chapter 4: RECREATION ECOLOGY RESEARCH

4.1 Introduction

The demand for wildland recreation and nature-based tourism opportunities continues to increase in many protected areas in North America (Cordell 2008) and worldwide (De Lacy and Whitmore 2006). With this increased use has come human disturbance and change to the environmental conditions of protected areas, and an associated management effort directed at minimizing undesirable resource impact. Understanding resource condition trends through assessment and monitoring is essential for many aspects of sound adaptive management, particularly in determining the effectiveness of management actions in achieving resource protection goals.

Visitor activities in wildland areas inevitably have some consequences to environmental conditions. Even the most careful visitors to natural environments can potentially disturb soil, vegetation and wildlife. Fundamental management decisions as to the level of acceptable and appropriate disturbance to natural systems can be difficult and challenging and must be well informed.

Considerable research conducted over the last 40 years has demonstrated the relationships between visitor use and resource change. Recently, this information has been reviewed and summarized (Monz et al. 2010a) and the new discipline of *Recreation Ecology* has evolved. Several fundamental principles can be generalized from this body of literature including:

- Recreation activities can directly affect the soil, vegetation, wildlife, water and air components of ecosystems
- Other ecosystem attributes (i.e., structure, function, etc.) can be affected given the interrelationships between ecosystem components
- For a given finite space, the relationship between change and use is generally curvilinear, with the majority of change occurring with initial use
- Although some generalizations apply, resistance and resilience to visitor use disturbance is ecosystem specific
- The amount and distribution of use and visitor behavior are primary driving variables in determining the amount of resource change

Given these principles, recreation ecology studies of two types are generally performed in wildland areas in an effort to assist managers in the avoidance and mitigation of visitor impacts. *Experimental studies* (e.g., Monz 2002, Cole and Monz 2002) examine causal relationships between use type and intensity and ecosystem-specific components. These studies employ carefully controlled experimental designs and can determine the levels of visitor use a given ecosystem (or ecosystem component) can tolerate. *Monitoring and assessment* studies (e.g., Marion and Leung 1997) are perhaps more common as managers often find them to be of considerable utility. These studies assess and monitor the location and extent of visitor use and resource impacts. Conducted over the long term, these studies provide an initial assessment of the current resource conditions, the trends of how impacts are changing over time, and an evaluation of the effectiveness of management actions.

Considerable literature also exists on the management of visitor resource impacts (e.g., Hammitt and Cole 1998; Manning 1999). The development of specific, accurate monitoring indicators is considered fundamental to the management process and moreover is an essential process in various management frameworks (Manning 1999). As such, recreation ecology studies are an integral component of framework approaches adopted by most land management agencies (e.g., Limits of Acceptable Change Planning Framework). Recreation ecology studies support these frameworks by contributing sound science to the process of developing monitoring indicators and in measuring indicators over time (NPS 1997).

The goal of this component of the study was to apply a practical and efficient *monitoring and assessment* approach to study areas in Rocky Mountain (RMNP). Specifically the study had several goals. First was to establish a baseline of resource conditions in visitor use areas off of designated, hardened trails and sites. This information would allow future assessments to determine the trajectory of resource change. To accomplish this goal we assessed all locations within the study area where recreation disturbance to areas away from hardened, designated surfaces was present and mapped these locations using GPS technology. We focused on areas since in some cases, off-trail visitor use can lead to rapid and often undesirable resource changes. A second goal was to determine areas where resource change is undesirable based on an assessment of visitor standards of resource condition. We accomplished this goal by determining visitor standards of vegetation cover loss and informal trail formation via visual research methods and determining locations where standards are being approached or exceeded via GIS mapping. A final goal was to integrate visitor use determinations and modeling with recreation ecology assessments to the greatest degree possible. To accomplish this goal we examined outputs from visitor use estimates and ecologic conditions such that areas of likely future change could be determined.

4.2 Methods

4.2.1 Study Site

For the recreation ecology assessment and analysis we focused on four primary study sites within the Bear Lake Road Corridor (Figure 4.1), Glacier Gorge trail to beyond Alberta Falls; Emerald Lake trail to the terminus at the lake; Bear Lake and immediate environs; and Bierstadt Lake and environs.

Figure 4.1. Recreation Ecology Study areas within the Bear Lake Corridor

4.2.2 Resource Condition Assessment

Preliminary site visits revealed that selected areas exhibited typical disturbances found in park settings: linear and nodal areas of intensive trampling disturbance resulting from visitors hiking off formal (official) trails and sites to access climbing routes, vistas, or for exploration and other reasons. Managers reported that the proliferation of informal (visitor-created) trails is a common problem that contributes substantial trampling impact to fragile vegetation and substrates. Observations also revealed that visitation frequently resulted in the trampling of substrates and vegetation in many gathering areas and vista sites. Assessing the conditions of these informal trails and sites is particularly important in alpine and subalpine ecosystems because of their limited spatial extent, fragility, and potential for permanent and irreversible vegetation and substrate loss.

To assess conditions on informal recreation sites we primarily relied on adapting recreation ecology assessment techniques developed for formal campsites (e.g., Marion 1995). For each location, an assessment area was mapped and foot searches identified all recreation sites, defined as nodal areas of visually obvious substrate disturbance created by visitor use. The size of each site was assessed using the radial transect method (Marion 1995); a permanent reference point was recorded with a Trimble® GeoXT GPS device and Hurricane antenna, and area calculations and GIS coordinates were provided by Excel spreadsheet calculations. All GPS data were post-processed using Trimble's Pathfinder Office to obtain the highest accuracy possible. Vegetation cover and soil exposure were evaluated onsite and in adjacent undisturbed controls as the mid-point value of six cover classes (Marion 1995). Assessments of condition class, the number of trees and shrubs with damage, root exposure, number of intersecting informal trails, and assessments of litter/trash also followed Marion (1995). Condition class definitions are provided in Appendix T. Digital photos were taken to document impacts and aid in site relocation.

Assessing informal trails was more challenging in some areas because the terrain is often dominated by barren rock and informal trails are readily apparent only on soil substrates. Thus, informal trails in these environments are frequently discontinuous and short, increasing the difficulty of locating and documenting the trail fragments and evaluating their condition. While remote sensing techniques are possible, they require expensive high-resolution imagery and complex analytical processing that place this option beyond the means of most land managers. Remote sensing is also challenging in subalpine areas due to the prevalence of well-developed tree canopies.

For this study, we used a GPS based mapping and assessment procedure, as used in similar surveys such as Leung and Marion (1999) and Marion et al. (2009). We used the GeoXT GPS and careful foot-based searching within each study area to map the locations of all informal trail segments. Two informal trail condition attributes were assessed during field collection as described in Marion et al. (2009): condition class (CC) ratings on a 1-5 scale (see appendix T), and an assessment of average tread width (TW). A new informal trail segment was designated and assessed when a consistent change in condition class or width was noted in the field.

4.2.3 Intensive Groundcover Assessment- Alberta Falls and Emerald Lake

Intensive measurements were conducted at Alberta Falls and Emerald Lake due the importance of these areas from a visitor use perspective and since these areas exhibited diffuse disturbances across large areas. In these areas we employed a quadrat-based, image analysis sampling technique (Booth et al. 2005) to measure vegetation and ground cover. This procedure involved three field components: 1) identification and mapping of an area of probable recreation use; 2) creation of a stratified random-grid of sampling locations using ArcGIS 9.3 software; and 3) navigation to sample locations with the GPS and obtaining digital images of $1m^2$ quadrats for subsequent image analysis of ground cover classes.

First the area of possible recreation use was mapped using the GPS, and a polygon was uploaded to ArcGIS (ESRI, Inc., Redlands, CA USA). The extent of this polygon was determined by observable areas of visitor disturbance and by trail and geographic boundaries. Hawth's Analysis Tools extension for ArcGIS was used to create a random grid overlay on the polygon. Quadrat photos were taken at each point on the grid with a Nikon COOLPIX P50 8.1-megapixel digital camera mounted on a frame with a $1m^2$ base that positioned the camera for nadir (overhead perspective) images 1.4m above ground level. Measurements from digital images were used to quantify the relative cover of ground cover types using SamplePoint software (Booth et al. 2006). Eight groundcover classes were included in the classification of these areas including graminoids, shrubs, forbs, lichens, mosses organic soil, mineral soil, and exposed rock.

Susceptibility Modeling

For each quadrat a susceptibility to resource damage score was calculated based on the type and proportion of groundcover present. The score is a weighted index based on the relative tolerance of each groundcover type to trampling disturbance (rated 0 through 5) multiplied by the percent cover of each groundcover class. Scores for each quadrat were then used as input for a kriging procedure in ArcGis that yielded a continuous surface for each polygon based on these ratings. Scores were ranked low to high and susceptibility maps were produced (See appendix G for more details on the procedure).

4.2.4 *Integration with Social Science and Visitor Use Dimensions of this Study*

Integration with other elements of this study was accomplished in three areas. First visitor judgments as to acceptable levels of vegetation cover loss due to recreation use were used to classify all sites assessed in the study. Sites were either within standard, approaching standard or exceeding standard (See Chapter 3 this report and Appendix H). Second, visitor created trails were assessed in accord with the above classification (i.e., in, approaching or exceeding standards) in accord with the density present at the study site and visual research estimates of acceptable densities (Chapter 3, Appendix H). Last, GPS based visitor use estimation was used to determine visitor's exposure to resources in, approaching and exceeding standards as a metric of the effect of resource degradation on visitors' experience.

4.2.5 *GPS Tracking Methodology*

GPS data on visitor routes were recorded using recreation grade Garmin GPS 60 units. Visitors were randomly intercepted at each trailhead according to a sampling protocol of random days stratified by time of day and weekend and weekdays. All visitors were asked to voluntarily participate. One GPS was given to a volunteer in each group and the visitor was asked to carry the unit clipped on to the outside of their pack for the duration of their hike. The GPS unit recorded location points at 15 second intervals. The units were returned to technicians at the trailheads at the end of the visitor's trip.

To measure the inherent positional error associated with recreation grade GPS measures, calibration techniques were employed. A sub-meter Trimble GeoXT GPS unit was used to map a calibration track along the center of the designated trail at each sampled trailhead. Before each sampling day began, a randomly selected Garmin GPS 60 unit was used to record the same calibration track. Upon completion of data collection, all of the calibration tracks from Garmin GPS 60 units were compared to the high accuracy tracks assessed by the Trimble in ArcGIS software. A Euclidian distance measure was used to determine the average positional error for each Garmin 60 GPS unit track. These error measures were then averaged to determine the overall positional error estimate for the Garmin GPS 60 during the sampling period.

The dataset resulting from GPS-based tracking methodologies is a series of point data that can then be examined in a geographic information system (GIS). Each dataset contains additional attributes such as time, speed, and elevation. The tracking data can then be further analyzed to examine issues such as visitor use level, visitor densities, temporal and spatial patterns of visitors use, and visitor characteristics when combined with survey techniques.

4.3 Results

4.3.1 Characterization of Current Resource Conditions

Assessment of current resource conditions show substantive changes in resource conditions throughout the study area (Tables 4.1-4.3; Figures 4.2-4.11). Resource changes are summarized in three overall categories: nodes (sites) of limited spatial extent but exhibiting intense disturbance (Table 4.1); larger areas (polygons) of more diffuse disturbance (Table 4.2) and visitor created, informal trails (Table 4.3).

Table 4.1 Summary of small and medium sized visitor sites

Analysis Area	Map in this Document	Number of Sites	Total Area (m^2)	Mean CC[1]	Mean Area (m^2)	Mean Veg Loss (%)
Bear Lake	Fig. 4	4	13.24	3.5	3.31	88
Glacier Gorge	Fig. 2	31	368.22	3.7	11.88	88
Emerald Lake	Fig. 6	45	478.03	3.8	10.62	82
Bierstadt	Fig. 3	3	6.00	4.0	2.00	94

[1] CC= Condition class ratings on a 1-5 scale.

Table 4.2 Summary of all polygons; areas of dispersed visitor use

Analysis Area	Map in this Document	Number of Sites	Total Area (m^2)	Mean CC[1]	Mean Area (m^2)	Mean Veg Loss (%)
Bear Lake	Fig. 4	18	8064	3.4	447.99	78
Glacier Gorge	Fig. 2	10	9548	3.8	954.83	71
Emerald Lake	Fig. 6	21	17273	3.8	822.51	74
Bierstadt	Fig. 3	3	1532	3.7	510.77	92

[1] CC= Condition class ratings on a 1-5 scale.

Table 4.3 Summary of informal trails and spurs

Analysis Area	Map in this Document	Number of Segments	Total Length (km)	Mean CC	Mean Length (m)	Number of Spur Segments*	Length of Designated Trail (km)
Bear Lake	Fig. 4	47	1.09	3.3	23.24	50	1.0
Glacier Gorge	Fig. 2	316	8.46	3.0	26.78	85	3.0
Emerald Lake	Fig. 6	282	8.15	3.6	28.91	50	3.0
Bierstadt	Fig. 3	15	0.84	3.2	55.86	11	1.0

*Spur is any informal trail <5m in length. [1] CC= Condition Class on a 1-5 scale.

Figure 4.2 Current extent of visitor-created disturbance along the Glacier Gorge trail including Alberta Falls

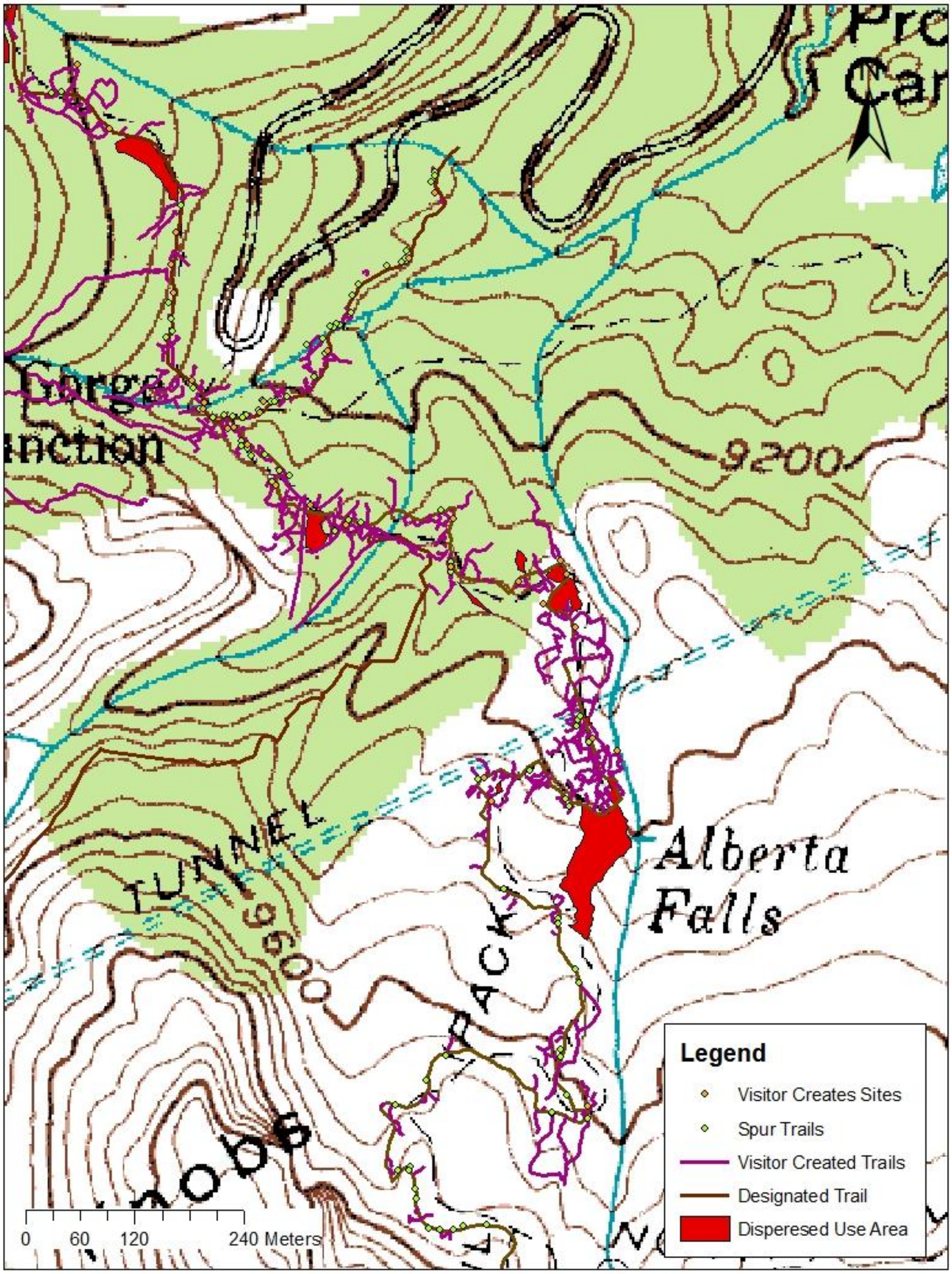


Figure 4.3 Current extent of visitor-created disturbance near Bierstadt Lake.

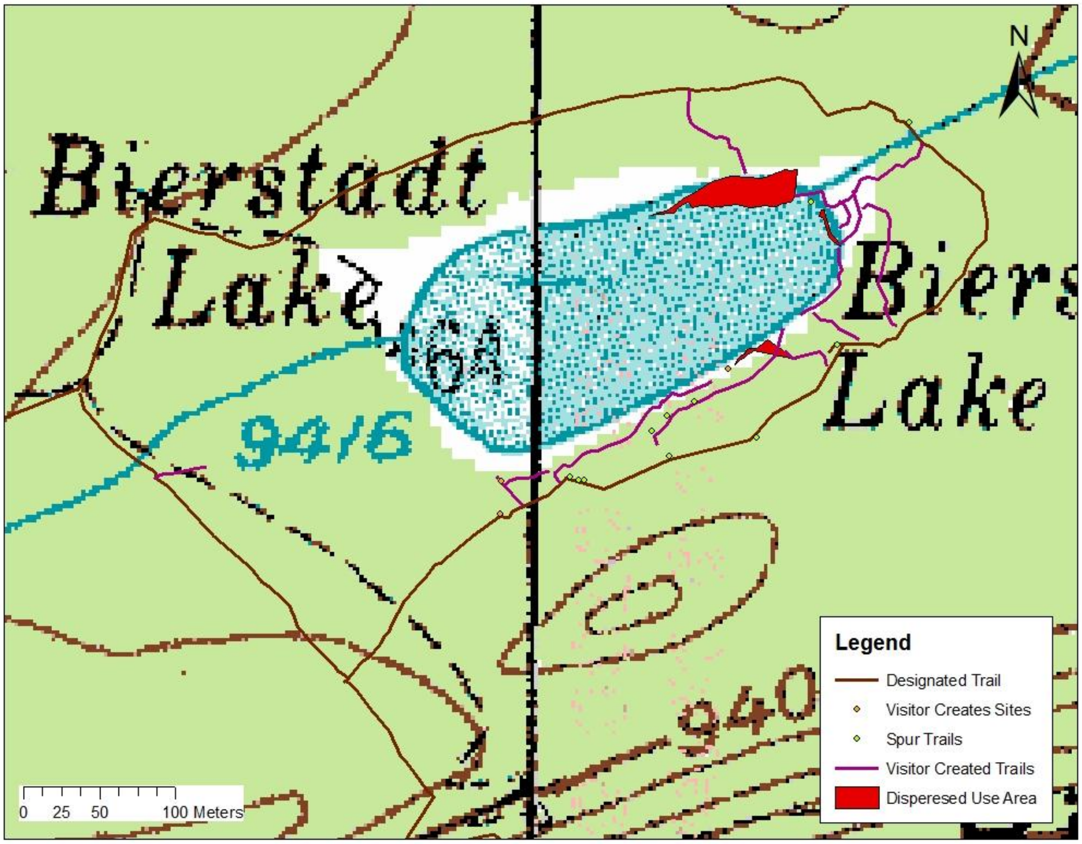


Figure 4.4 Current extent of visitor-created disturbance near Bear Lake

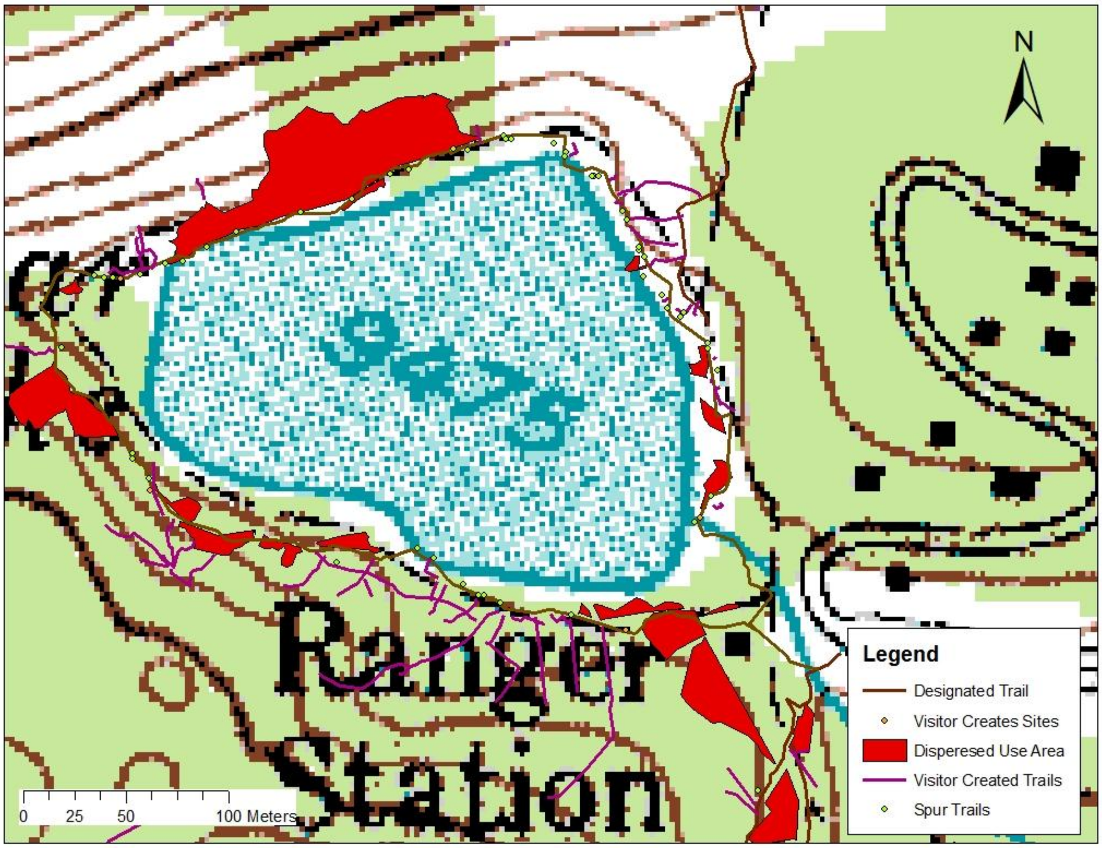


Figure 4.5 Current extent of visitor-created disturbance near Dream Lake.

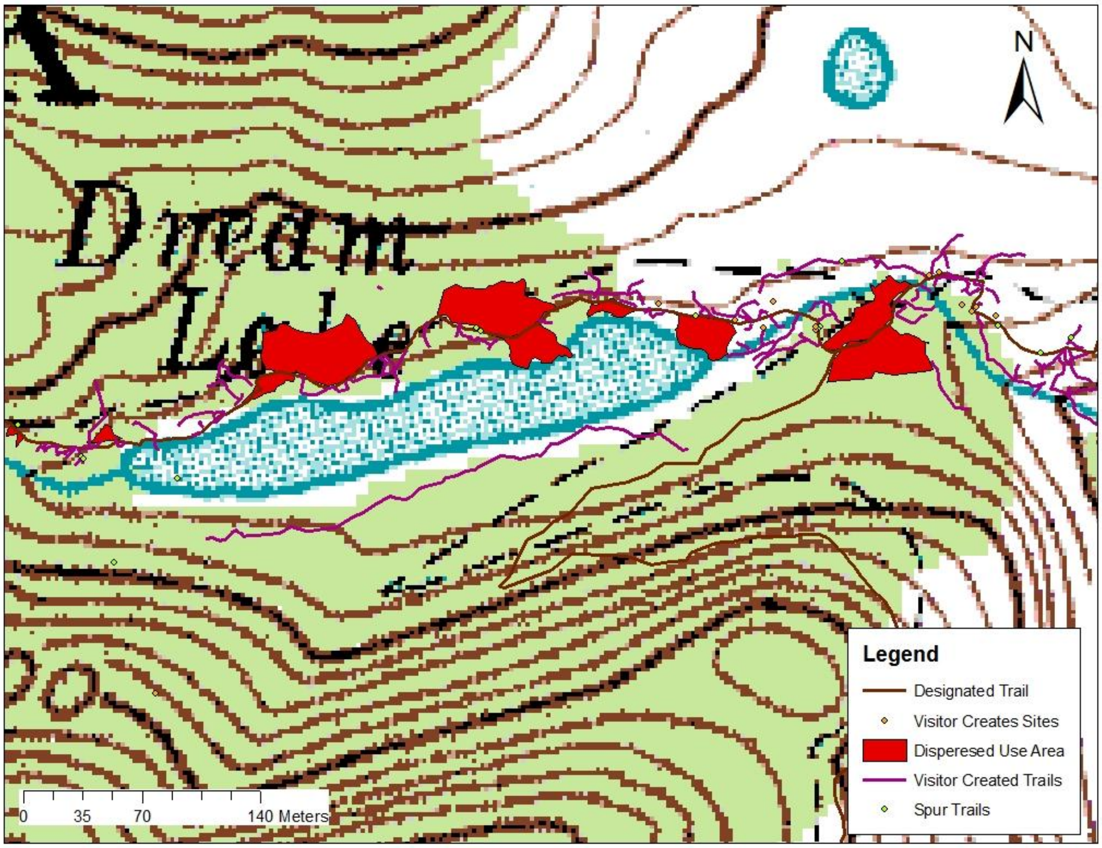


Figure 4.6 Current extent of visitor-created disturbance near Dream Lake.

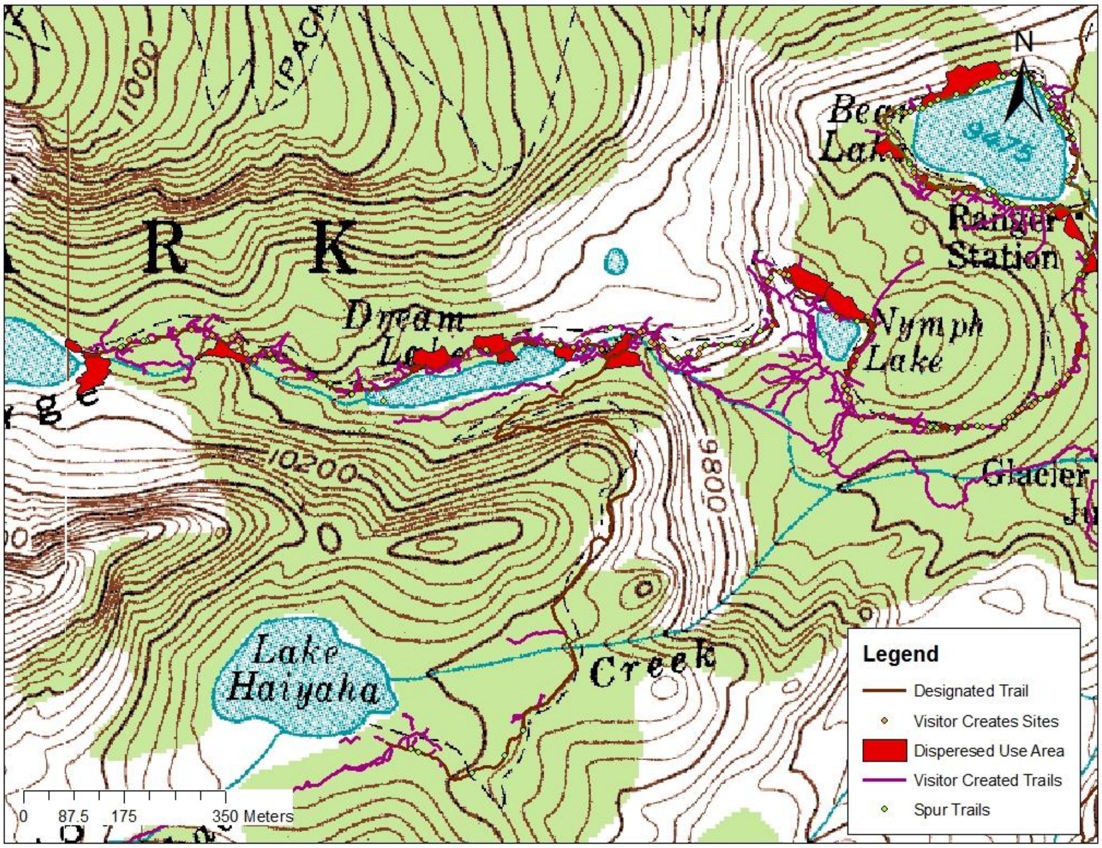


Figure 4.7 Current extent of visitor-created disturbance near Emerald Lake

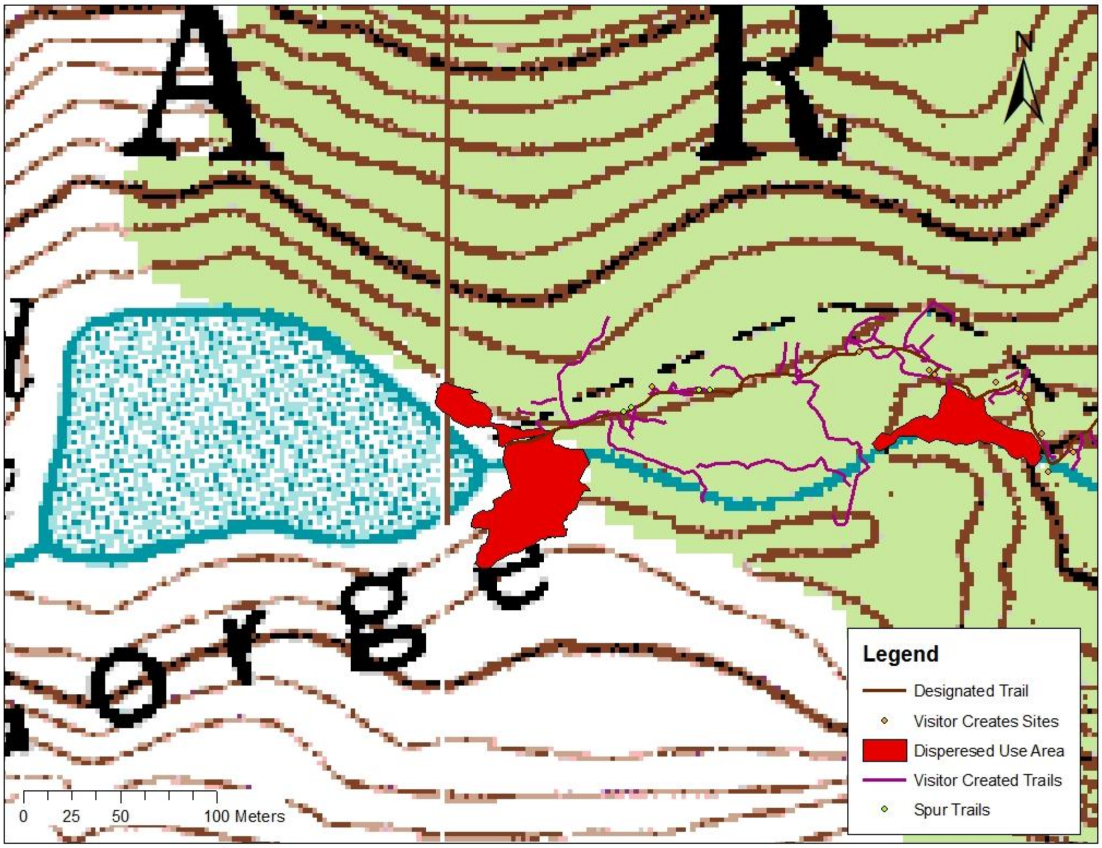


Figure 4.8 Detail of the extent of visitor-created disturbance near Alberta Falls.

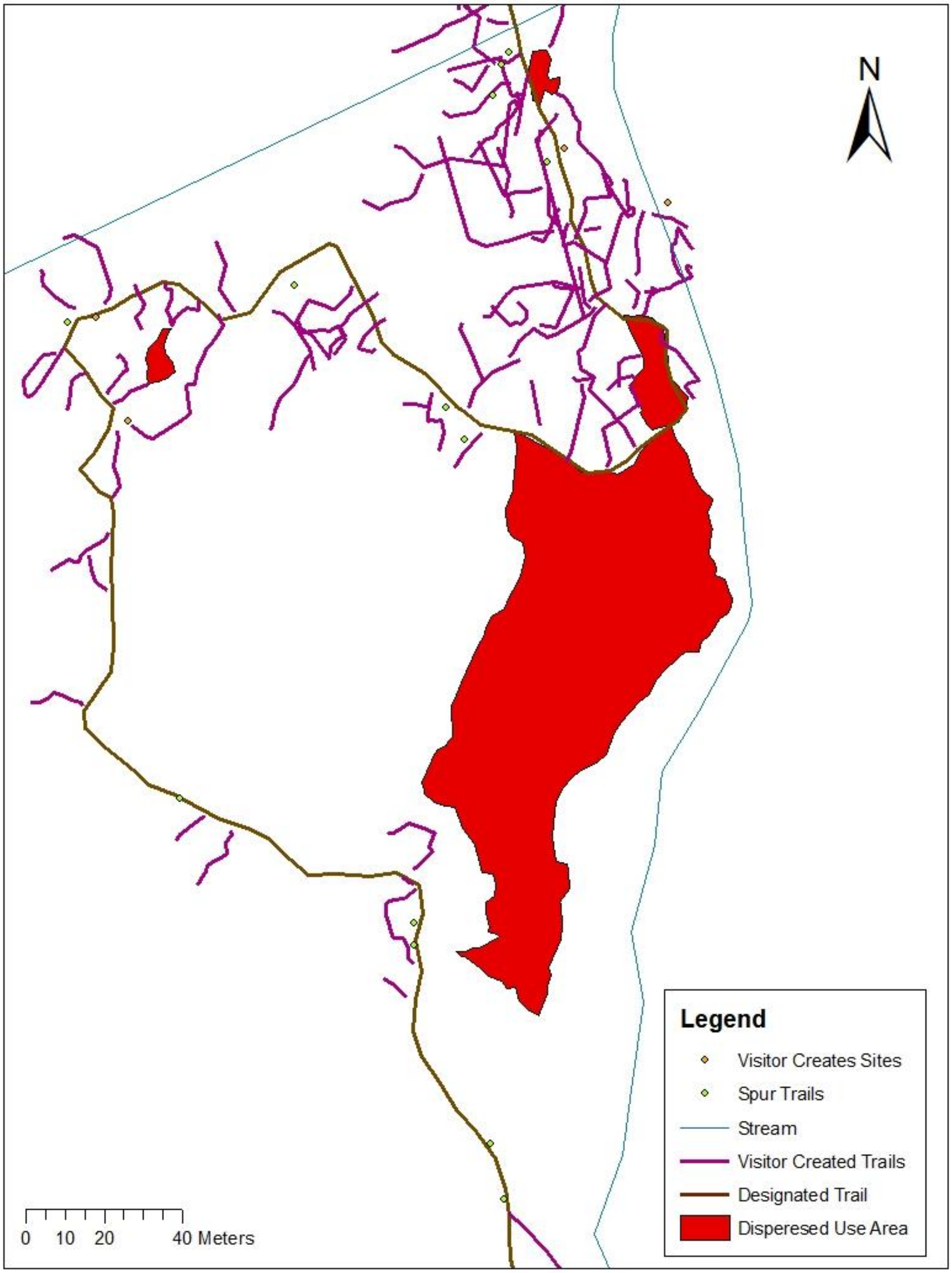


Figure 4.9 Current extent *of visitor-created disturbance near Lake Haiyaha*.

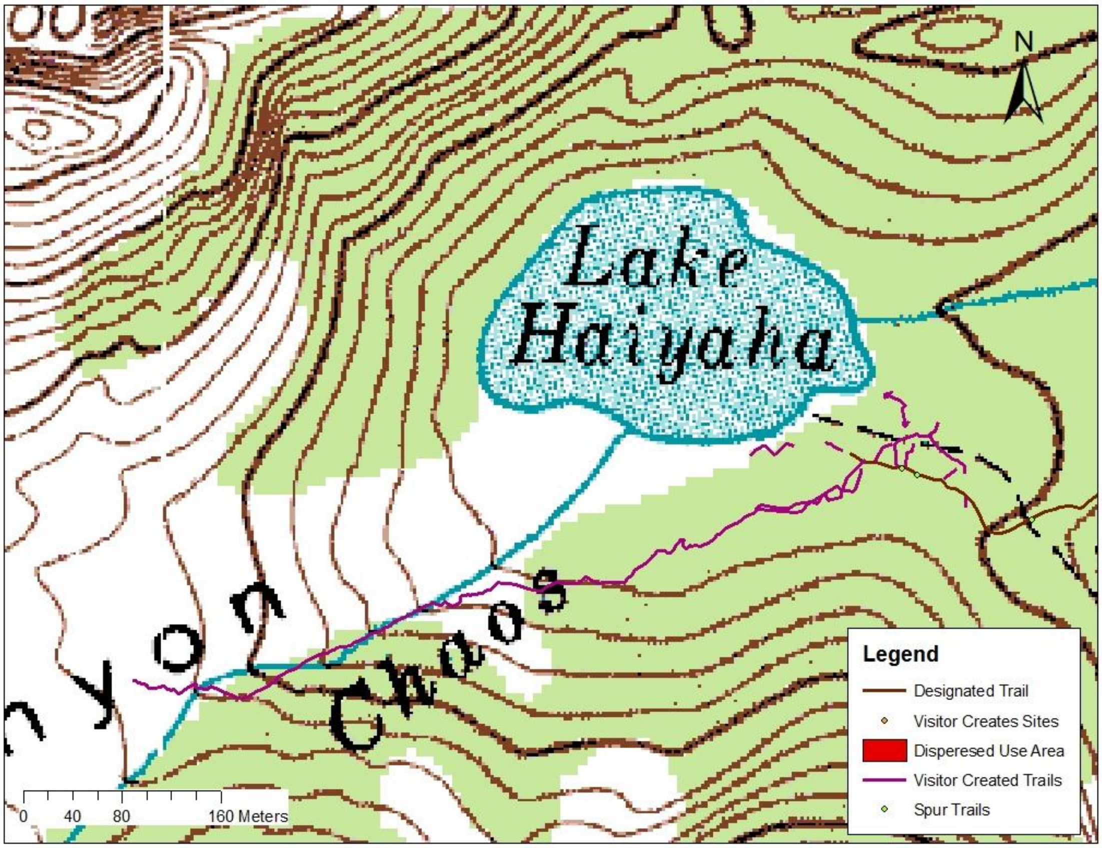


Figure 4.10 Current extent of visitor created disturbance near Nymph Lake.

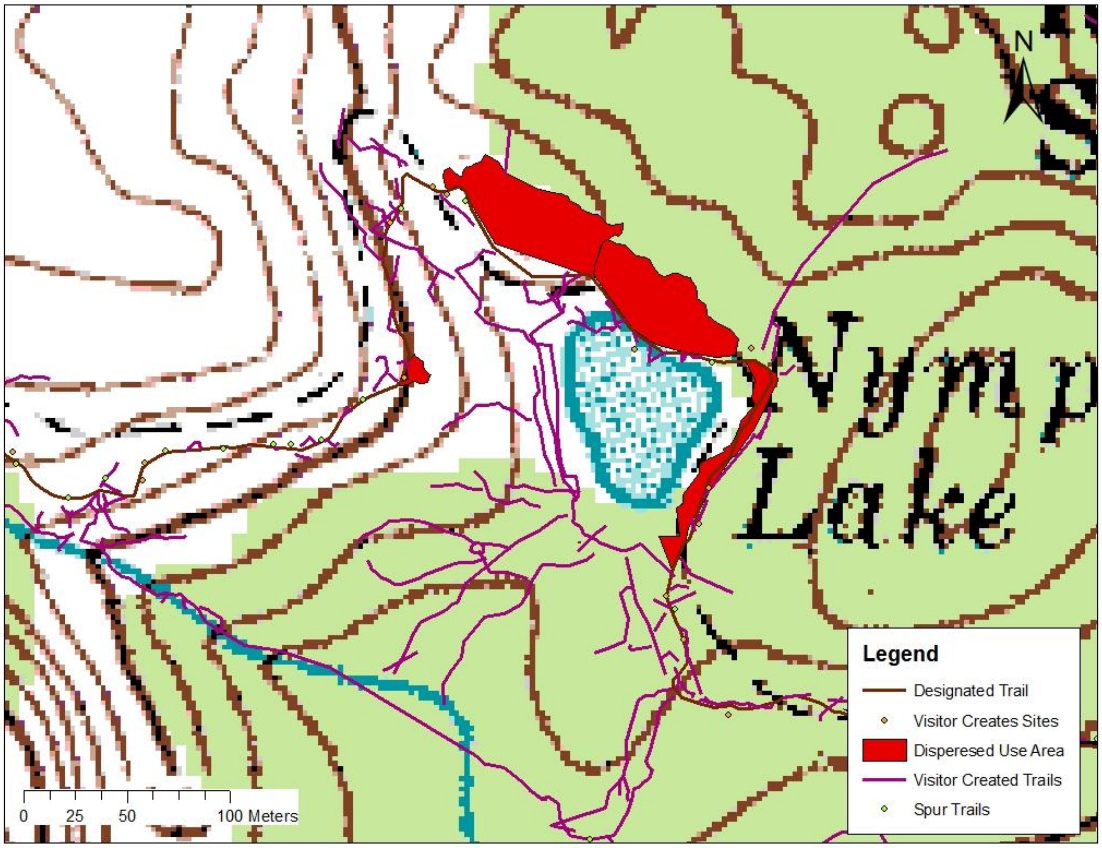
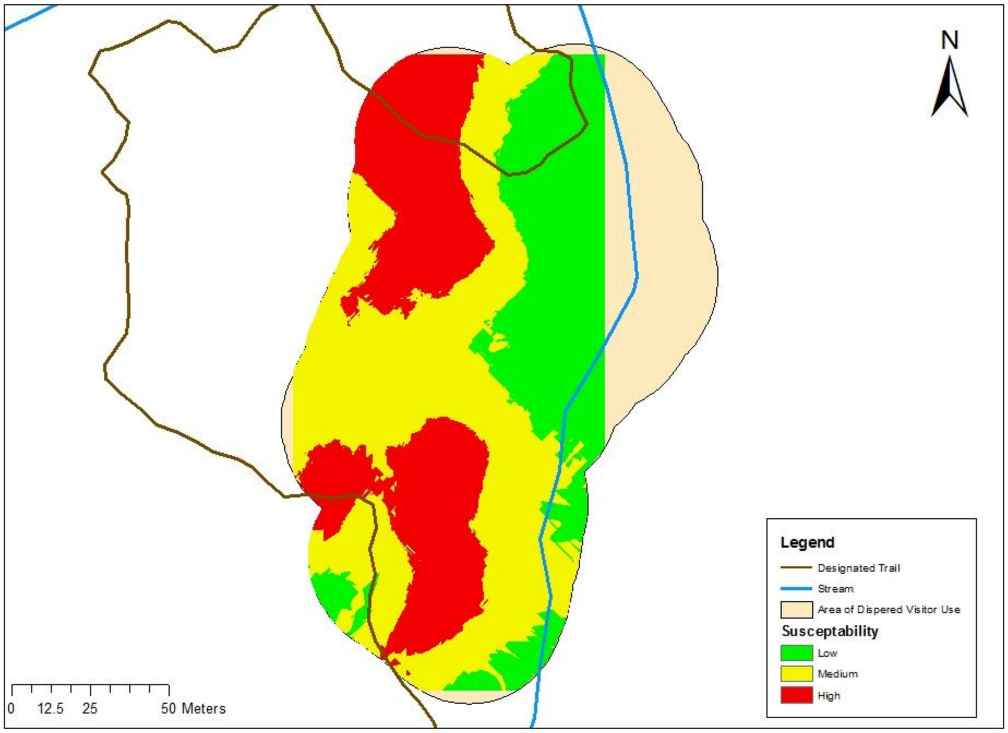


Figure 4.11 Areas susceptible to additional groundcover change near Alberta Falls



Nodes of intense visitor disturbance (Table 4.16) occur frequently in the study area and are generally located where visitors congregate—at vistas, along lakeshores and at other attraction sites. While these areas are limited spatially, they exhibit high levels of vegetation loss (82%-92%; Table 4.16), range from 3.5 to 5 on the condition class scale and occur frequently. For example, along the Emerald Lake Trail, 45 such locations were found, a rate of one per every 66 meters of designated trail, on average.

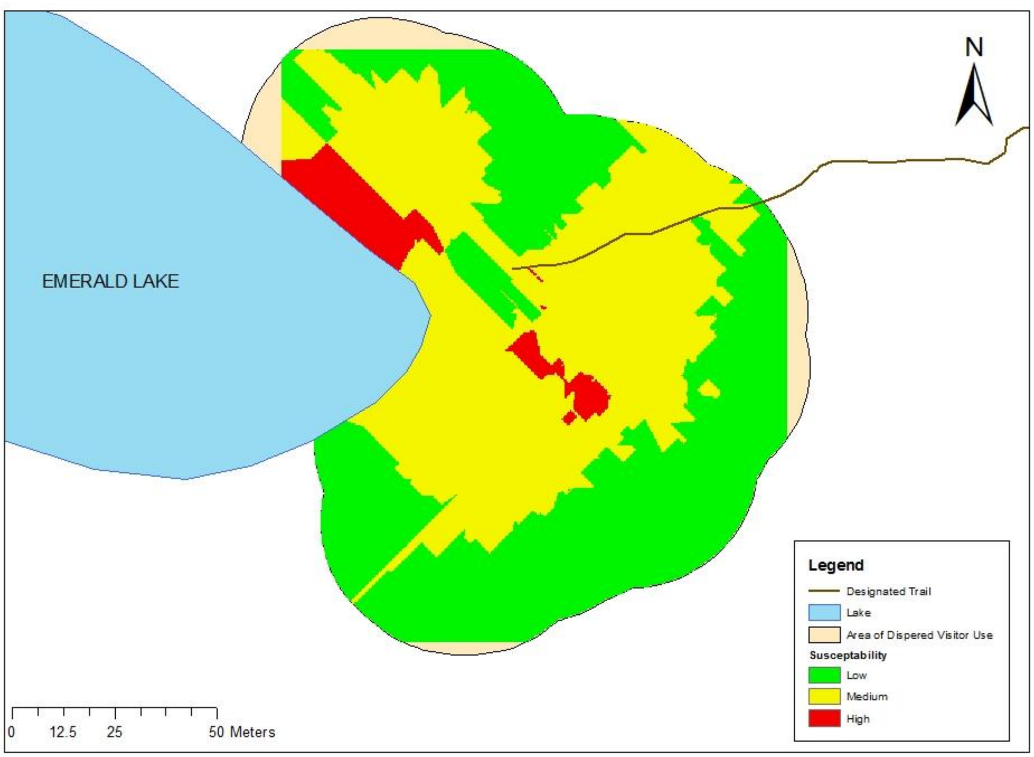
Larger areas of more diffuse impact (polygons) are somewhat less frequent throughout the study area generally, but occupy considerably more overall area. These areas are particularly prevalent along popular lakeshores such as Bear Lake and Dream Lake (Figures 4.4 and 4.5) and at specific attraction sites and destination points (e.g., terminus of the Emerald Lake Trail and Alberta Falls. In general these areas represent locations where visitor disturbances are too randomly located to be classified as a node or linear feature and therefore they cannot be monitored and assessed with standard site and trail metrics. While occupying a fairly extensive area in some cases, overall vegetation loss and condition class of these areas tends to be marginally less (Grand mean = 3.67;Table 4.2) than that of visitor sites (Grand mean= 3.75; Table 4.1), but nonetheless these impacts remain substantial.

Informal trails and spur segments are extensive and frequent in the study area, occurring in all locations (Table 4.3 and figures 4.2-4.11). In all study areas, the extent of informal trails equals or exceeds that of the system (designated) trails in that area (Table 4.3). Although mean segment length for these trails ranges only from 23.2m to 55.9m, trail formation is extensive particularly in the Glacier Gorge and Emerald Lake areas where the number of segments found was 316 and 282 respectively. Spur segments (sections of informal trails < 5m) are also common and widespread.

Intensive Measurements at Alberta Falls and Emerald Lake: Susceptibility Modeling

Results of the susceptibility modeling procedure indicate that substantial areas of groundcover near Alberta Falls are sensitive to potential change from current condition, i.e., these resources are located within the use polygon and are relatively intolerant of trampling (Figure 4.11). At Emerald Lake, more areas of bare rock and exposed soil currently exist, resulting in less vegetated areas of high susceptibility (Figure 4.12).

Figure 4.12 Areas susceptible to additional groundcover change near Emerald Lake



4.4 Integration with Social Science and Visitor Use Dimensions of this Study

4.4.1 Areas Exceeding Standards for Vegetation Loss

Results from the normative visual research conducted in this study (see Chapter 3) were integrated with the assessments of current conditions to determine which areas of resource change approach or exceed visitor thresholds of acceptability. In the visual research, we determined thresholds of tolerance (norm curves) for vegetation loss and informal trail formation. In this analysis we determined that a 53% relative percent cover was the minimally acceptable condition and a social trail density of 115 km/km^2 was the minimally acceptable condition for social trails (see Appendix G and H for more detail). GIS analysis reveals the location and extent of these conditions for the study area (Figures 4.13- 4.23).

Figure 4.13 Visitor sites and polygons and vegetation cover loss standards in the Glacier Gorge area.

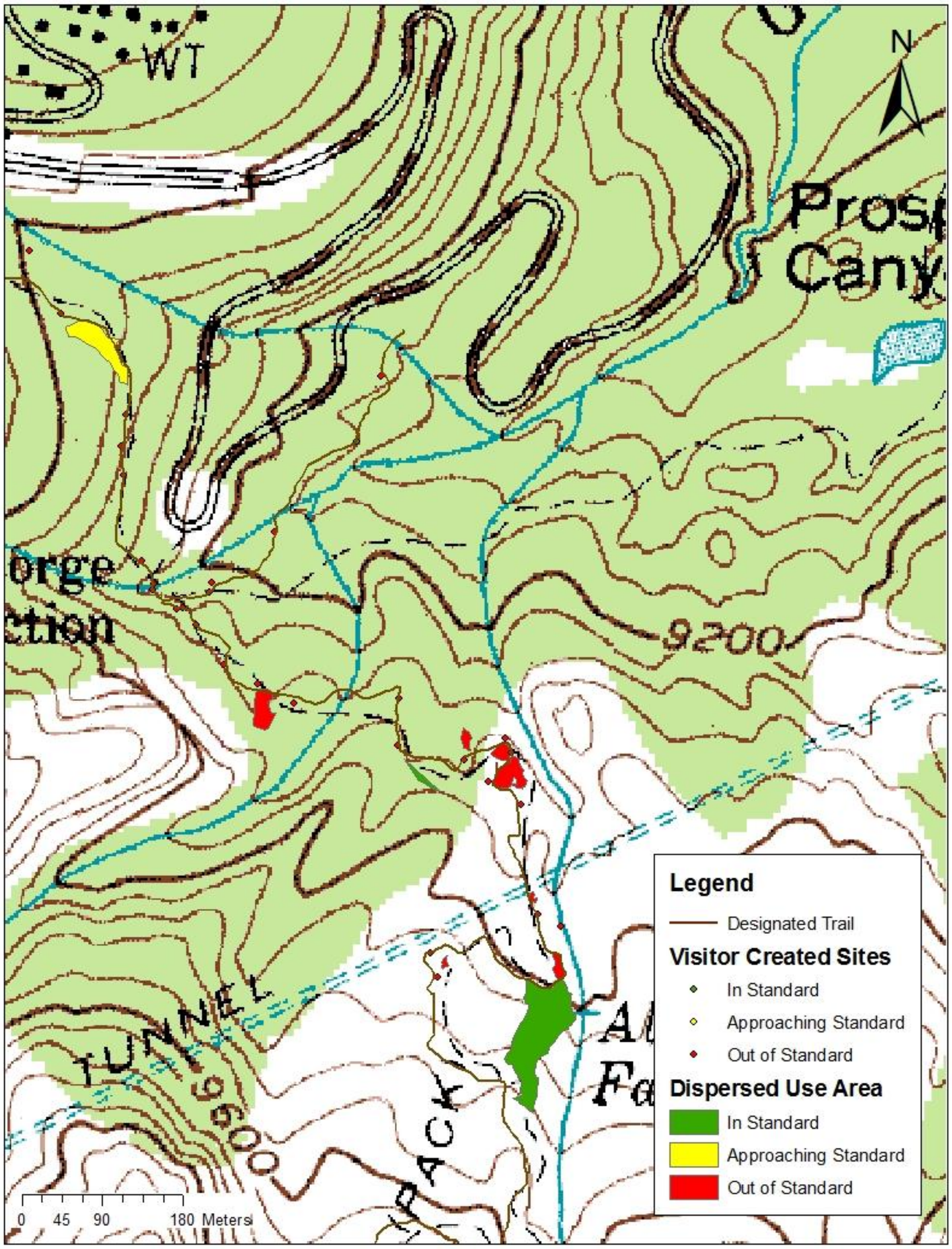


Figure 4.14 Visitor sites and polygons and vegetation cover loss standards in the Bierstadt Lake area

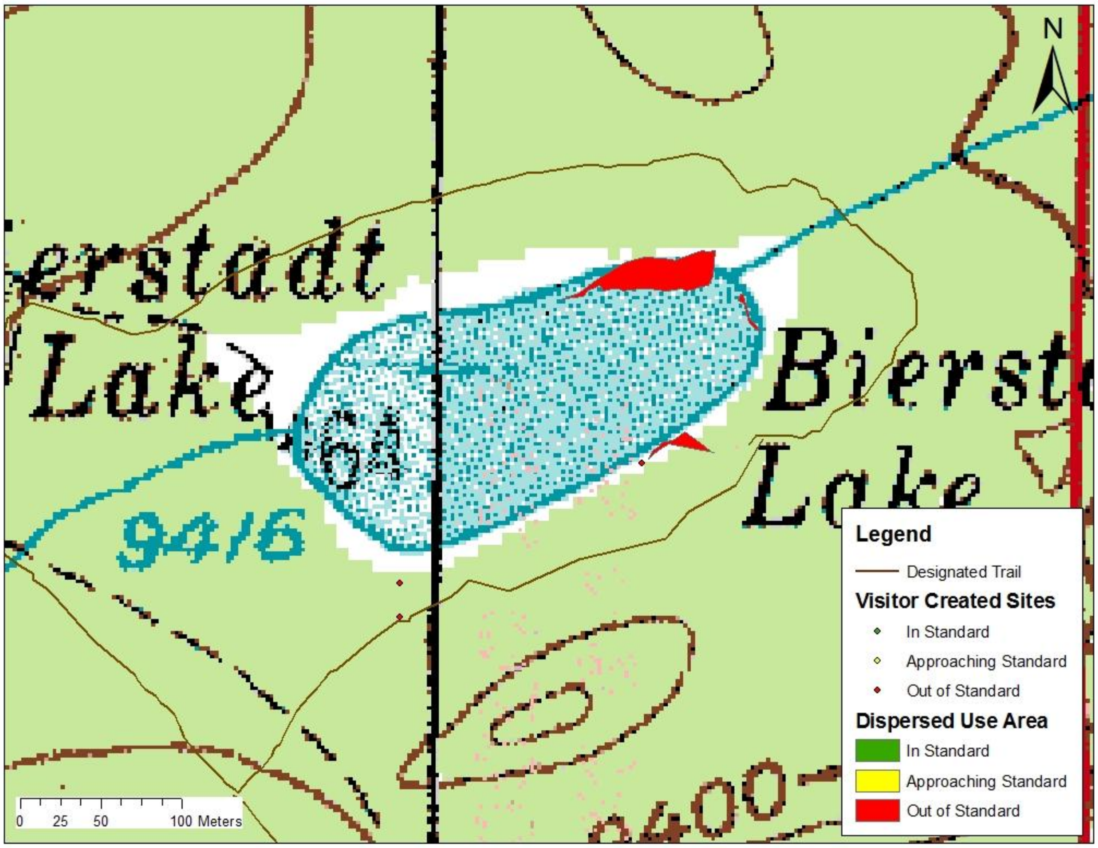


Figure 4.15 Visitor sites and polygons and vegetation cover loss standards in the Glacier Gorge area.

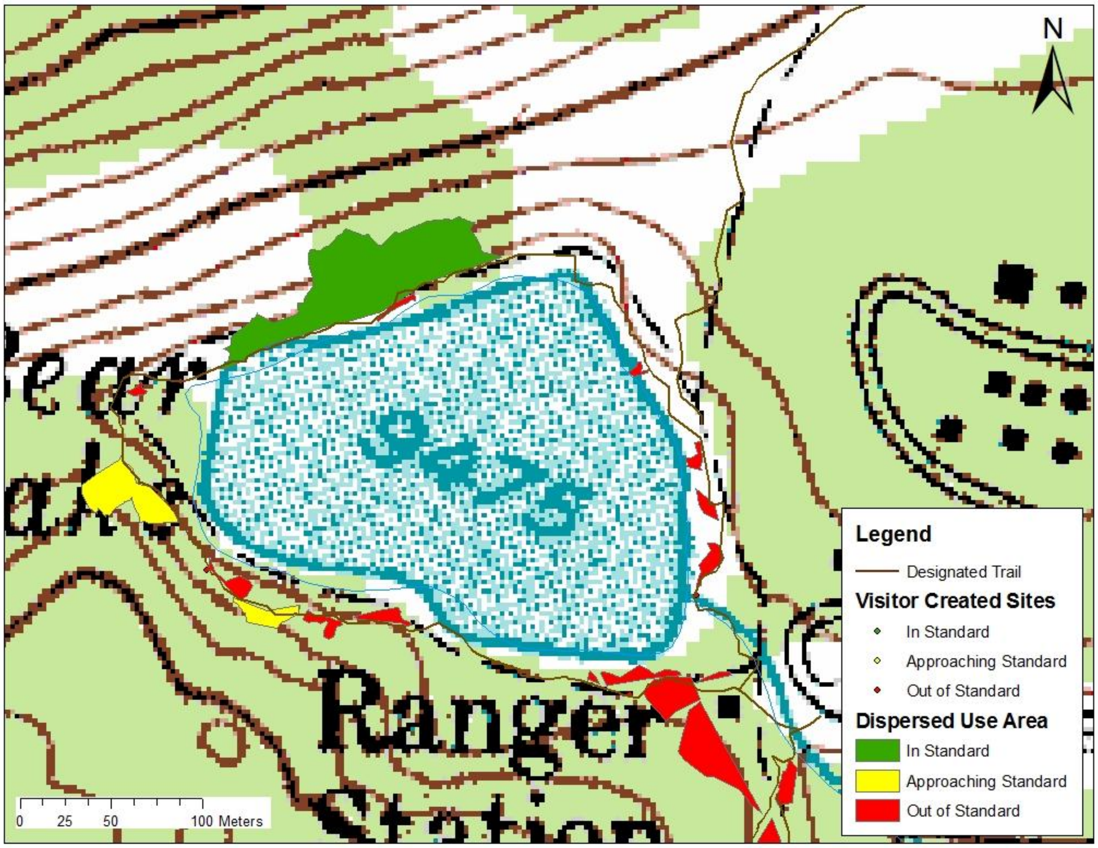


Figure 4.16 Visitor sites and polygons and vegetation cover loss standards in the Nymph Lake area.

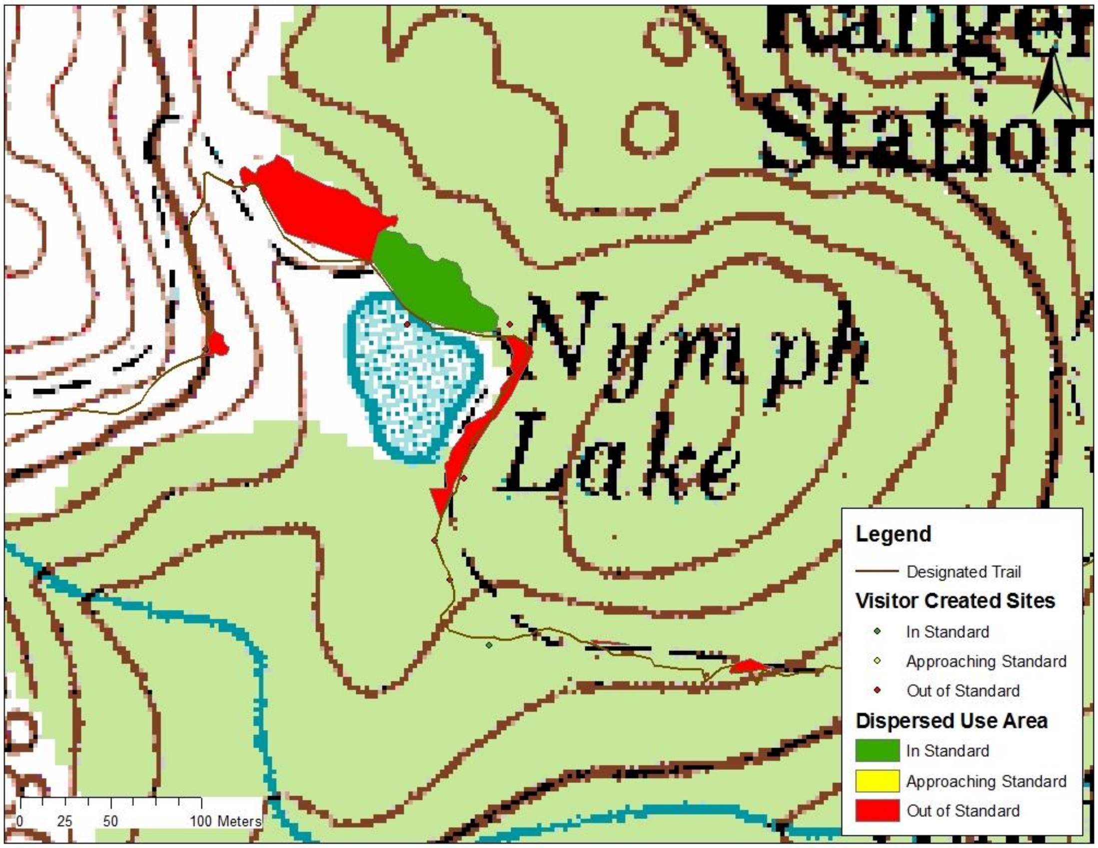


Figure 4.17 Visitor sites and polygons and vegetation cover loss standards in the Dream Lake area.

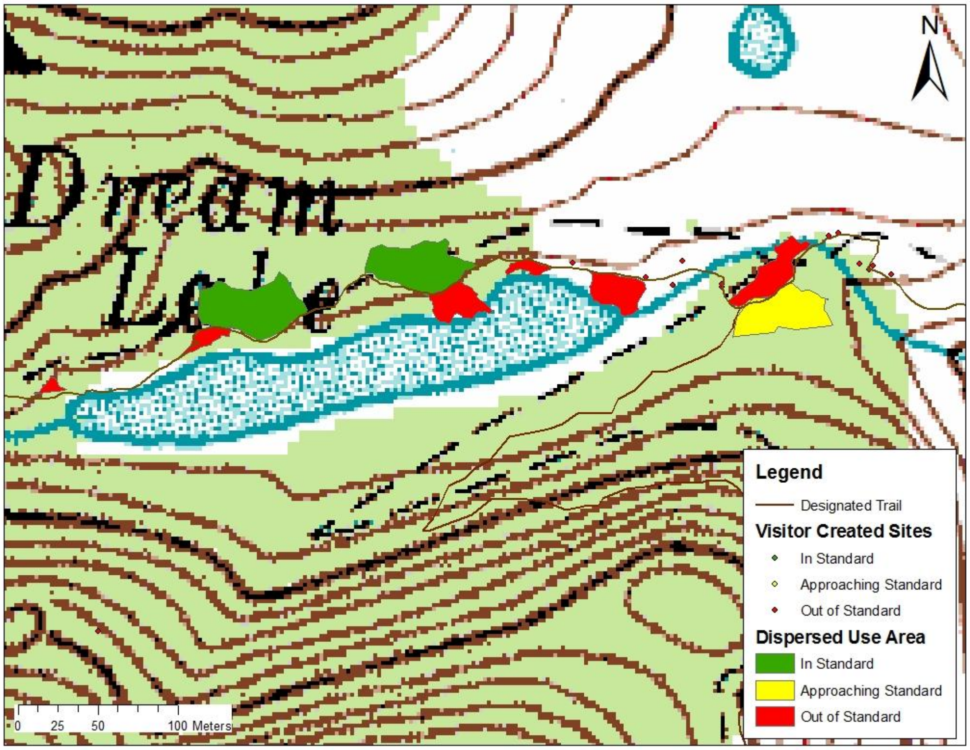


Figure 4.18 Visitor sites and polygons and vegetation cover loss standards in the overall Emerald Lake area.

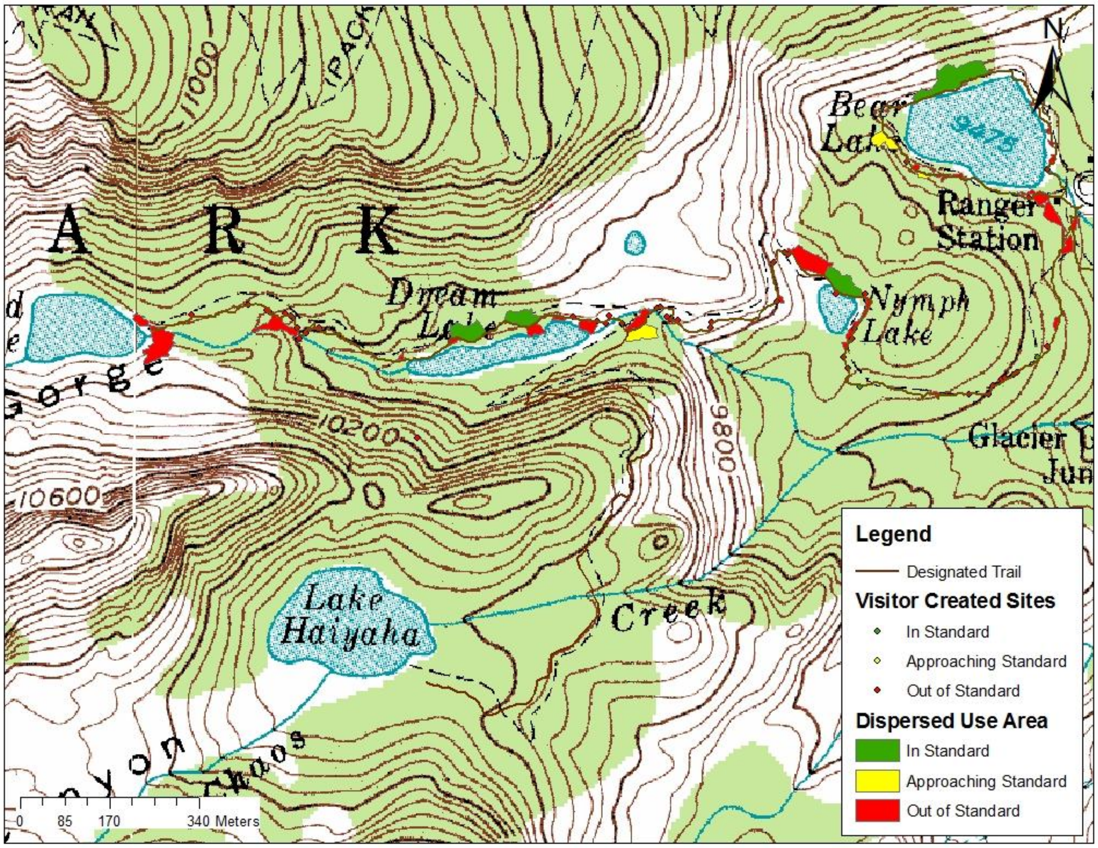


Figure 4.19 A detail of visitor sites and polygons and vegetation cover loss standards at Emerald Lake.

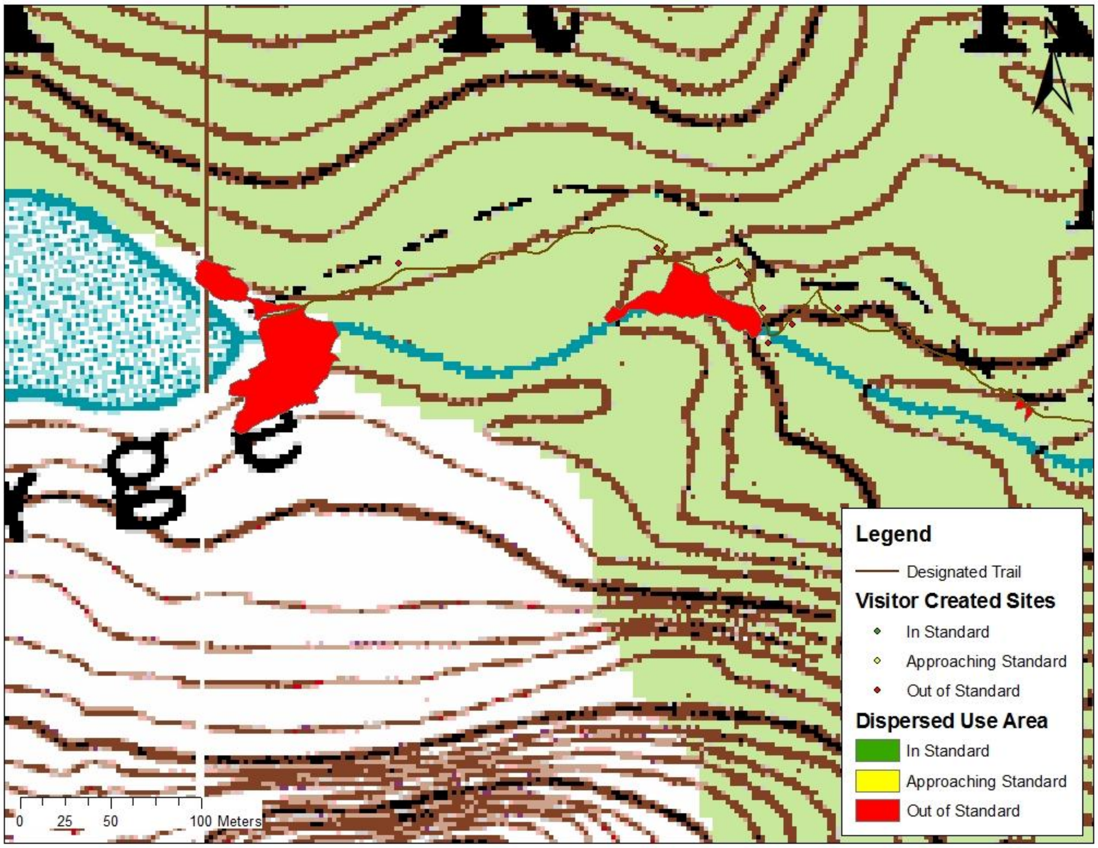


Figure 4.20 Areas where visitor created trail densities exceed visitor standards near Alberta Falls.

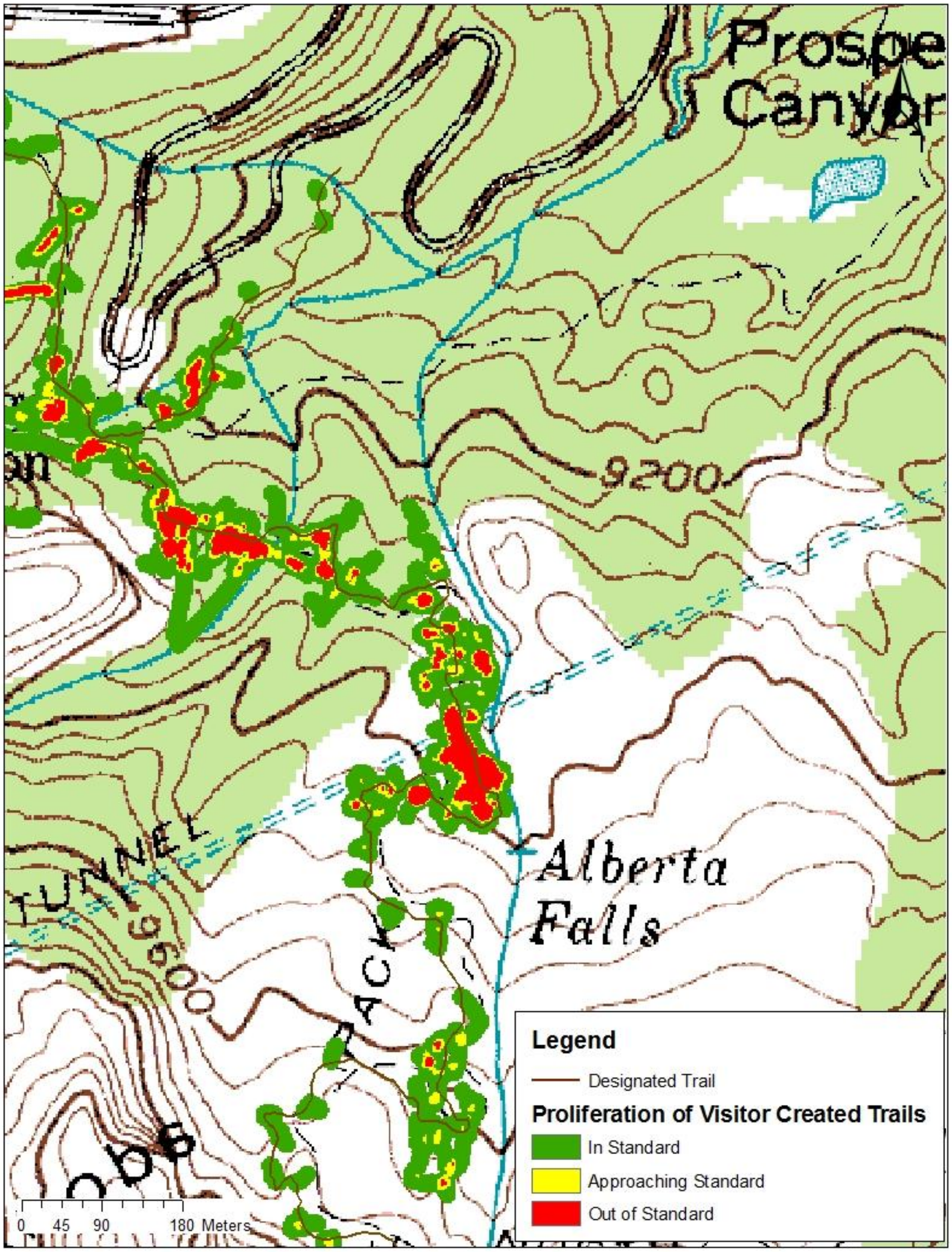


Figure 4.21 Areas where informal trail densities exceed visitor standards along the Emerald Lake trail.

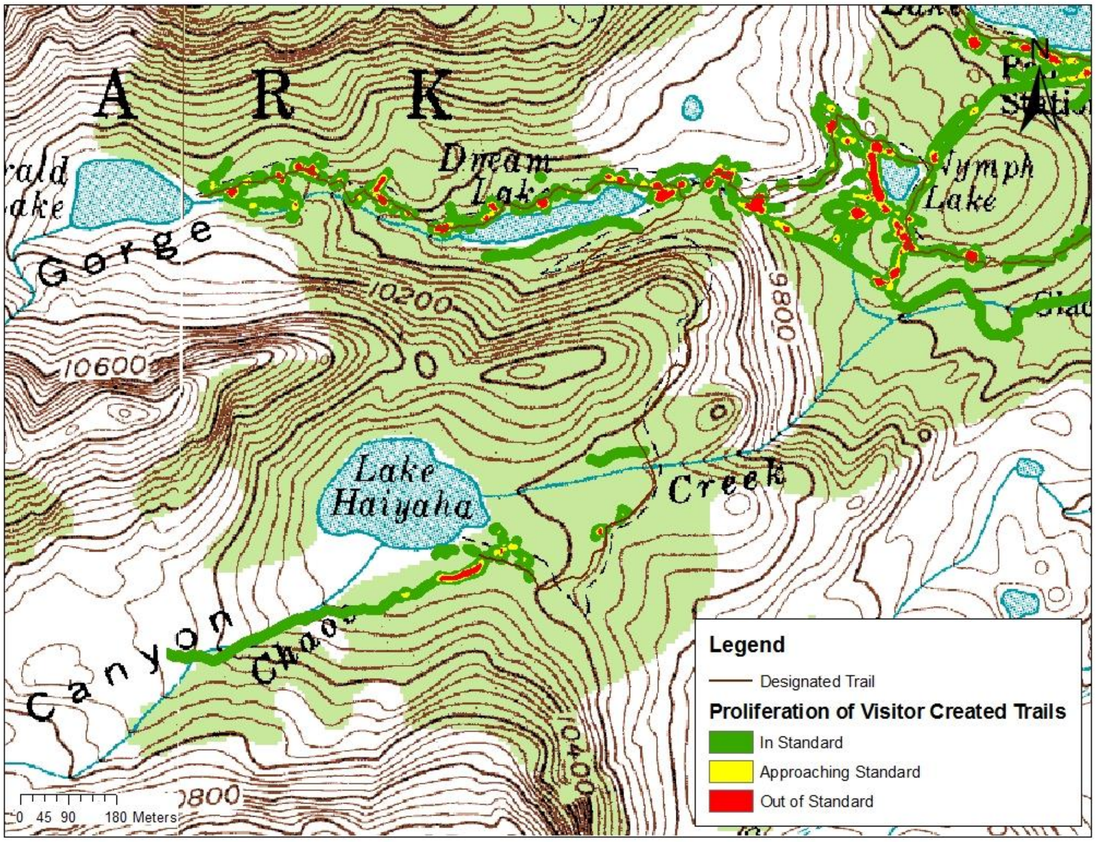


Figure 4.22 Areas where informal trail densities exceed visitor standards near Bear Lake.

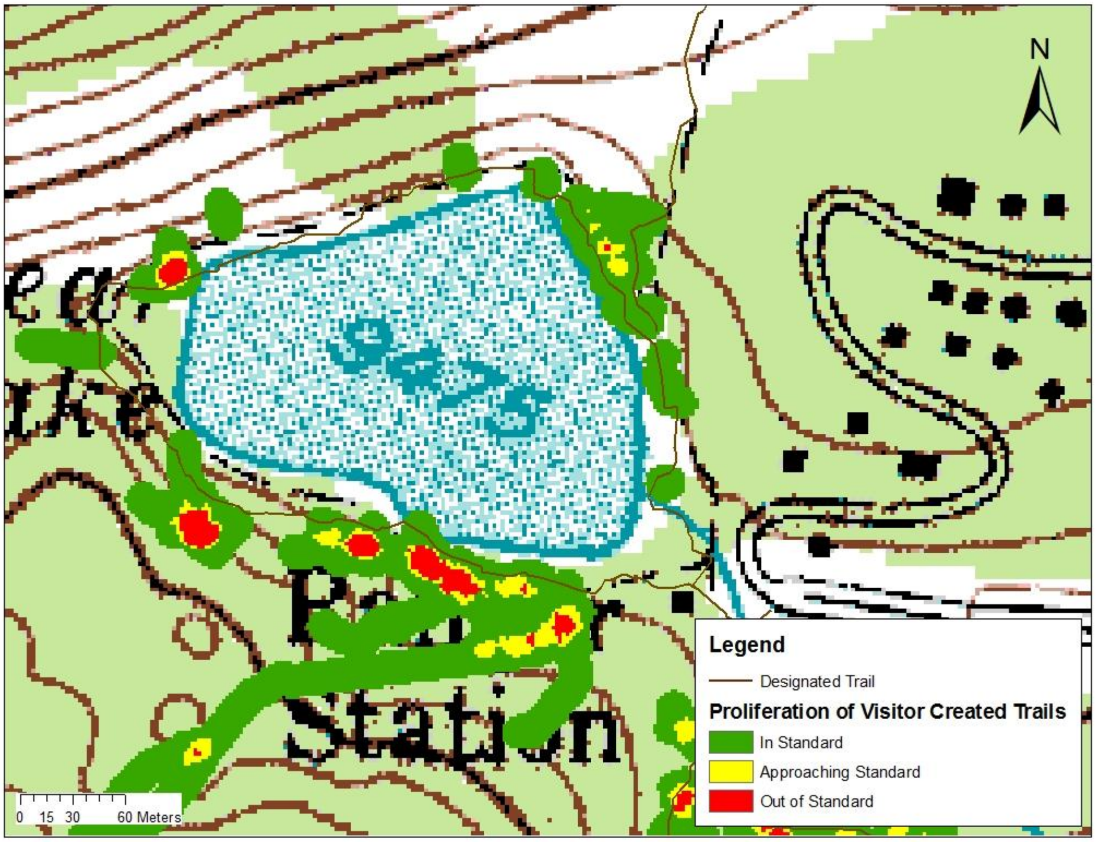
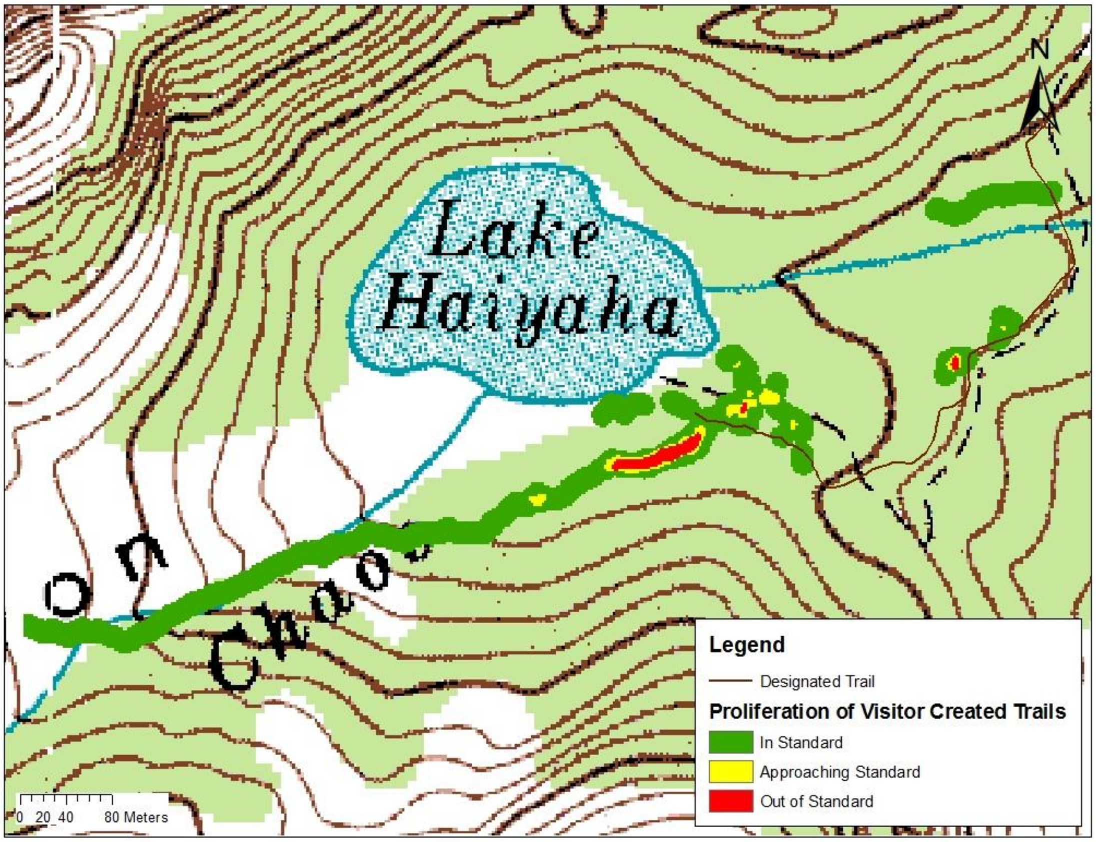


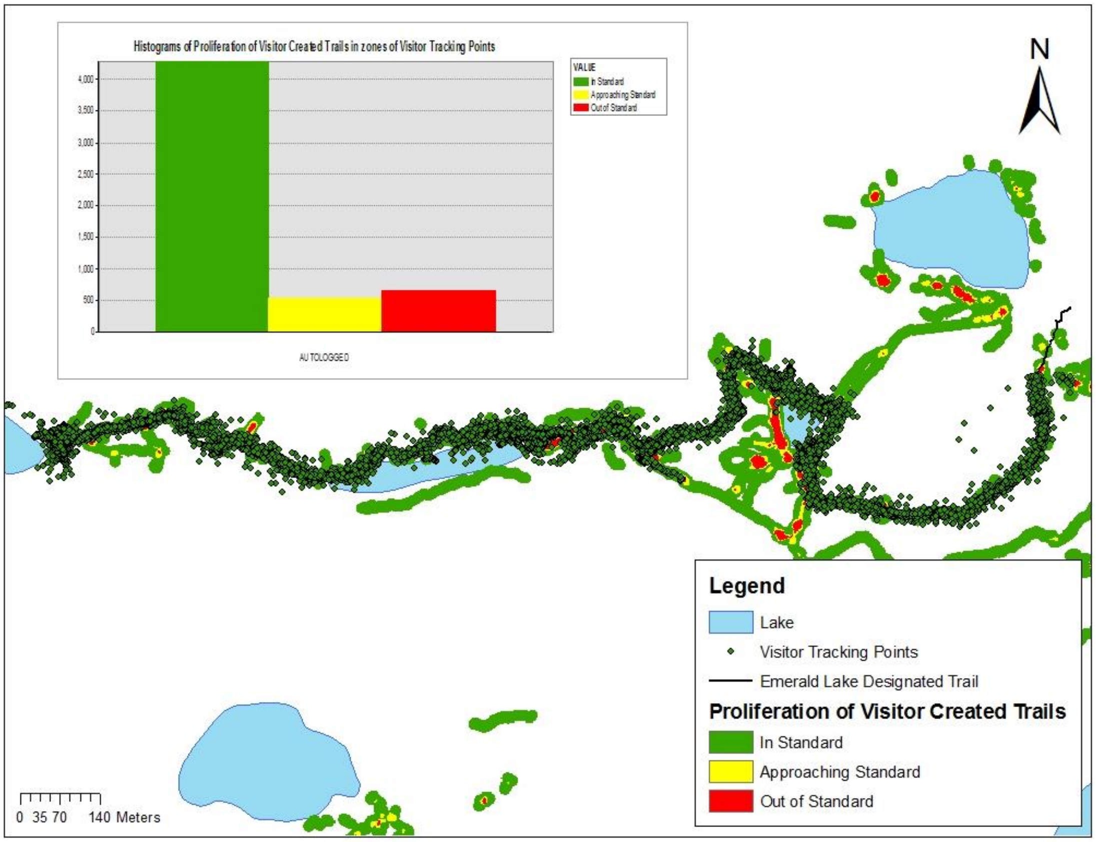
Figure 4.23 Areas where informal trail densities exceed visitor standards near Lake Haiyaha.



4.4.2 Visitors' exposure to out of standard resource conditions

Integration of the GPS visitor use assessment data and the areas exceeding standard determination provides one context for evaluating the importance of recreation impacts. We estimated visitor contact with areas where informal trail density exceeds acceptability thresholds by determining the spatial overlap between visitor use and locations where high densities occurred (Figure 4.24). Overall counts of the frequency of occurrence (i.e., the number of visitor use points that fall in areas where standards are exceeded) indicate that 23% of the time visitors are in locations that are out of standard for informal trails.

Figure 4.24 Visitors' estimated exposure to areas of social trails out of standard.



4.4.3 Areas of Potential Resource Change

Further analysis and integration of the susceptibility modeling of areas surrounding Alberta Falls and Emerald Lake was conducted. A use density layer was determined from the GPS tracking of visitor conducted in this study for these areas. Spatial analysis of the susceptibility and the use density layers allowed for a classification of zones of potential resource change based on these two characteristics (Figures 4.25 and 4.26). For example, areas where use level and susceptibility are high would be classified as having a high potential for resource change.

Figure 4.25 Areas of potential resource change at Alberta Falls

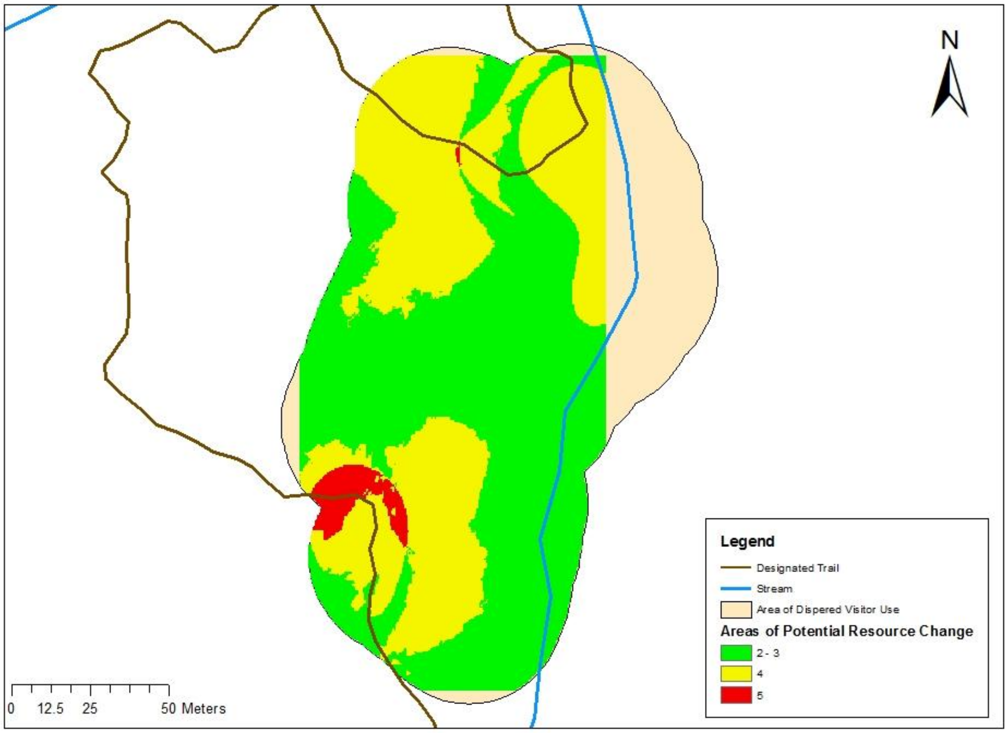
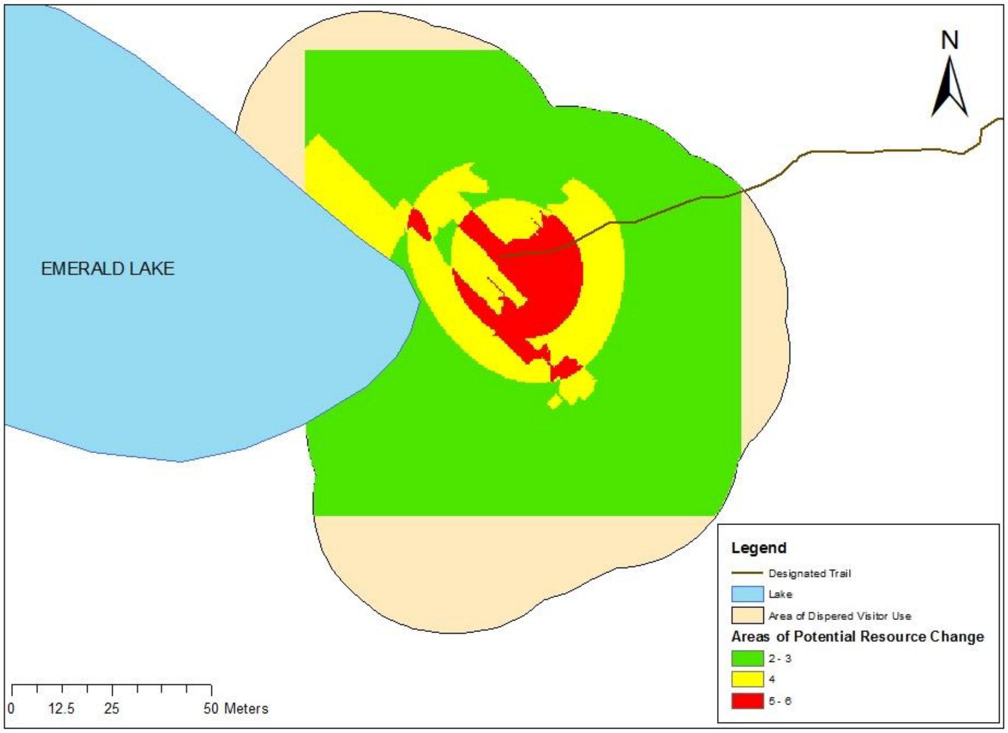


Figure 4.26 Areas of potential resource change at Emerald Lake



4.5 Discussion

The assessment and monitoring of recreation resource conditions is an important information-gathering step in the overall management of park resources. Monitoring programs have been applied effectively in many natural areas (e.g., Frissell 1977, Cole 1983b, Marion and Leung 1997), and are fundamental components in the application of long-term planning frameworks such as the Visitor Experience and Resource Protection (National Park Service 1997). Determining trends in resource conditions often highlights the need for management actions, and monitoring can help ascertain their effectiveness. Nonetheless, difficult decisions must be made from a management standpoint and monitoring can inform but not accomplish the decision process.

In addition to monitoring trends, an important and growing application of recreation ecology data is the integration with social science approaches, both normative and behavioral (Manning 2007; Goonan 2009). These integrated studies have the ability to provide managers with a context from which to begin evaluating the extent and intensity of resource change, from a visitor's perspective. While few integrated approaches have been used previously in park research, these methods show substantial future promise.

Several important conclusions and implications for park management appear warranted from the above presentation of recreation ecology and integrated research conducted in this study. First, this work provides managers with a spatially explicit census of off-trail recreation impacts in the study areas of ROMO. This analysis provides immediate information on the extent and degree of recreation impacts in settings where change may be rapid (off of hardened surfaces and maintained trails) and where managers may choose to implement actions to protect resources other than hardening surfaces. In addition this information forms the basis for continued monitoring to examine the trajectory of resource conditions over time and to examine the effectiveness of management actions to limit current and future impacts.

Several aspects of the current assessment are worth noting. First, many recreation disturbances occur in close proximity to the lakes in this study. Bear Lake (Figure 4.4), Dream Lake (Figure 4.5) and Nymph Lake (Figure 4.6) appear partially problematic in these regards with a considerable length of shoreline and near shore areas disturbed by recreation use. Disturbances in proximity to lake shores have the potential to result in effects to the lake ecosystems such as increased turbidly and nutrient content particularly in high-elevation, oligotrophic lakes (Hammitt and Cole 1998). Managers should carefully reflect on these issues and consider, if appropriate, hardening and designating certain areas for lake access thus minimizing additional informal trail formation and site expansion.

A second overall conclusion is that areas approaching or exceeding visitor standards for vegetation loss or informal trail formation are prevalent in the study area (Figures 4.13-4.23). This information provides the visitor’s perspective on the acceptability and should be considered carefully in an overall process of park management. Of particular concern are locations at high value destination points such as Nymph Lake (Figure 4.16) and Dream Lake (Figure 4.17) and Emerald Lake (Figure 4.19).

A final overall conclusion is that visitors appear to be interacting with affected resources for a significant part of their hiking experience in ROMO. While these results are limited and deserve more development, results suggest that 23% of the time visitors are experiencing resource conditions that either approach or exceed visitor standards of acceptability.

4.6 Literature Cited

Booth D.T., Cox S.E., Fifield C, Phillips M, Williamson N. 2005. Image Analysis Compared with Other Methods for Measuring Ground Cover. Arid Land Research and Management 19: 91-100.

Booth D.T., Cox S.E,. Berryman, R.D. 2006. Point Sampling Digital Imagery with 'SamplePoint'. Environmental Monitoring and Assessment. 123: 97-108.

Cole, D. N. and Monz, C. A. (2002) Trampling disturbance of subalpine vegetation, Wind River Mountains, Wyoming. Arctic, Antarctic and Alpine Research. 34(4): 365-376.

Cordell, H.K (2008). The latest on trends in nature-based outdoor recreation and tourism. Forest History Today Spring:4-10

De Lacy T., Whitmore M. 2006. Tourism and recreation. *In:* Lockwood M, Worboys GL, Kothari, A., editors. *Managing protected areas: a global guide*. Earthscan, London, pp. 497-527

Hammitt W.E., Cole D.N. 1998. Wildland recreation: ecology and management. Second Edition. John Wiley, New York

Manning, R.E. 1999. Studies in Outdoor Recreation. Second edition. Oregon State University Press. Corvallis, OR. 374 p.

Marion, J.L. 1995. Capabilities and management utility of recreation impact monitoring programs. Environmental Management, 19: 763–771

Marion, J.L. and Leung, Y. (1997) An assessment of campsite conditions in Great Smoky Mountains National Park. USDI National Park Service Research Resources Management Report. 127 pp.

Marion J.L, Wimpey J, Park L. 2009. Monitoring protocols for characterizing trail conditions, understanding degradation, and selecting indicators and standards of quality, Acadia National Park, Mount Desert Island. Virginia Tech College of Natural Resources, Forestry/Recreation Resources Management, Blacksburg, VA.

Monz, C.A. 2002. The response of two arctic tundra plant communities to human trampling disturbance. Journal of Environmental Management. 64: 207-217

Monz C.A., Cole D.N., Marion J.L., Leung, Y-F. 2010a. Sustaining Visitor Use in Protected Areas: Future Opportunities in Recreation Ecology Research Based on the USA Experience. Environmental Management. 45(3) 551-562.

Monz, C.A., Marion, J. L., Goonan, K. A., Manning, R.E., Wimpey, J., Carr, C. 2010b. Assessment and monitoring of recreation impacts and resource conditions on mountain summits: Examples from the Northern Forest, USA. Mountain Research and Development. In review.

National Park Service. 1997. VERP: The visitor experience and resource protection framework– a handbook for planners and managers. Denver: Denver Service Center.

Chapter 5: TRANSPORTATION MODELING

5.1 Introduction

This report summarizes the transportation analysis conducted to support RMNP's Alternative Transportation in Parks and Public Lands (ATPPL) project to investigate the extent to which the overall visitor delivery system – private vehicles and bus transit – affects visitor experience and resource conditions at 2 key locations in the Park: Bear Lake (and surrounds) and Glacier Gorge. Information from this planning study will inform Park managers of the implications of different visitor access plans for visitor experience and biophysical conditions at these two popular locations.

One potential outcome of this work is to assist the NPS in the design of RMNP's shuttle bus system in a manner that optimizes the operational efficiency and economic feasibility of the transportation system, while protecting the park's resources and the quality of visitors' experiences.

Integration of the four components of this study will assist the park in evaluating the extent to which the existing shuttle system maintains the desired future conditions of park resources and visitor experiences. Thus, this project is expected to enhance the park's ability to use alternative transportation as an essential element of visitor capacity management and resource protection.

This ATPPL planning project has four integrated components: 1) modeling of private and transit vehicle traffic in the Bear Lake Road corridor, 2) modeling of visitor use at selected recreation sites serviced by the Bear Lake shuttle bus, 3) assessing resource impacts at selected recreation sites serviced by the Bear Lake shuttle bus, and 4) conducting visitor survey research at selected recreation sites serviced by the Bear Lake shuttle bus. This component of the larger four-part integrated project involves the development of a transportation simulation model of the Bear Lake Road corridor, connecting Estes Park with the Bear Lake trailhead, and with the locations in-between. To construct this simulation model, a significant amount of "existing conditions" data were collected (described in Section 2.0).

5.2 Background

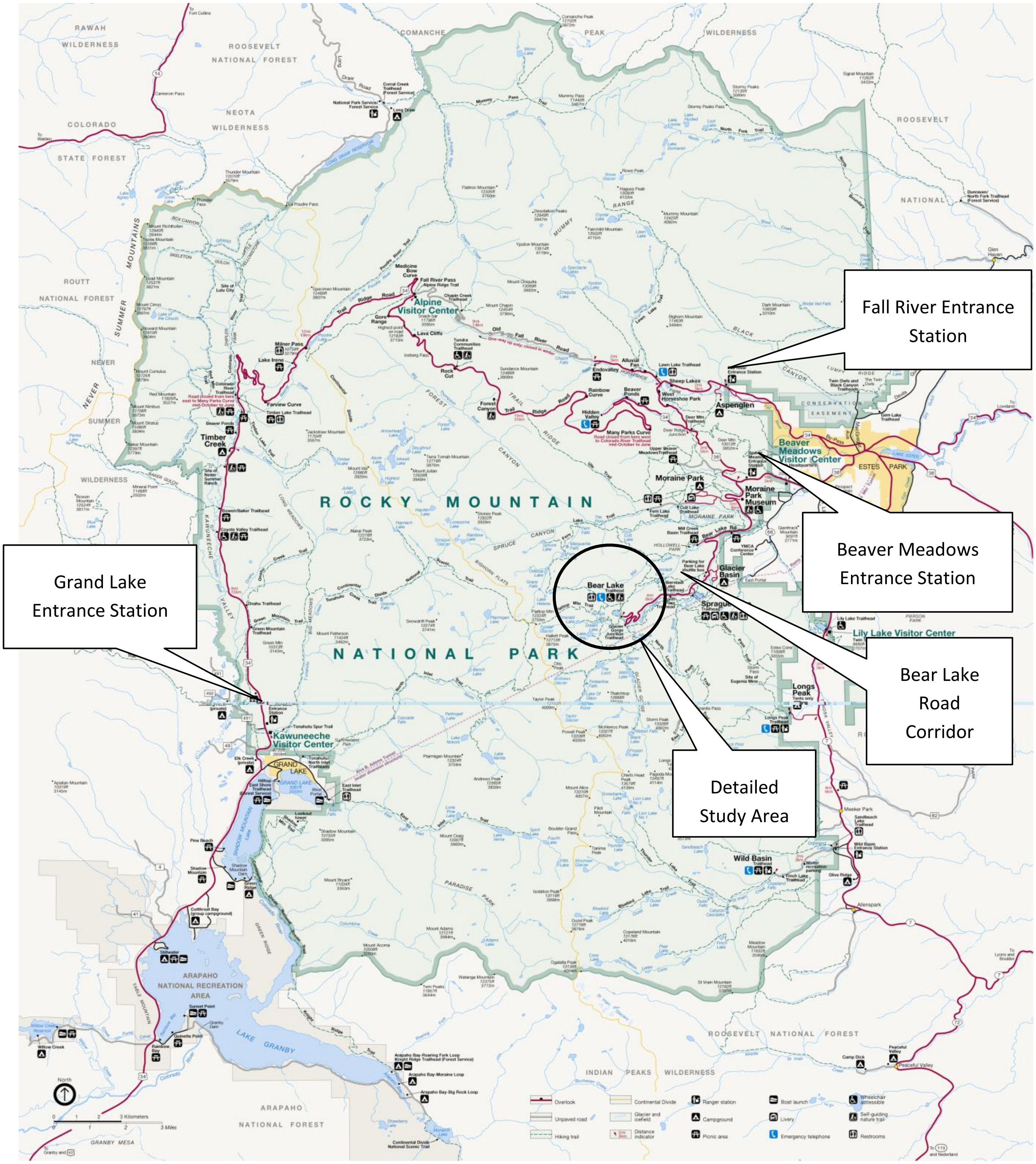
In 1917 Bear Lake Road was constructed off of State Route 34/36 to serve the Bear Lake corridor. In 1929 a 100-space parking lot was constructed at the terminus of Bear Lake Road to enable visitors to access some of the most scenic areas of the Park. Over time, the parking lot at the Bear Lake trailhead was expanded to its current capacity of 235 spaces.

Transportation infrastructure associated with the Bear Lake Road corridor has been improved over time. Notable more recent access improvements include:

- 1978 -- the introduction of a shuttle system serving the corridor and the construction of Park and Ride lot with a capacity of 208 spaces.
- 2000 -- expansion of the shuttle system between the Park & Ride lot and Bear Lake to operate on 10-minute headways during peak periods.
- 2002 -- expansion of the Park & Ride lot to 340 spaces plus approximately 50 overflow spaces.
- 2006 – provision of new shuttle service from Estes Park to the Park & Ride (the Hiker Shuttle)

RMNP has 3 main entrance gates: the Beaver Meadows Entrance Station (Route 34/36), Fall River Entrance Station, and the Grand Lake Entrance Station. State Route 34/36 traverses the park over the scenic Trail Ridge Road connecting the two entrance stations near Estes Park with the one at Grand Lake. Figure 5.1 shows a map of Rocky Mountain National Park, providing the location of the 3 visitor entrance stations and the Bear Lake Road corridor, the site of intensive study area for this investigation.

Figure 5.1 Rocky Mountain National Park, Entrance Stations and Bear Lake Road Corridor



The Beaver Meadows entrance gate is most proximate to the detailed study area and is also the most prominently used entrance gate for vehicles entering (44-49% of all entries) and exiting (56-57% of all exiting vehicles). Figure 5.2 provides estimates of gate entries and exits for each of the 3 entrance stations for two July days in 2008. The estimates in Figure5.2 are based on actual counts conducted for this project at the Beaver Meadows entrance station, and extrapolated to the other two entrance stations based on relationships established in the Rocky Mountain National Park Transportation Study.[1]

Figure 5.2 Estimated Entering and Exiting Vehicles at 3 Entrance Stations

Estimated Entering and Exiting Vehicles for July 10 & 12, 2008

Weekday of July 10

	Enter	Exit	% of Park Entering Vehicles	% of Park Exiting Vehicles
Beaver Meadows	2913	3274	49%	57%
Fall River	1640	942	28%	16%
Grand Lake	1360	1516	23%	26%
	5913	5732		

Weekend Day of July 12

	Enter	Exit	% of Park Entering Vehicles	% of Park Exiting Vehicles
Beaver Meadows	3622	4034	44%	56%
Fall River	2465	1221	30%	17%
Grand Lake	2073	1899	25%	27%
	8160	7154		

5.3 Transportation Data Collection

The traffic data collection plan focused on intense data collection over an 8-hour period (8AM to 4PM) on the two days highlighted in Figure 5.2 Thursday, July 10 and Saturday, July 12. The one exception to this is a 2-week automatic vehicle count that occurred at 3 locations from July 7 to July 21, 2008.

The transportation engineering profession has developed quantitative estimation techniques for processing and adjusting data from spot counts to facilitate capacity analysis. For example, when analyzing congestion, traffic engineers often use the concept of a design hour. The design hour volume represents the hourly traffic volume a transportation facility should be designed to handle with tolerable congestion. There is general agreement that the transportation system should not be designed to handle the highest hour of traffic in a year since the system would be severely underutilized for most of the remaining hours and would be extremely expensive to build and maintain. Generally, the design hour represents the 30th highest hour of traffic in a year.

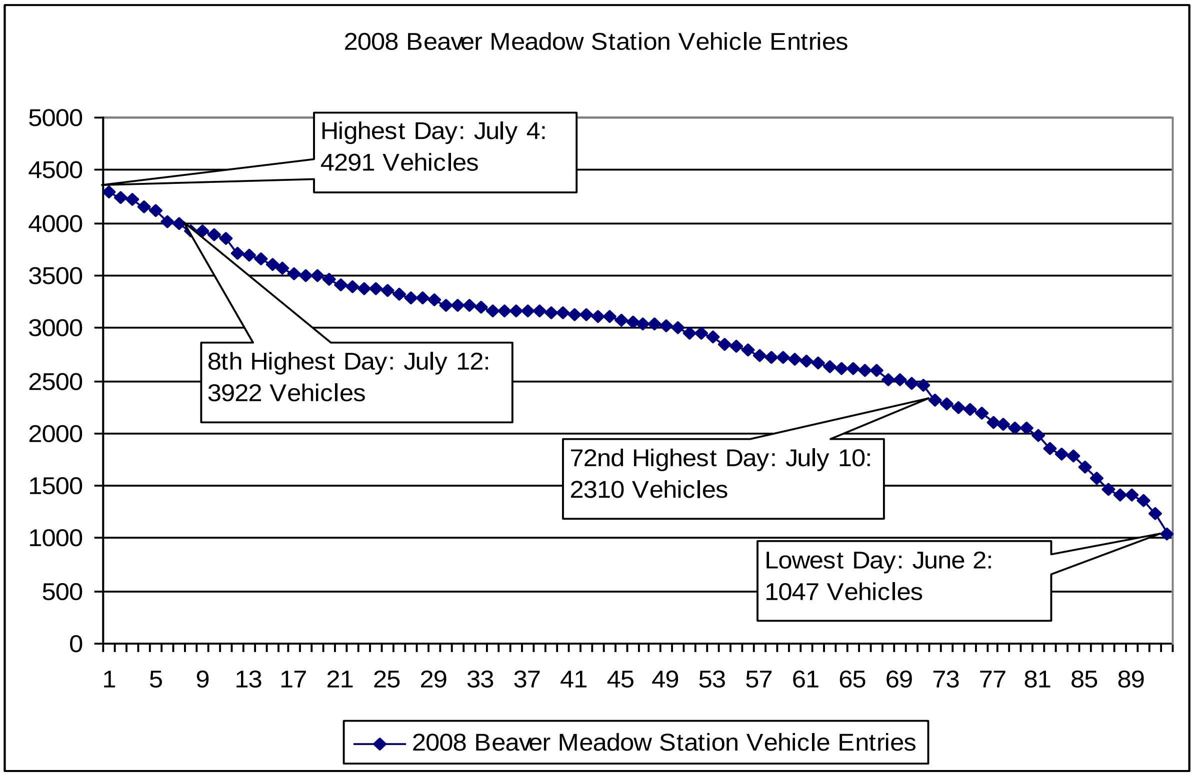
Standard traffic engineering concepts, such as the design hour, are directly applicable to National Park roadways. However, in practice in other National Parks, transportation analysts have used a day within the top 5-10 busiest as the standard for design and analysis. This concept indicates that the transportation system as a whole, incorporating both private vehicle and transit access, should seek a level of tolerable congestion for a level of traffic experienced in the top 5-10 busiest days.[2]

[1] Final Report of the Rocky Mountain National Park Transportation Study. Prepared by Parsons, Brinckerhoff Quade & Douglas. September 5, 2000.

[2] Traffic modeling conducted at Yosemite National Park has selected the 7th busiest day as the traffic level to calibrate to.

Figure 5.3 is a chart of vehicle entries at the Beaver Meadows entry station for June, July, and August 2008, encompassing 91 days total. The vehicle entry data were obtained from RMNP and sorted from the highest day (July 4 at 4291 vehicles) to the lowest day (June 2 at 1047 vehicles). The July 12 Saturday was the 8th busiest day at this location. Transportation data collected on this day are well suited for traffic modeling and for inferring larger issues associated with visitor access and experience. The average day for vehicle entries at the Beaver Meadows entry station was 2904 vehicles. Thus, July 12 represents vehicular entry activity that is 35% higher than average. July 10 represents vehicular entries at 80% average conditions.

Figure 5.3 Chart of Vehicle Entries at Beaver Meadows Entry Station, June –August 2008



5.4 Count Program

The traffic count program consisted of the following parts:

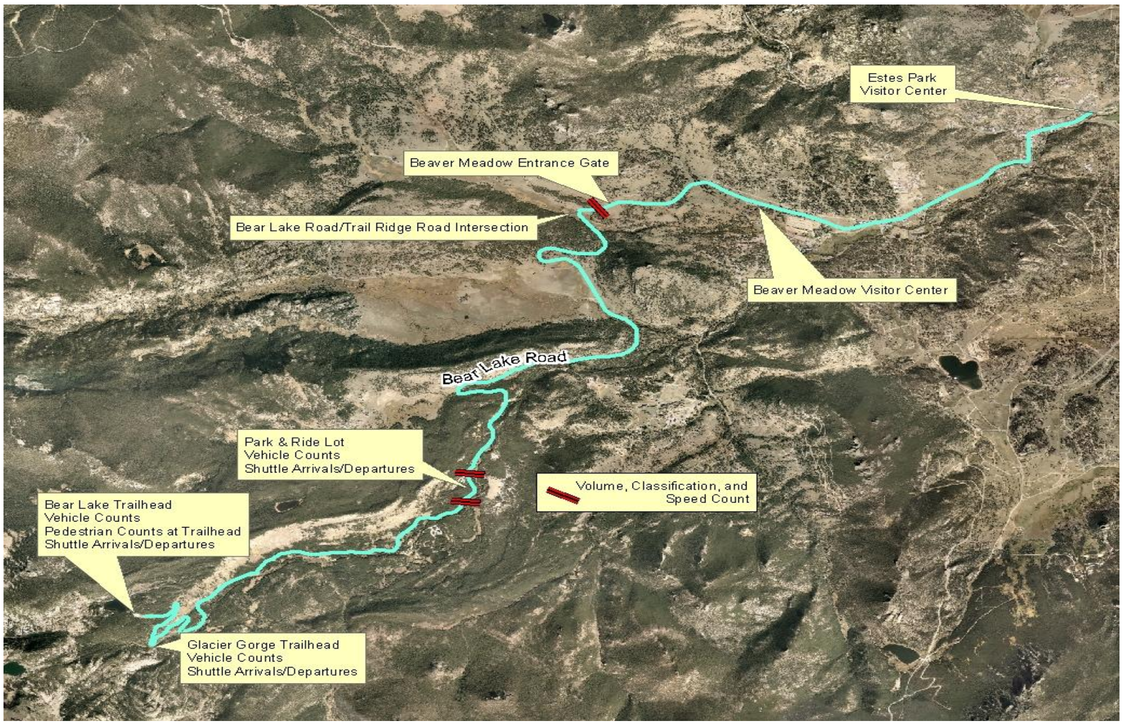
- Vehicle arrival/departure at the Bear Lake and Glacier Gorge trailheads;
- Vehicle turning movement counts (8 hour) at the Bear Lake Road/Rt. 36 intersection and at the Bear Lake Road/Bear Lake Park & Ride intersection;
- Vehicle volume, class, and speed counts at 3 locations:
    1) At a point immediately west of the Beaver Meadows Entrance Station.
    2) At a point on Bear Lake Road approximately 1,000 feet north of the Park & Ride.
    3) At a point on Bear Lake Road approximately 1,000 feet south of the Park & Ride.
- Bear Lake shuttle ridership counts, including boardings and alightings at 3 locations:
    1) at the Park and Ride;

2) at the Glacier Gorge lot;

3) at the Bear Lake trailhead.

- Hiker shuttle ridership counts at the Bear Lake Park & Ride and at the Hiker Shuttle terminus in Estes Park.

Figure 5.3: Project Area Showing Key Data Collection Locations



5.5 Vehicle Turning Movement Counts

Vehicle turning movement counts will occur for the 8-hour period at 2 locations:

1) at the Bear Lake Road/Rt. 36 intersection;

2) at the Bear Lake Road/Bear Lake Park & Ride intersection.

Traffic counts were conducted at these locations to obtain estimates of the numbers of vehicles entering the Bear Lake Road corridor and traveling toward the southern extent of the corridor south of the Park & Ride. This information does not shed light on the total number of vehicles in the corridor as many vehicles associated with overnight camping and park management were already present within the corridor prior to conducting the count. The data do, however, provide insight into vehicle movement into the corridor from external points.

Figure 5.5 shows the total hourly volume at the Bear Lake Road/Rt. 36 intersection for both 10 and 12 July. Traffic volume peaks in the afternoon on both days, and slightly later on the Saturday (3PM) than on the Thursday (2PM). The Saturday traffic is higher for each hour of the day, ranging from 16% higher at 8AM to 87% higher at 3PM.

Figure 5.4: Total Hourly Intersection Volume, Route 36/Bear Lake Road, 10 and 12 July 2008

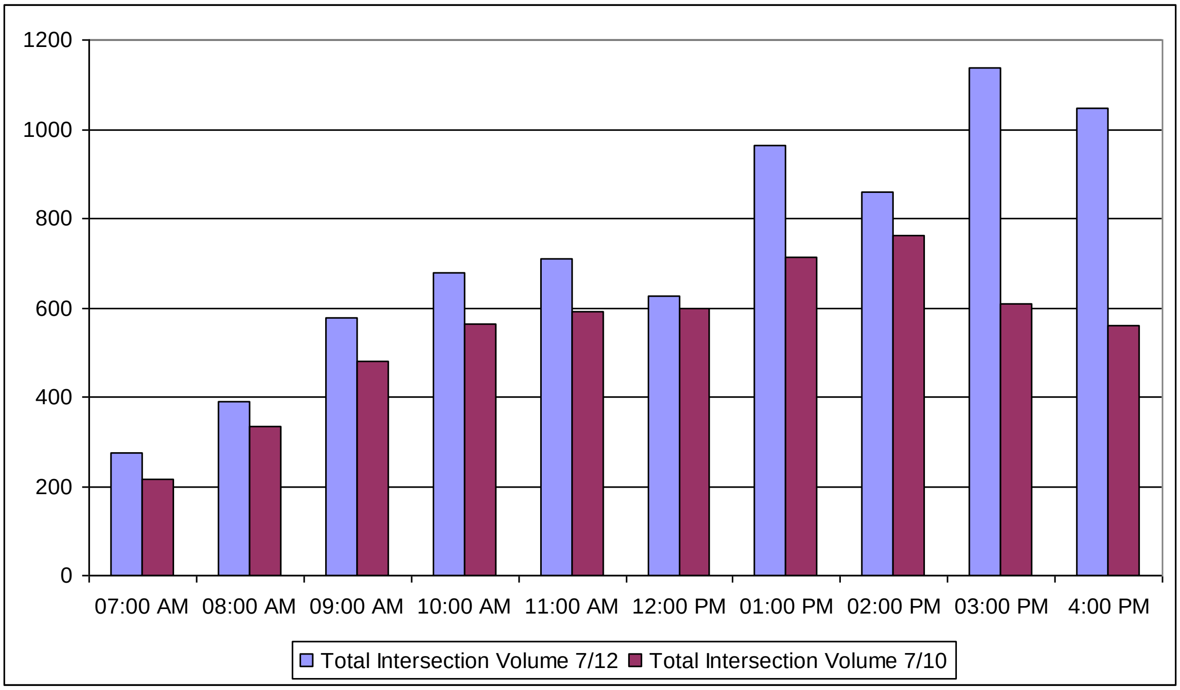
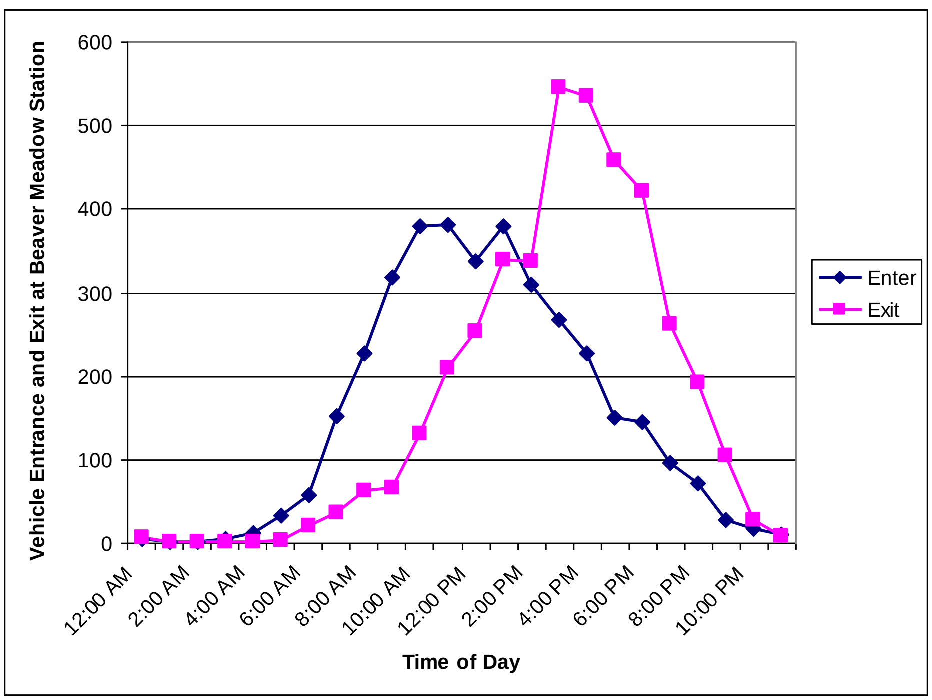


Figure 5.5 shows hourly vehicle entries and exits at the Beaver Meadows entrance station for 12 July 2008. The peak entry hour began at 12 noon on this date at this location, with approximately 380 vehicles accessing RMNP at this portal. Vehicle exiting peaks 3 hours later, beginning at 3PM, with approximately 550 vehicles exiting in the hour. Past data collection efforts have consistently shown the Beaver Meadows entrance to be a preferred exiting destination, with over 50% of all vehicles exiting the park at this location.

Figure 5.5: Hourly Vehicle Entries/Exits at the Beaver Meadows Entrance Station, 12 July 2008



The data from the turning movement count enables an estimate of the accumulation of vehicles within the corridor over the course of a typical day. Vehicles already within the corridor (e.g. parked at a camping area) are not included in this information. The data in Figure 5.7 indicate that approximately 700 vehicles were present in the corridor at 1:30PM, having originated outside the corridor earlier in the day.

Figure 5.6: Vehicle Accumulation in the Bear Lake Road Corridor, 12 July 2008

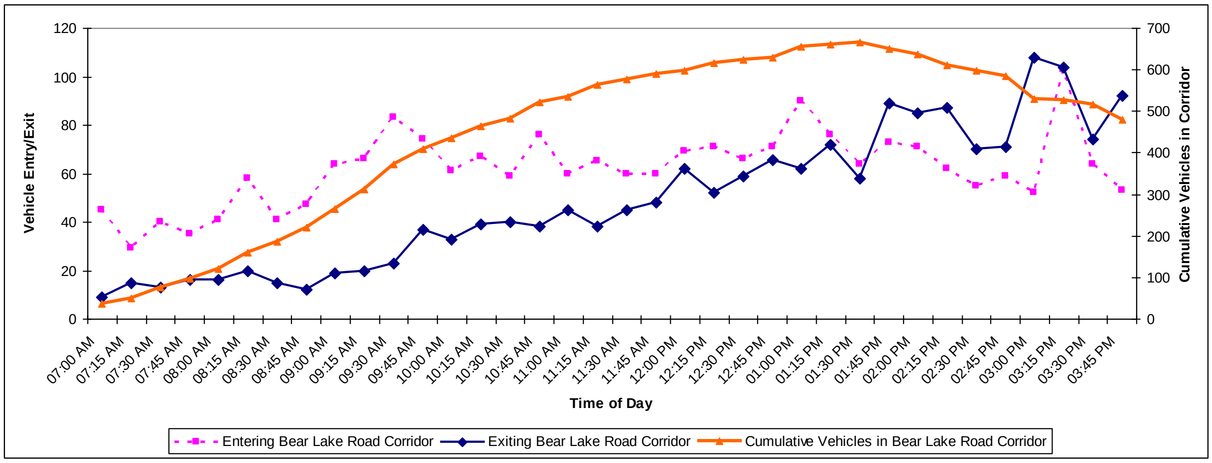
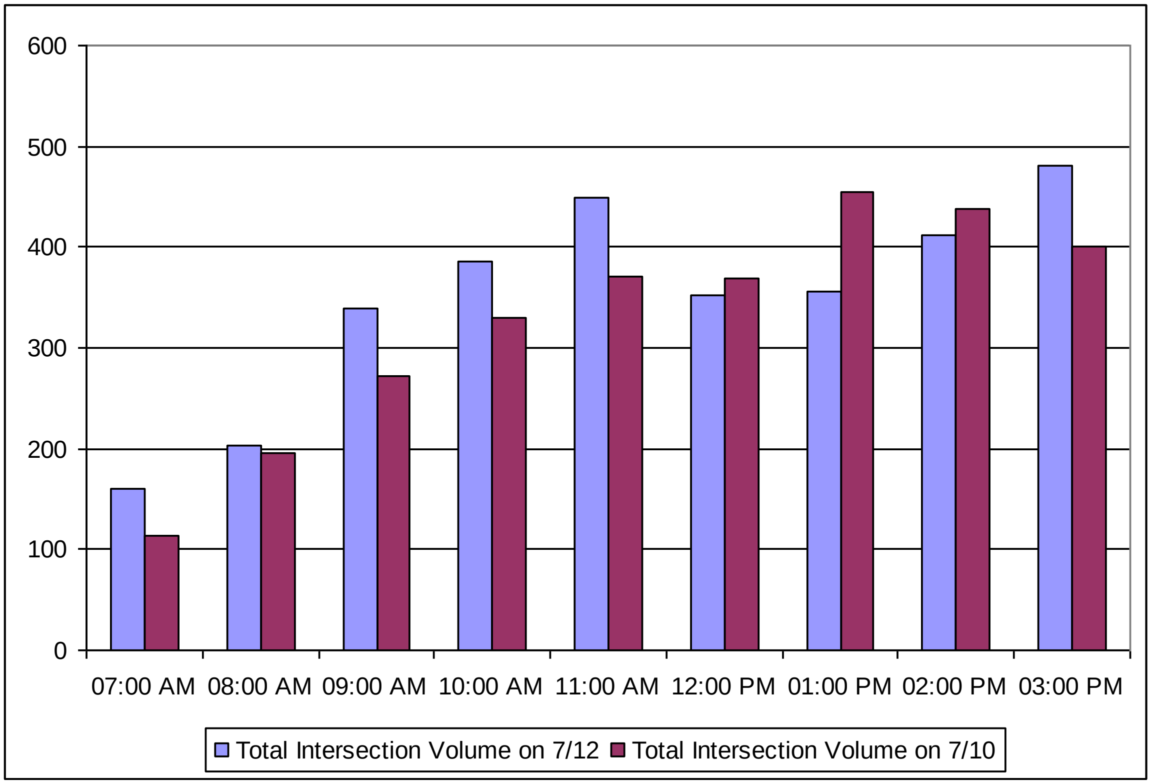


Figure 5.7 shows total intersection volumes further up the Bear Lake Road corridor at the Bear Lake Park & Ride. Volumes at this location are range from 37% to 63% of those measured at Rt. 36 on 12 July, and from 53% to 66% of those measured on 10 July.

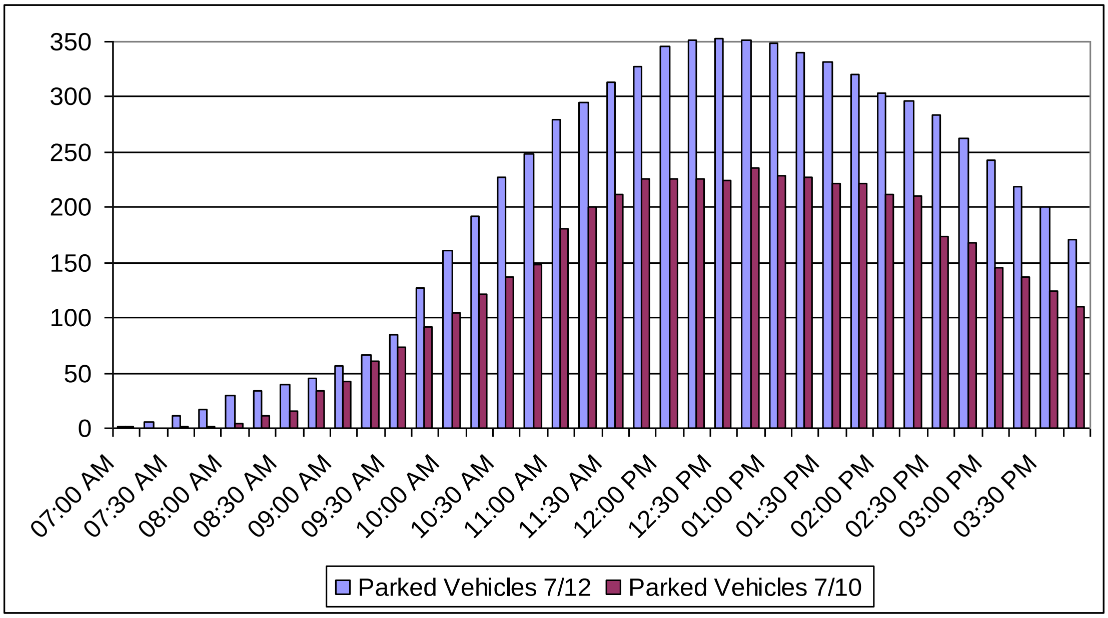
Figure 5.7: Total Hourly Intersection Volume, Bear Lake Road/Bear Lake Park & Ride, 10 and 12 July 2008



56-60%% of the traffic approaching this intersection from the north continues southbound through the intersection, traveling further into the Bear Lake Road corridor.

The turning movement count data at the Park & Ride enable an estimate of parking occupancy at that location for the 2 intense count days. This information is shown in Figure 5.8.

Figure 5.8: Parking Occupancy at the Bear Lake Park & Ride, 10 and 12 July 2008



The striped parking capacity of the Bear Lake Park & Ride is 300 spaces. However, in practice, approximately 50 additional vehicles can be accommodated along the parking lot edges for a maximum capacity of 350 vehicles. As shown in Figure 5.8, this capacity was exceeded slightly on July 12.

The data in Figure 5.8 track very closely historical data for this parking lot collected for the Rocky Mountain National Park Transportation Study in 2000. At that time, the parking capacity at the Park & Ride was around 208, and severe overcapacity conditions were regularly observed. For example, on Saturday, August 7, 2000 a peak parking occupancy of 272 vehicles (131% capacity) was observed at 12:30PM. This time period approximately represents the peak parking demand for the 2008 count for both count days.

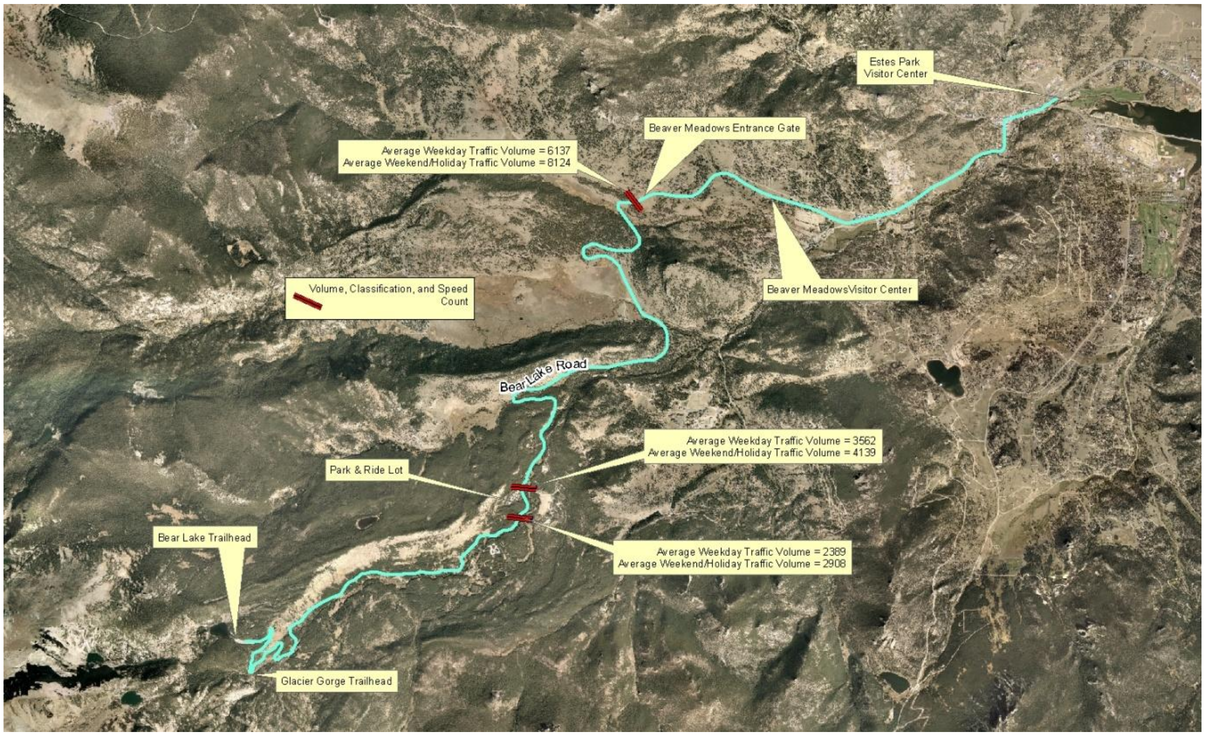
5.6 Vehicle Class and Volume Counts

Vehicle volume data were collected at 3 locations over a 2-week period (3-17 July 2008):

1) Location 1: at a point immediately west of the Beaver Meadows Entrance Station, and east of the Bear Lake Road/Trail Ridge Road intersection. A vehicle classification count was also conducted at this location.
2) Location 2: at a point on Bear Lake Road approximately 1,000 feet north of the Park & Ride.
3) Location 3: at a point on Bear Lake Road approximately 1,000 feet south of the Park & Ride.

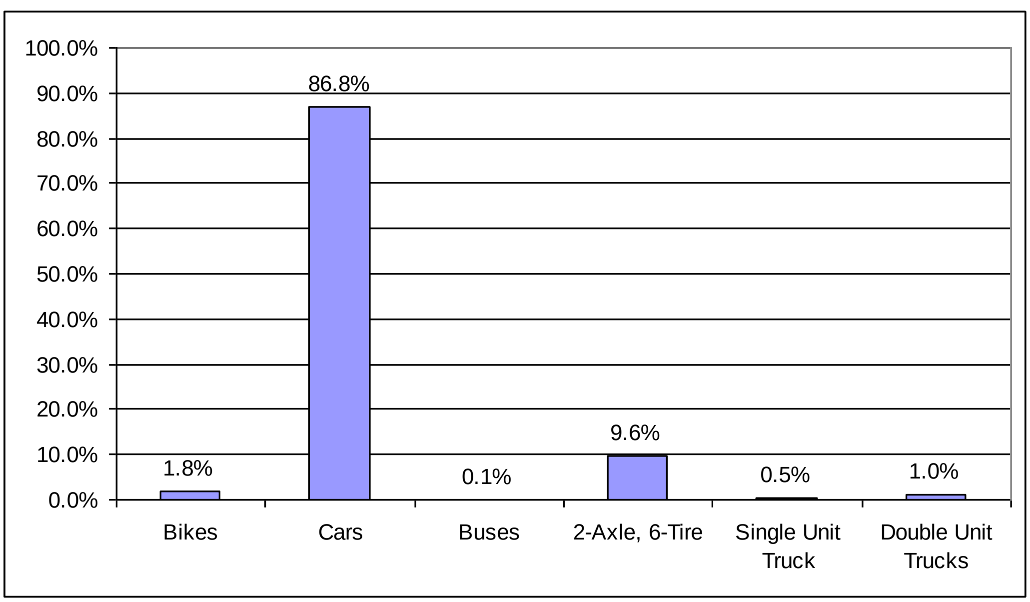
Volume data representing average weekday and average weekend/holiday daily (24-hour) traffic are shown in Figure 5.9. Weekday traffic for all locations ranges from 76% - 86% of weekend/holiday traffic (July 4 included in weekend/holiday traffic). Traffic at Location 2 is 51% (weekday) and 58% (weekend/holiday) of the traffic at Location 1, immediately proximate to the Beaver Meadows Entrance Station. Traffic at Location 3, immediately south of the Park & Ride, is 39% of the traffic measured proximate to the Beaver Meadows Entrance Station (Location 1) for weekdays and 39% for weekends/holidays,

Figure 5.9: Average Weekday Daily Volume and Average Weekend/Holiday Daily Volume, 3 Locations, July 3-17, 2008



Vehicle classification data for Location 1, proximate to the Beaver Meadows Entrance Station, are shown in Figure *5.10*.

Figure 5.10: Vehicle Classification at Location 1, Proximate to the Beaver Meadows Entrance Station



5.7 Parking Area Arrival/Departure Counts

For each count day, vehicle arrivals and departures were counted at the Bear Lake parking area and at the Glacier Gorge parking area. Each arrival and departure was time stamped and the occupancy of each vehicle was recorded. From this information, hour-by-hour parking lot occupancy could be derived, as well as an estimate of the overall number of people at each trailhead who had arrived by private automobile.

The average auto occupancy for arriving vehicles at each parking area is shown in Figure 5.11.

Figure 5.11: Average Auto Occupancy of Vehicles Arriving at Bear Lake and Glacier Gorge Parking Areas

Average Auto Occupancy (people/car)

	Bear Lake Parking Area	Glacier Gorge Parking Area
10-Jul	2.5	3.1
12-Jul	2.7	2.6

The Bear Lake parking area has a normal capacity of 245 spaces, but additional vehicles are observed to park outside of striped spaces during peak times. The Glacier Gorge parking area has a capacity of 40 vehicles. Because the overall parking area is more confined at Glacier Gorge, less unendorsed parking is possible. In addition, Glacier Gorge was observed on both survey days to reach capacity before 8:00 AM. Over half of the spaces were occupied at 7:00 AM, when the occupancy counts began, suggesting that overnight trips, longer hiking trips, or early birds are staging from Glacier Gorge.

Figure *5.12* and Figure 5.13 display the parking accumulation at the Bear Lake parking area for 10 July and 12 July respectively. On 10 July, a Thursday, the parking capacity (245) was exceeded at 11AM by a handful of vehicles, but overcapacity persisted for less than one hour. On 12 July, a Saturday, a high of 230 parked vehicles was reached at 11AM. From a visual inspection it is evident that the Saturday data show more persistent demand over a 6 hour period (roughly from 10AM to 3PM)

Figure 5.12: Vehicles Parked at the Bear Lake Parking Area, and Resulting People Accessing the Area from a Parked Automobile, 10 July 2008

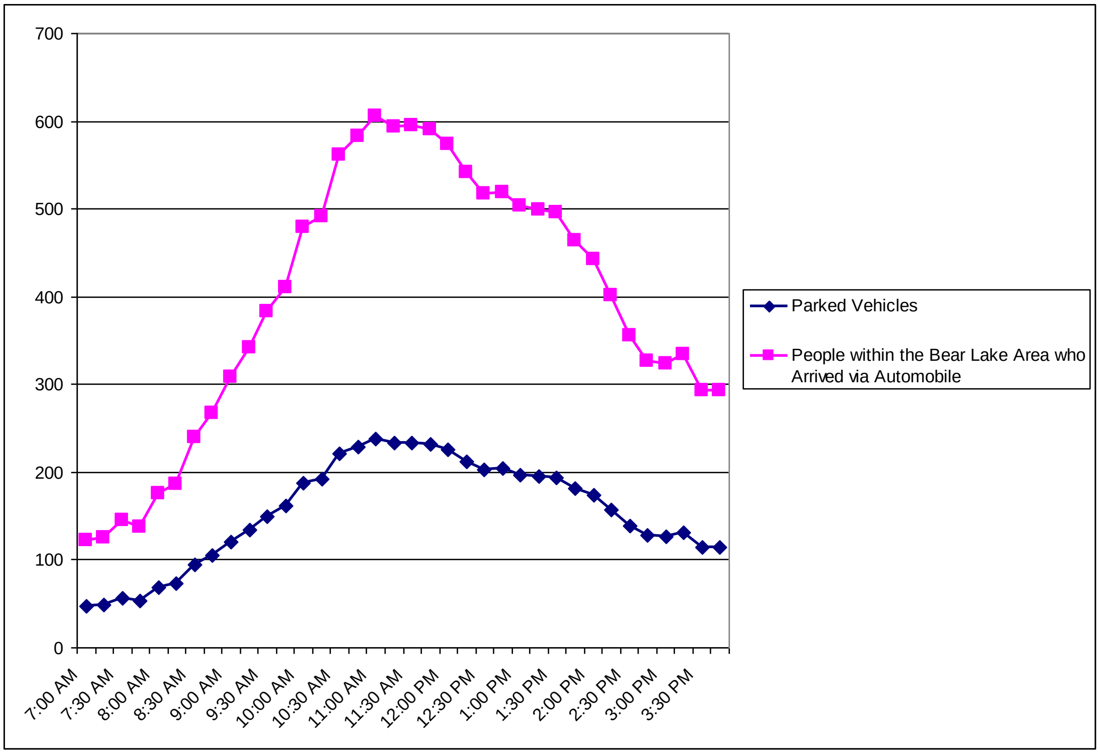


Figure 5.13: Vehicles Parked at the Bear Lake Parking Area, and Resulting People Accessing the Area from a Parked Automobile, 12 July 2008

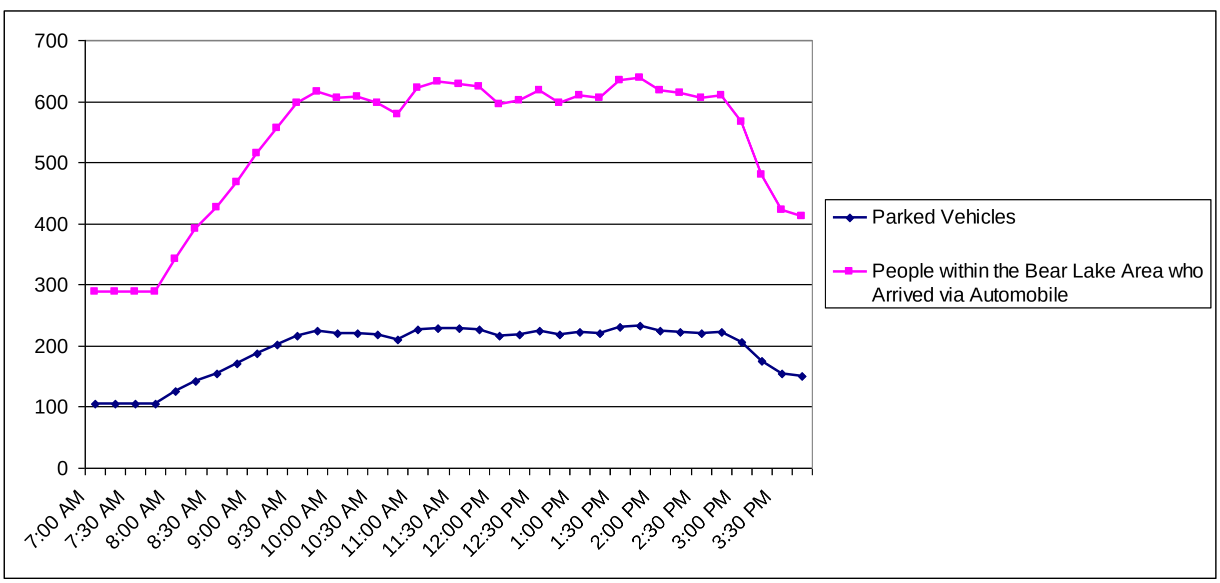


Figure *5.12* and Figure 5.13 also show the estimated number of people who access the Bear Lake area via automobile. These data are estimated from the auto occupancy counts that occurred during the vehicle counts. The data map directly to the parking occupancy and show that a peak number of 605 people had accessed the Bear Lake area via automobile on 10 July, after which the numbers fall off gradually toward the end of the afternoon. For July 12, the peak number of people accessing the area with an automobile peaked at 638 people (1:45PM), but stayed above 600 over a 6 hour period from 9:45AM to 2:45PM.

These data show graphically how parking capacity constrains the number of people who can access this popular area.

5.8 Rocky Mountain National Park's Shuttle Service

Rocky Mountain National Park's shuttle system is operated by a private contractor, McDonald Transit. The bus fleet assigned to the Bear Lake Road corridor consists of 6 low-floor buses with a maximum capacity of 45 people (28 seated). On the Park's peak visitation days (Friday-Sunday from June through August), all 6 buses operate on 8-10 minute headways. The shuttle system serves 4 stops between and inclusive of the Park & Ride lot and the Bear Lake trailhead (Figure 5.14). Smaller cut-away buses (maximum capacity of 30) are used for other routes within RMNP, including service to several campgrounds.

McDonald Transit also operates the Hiker Shuttle, which RMNP implemented in 2002. The Hiker Shuttle extends the access of the Bear Lake area to Estes Park where a considerably larger parking inventory is available (Figure 5.15). The Hiker shuttle currently accounts for approximately 6% of transit ridership within the Bear Lake corridor.

Figure 5.14: Bear Lake Road Shuttle Route and Trailhead Stops

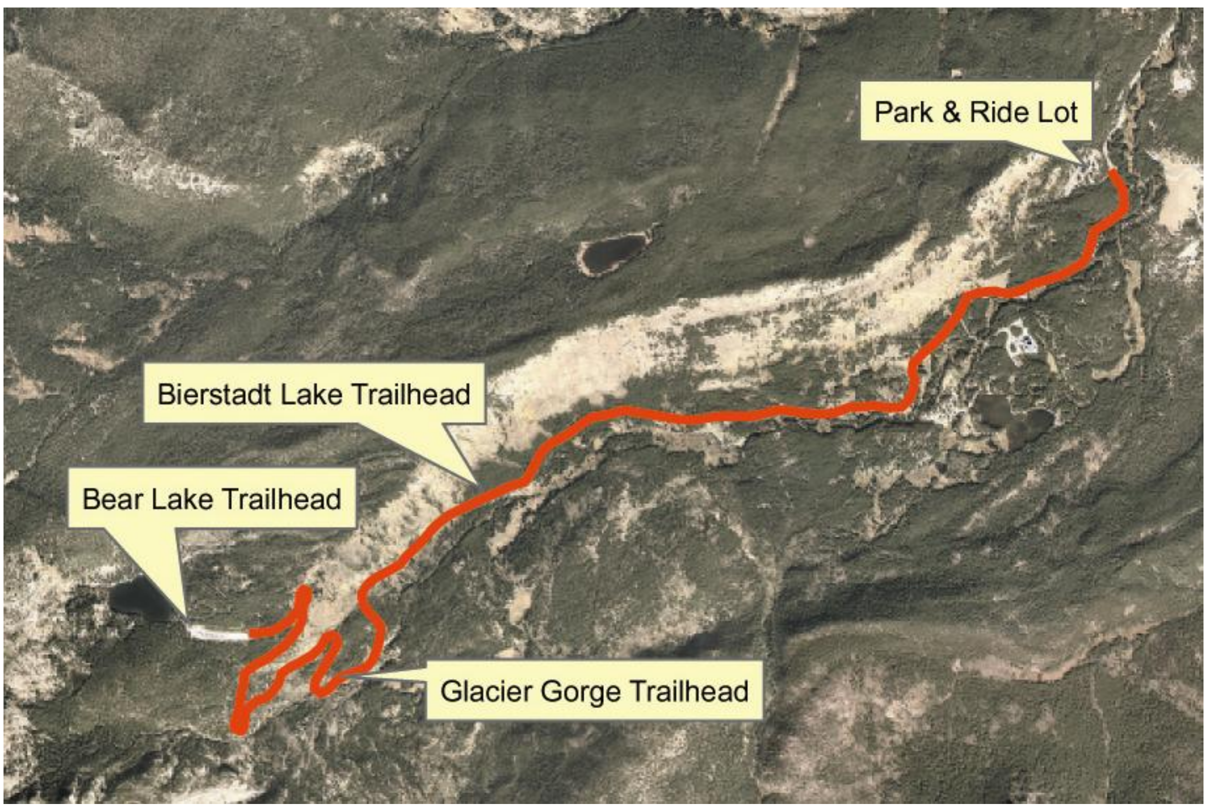
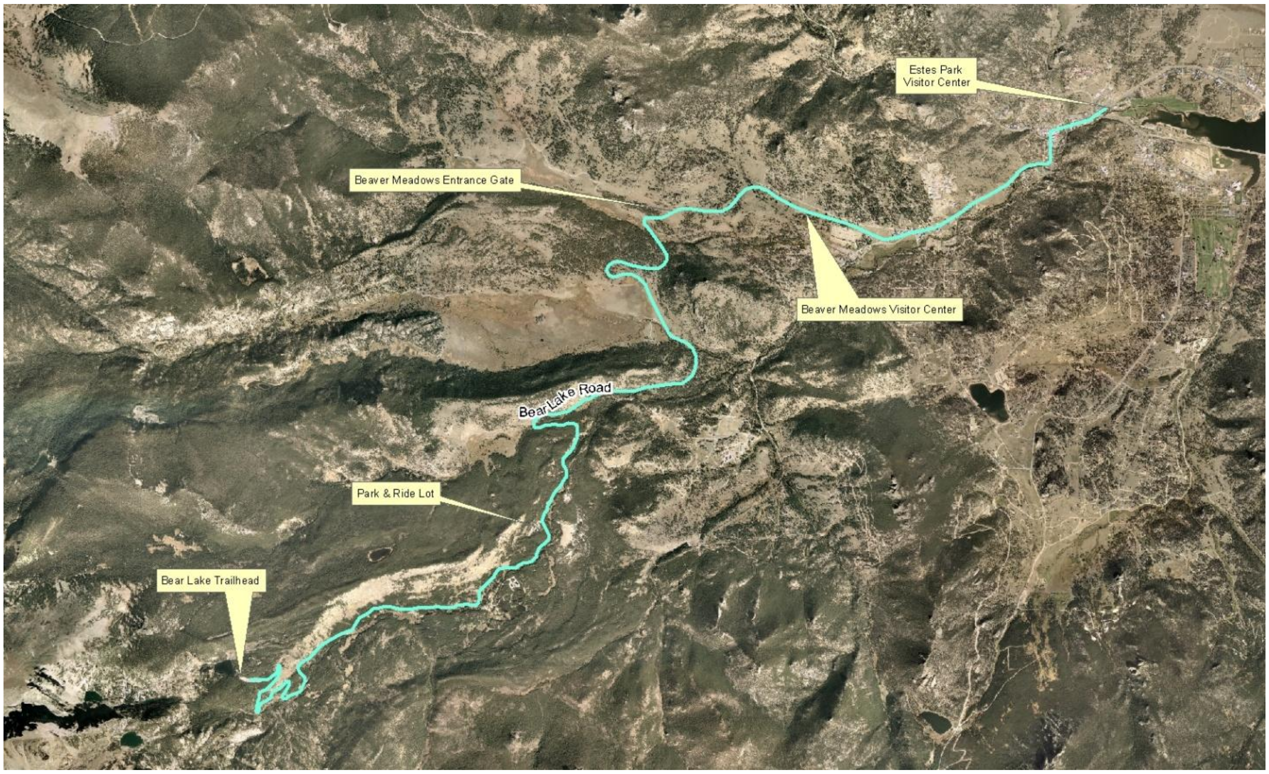


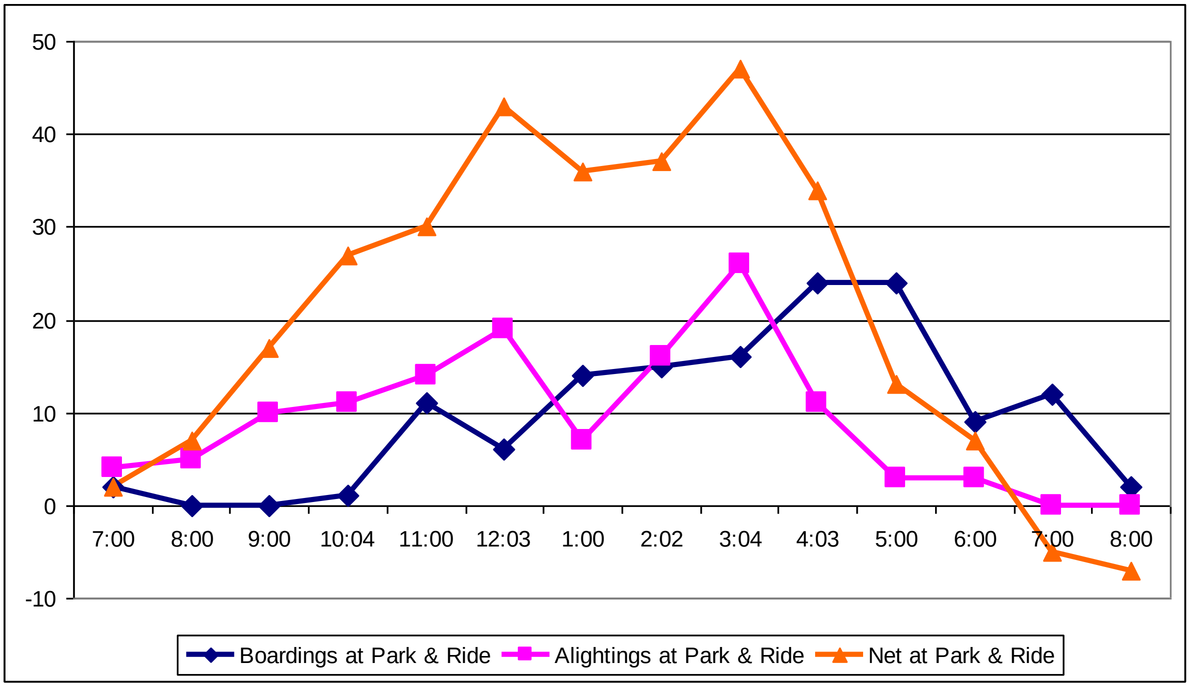
Figure 5.15: Combined Transit Routes of the Hiker Shuttle and Bear Lake Shuttle from the Estes Park Visitor Center to the Bear Lake Trailhead



The joint parking capacity at the Bear Lake Trailhead, the Glacier Gorge Trailhead, and at the Park and Ride lot (585 spaces) constrains access to the upper reaches of the Bear Lake area. When the parking lot at the Bear Lake trailhead fills up, which usually occurs before 10AM each day, RMNP staff display a sign along Bear Lake Road informing motorists wishing to access the higher reached of the Bear Lake Road corridor to use the Park and Ride lot. During the July 2008 survey days, transit access from the Park & Ride to the Bear Lake Trailhead began increasing steadily after 10AM, peaking in the early afternoon.

Figure 5.16 through Figure *5.20* show transit passenger activity for the Hiker Shuttle and Bear Lake Shuttle for 12 July 2008. Figure 5.16 shows the numbers of people arriving at the Park & Ride via the Hiker Shuttle (alightings), the number of people departing the Park & Ride via the Hiker Shuttle (boardings), and the net of boardings and alightings. In the evening hours, more people board the Hiker Shuttle than had arrived by it, indicating that they had arrived by other means (e.g. by hiking or private vehicle).

Figure 5.16: Hiker Shuttle Service to the Bear Lake Park & Ride, 12 July 2008



Once at the Park & Ride visitors have the option to board the Bear Lake Shuttle to venture further into the Bear Lake Road corridor. Between the Park & Ride and the terminus at the Bear Lake Trailhead, the shuttle stops at the Bierstadt Lake trailhead and then at the Glacier Gorge trailhead. The Bierstadt Lake trailhead is lightly used relative to the other 2 stops on the route (i.e. Glacier Gorge and Bear Lake Trailhead). For July 12, a total of 76 people took the shuttle to the Bierstadt Lake trailhead; a total of 154 people boarded the shuttle at the same location. Presumably some of these 154 were at the end of a trail hike, and a subset of these began their hike at the Bear Lake Trailhead.

Figure *5.17* shows transit passenger activity at Glacier Gorge. As discussed previously, the parking lot at this location, with only 40 spaces, is typically full by 10AM. On 12 July, the Glacier Gorge parking lot was full by 8AM. Minimal turnover occurs over the course of the day and opportunistic parking occurs whenever a space opens up. Given average auto occupancies on that day of 2.6, an estimated 90-150 people arrived at Glacier Gorge using a private automobile. Access by transit is considerably higher than this. For July 12 the data indicate that a maximum of 350 people who arrived by transit were present within the Glacier Gorge area. This maximum occurred around 1:00 PM. In summary, it is reasonable to conclude between 3 and 3-1/2 times as many people access Glacier Gorge via transit as via private vehicle on a busy visitation day at RMNP.

Figure 5.17: Boardings, Alightings, and Net People Arrived by Transit, Glacier Gorge, 12 July 2008

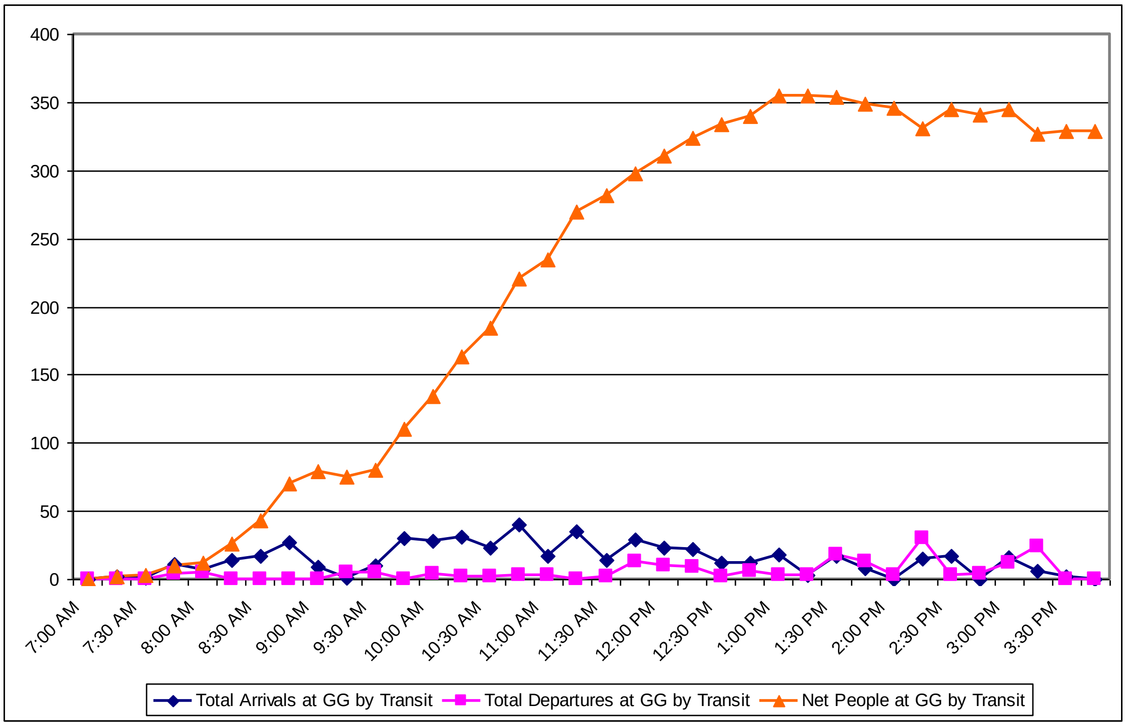


Figure 5.18 shows the same data for transit passenger access to the Bear Lake trailhead. The data show that a maximum of 600 people arrived by transit within the Bear Lake area. This maximum occurred at 1:30PM on 12 July.

Figure 5.18: Boardings, Alightings, and Net People Arrived by Transit, Bear Lake Trailhead, 12 July 2008

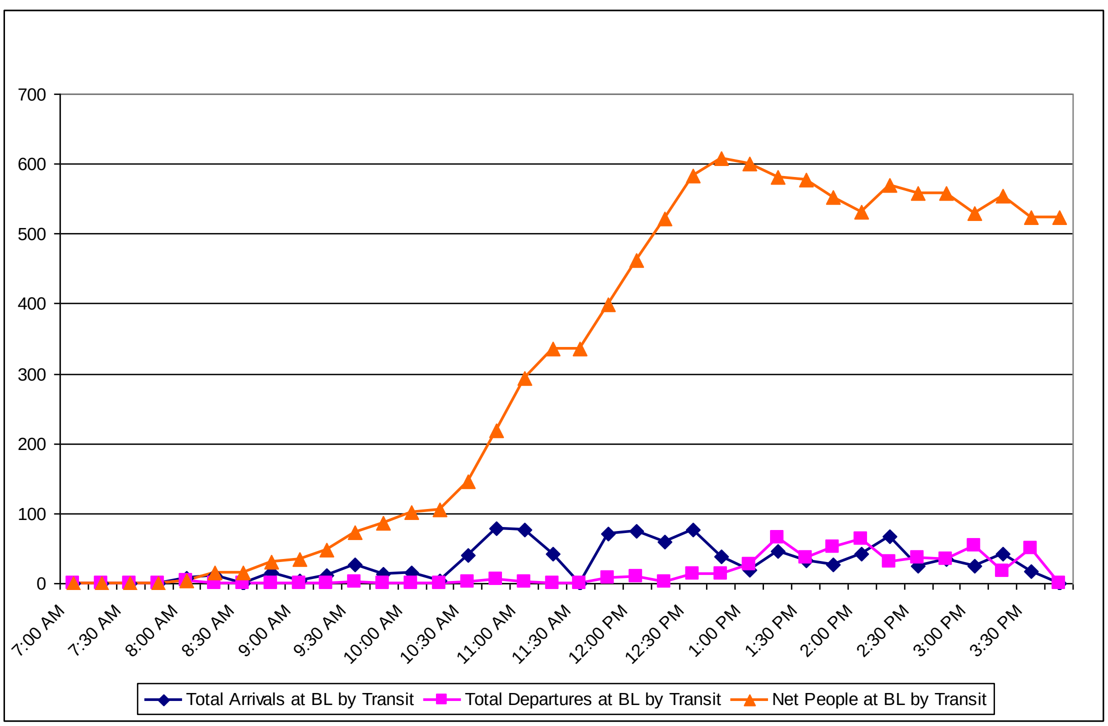


Figure 5.19 combines the information from Figure *5.12* and Figure 5.18 to compare the number of people arriving at the Bear Lake Trailhead via private vehicle and transit. Both modes deliver a similar number of people over the course of the day, with a maximum of around 1200 people present around 1:00PM, with approximately equal shares having arrived by private automobile and transit. Figure 5.19 illustrates the greater access to this area that transit has made possible, roughly doubling the number that would otherwise access the area under the current parking capacity.

Figure 5.19: People at the Bear Lake Trailhead and Surrounds, Total and Arrived by Private Vehicle and by Transit

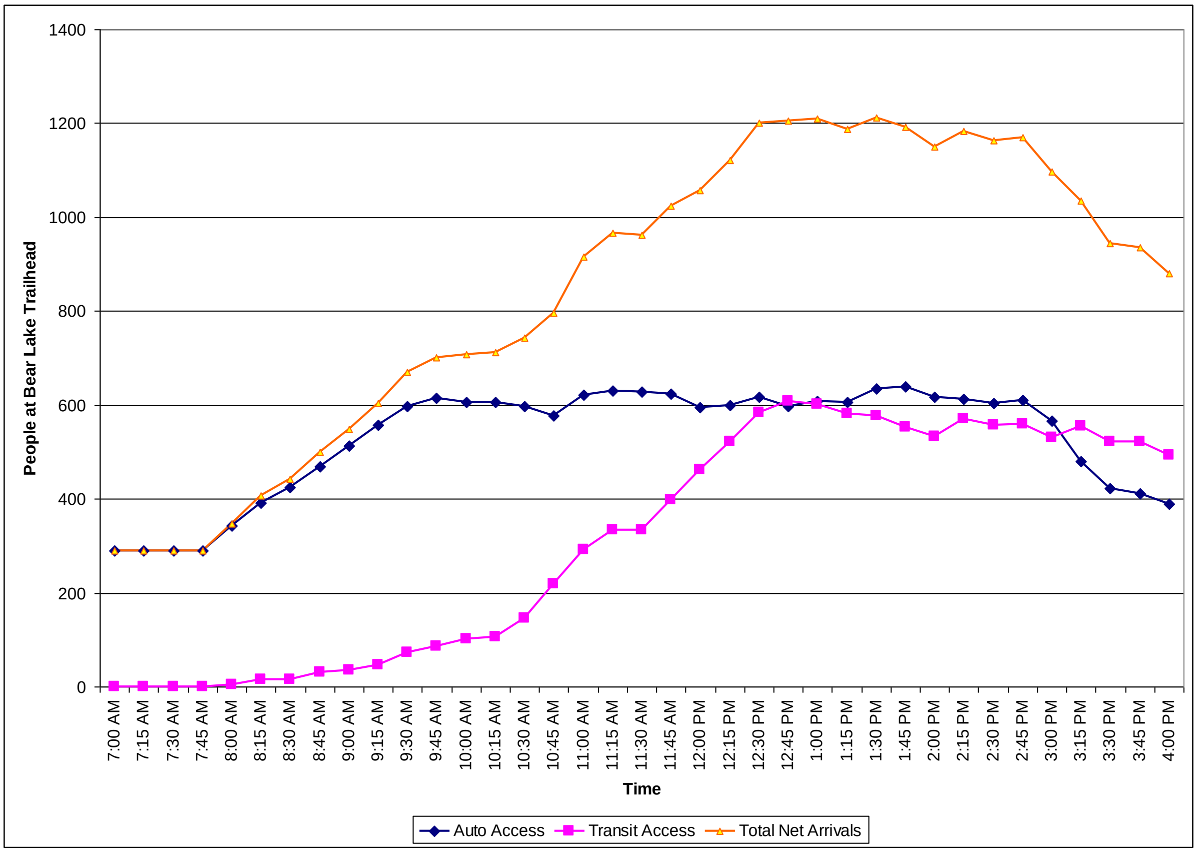


Figure *5.20* compares transit access into the Bear Lake corridor via the Hiker Shuttle and via the Bear Lake Shuttle at Glacier Gorge and the Bear Lake Trailhead.

Figure 5.20: Hourly Totals for Net People at the Park & Ride, Glacier Gorge, and Bear Lake Trailhead Having Arrived by Transit

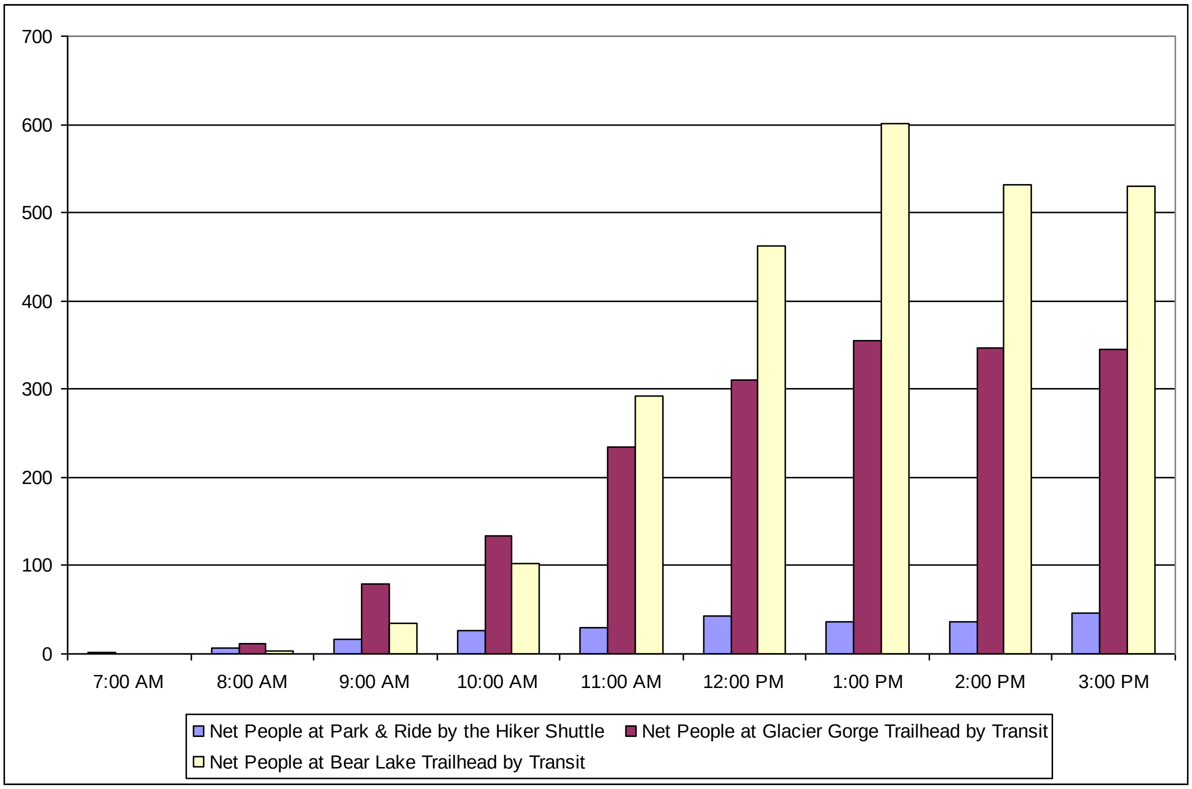
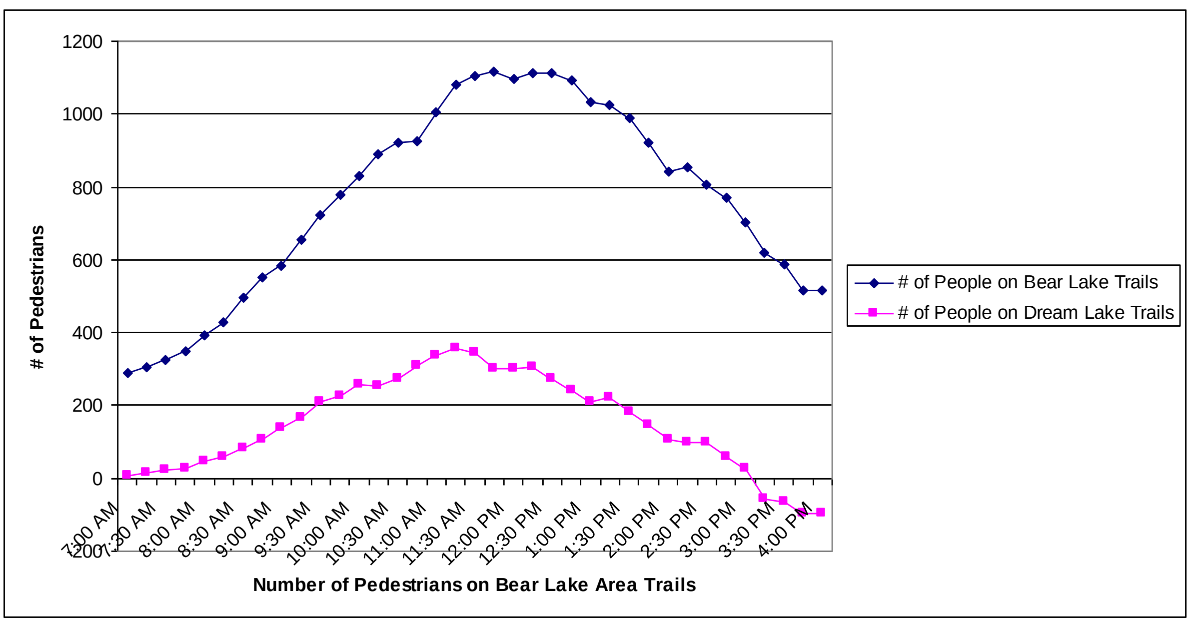


Figure 5.21: People on the Bear Lake Trails and Dream Lake Trails, 12 July 2008



The numbers of pedestrians entering the trail to the Dream Lake corridor from 9:00 – 2:00 PM ranges from 13% - 33% of the numbers in the Bear Lake area. The Dream Lake area is considerably less developed as a hiking area.

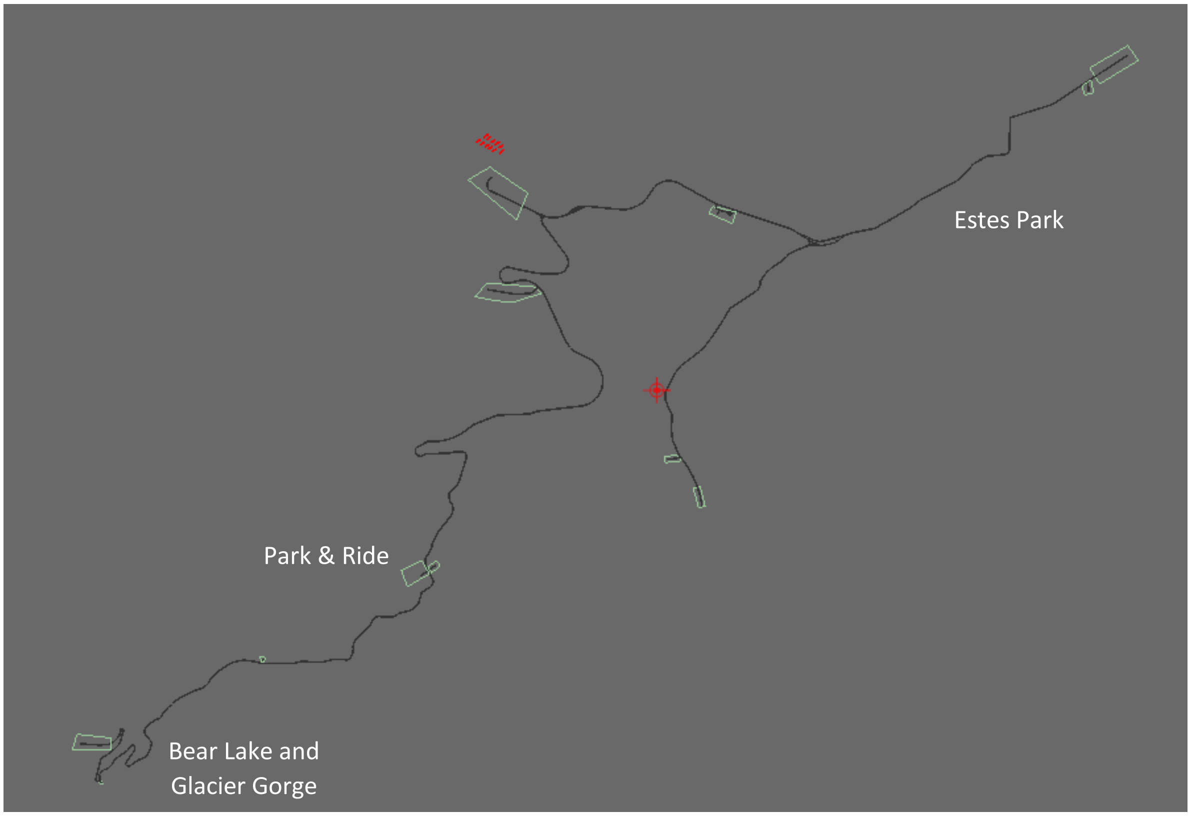
5.9 Transportation Model Development

A detailed micro-simulation traffic model of Rocky Mountain National Park and the surrounding Estes Park area was developed for analysis of visitor arrival patterns and evaluation of potential changes to the area road network, modal distributions, and land use/access changes associated with potential park improvements or policies.

This Rocky Mountain National Park traffic model was developed using Paramics microscopic traffic simulation software. The model replicates transportation patterns within Rocky Mountain National Park and the surrounding Estes Park area based on hourly traffic demands between 12 origin and destination zones. The model is calibrated to traffic volume data collected on 12 July 2008, which was the 8th busiest day in 2008, for 10 discrete hour long periods between 7:00 AM and 5:00 PM. The model incorporates both vehicular and transit access to the park and was designed to link with the Rocky Mountain Extend pedestrian model used to assess visitor experience at main park attractions and trails.

Figure 5.22 presents the graphical interface associated with the Rocky Mountain Paramics model and illustrates the level of detail associated with the various network elements and zone structure.

Figure 5.22: Rocky Mountain National Park Paramics Micro-Simulation Transportation Model



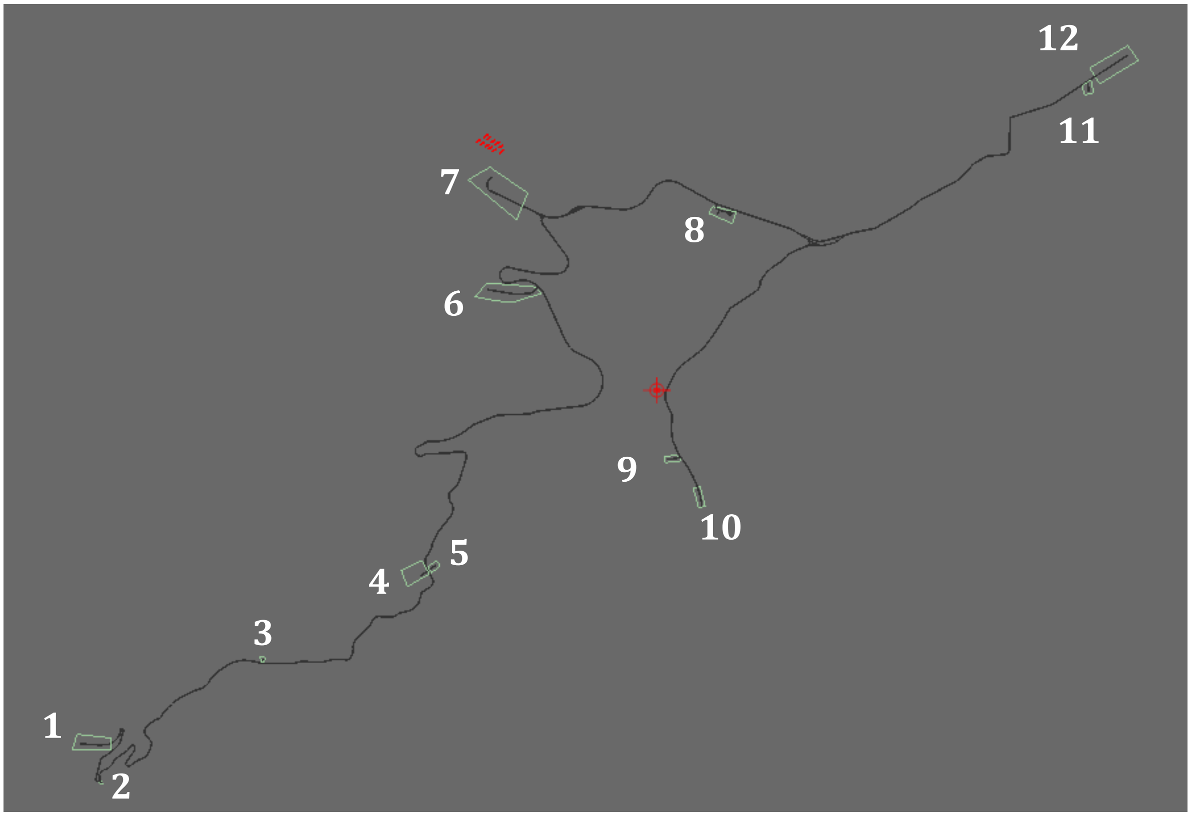
5.10 Transportation Network

Within the model road links are coded to represent road types differentiated by functional class (e.g. arterial, collector, local), incorporating information on road capacity and operating speed. Intersections are coded with varying levels of control as observed in the field.

Traffic volumes on the model road network are driven by demand between origin and destination zones representing areas of traffic generation within the study area. The 12 distinct zones used in this model are listed below and represented graphically in Figure 5.23.

1. Bear Lake Parking Lot
2. Glacier Gorge Parking Lot
3. Bierstadt trailhead and other destinations between the Park and Ride and Glacier Gorge Parking Lot[1]
4. Park and Ride Lot
5. Campground
6. Moraine Park
7. Route 36 West of Bear Lake Road
8. Beaver Meadows Visitor Center
9. YMCA
10. Route 66 south of YMCA
11. Estes Park Visitor Center
12. Route 34 East of Estes Park Visitor Center

Figure 5.23: Model Origin & Destination Zones



[1] While this zone is located at the Bierstadt trailhead it is used to represent traffic at all destinations between the Park and Ride and Glacier Gorge.

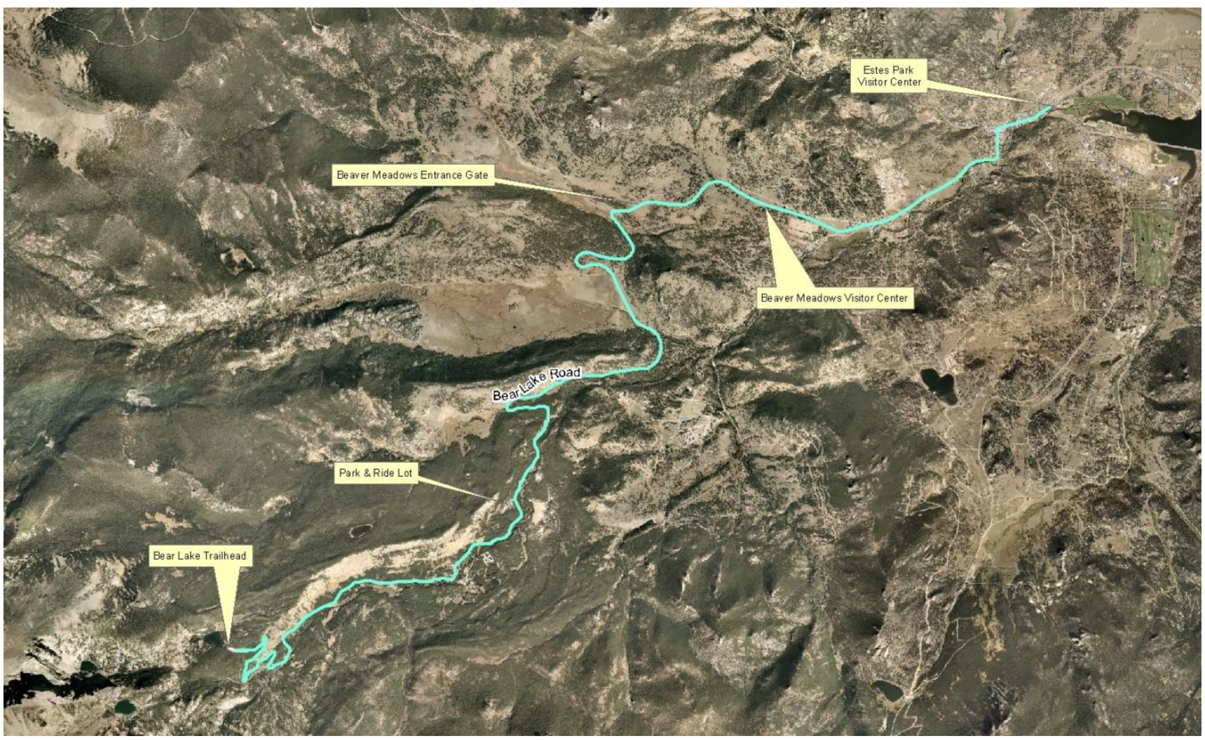
5.11 Transit Modeling

The two main transit routes delivering visitors to Rocky Mountain National Park and the Bear Lake corridor were modeled for scenario analysis. Transit routes were both coded into the Paramics transportation model and modeled explicitly in a Microsoft Excel based model. Hiker Shuttle routes between the Bear Lake Park and Ride and Estes Park advertise operation with hourly headways while the Bear Lake Shuttle Routes between the Bear Lake Park and Ride and the Bear Lake Parking Lot advertise operation on 10 -15 minute headways. Field observations, however, revealed significantly shorter headways for the Bear Lake Shuttle, ranging between only a few minutes to over 15 minutes depending on the time of day. Due to the wide variation in actual transit headways the Excel based transit model outputs were integrated with the Extend pedestrian model to maintain a higher level of precision.

5.12 Model Calibration

The Rocky Mountain National Park Paramics traffic model was calibrated to traffic counts conducted on 12 July 2008 for all 10 hours of simulation and analysis. Traffic volume data collected at the six locations shown in Figure 5.24 were used for calibration.

Figure 5.24: Rocky Mountain National Park Data Collection Sites



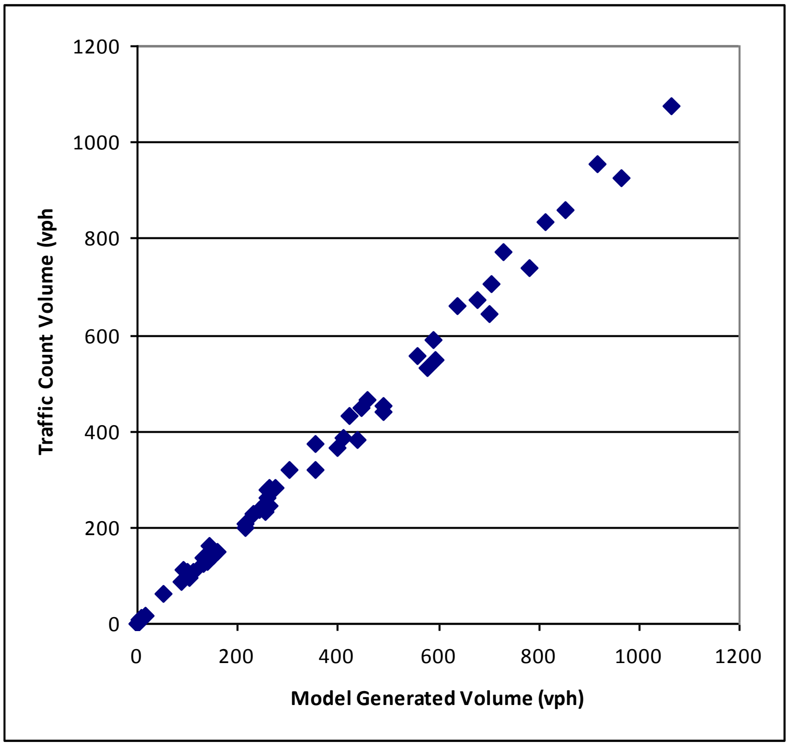
The critical process in model calibration is the estimation of an origin-destination matrix ("O-D matrix") that represents the zone-to-zone vehicle trips during the 10 separate analysis hours. The Rocky Mountain National Park Paramics model has 12 transportation analysis zones (TAZs), leading to a 12 X 12 matrix of vehicle trips. A matrix estimation process was used to develop the calibrated hourly trip tables.

The estimation process involves assigning an estimated O-D matrix to the roadway network and comparing the accumulated vehicle travel paths against the calibration count set for each analysis hour. Thus, every left turn, through movement, and right turn estimated in the model is compared against the actual number of left turns, through movements, and right turns within the calibration count set.

As the process evolves, confidence in the values of specific origin-destination pairs increases, allowing those values to be constrained. This, in turn, focuses the O-D estimation process on those O-D pairs for which less information is available. After each iteration step the estimated O-D pair is assigned to the roadway network and compared with the count set. There are statistical measures of fit (described below) that provide the analyst with a quantification of the calibration. When those calibration thresholds are met, the calibration process is considered complete and the resulting model is considered valid for planning purposes.

Figure 5.25 shows the distribution of model projected traffic volumes as compared with the actual count volumes for the entire 10 hours of analysis. A 45-degree line represents a perfect correlation of model output against the traffic count.

Figure 5.25: Distribution of Traffic Counts vs. Model Output



There are two levels of calibration standards that the model has been compared to. The first level relates to the standards that are conventionally applied to travel demand models. These standards have been developed by the Federal Highway Administration (FHWA) to provide a threshold of quality for transportation models used for regional transportation planning. Figure 5.26 shows the model performance relative to the recommended FHWA standards for traffic volumes assigned to functional classes.

Figure 5.26: Model Calibration Relative to Recommended Calibration Thresholds for Regional Travel Demand Models

Time Period	Hourly Calibration Summary	Value	Goal
7:00 AM – 8:00 AM	RMSE	10%	<40%
	Coefficient of Correlation (r)	0.997	>= 0.88
	Percent Error (Region)	1%	+/- 5%
	Percent Error (Arterials)	2%	15%
	Percent Error (Collectors)	23%	25%

Time Period	Measure	Value	Goal
8:00 AM – 9:00 AM	RMSE	13%	<40%
	Coefficient of Correlation (r)	0.997	>= 0.88
	Percent Error (Region)	3%	+/- 5%
	Percent Error (Arterials)	6%	15%
	Percent Error (Collectors)	0%	25%
9:00 AM – 10:00 AM	RMSE	12%	<40%
	Coefficient of Correlation (r)	1.000	>= 0.88
	Percent Error (Region)	8%	+/- 5%
	Percent Error (Arterials)	7%	15%
	Percent Error (Collectors)	10%	25%
10:00 AM – 11:00 AM	RMSE	17%	<40%
	Coefficient of Correlation (r)	0.998	>= 0.88
	Percent Error (Region)	1%	+/- 5%
	Percent Error (Arterials)	12%	15%
	Percent Error (Collectors)	1%	25%
11:00 AM – 12:00 PM	RMSE	9%	<40%
	Coefficient of Correlation (r)	0.997	>= 0.88
	Percent Error (Region)	4%	+/- 5%
	Percent Error (Arterials)	4%	15%
	Percent Error (Collectors)	7%	25%
12:00 PM – 1:00 PM	RMSE	5%	<40%
	Coefficient of Correlation (r)	0.999	>= 0.88
	Percent Error (Region)	3%	+/- 5%
	Percent Error (Arterials)	2%	15%
	Percent Error (Collectors)	3%	25%
1:00 PM – 2:00 PM	RMSE	9%	<40%
	Coefficient of Correlation (r)	0.998	>= 0.88
	Percent Error (Region)	4%	+/- 5%
	Percent Error (Arterials)	6%	15%
	Percent Error (Collectors)	5%	25%
2:00 PM – 3:00 PM	RMSE	5%	<40%
	Coefficient of Correlation (r)	0.999	>= 0.88
	Percent Error (Region)	2%	+/- 5%
	Percent Error (Arterials)	0%	15%
	Percent Error (Collectors)	4%	25%
3:00 PM – 4:00 PM	RMSE	3%	<40%
	Coefficient of Correlation (r)	1.000	>= 0.88
	Percent Error (Region)	1%	+/- 5%
	Percent Error (Arterials)	0%	15%
	Percent Error (Collectors)	2%	25%
4:00 PM – 5:00 PM	RMSE	9%	<40%
	Coefficient of Correlation (r)	0.998	>= 0.88
	Percent Error (Region)	3%	+/- 5%
	Percent Error (Arterials)	2%	15%
	Percent Error (Collectors)	5%	25%

Additional standards have been developed specifically for microsimulation travel models. These standards were first published in 2004 by the Transportation Research Board (TRB), a branch of the National Science Foundation. The TRB standards rely upon the GEH statistic, which is an empirical measure of fit used to compare errors across roadways with largely different traffic flows. The GEH statistic is computed as follows:

$$GEH = \sqrt{\frac{(ModelVolume - CountVolume)^2}{0.5 * (ModelVolume + CountVolume)}}$$

Figure 5.27 shows the performance of the Rocky Mountain National Park Paramics Model relative to the standard for the GEH statistic for all 10 analysis hours. As can be seen in the figure, all calibration volumes are modeled closely enough to fall within the most stringent, <5, category for GEH.

Figure 5.27: Model Performance Relative to Calibration Standards for Microsimulation Models

	GEH by Movement		
	<5	5-->10	>10
Recommended Range	>85%	<=15%	0%
Model Range	100%	0%	0%

5.13 Model Results and Findings

For this analysis baseline conditions (calibrated to the 8th busiest day in 2008) were compared against two potential transportation demand alternatives. In these alternative scenarios increased transit capacity and ridership was modeled assuming two different levels of effectiveness, creating the two study alternatives. Both assume increased Hiker Shuttle service from Estes Park to the Bear Lake Park and Ride, with bus headways decreasing from 1 hour to 15 minutes, and the implementation of an intelligent transportation system (ITS) designed to capture personal vehicle trips to the Bear Lake corridor in Estes Park and at the Bear Lake Park and Ride. Personal vehicle trips captured at these two locations would become new transit trips to Bear Lake corridor destinations. The ITS system, consisting of multiple integrated signs, would confront motorists on the approach to Estes Park from the east as well as on the approach to the park and ride lot, stimulating demand for both the Hiker Shuttle and the Bear Lake Shuttle. The thrust of the ITS message in both locations would be:

- "avoid parking hassles;
- avoid congestion in the park;
- reduce your carbon footprint;
- park here and ride the free shuttle bus"

The two increased transit ridership scenarios assume a 10% capture rate and a 25% capture rate for the Hiker Shuttle and the Bear Lake Shuttle. This translates to either 10% or 25% of the vehicle trips currently traveling from points east of the park to the Bear Lake Park and Ride would end their trips in Estes Park and become new passengers on the Hiker shuttle and, in addition, 10% or 25% of the vehicle trips heading beyond the park and ride toward the Bear Lake area (inclusive of the higher elevation areas around Bierstadt Lake, Glacier Gorge, etc.) would end their trips at the Bear Lake Park and Ride and would become new passengers on the Bear Lake shuttle.

5.14 Impacts to Passenger Vehicle Traffic and Air Quality

The Baseline, 10% Transit Capture, and 25% Transit Capture scenarios were analyzed with the transportation model. Daily[1] network performance measures on vehicle miles travelled (VMT), vehicle hours travelled (VHT), fuel consumption, and greenhouse gas emissions were obtained for the three scenarios. Fuel consumption estimates are based on an average vehicle fleet fuel economy of 20 mpg. Carbon Dioxide (CO_2) projections assume 19.4 lbs of CO_2 per gallon of gasoline consumed. Carbon Monoxide (CO), Nitrogen Oxides (NO_x), and Volatile Organic Compound (VOC) emissions are derived from emissions factors provided by the New Hampshire Department of Environmental Services.[2]

Figure 5.28 shows the projected values for each of these metrics while Figure 5.29 shows the projected change from Baseline values for the two alternative scenarios. Both alternative scenarios are projected to significantly reduce overall number of personal vehicles on the road. Figure 5.30 and Figure 5.31 present the corresponding projections in scenario fuel consumption and emissions and the projected change between the Baseline and two alternate scenarios. Again, the two increased transit scenarios are projected to significantly reduce local fuel consumption and emissions levels.

Figure 5.28: Daily Network Performance Indicators

	VMT	VHT
Baseline	52183	1606
10% Transit Capture	51257	1579
25% Transit Capture	49541	1516

Figure 5.29: Daily Network Performance Indicators Change from Baseline

	VMT	VHT
Baseline		
10% Transit Capture	-926	-27
25% Transit Capture	-2642	-89

Figure 5.30: Daily Projected Scenario Fuel Consumption and Emissions

	Fuel (gal)	CO2 (kg)	CO (kg)	NOx (kg)	VOCs (kg)
Baseline	2609	22960	735	53	32
10% Transit Capture	2563	22552	722	52	32
25% Transit Capture	2477	21797	698	50	31

Figure 5.31: Daily Projected Fuel Consumption and Emissions Change from Baseline

	Fuel (gal)	CO2 (kg)	CO (kg)	NOx (kg)	VOCs (kg)
Baseline					
10% Transit Capture	-46	-407	-13	-1	-1
25% Transit Capture	-132	-1163	-37	-3	-2

[1] Daily figures represent totals for the 10 analysis hours studied in this analysis.

[2] While the NHDES emissions factors are generated to represent emissions locally in New Hampshire, lacking similar data for Colorado they are used in this analysis and provide a good indication of relative emissions impacts between the various scenarios.

5.15 Impacts on Parking Lot Capacities

Hourly parking lot capacities at the Bear Lake Park and Ride, the Bear Lake trailhead, and the Glacier Gorge Trailhead were analyzed based on the projected shifts in visitor arrival modes. Figure 5.32 through Figure 5.34 present the observed hourly parking utilization and the projected parking utilization in the 10% Transit Capture and 25% Transit Capture scenarios at the Bear Lake Lot, Glacier Gorge Lot, and Bear Lake Park and Ride Lot respectively. Hours when projected demand exceeds available capacity are shown in orange. Additionally at the Bear Lake Park and Ride while the official authorized parking capacity is 300 spaces there exists additional room along the periphery of the lot for additional, unauthorized, parking. It is estimated that a comfortable total capacity beyond the official striped parking is roughly 350 vehicles. Scenario time periods where Bear Lake Park and Ride parking demand exceeds 350 spaces are highlighted in red.

As can be seen below, the two alternative scenarios shift parking demand from the Bear Lake and Glacier Gorge trailhead parking lots to the centralized Bear Lake Park and Ride Lot. While this reduces pressure on the trailhead lots it increases demand at the Park and Ride which is already heavily utilized. If the more aggressive 25% Transit Capture scenario were to be realized increased parking capacity would need to be obtained at the Bear Lake Park and Ride as demand is projected to exceed capacity during three midday hours in this scenario.

Figure 5.32: Parking Utilization at the Bear Lake Lot

	Observed Parking	**Parking 10% Transit**	**Parking 25% Transit**
7:00 AM	105	**101**	**95**
8:00 AM	170	**158**	**138**
9:00 AM	224	**201**	**167**
10:00 AM	210	**185**	**148**
11:00 AM	227	**204**	**170**
12:00 PM	217	**199**	**171**
1:00 PM	232	**212**	**181**
2:00 PM	222	**202**	**172**
3:00 PM	150	**134**	**110**
4:00 PM	84	**76**	**63**
Average Lot Usage	75%	**68%**	**58%**

Figure 5.33: Parking Utilization at the Glacier Gorge Lot

	Observed Parking	**Parking 10% Transit**	**Parking 25% Transit**
7:00 AM	37	**37**	**37**
8:00 AM	37	**37**	**36**
9:00 AM	37	**37**	**36**
10:00 AM	36	**36**	**36**
11:00 AM	35	**35**	**34**
12:00 PM	35	**34**	**33**
1:00 PM	34	**33**	**32**
2:00 PM	33	**32**	**31**
3:00 PM	31	**30**	**27**
4:00 PM	29	**27**	**24**
Average Lot Usage	86%	**84%**	**81%**

Figure 5.34: Parking Utilization at the Bear Lake Park and Ride Lot

	Observed Parking	**Parking 10% Transit**	**Parking 25% Transit**
7:00 AM	28	**35**	**46**
8:00 AM	56	**71**	**94**
9:00 AM	138	**165**	**205**
10:00 AM	259	**286**	**327**
11:00 AM	338	**366**	**407**
12:00 PM	364	**388**	**424**
1:00 PM	359	**385**	**424**
2:00 PM	314	**342**	**384**
3:00 PM	254	**284**	**330**
4:00 PM	167	**195**	**239**
Average Lot Usage	73%	**80%**	**92%**

5.16 Impacts on Transit Capacity

Figure 5.35 and Figure 5.36 present the hourly Baseline transit ridership on the Bear Lake Shuttle and the Hiker Shuttle alongside the projected ridership in the 10% Transit Capture and 25% Transit Capture scenarios. Capacity for the Bear Lake Shuttle assumes 10 trailhead bus deliveries per hour while with a maximum capacity of 45 visitors per bus (including standing riders). Capacity for the Hiker Shuttle is currently 26 riders per bus on a single bus per hour. Both the 10% Transit Capture and 25% Transit Capture scenarios assume service would be expanded to 4 busses per hour resulting in an hourly capacity of 104 visitors per hour. Hours where demand exceeds capacity are highlighted in orange.

As can be seen below, reduced headways (higher frequency) on the Bear Lake Shuttle would be necessary to accommodate ridership demand during the busiest hour (11:00 AM – 12:00 PM). Some increase in shuttle capacity may be achieved as busses fill faster and initiate routes earlier with increased demand (reducing idle time spent waiting for passenger demand). However, increases in transit capacity may be required to accommodate the more ambitious 25% transit capture goal. The proposed increase in transit capacity for the Hiker Shuttle is projected to be more than sufficient to accommodate increased demand in both the 10% and 25% transit capture scenarios.

Figure 5.35: Bear Lake Shuttle Ridership Projections

	Riders/Hour Observed	**Riders/Hour 10% Transit**	**Riders/Hour 25% Transit**
7:00 AM	33	**61**	**103**
8:00 AM	95	**127**	**175**
9:00 AM	101	**154**	**234**
10:00 AM	257	**301**	**368**
11:00 AM	432	**475**	**538**
12:00 PM	312	**344**	**392**
1:00 PM	149	**185**	**238**
2:00 PM	194	**228**	**279**
3:00 PM	138	**170**	**218**
4:00 PM	197	**225**	**267**

Figure 5.36: Hiker Shuttle Ridership Projections

	Riders/Hour Observed	**Riders/Hour 10% Transit**	**Riders/Hour 25% Transit**
7:00 AM	3	**9**	**19**
8:00 AM	1	**10**	**24**
9:00 AM	8	**27**	**56**
10:00 AM	17	**38**	**69**
11:00 AM	21	**40**	**68**
12:00 PM	20	**29**	**42**
1:00 PM	17	**23**	**31**
2:00 PM	12	**17**	**24**
3:00 PM	22	**24**	**26**
4:00 PM	13	**16**	**20**

Additional metrics for comparing transit effectiveness and feasibility were calculated for the two alternative scenarios. Basic data on route lengths, frequencies, schedules, and ridership in conjunction with approximate operating costs inform the comparative values presented in Figure 5.37.[1] The approximate one-way length of the Hiker Shuttle route is 9.5 miles while the approximate one-way route distance for the Bear Lake Shuttle is 4.5 miles.

Figure 5.37: Indicators of Transit Efficiency

	Baseline	10% Transit Capture	25% Transit Capture
Operating Hours	70	100	100
Operating Costs ($/day)	4900	7000	7000
Passengers/Day	3073	3765	4803
Passengers/Hour	307	377	480
Cost/Passenger ($)	1.6	1.9	1.5
Transit Miles Traveled/Day	775	1345	1345
Passengers/Transit Mile Travelled	4.0	2.8	3.6

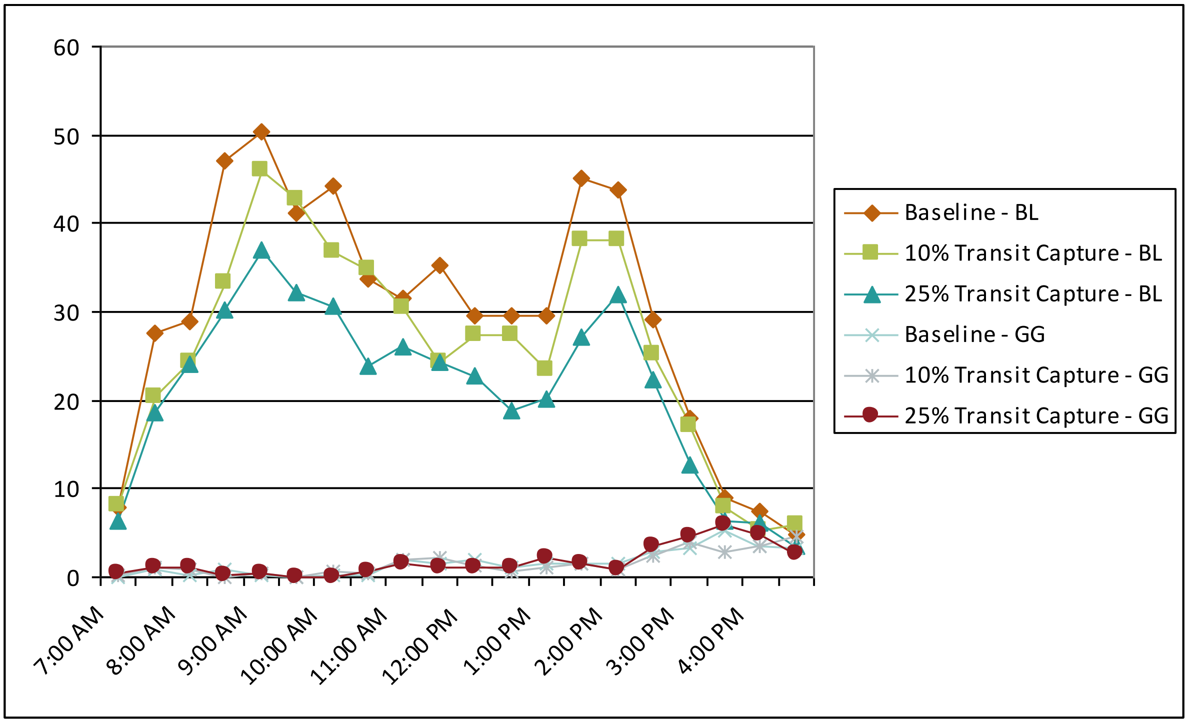
5.17 Visitor Arrivals at Bear Lake and Glacier Gorge Trailheads

Visitor arrival patterns from transit and personal vehicles to the two study site trailheads were also generated using the transportation model. Personal vehicle arrivals were generated in 30 minute bins, while Bear Lake Shuttle arrivals were generated following the varied arrival pattern observed in the field. Visitor arrivals were supplied to the Rocky Mountain National Park Extend model for analysis of visitor-based standards of quality.

Figure 5.38 presents the Paramics generated vehicle arrivals every half hour at the Bear Lake and Glacier Gorge trailheads used in the Extend pedestrian modeling.

[1] The approximate one-way length of the Hiker Shuttle route is 9.5 miles while the approximate one-way route distance for the Bear Lake Shuttle is 4.5 miles. While transit system operating costs vary, we are assuming an average cost per operating hour of $70.00.

Figure 5.38: Bear Lake and Glacier Gorge Vehicle Arrivals by Scenario



5.18 Summary of Results and Findings

This chapter provides a summary of study findings. The primary purposes of this study were to: 1) model personal vehicle and transit arrivals and departures and parking and transit capacities within the Bear Lake Road corridor: 2) estimate impacts to parking and transit capacities resulting from implementation of various travel demand strategies including installation of intelligent transportation system (ITS) signing; and 3) project personal vehicle and transit visitor arrival patterns over the of the course of the day at the Bear Lake and Glacier Gorge trailheads to inform modeling of visitor based standards of quality at key park destinations.

The results of this study are intended to assist the NPS in managing visitor use, personal vehicle traffic, and shuttle service in the Bear Lake Corridor in a manner that accounts for user capacities on the Glacier Gorge and Dream Lake Trails.

5.18.1 Sampling Summary –Vehicle, Transit, and Parking Counts

- Comprehensive traffic data was collected on July 10th 2008 (a weekday) and July 12th 2008 (a weekend day).
- Based on Beaver Meadows Entrance gate records July 10th was the 72nd busiest day of 2008 and July 12th was the 8th busiest day of 2008.
- The average day for vehicle entries at the Beaver Meadows entry station was 2904 vehicles. July 12 represents vehicular entry activity that is 35% higher than average.
- The traffic count program consisted of the following parts:
  - Vehicle arrival/departure at the Bear Lake and Glacier Gorge trailheads;

- Vehicle turning movement counts (8 hour) at the Bear Lake Road/Rt. 36 intersection and at the Bear Lake Road/Bear Lake Park & Ride intersection;
- Vehicle volume, class, and speed counts at 3 locations:
  4) At a point immediately west of the Beaver Meadows Entrance Station.
  5) At a point on Bear Lake Road approximately 1,000 feet north of the Park & Ride.
  6) At a point on Bear Lake Road approximately 1,000 feet south of the Park & Ride.
- Bear Lake shuttle ridership counts, including boardings and alightings at 3 locations:
  4) at the Park and Ride;
  5) at the Glacier Gorge lot;
  6) at the Bear Lake trailhead.
- Hiker shuttle ridership counts at the Bear Lake Park & Ride and at the Hiker Shuttle terminus in Estes Park.

5.18.2 Summary of Findings – Vehicle, Transit and Parking Counts

- Daily traffic in the park peaks in the mid afternoon (2:00 PM on Thursday and 3:00 PM on Saturday).
- Saturday traffic volumes are consistently higher than Thursday traffic volumes. Saturday volumes range from 16% higher than Thursday volumes at 8:00 AM to 87% higher than Thursday volumes at 3:00 PM.
- The peak hour for vehicle entries to the park begins at 12:00 PM while the peak hour for vehicle exits begins at 3:00 PM.
- Peak parking utilization at the Bear Lake Park and Ride occurs in the early afternoon. On Saturday July 12th parking demand exceeded dedicated capacity from 11:30 AM until 2:30 PM.
- The Bear Lake parking lot was observed to be over 90% utilized starting at 9:00 AM and remained over 85% utilized until 3:00 PM on Saturday July 12th.
- The Glacier Gorge parking lot was observed to be over 90% utilized starting at 7:00 AM and remained heavily utilized for the entire day. The average utilization from 7:00 AM to 5:00 PM was 86%.
- Approximately equal numbers of people access the Bear Lake Road corridor via transit and personal vehicle during times of peak visitation.
- As personal vehicle access is currently limited by parking constraints at the Bear Lake and Glacier Gorge trailheads, current transit service roughly doubles visitor access to high demand park destinations.
- Over 1900 visitors used the Bear Lake Shuttle to access the Bear Lake and Glacier Gorge trailheads on Saturday July 12th. This is approximately half the current daily shuttle capacity.

5.18.3 Summary of Findings – Transportation Simulations and Capacity Estimates

Personal vehicle and transit visitor arrival patterns were modeled using a calibrated Paramics micro-simulation model of Rocky Mountain National Park. Baseline peak summer conditions (calibrated to the 8th busiest day in 2008) were compared with projected conditions in two alternative simulation scenarios in which a greater proportion of visitors access the park via the Hiker Shuttle from Estes Park and access the Bear Lake Road Corridor via the Bear Lake Shuttle. The scenarios assume that an intelligent transportation system (ITS) would be implemented resulting in a shift from personal vehicle to transit travel within the park. The two scenarios that were modeled differ in the degree to which this mode shift would occur; the first scenario assumes a 10% "capture rate" and the second scenario assumes a 25% "capture rate." In other words, the scenarios assume either 10% or 25% of visitors who travel in their personal vehicles to their park destinations under existing conditions would instead park in Estes Park or at the Bear Lake Park and Ride and use the park's shuttle bus system.

The results of the transportation model simulations for the two alternative scenarios in comparison to baseline conditions are presented as follows:

- A 10% transit capture rate would result in an overall 2% reduction in daily vehicle miles travelled with the park, while a 25% transit capture rate would result in an overall 5% reduction in daily vehicle miles travelled in the park.
- Similarly the 10% and 25% transit capture rates would result in 2% or 5% reductions in overall daily vehicle emissions and fuel consumption within the park.
- Parking capacity at the Bear Lake parking lot would increase by 7% with the 10% transit capture rate and by 17% with the 25% transit capture rate.
- Parking capacity at the Glacier Gorge parking lot would increase by 2% with the 10% transit capture rate and by 5% with the 25% transit capture rate.
- Conversely, parking capacity at the Glacier Gorge parking lot would decrease by 8% with the 10% transit capture rate and by 19% with the 25% transit capture rate.
- Current parking capacity at the Bear Lake Park and Ride is not necessarily a fixed value. While there are 300 official striped spaces in the lot there is enough paved space to comfortably accommodate an estimated additional 50 cars. However, 2008 observations found some time periods with as many as 364 cars parked at the Bear Lake Park and Ride. Under current conditions there were 2 hours observed where parking demand (and actual parking) exceeded the assumed 350 space limit. In the 10% transit capture scenario there are three hours where projected parking demand exceeds the estimated 350 space limit. In the 25% transit capture scenario there are four hours where parking demand is projected to exceed the estimated 350 space limit.
- The increasing potential for overcapacity parking at the Bear Lake Park and Ride resulting from higher transit usage raises the issue of capturing a higher number of vehicles in Estes Park. A coordinated policy to encourage transit ridership and parking outside the park focuses attention on parking capacity in Estes Park.
- The maximum parking demand projected for the 10% transit capture scenario was 388 vehicles. The maximum parking demand projected for the 25% transit capture scenario was 424 vehicles, which is likely not achievable with the existing Park and Ride lot.
- Capacity for the Hiker Shuttle is currently 26 riders per bus on a single bus per hour. Both the 10% Transit Capture and 25% Transit Capture scenarios assume service would be expanded to 4 busses per hour resulting in an hourly capacity of 104 visitors per hour.
- Capacity for the Bear Lake Shuttle assumes 10 trailhead bus deliveries per hour with a maximum capacity of 45 visitors per bus (including standing riders) for an estimated maximum capacity of 450 visitors per hour.
- An expansion of Hiker Shuttle service to 15 minute headways would more than adequately accommodate increased demand in both the 10% and 25% transit capture scenarios.

- Increased demand for the Bear Lake Shuttle is projected to exceed the estimated capacity of 450 passengers per hour for one hour from 11:00 AM to 12:00 PM in both the 10% and 25% transit capture scenarios. During no other hours is demand projected to exceed capacity.

Chapter 6: Visitor Use Modeling

6.1 Introduction

This chapter of the report summarizes visitor use modeling conducted to support RMNP's Alternative Transportation in Parks and Public Lands (ATPPL) project. This component of the ATPPL project involves the development of computer simulation models of visitor use at two recreation sites serviced by the Bear Lake shuttle bus: 1) the Glacier Gorge Trail to Alberta Falls; and 2) the Dream Lake Trail to Emerald Lake. Visitor counts and hiking route surveys were conducted to collect information needed to develop the models of visitor use and behavior at the two study sites. Discrete-event systems simulation software was used to construct the visitor use models and conduct simulations of visitor use associated with existing and alternative visitation and transportation system operations scenarios.

Results of simulations conducted with the visitor use models include estimates of visitor use and crowding on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake. Further, modeling results include estimates of the total number of people that can be accommodated on the Glacier Gorge Trail and Dream Lake Trail without violating crowding-related standards of quality derived from visitor surveys conducted as part of the ATPPL project (see Chapter 2). Information from the resource assessments and visitor behavior observations described in Chapter 3 were incorporated with the visitor use models to estimate the extent of off-trail hiking under existing and alternative visitation and transportation system operations scenarios. Finally, the computer modeling results include estimates of the extent to which shuttle service to the Glacier Gorge Trail and Dream Lake Trail would need to be modified to maintain visitor use levels in accordance with crowding-related standards of quality derived from the visitor surveys noted.

Thus, the visitor use models developed for this project and their results are intended to assist the NPS in managing visitor use, vehicle traffic and shuttle service along the Bear Lake Road Corridor in a manner that maintains or restores desired conditions of park resources and visitor experiences. The methods used to develop the visitor use models and their results are presented in the following sections of this chapter.

6.2 Study Sites

As noted, the sites selected for visitor use modeling include the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake. These two sites were selected for visitor use modeling because they are among the most popular destinations in the Bear Lake Road Corridor, are thought to be important to the quality of visitors' experiences of the area, receive intensive amounts of visitor use during the summer, and are accessed by visitors via private vehicle and shuttle bus modes of transportation.

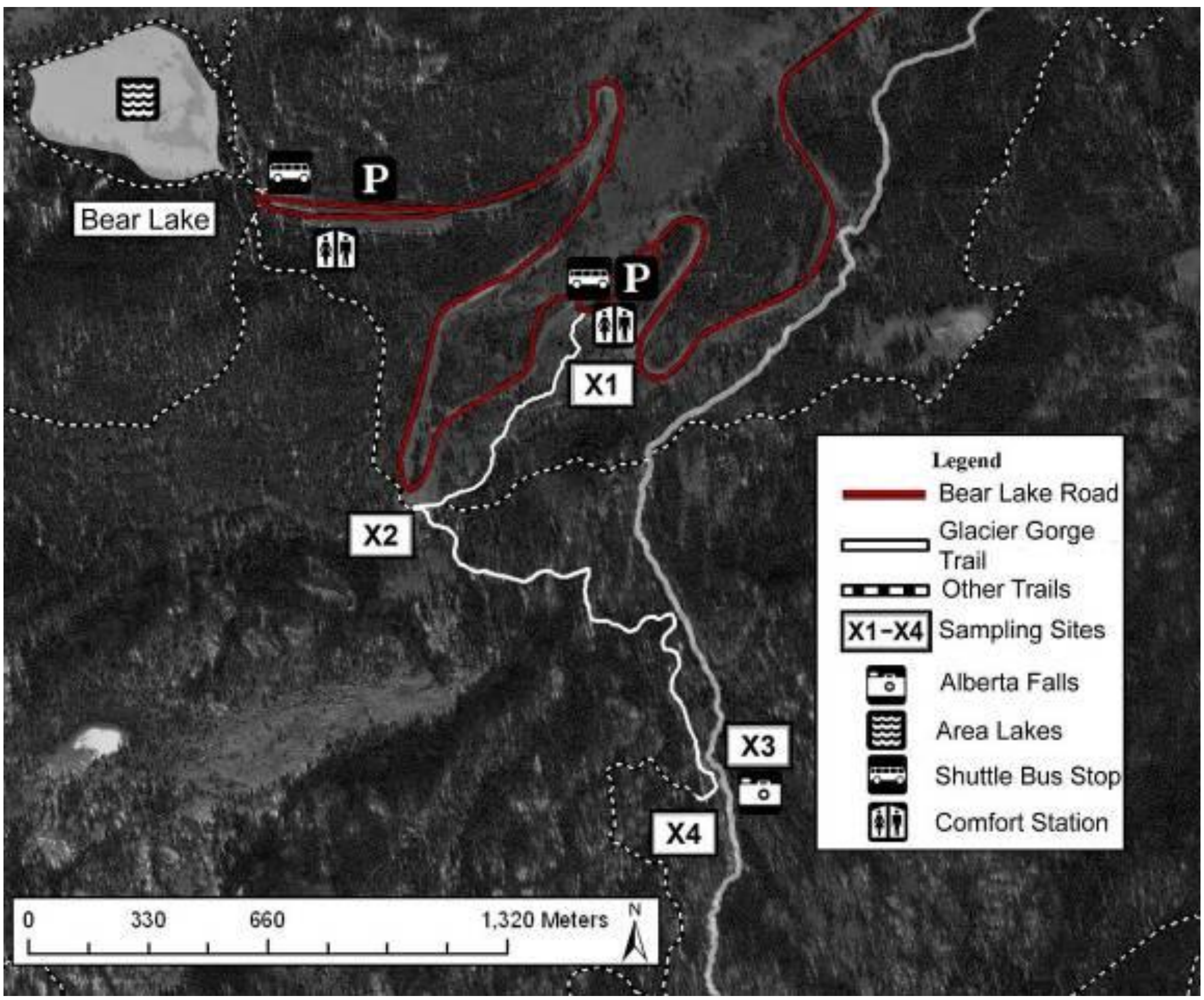
A scoping trip to the park was conducted in October, 2007, during which time researchers from Resource Systems Group, Virginia Tech, Colorado State University, and Utah State University consulted with the NPS to define the geographic boundaries of each of the two study site for the purposes of data collection and modeling. Based on this scoping trip, schematic diagrams of each study site were developed and used to guide the selection of sampling locations. Within the study, there were two primary types of sampling locations where field staff were stationed to conduct visitor surveys and visitor counts – access points and attraction site boundaries. Access points are places where visitors enter and exit the study sites (i.e., trailheads and trail junctions), while attraction site boundaries are places where visitors enter and exit specific attraction areas *within* each study site (i.e., the viewing area at Alberta Falls and the shoreline of Emerald Lake where visitors congregate). All sampling locations are marked on the schematic diagrams of the study sites with text boxes numbered X1-XN, where N is the total number of sampling locations within the study site. Site descriptions and schematic diagrams for both study sites are presented below and specific sampling procedures are described in the next section.

The study area for the Glacier Gorge Trail to Alberta Falls includes four sampling locations, including two access points, one attraction site boundary, and one location that served as both an access point and attraction site boundary (Figure 6.1). One of the access points is the Glacier Gorge Trailhead (X1) located at the south end of the Glacier Gorge parking lot. The second major access point (X2) is at the junction of the Glacier Gorge Trail and a connector trail from the Bear Lake area and parking lot. The third access point (X4) captures visitors entering the study area from the park's backcountry. The X4 sampling location is also the attraction site boundary on the south side of the Alberta Falls viewing area, while X3 denotes the location of the attraction site boundary to the north of Alberta Falls.

The distance on the Glacier Gorge Trail between the X1 and X2 sampling locations is 402 meters, while the distance between X2 and X3 is 847 meters. The lineal extent of the Alberta Falls viewing area between the X3 and X4 sampling locations is 104 meters.

The primary modes of transportation used to access the Glacier Gorge Trail and Alberta Falls during the summer months include: 1) the Bear Lake shuttle bus service to the Glacier Gorge Trailhead; 2) the Bear Lake shuttle bus service to the Bear Lake Trailhead; 3) private vehicles parked in the Glacier Gorge Trailhead parking lot; and 4) private vehicles parked in the Bear Lake Trailhead parking lot.

Figure 6.1 Glacier Gorge Trail and Alberta Falls Study Site Schematic Diagram

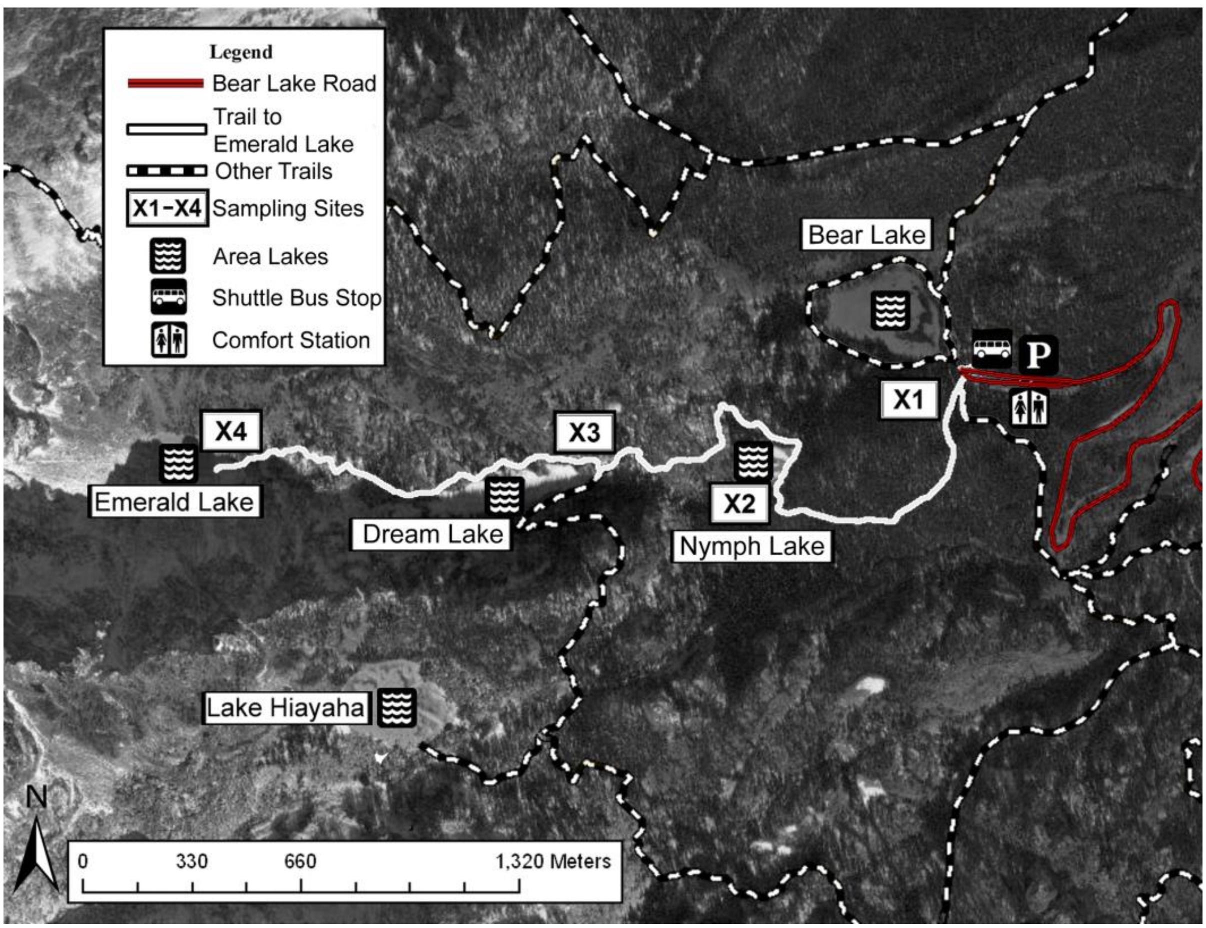


The study area for the Dream Lake Trail to Emerald Lake includes four sampling locations, including two access points and two attraction site boundaries (Figure 6.1). One of the access points is the Dream Lake Trailhead (X1), which is located near the west end of the Bear Lake parking lot, while the other access point (X3) is at the junction of the Dream Lake Trail and the trail to Lake Hiayaha. The primary attraction site for this study area was Emerald Lake; the X4 attraction site boundary is located at the east end of the Emerald Lake viewing area. A second attraction site boundary is located at the east end of Nymph Lake (X2) and was used to capture hiking times between the Dream Lake Trailhead and Nymph Lake.

The distance on the Dream Lake Trail between the X1 and X2 sampling locations (i.e., from the trailhead to the east side of Nymph Lake) is 703 meters, while the distance between X2 and X3 (i.e., from the east side of Nymph Lake to the junction with the trail to Lake Hiayaha) is 820 meters. The distance on the Dream Lake Trail between the X3 and X4 sampling locations (i.e., from the junction with the trail to Lake Hiayaha to the east side of Emerald Lake) is 985 meters.

The primary modes of transportation used to access the Dream Lake Trail to Emerald Lake during the summer months include: 1) the Bear Lake shuttle bus service to the Bear Lake Trailhead; 2) the Bear Lake shuttle bus service to the Glacier Gorge Trailhead; 3) private vehicles parked in the Bear Lake Trailhead parking lot; and 4) private vehicles parked in the Glacier Gorge Trailhead parking lot.

Figure 6.2 Dream Lake Trail and Emerald Lake Study Site Schematic Diagram



6.3 Data Collection

Hiking route surveys and visitor counts were administered during the summer of 2008 to collect information about visitor use and behavior needed to construct computer simulation models of visitor use on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake. This section describes the hiking route survey and visitor counting methods used in this study, beginning with the hiking route survey methods.

6.3.1 Hiking Route Survey

Hiking route surveys were administered to random samples of visitors on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake during the summer of 2008. The purpose of the hiking route surveys was to collect information needed to develop site-specific visitor use models, including visitors': 1) group sizes; 2) modes of transportation to access the study sites; and 3) hiking routes in the study areas, including length of time spent hiking on various sections of the trail and lingering at attractions (i.e., Alberta Falls or Emerald Lake).

Site-specific hiking route survey cards were designed by researchers at Resource Systems Group and Virginia Tech, in consultation with NPS officials at RMNP, and were reviewed and approved by the Virginia Tech Internal Review Board and the Office of Management and Budget. Appendix I contains a copy of the hiking route survey card administered to visitors on the Glacier Gorge Trail to Alberta Falls and Appendix J contains a copy of the hiking route survey card administered to visitors on the Dream Lake Trail to Emerald Lake. Appendix K contains a copy of the survey log used to record information about survey response rates at both study sites. Site-specific visitor survey data files in Excel format have been archived with Rocky Mountain National Park and codesheets corresponding to the data files are contained in Appendix L (Glacier Gorge Trail data) and Appendix M (Dream Lake Trail data).

Hiking route surveys were administered for a total of four days at each study site, with sampling occurring at only one study site on any single sampling day (Table 6.1 and Table 6.2). Hiking route survey sampling included two weekend days and two weekdays at each study site.

Table 6.1 Glacier Gorge Trail and Alberta Falls Visitor Survey Card Sampling Effort

Date	Day of Week	Solicitations	Accept	Refuse	Unusable [a]
06.28.2008	Saturday	178	153	16	7
07.02.2008	Wednesday	158	144	10	2
07.03.2008	Thursday	175	148	20	2
07.05.2008	Saturday	166	141	20	4
	Total	677	586	66	15

[a] "Unusable" includes cards that were not returned and those that contained no useable data.

Table 6.2 Dream Lake Trail and Emerald Lake Visitor Survey Card Sampling Effort

Date	Day of Week	Solicitations	Accept	Refuse	Unusable [a]
07.04.2008	Friday (holiday)	87	74	12	1
07.06.2008	Sunday	81	67	9	4
07.08.2008	Tuesday	44	32	7	5
07.09.2008	Wednesday	88	78	6	3
	Total	300	251	34	13

[a] "Unusable" includes cards that were not returned and those that contained no useable data.

On each visitor survey sampling day, a survey administrator was located at each sampling location (i.e., each access point and attraction site boundary) within the selected study site from 8:00 AM to 5:00 PM. Surveyors stationed at access points recruited groups arriving to the study site to participate in the visitor survey; however, due to different levels of visitation on the Glacier Gorge Trail and Dream Lake Trail, the survey sampling protocols differed across the two study sites. In particular, on the more heavily visited Glacier Gorge Trail, surveyors recruited one visitor group every 5 minutes to ensure surveyors could reliably track and collect survey cards from all study participants. In contrast, on the less heavily visited Dream Lake Trail, an attempt was made to recruit each arriving visitor group to participate in the survey.

Each time a surveyor at an access point at either study site recruited a visitor group for the hiking route survey, the surveyor asked the group what mode of transportation they used to travel to the study site and recorded this information on the survey card. The surveyor also recorded the size of the visitor group, the groups' primary activity that day (e.g., hiking or fishing), the date, the location where the group began their hike (e.g., Glacier Gorge Trailhead, Bear Lake Trailhead, other), and the current time. The surveyor then handed the card to the visitor group and instructed them to carry the card during their visit to the study site and to hand the card to each survey administrator they passed during their visit. Surveyors stationed at access points also collected survey cards from participating groups as they exited the study site and recorded the current time, whether the exiting visitor group intended to board the Bear Lake shuttle bus at the end of their hike, and if they intended to board the shuttle bus, at which shuttle bus stop they intended to do so.

During hiking route survey sampling at both study sites, surveyors stationed at attraction site boundaries collected visitor survey cards from study participants each time they passed their sampling locations, and recorded the current time. Surveyors then returned the survey cards to participants, and instructed them to continue carrying the cards and to hand the cards to each surveyor they met during their visit.

Thus, the hiking route survey cards contained information about: 1) the routes visitors hiked in the study areas; 2) the amount of time visitor groups spent hiking on each section of trail and/or lingering at each attraction within the study sites; and 3) the proportion of visitors intending to ride the shuttle bus at the end of their visit to the study site.

To track hiking route survey response rates, surveyors stationed at access points recorded a survey log entry for each visitor group asked to participate in the study (see Appendix K for a copy of the survey log used to record information about survey response rates at both study sites). Information recorded on the survey log for each contacted visitor group includes: 1) current time; 2) visitor group size; 3) whether the group accepted or refused to participate; 4) transportation mode used to access the study site; 5) hiking route survey card ID number for those groups who participated; and 6) comments concerning the contact, as needed (e.g., if a group refused to participate due to a language barrier with the surveyor).

The hiking route survey response log data were intended to be used to examine whether those visitor groups who refused to participate in the survey were systematically different than those who did participate (i.e., whether the survey data may be subject to non-response bias). However, response rates at both study sites were relatively high - 86.6% on the Glacier Gorge Trail to Alberta Falls and 83.7% on the Dream Lake Trail to Emerald Lake (Tables 6.3 and 6.4, respectively). Thus, there were too few refusals to conduct robust statistical tests for non-response bias. The high response rates at both study sites, however, suggest that the visitor survey data are not likely to be biased due to systematic differences between study participants and visitor groups who did not participate in the study.

Table 6.3 Glacier Gorge Trail and Alberta Falls Visitor Survey Response Rate

	Overall [a]
Acceptance Rate	86.6%
Refusal Rate	13.4%

[a] "Unusable" surveys treated as refusals.

Table 6.4 Dream Lake Trail and Emerald Lake Visitor Survey Response Rate

	Overall [a]
Acceptance Rate	83.7%
Refusal Rate	16.3%

[a] "Unusable" surveys treated as refusals.

6.3.2 Visitor Counts

Visitor counts were conducted at each of the access points on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake during the summer of 2008. The visitor counts were conducted to document the number of visitors arriving to the study sites, by time of day and point of access into the study sites. Visitor counts were conducted on three weekdays and two weekend days at each study site, with sampling occurring at only one study site on any single sampling day. Due to staffing constraints, visitor counts and visitor survey sampling were conducted on different days.

The site-specific counting procedures used to collect information about visitor arrivals were designed by researchers at Resource Systems Group and Virginia Tech, in consultation with NPS officials at Rocky Mountain National Park. Data collection for the visitor counts was administered on handheld computers (PDAs) using a program scripted by Resource Systems Group, Inc. entitled “Event Counter.” On each day visitor counts were conducted, a data collector was stationed with a PDA at each access point into the selected study site from 8:00 AM to 4:00 PM. The PDA’s contained the Event Counter program designed for recording timestamps (current date and time, to the second) each time a visitor entered the study site.

Figure 6.3 illustrates the graphical user interface for the Event Counter program used to record timestamps for visitor arrivals. The lettered buttons were used to differentiate arrivals by direction of travel. For example at X2, located at the junction of the connector trail to Bear Lake and the Glacier Gorge Trail (Figure 6.4), arrivals from the Bear Lake connector toward X3 (Alberta Falls) were recorded using the “E” button, and arrivals from the Bear Lake connector toward X1 (Glacier Gorge Trailhead) were recorded using the “F” button. It was not possible at any access point to differentiate visitors by mode of transportation because of the distance from the parking area and shuttle bus stops to the access points. Each time a lettered button was tapped on the PDA screen, a timestamp and lettered code were written to an ASCII text file. Site-specific timestamp data files in ASCII text format have been archived with Rocky Mountain National Park and a code sheet of site-specific event codes is contained in Appendix .

Figure 6.3 Event Counter Program Interface

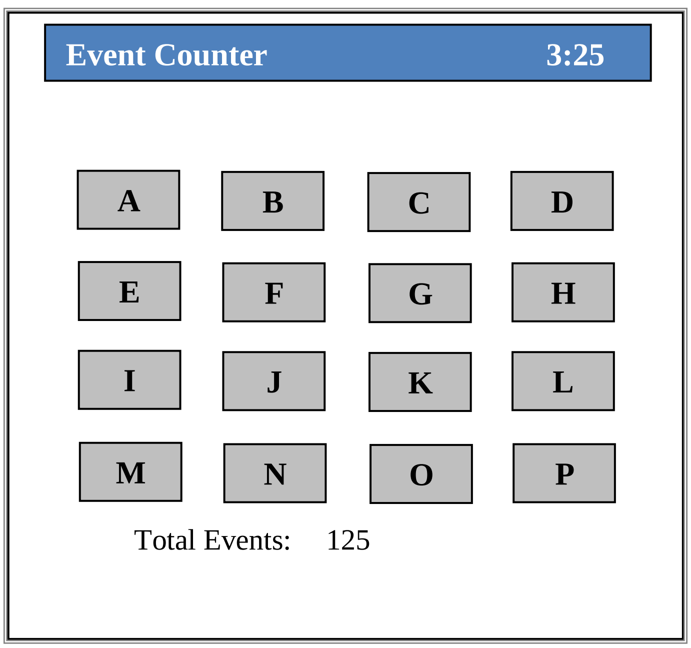


Figure 6.4 Example of Event Counter Data Output

```
Device: VT_Dell
Event: Begin Session   7/10/2008   8:29:24
Event:        A        7/10/2008   8:40:57
Event:        A        7/10/2008   8:40:57
Event:        A        7/10/2008   8:40:58
Event:        A        7/10/2008   8:40:59
Event:        C        7/10/2008   8:43:48
Event:        C        7/10/2008   8:43:48
Event:        A        7/10/2008   8:46:06
Event:        A        7/10/2008   8:46:07
Event:        C        7/10/2008   8:46:39
Event:        C        7/10/2008   8:46:40
Event:        C        7/10/2008   8:46:40
Event:        A        7/10/2008   8:50:50
Event:        A        7/10/2008   8:50:51
Event:        A        7/10/2008   8:50:52
Event:        A        7/10/2008   8:55:19
Event:        A        7/10/2008   8:55:20
Event:        D        7/10/2008   8:56:27
Event:        D        7/10/2008   8:56:28
Event:        D        7/10/2008   8:56:30
```

Given the relatively low number of sampling days on which visitor counts were conducted, vehicle entry data recorded by the NPS at the Beaver Meadows Entrance Station for June, July, and August 2008 (91 days in total) were obtained to assess how representative the visitor count sampling days were of “typical” visitation levels at the study sites. The vehicle entry data were sorted from the busiest day (July 4 at 4,291 vehicle entries) to the least busy day (June 2 at 1,047 vehicle entries) of the 2008 summer season and used to rank the visitor count sampling dates, according to the level of visitation recorded at the Beaver Meadows Entrance Station. The results of this ranking suggest that the sampling dates on which visitor counts were conducted on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake span a representative range of park visitation levels.

Table 6.5 Visitation Rank of Sampling Dates for Visitor Counts

	Sampling Date	Day of Week	Visitation Rank for Season
Glacier Gorge Trail	07.14.2008	Monday	49th busiest day
	07.16.2008	Wednesday	37th busiest day
	07.19.2008	Saturday	4th busiest day
	07.20.2008	Sunday	6th busiest day
	07.25.2008	Friday	12th busiest day
Dream Lake Trail	07.10.2008	Thursday	72nd busiest day
	07.11.2008	Friday	19th busiest day
	07.12.2008	Saturday	8th busiest day
	07.13.2008	Sunday	10th busiest day
	07.15.2008	Tuesday	34th busiest day

The timestamp data were used to generate tabular and graphical summaries of hourly and total daily visitation on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake, results of which are presented below. In addition, the timestamp data were used as a primary input into the computer simulation models of visitor use on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake. The methods used to model these arrival data and the hiking route survey data are described in the next section.

6.4 Data Analysis and Modeling

Data from the hiking route surveys and visitor counts described in the previous sections served as the primary inputs into the computer simulation models of visitor use on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake. However, a series of data formatting and data analysis steps were required prior to implementing the hiking route survey and visitor counts data within the visitor use models. This chapter of the report describes the analysis and modeling procedures used to construct the computer models of visitor use at the two study sites. The procedures described below were performed independently for each of the two study sites in order to construct site-specific models of visitor use.

6.4.1 Hiking Route Survey Data Analysis and Modeling

The hiking route survey data served as the source for five primary types of inputs to the visitor use models developed in this study: 1) frequency distributions of visitor group sizes; 2) frequency distributions of visitors' modes of transportation used to access the study sites; 3) probability distributions to model visitors' hiking routes; 4) empirical distributions of hiking times on the trails in the study sites; and 4) empirical distributions of lingering times at attractions (e.g., Alberta Falls for the model of visitor use on the Glacier Gorge Trail and Emerald Lake for the model of visitor use on the Dream Lake Trail) within the study sites.

The first step in the analysis of hiking route survey data involved screening the data for outlier cases with respect to group sizes, hiking times on trails, and lingering times at attractions. The purpose of the outlier analyses was to remove cases with group sizes, hiking times, and/or lingering times that are "numerically distant" from the rest of the data and consequently exert inordinate influence on averages and standard deviations of these variables. The decision rule for classifying cases as outliers was based on the distance of variable values from the interquartile range, and was operationalized through the following equations:

(1) $$\text{Outlier, lower bound} < Q1 - 3*IQR$$
(2) $$\text{Outlier, upper bound} > Q3 + 3*IQR$$

where: Q1 = 1st quartile
Q3 = 3rd quartile
IQR = Q3 – Q1

Cases with outlier values for group size, hiking time, and/or lingering time were excluded from the analysis and modeling described below. In situations where a case had outlier values for one or more, but not all three of the variables, the case was only excluded from analysis and modeling of the variable(s) for which outlier values were observed. For example, a case with an outlier group size value but non-outlier values for hiking time and lingering time would be excluded from analysis and modeling of visitor group sizes but retained for analysis and modeling of hiking and lingering times.

After outlier cases were removed, a series of statistical tests was performed to compare hiking times and lingering times by mode of transportation used to visit the study site. Independent Samples t-tests were performed to compare mean hiking and lingering times for groups that arrived in a personal vehicle versus those who took the shuttle or were dropped off to access the study site. Mean hiking times between trail segments and mean lingering times at attraction sites for both study sites were not statistically different by mode of transportation. Thus, the visitor use models were not programmed to distinguish hiking times on the trails and lingering times at attractions sites, by mode of transportation used to access the study site.

The next step within the analysis was to test for differences in hiking times and lingering times at each study site, by visitor group size. To do this, the frequency distribution of group sizes was examined to select a cutoff point to categorize each visitor group within the visitor survey data as a large group or small group. For both study sites, small groups were defined as groups of 1-3 people and large groups were defined as groups with 4 or more people. Next, Independent Samples t-tests were performed to compare hiking times and lingering times by group size category. For example, tests were conducted to assess whether the amount of time visitors spend lingering at Emerald Lake differs significantly depending on the size of the group. Most hiking and lingering times were significantly different by group size. Thus, hiking and lingering times are modeled separately by group size.

As a result of the two stages of analysis described above (i.e., tests of hiking and lingering times by mode of transportation and group size), means and standard deviations of hiking and lingering times were computed for small groups and large groups (Table 6.6 and Table 6.7). In addition, the distributions of hiking and lingering times for each independent sample of visitor groups were inspected to select distributions with which to "fit" the data within the visitor use models. These results were used to specify distributions of hiking and lingering times within the visitor use models, from which simulated visitor groups are assigned hiking and lingering times for their simulated hikes on the Glacier Gorge Trail or Dream Lake Trail.

Table 6.6 Mean and Standard Deviations of Hiking and Lingering Times on the Glacier Gorge Trail.

Activity	Group Size	N	Mean (h:mm:ss)	Std. Dev. (h:mm:ss)
Hiking Time from Glacier Gorge Trailhead to Bear Lake Connector Trail	Small Group (3 or Less)	108	0:08:55	0:03:10
	Large Group (4 or More)	67	0:10:11	0:03:31
Hiking Time from Bear Lake Connector Trail to Alberta Falls	Small Group (3 or Less)	207	0:16:27	0:05:27
	Large Group (4 or More)	149	0:20:13	0:07:08
Lingering Time at Alberta Falls (first time through)	Small Group (3 or Less)	214	0:11:03	0:08:50
	Large Group (4 or More)	145	0:17:22	0:12:39
Lingering Time at Alberta Falls (second or more times through)	Small Group (3 or Less)	102	0:03:07	0:01:48
	Large Group (4 or More)	56	0:03:21	0:02:06
Hiking Time from Alberta Falls to Bear Lake Connector Trail	Small Group (3 or Less)	208	0:13:31	0:03:28
	Large Group (4 or More)	149	0:15:27	0:04:22
Hiking Time from Bear Lake Connector Trail to Glacier Gorge Trailhead	Small Group (3 or Less)	143	0:07:24	0:02:02
	Large Group (4 or More)	107	0:07:47	0:02:04

Table 6.7 Mean and Standard Deviations of Hiking and Lingering Times on the Dream Lake Trail

Activity	Group Size	N	Mean (h:mm:ss)	Std. Dev. (h:mm:ss)
Hiking Time from Dream Lake Trailhead to Nymph Lake	Small Group (3 or Less)	110	0:13:17	0:03:33
	Large Group (4 or More)	88	0:15:14	0:04:28
Lingering Time at Nymph Lake	Small Group (3 or Less)	14	0:19:18	0:21:08
	Large Group (4 or More)	14	0:21:39	0:13:09
Lingering and Hiking Time from Nymph Lake to Dream Lake	Small Group (3 or Less)	97	0:27:18	0:11:33
	Large Group (4 or More)	69	0:32:28	0:10:34
Lingering Time at Dream Lake	Small Group (3 or Less)	32	0:22:43	0:19:20
	Large Group (4 or More)	11	0:25:25	0:14:23
Hiking Time from Lake Hiayaha Trail to Emerald Lake	Small Group (3 or Less)	55	0:33:24	0:14:53
	Large Group (4 or More)	48	0:39:36	0:14:17
Lingering Time at Lake Hiayaha	Small Group (3 or Less)	5	1:31:47	0:25:30
	Large Group (4 or More)	8	2:06:40	0:28:24
Lingering Time at Emerald Lake	Small Group (3 or Less)	50	0:25:59	0:20:30
	Large Group (4 or More)	46	0:27:55	0:14:59
Hiking Time from Emerald Lake to Lake Hiayaha Trail	Small Group (3 or Less)	51	0:21:44	0:07:05
	Large Group (4 or More)	43	0:21:21	0:05:07
Lingering and Hiking Time from Dream Lake to Nymph Lake	Small Group (3 or Less)	99	0:18:23	0:06:46
	Large Group (4 or More)	73	0:17:22	0:04:27
Hiking Time from Nymph Lake to Dream Lake Trailhead	Small Group (3 or Less)	112	0:10:26	0:02:23
	Large Group (4 or More)	86	0:10:31	0:02:21

The next step within the visitor survey data analysis was to conduct Chi-Square tests comparing group size distributions, by access point. The results of these tests suggested there are no statistically differences in group size across access points within each study site. Thus, a single group size frequency distribution was generated for each study site and used to assign group sizes to simulated visitor groups in the models, irrespective of access point (Table 6.8).

Table 6.8 Group Size Frequency Distribution, by Study Site

Glacier Gorge Trail		Dream Lake Trail	
Group Size	Frequency	Group Size	Frequency
1	48	1	19
2	228	2	92
3	74	3	33
4	112	4	53
5	48	5	20
6	28	6	14
7	22	7	7
8	6	8	6
9	7	9	3
10	4	10	3

Finally, the visitor survey data were used to generate frequency distributions of transportation modes used to travel to the study sites (Table 6.9). The mode of transportation distributions are used within the visitor use models to assign transportation modes to simulated visitor groups. It should be noted that these transportation modes refer to the mode of transportation used to travel to the study site (e.g., shuttle bus and private vehicle), not the mode of transportation used while visiting the study site. In fact, both study sites allow foot travel only.

Table 6.9 Transportation Mode Frequency Distributions, by Study Site and Access Point

	Glacier Gorge Trail			Dream Lake Trail
	X1	X2	X4	X1
Personal Vehicle	24.0%	63.6%	54.4%	62.7%
Shuttle	76.0%	36.4%	45.6%	37.3%

The data in Table 6.9 suggest that about three-quarters (76%) of visitors who enter the Glacier Gorge Trail from the Glacier Gorge Trailhead arrive by shuttle bus. In contrast, only about one-third (36.4%) of visitors who hike from Bear Lake to the Glacier Gorge Trail travel to the Bear Lake area by shuttle bus to begin their hikes, while about two-thirds (63.6%) drive personal vehicles to the Bear Lake parking lot before beginning their hikes to the Glacier Gorge Trail. About two-thirds (62.7%) of visitors on the Dream Lake Trail drive their personal vehicles to the Bear Lake parking lot, while about one-third (37.3%)take the shuttle bus to Bear Lake. These findings, coupled with the relative sizes of the Bear Lake Trailhead and Glacier Gorge Trailhead parking lots suggest that visitors will generally drive their personal vehicles to their destinations, rather than use the shuttle bus system, if parking is available at their destination.

6.4.2 Visitor Count Data Analysis and Modeling

This section reports the results of the visitor counts conducted on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake, starting with results from the Glacier Gorge Trail and then reporting results for the Dream Lake Trail. This section then describes the analysis and modeling performed with the visitor count data to incorporate them into the visitor use models for the two study sites.

The Glacier Gorge Trail to Alberta Falls received an average of 1,305 visitors per day (8:00 AM to 4:00 PM) during the 2008 visitor count sampling period (Table 6.10). A maximum daily visitor use of 1,509 was observed on Saturday, July 19, 2008; this date ranked as the 4th busiest day of vehicle entries at the Beaver Meadows Entrance Station during the 2008 summer season. The minimum daily visitor use observed on the Glacier Gorge Trail to Alberta Falls was 1,093 visitors; this level of visitation was observed on July 14, 2008, which ranked as the 49th busiest day of vehicle entries at the Beaver Meadow Entrance Station during the 2008 summer season.

Table 6.10 Glacier Gorge Trail Visitor Arrivals, by Sampling Date and Point of Entry Into Study Area-2008 (8AM-4PM)

Sampling Date	Day of Week	Glacier Gorge Trailhead (X1) Number	%	Bear Lake Connector Trail - Toward Glacier Gorge Trailhead (X2) Number	%	Bear Lake Connector Trail - Toward Alberta Falls (X2) Number	%	Glacier Gorge Trail from South of Alberta Falls (X4) Number	%	Total Arrivals
07.14.2008	Monday	518	47%	43	4%	501	46%	32	3%	1,093
07.16.2008	Wednesday	523	44%	47	4%	592	49%	38	3%	1,200
07.19.2008	Saturday	772	51%	121	8%	568	38%	47	3%	1,509
07.20.2008	Sunday	748	55%	50	4%	529	39%	41	3%	1,367
07.25.2008	Friday	627	46%	56	4%	632	47%	43	3%	1,358
	Mean	**638**	**49%**	**63**	**5%**	**564**	**44%**	**40**	**3%**	**1,305**
95% Confidence Interval		**+/- 105.4**		**+/- 28.8**		**+/- 45.4**		**+/- 5.0**		**+/- 141.4**

For the purposes of visitor use modeling, the visitor count data were averaged into 30-minute increments; these data for the Glacier Gorge Trail to Alberta Falls are presented in Table 6.11. It should be noted that while the visitor counts were conducted from 8:00 AM to 4:00 PM, for consistency with the traffic simulation model described in Chapter 5, the visitor use models were programmed to simulate visitor use from 7:00 AM to 5:00 PM. Thus, it was necessary to estimate visitor use at the two study sites for the 7:00 AM-8:00 AM and 4:00 PM-5:00 PM hours. For the Glacier Gorge Trail, visitor count data were estimated for the 7:00 AM-8:00 AM and 4:00 PM-5:00 PM hours in proportion to the rates of increase (for the morning) and decrease (for the afternoon) observed in visitor use data collected during summer 2008 at nearby automatic trail counters.

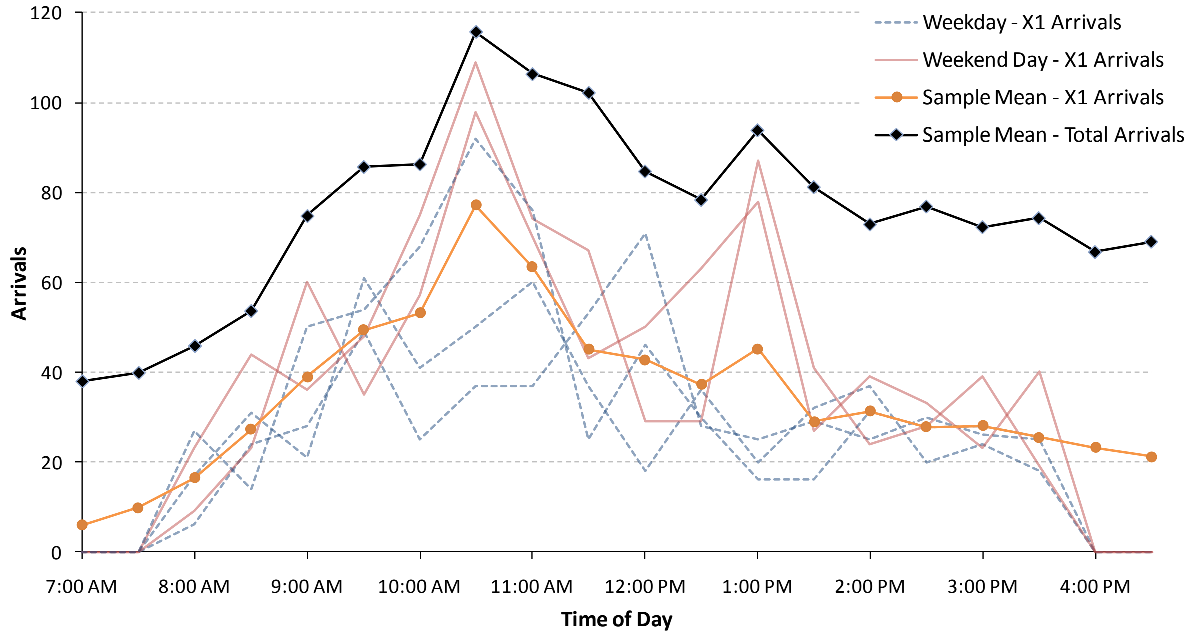
Data suggest that about half of the visitor use on the Glacier Gorge Trail to Alberta Falls originates at the Glacier Gorge Trailhead and about half originates from the Bear Lake area, entering at the Bear Lake Connector Trail. The data also suggest that visitor use originating from the Glacier Gorge Trailhead begins to peak around 9:00 AM and is somewhat more intensive on weekend days than weekdays. Visitor arrivals onto the Glacier Gorge Trail from the Bear Lake Connector Trail begins to peak around 11:00 AM and there does not appear to be a substantial difference in weekend day and weekday visitation patterns. Very little use on the Glacier Gorge Trail to Alberta Falls originates from the park's backcountry, with most of these arrivals onto the trail occurring in the afternoon.

Table 6.11 Mean Visitor Arrivals by Time of Day and Access Point, Glacier Gorge Trail to Alberta Falls

	Glacier Gorge Trailhead (X1)	Glacier Gorge Trail Bear Lake Connector Trail (X2)	Glacier Gorge Trail from South of Alberta Falls (X4)
7:00 AM-7:30 AM	*6*	*32*	*0*
7:30 AM-8:00 AM	*10*	*30*	*0*
8:00 AM-8:30 AM	16	29	0
8:30 AM-9:00 AM	27	26	0
9:00 AM-9:30 AM	39	36	0
9:30 AM-10:00 AM	49	36	0
10:00 AM-10:30 AM	53	32	1
10:30 AM-11:00 AM	77	38	1
11:00 AM-11:30 AM	63	42	1
11:30 AM-12:00 PM	45	54	3
12:00 PM-12:30 PM	43	39	3
12:30 PM-1:00 PM	37	37	4
1:00 PM-1:30 PM	45	45	4
1:30 PM-2:00 PM	29	48	4
2:00 PM-2:30 PM	31	36	6
2:30 PM-3:00 PM	28	45	5
3:00 PM-3:30 PM	28	40	5
3:30 PM-4:00 PM	26	44	5
4:00 PM-4:30 PM	*23*	*39*	*5*
4:30 PM-5:00 PM	*21*	*43*	*4*
Total	698	772	49

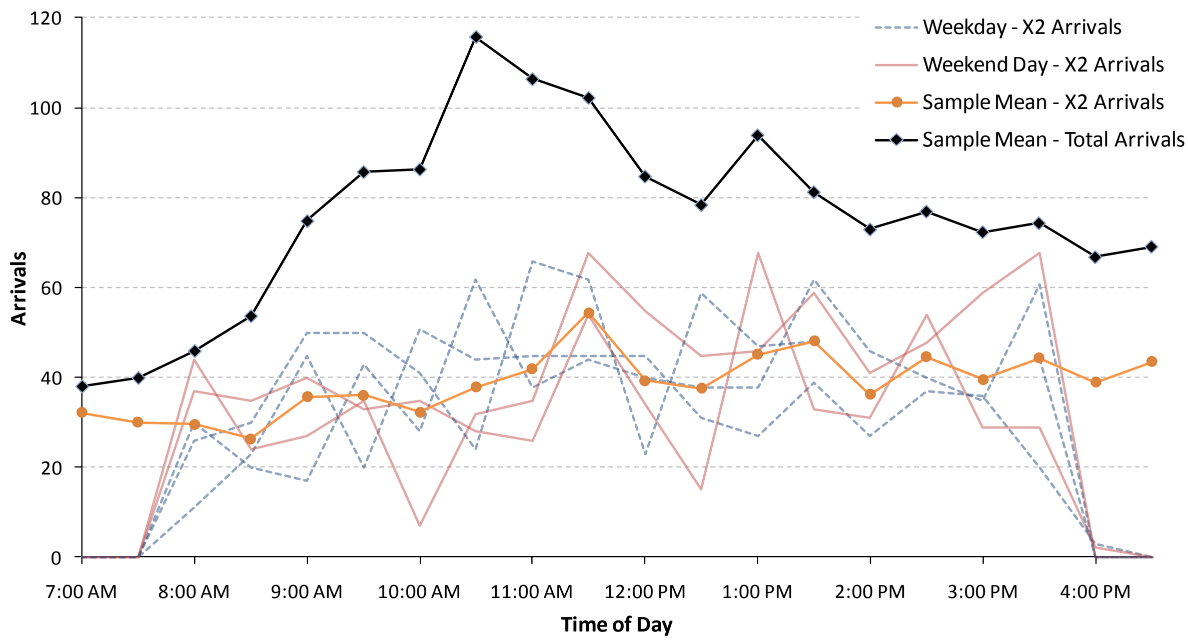
Note: Numbers in italics denote estimated arrivals.

Figure 6.5 Mean Visitor Arrivals onto the Glacier Gorge Trail from the Glacier Gorge Trailhead (X1), by Time of Day



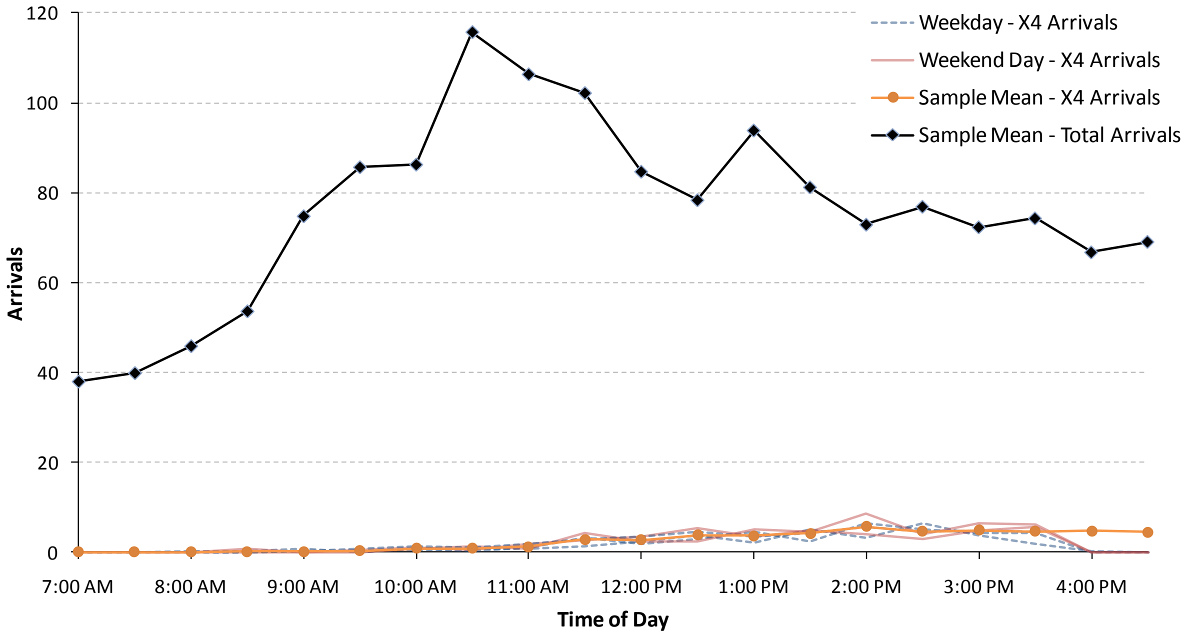
Note: Arrivals between 7:00 AM and 8:00 AM and between 4:00 PM and 5:00 PM are estimated arrivals.

Figure 6.6 Mean Visitor Arrivals onto the Glacier Gorge Trail from the Bear Lake Connector Trail (X2), by Time of Day



Note: Arrivals between 7:00 AM and 8:00 AM and between 4:00 PM and 5:00 PM are estimated arrivals.

Figure 6.7 Mean Visitor Arrivals onto the Glacier Gorge Trail from the Park's Backcountry (X4), by Time of Day



Note: Arrivals between 7:00 AM and 8:00 AM and between 4:00 PM and 5:00 PM are estimated arrivals.

The Dream Lake Trail to Emerald Lake received an average of 1,085 visitors per day (8:00 AM to 4:00 PM) during the 2008 visitor count sampling period (Table 6.12). A maximum daily visitor use of 1,128 was observed on Tuesday, July 15, 2008; this date ranked as the 34th busiest day of vehicle entries at the Beaver Meadows Entrance Station during the 2008 summer season. The minimum daily visitor use observed on the Dream Lake Trail to Emerald Lake was 1,033 visitors; this level of visitation was observed on July 11, 2008, which ranked as the 19th busiest day of vehicle entries at the Beaver Meadows Entrance Station during the 2008 summer season.

Table 6.12 Dream Lake Trail Visitor Arrivals, by Sampling Date and Point of Entry Into Study Area-2008 (8AM-4PM)

Sampling Date	Day of Week	Dream Lake Trailhead - From Bear Lake (X1) Number	%	Dream Lake Trailhead - From Glacier Gorge (X1) Number	%	Lake Hiayaha Trail - Toward Nymph Lake (X3) Number	%	Lake Hiayaha Trail - Toward Emerald Lake (X3) Number	%	Total Arrivals
07.10.2008	Thursday	1,049	96%	24	2%	18	2%	6	1%	1,097
07.11.2008	Friday	995	96%	13	1%	17	2%	9	1%	1,033
07.12.2008	Saturday	1,062	97%	10	1%	19	2%	8	1%	1,099
07.13.2008	Sunday	1,023	96%	16	1%	26	2%	4	0%	1,069
07.15.2008	Tuesday	1,084	96%	12	1%	22	2%	10	1%	1,128
	Mean	**1,043**	**96%**	**15**	**1%**	**20**	**2%**	**7**	**1%**	**1,085**
95% Confidence Interval		**+/- 30.3**		**+/- 4.8**		**+/- 3.1**		**+/- 2.1**		**+/- 31.4**

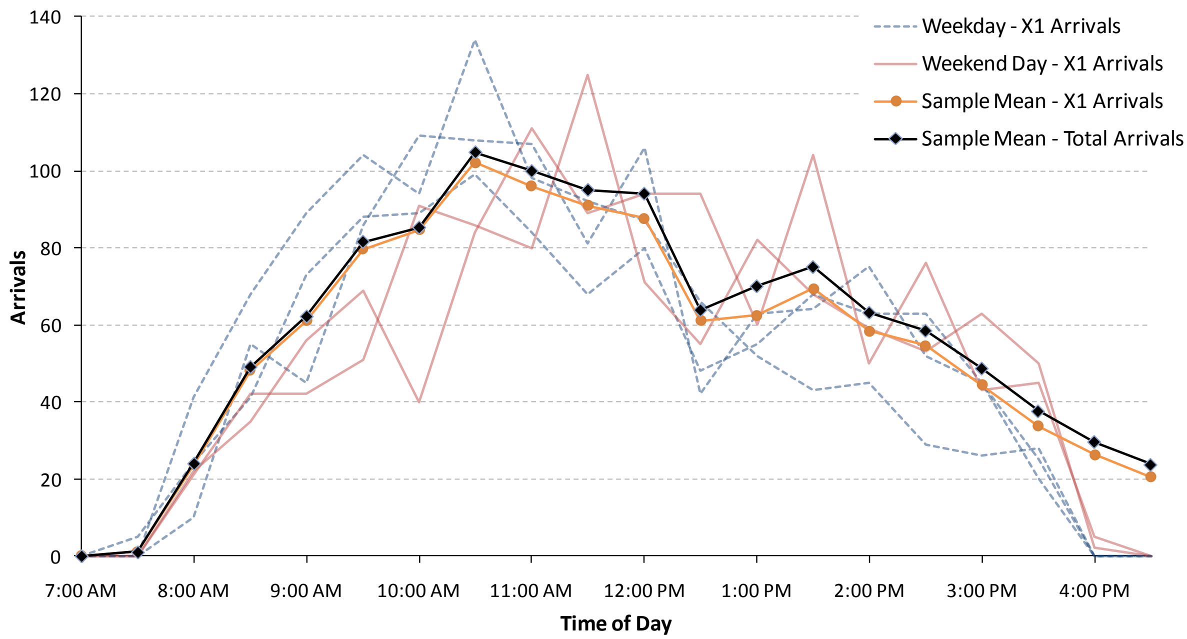
For the purposes of visitor use modeling, the visitor count data were averaged into 30-minute increments; these data for the Dream Lake Trail to Emerald Lake are presented in Table 6.13 and Figure 6.8 through Figure 6.9. As noted, it was necessary to estimate visitor use at the two study sites for the 7:00 AM-8:00 AM and 4:00 PM-5:00 PM hours to maintain consistency among the project's visitor use and traffic simulation models. For the Dream Lake Trail, visitor count data were estimated for those same hours in proportion to the rates of increase (for the morning) and decrease (for the afternoon) of the arrival data at each location.

The data in Table 6.13 and Figures 6.8 and 6.9 that virtually all of the visitor use on the Dream Lake Trail to Emerald Lake originates at the Bear Lake Trailhead. The data also suggest that visitor use originating from the Bear Lake Trailhead grows steadily and substantially beginning at about 8:00 AM; arrivals onto the trail from the Dream Lake Trailhead peak at about 11:00 AM and decline somewhat gradually but steadily through the remainder of the day. Very little use on the Dream Lake Trail to Emerald Lake originates from the Lake Hiayaha Trail, with most of these arrivals onto the trail occurring in the afternoon.

Table 6.13 Mean Visitor Arrivals by Time of Day and Access Point, Dream Lake Trail to Emerald Lake

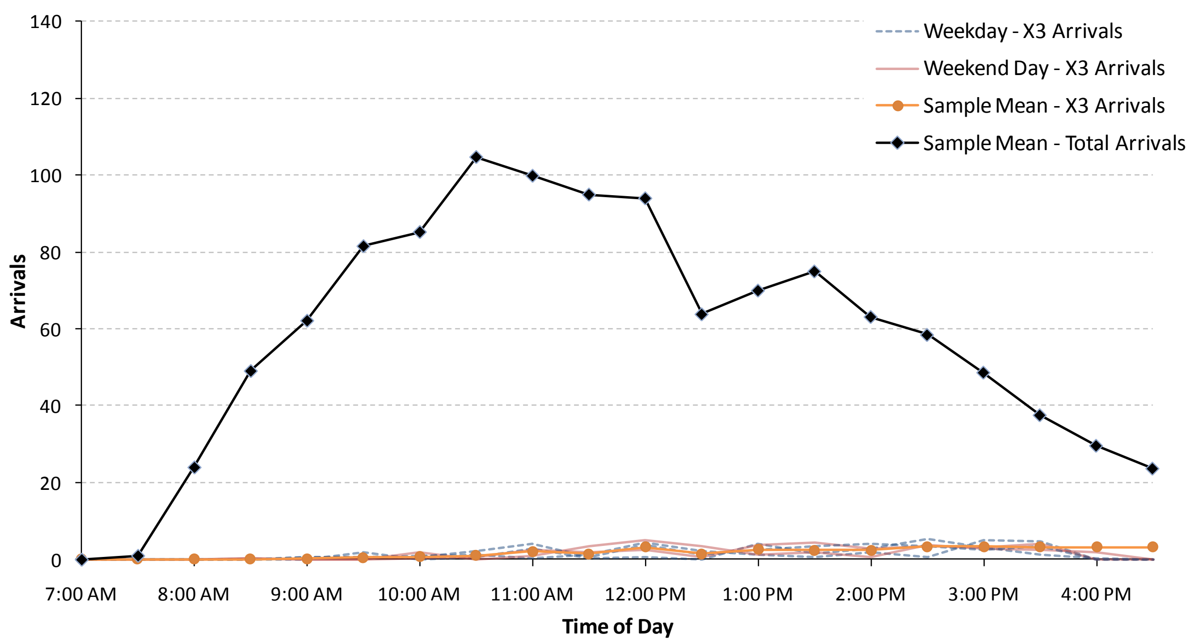
	Dream Lake Trail	
	Dream Lake Trailhead (X1)	Lake Hiayaha Trail (X3)
7:00 AM-7:30 AM	*0*	*0*
7:30 AM-8:00 AM	*1*	*0*
8:00 AM-8:30 AM	24	0
8:30 AM-9:00 AM	48	0
9:00 AM-9:30 AM	61	0
9:30 AM-10:00 AM	80	1
10:00 AM-10:30 AM	85	1
10:30 AM-11:00 AM	102	1
11:00 AM-11:30 AM	96	2
11:30 AM-12:00 PM	91	1
12:00 PM-12:30 PM	88	3
12:30 PM-1:00 PM	61	1
1:00 PM-1:30 PM	62	3
1:30 PM-2:00 PM	69	2
2:00 PM-2:30 PM	58	2
2:30 PM-3:00 PM	55	3
3:00 PM-3:30 PM	44	3
3:30 PM-4:00 PM	34	3
4:00 PM-4:30 PM	*26*	*3*
4:30 PM-5:00 PM	*21*	*3*
Total	1,105	34

Figure 6.8 Dream Lake Trail X1 Visitor Arrivals by Hour.



Note: Arrivals between 4:00 PM and 5:00 PM are estimated arrivals.

Figure 6.9 Dream Lake Trail X3 Visitor Arrivals by Hour.



Note: Arrivals between 4:00 PM and 5:00 PM are estimated arrivals.

The visitor count data were used to model the arrival of visitors to the study sites by time of day. To do this, a series of computations was performed with the visitor count data to construct what are termed visitor group interarrival time distributions. These steps are described in the following paragraphs.

As noted above, the visitor count data were used to calculate mean arrivals, by 30-minute time interval, for each access point within each study site (Table 6.13). Once mean visitor arrivals were summarized into 30-minute intervals, they were used to compute interarrival times (i.e., the average amount of time, in minutes, between visitor arrivals) for each 30 minute time interval using the following equation:

$$IT_{(7:00\ AM - 7:30\ AM)} = 30 \text{ minutes} / MVA_{(7:00\ AM - 7:30\ AM)} \quad (3)$$

where:
$IT_{(7:00\ AM - 7:30\ AM)}$ = mean interarrival time for the 7:00 AM to 7:30 AM time period
$MVA_{(7:00\ AM - 7:30\ AM)}$ = mean visitor arrivals for the 7:00 AM to 7:30 AM time period

Thus, the unit of measurement for interarrival times is minutes per visitor arrival. Next, individual interarrival times (as computed in Equation 3) were converted to group interarrival times. To do this, a "groups per people" factor was computed using the group size frequency distributions, where the number of groups contained within the frequency distribution was divided by the number of people contained within the groups. For example, the "dummy data" presented in Table 6.14 include 73 groups (sum of column 2) and 190 individuals (sum of the products of columns 1 and 2). Thus, the groups per people factor for the dummy data in Table 6.14 equals 73 divided by 190, or 0.38 groups per people. Next, the individual interarrival times were divided by the groups per people factor to compute group interarrival times for each 30-minute time interval. The results of these computations were used to generate group interarrival distributions, by access point.

Table 6.14 Group Size Distribution Dummy Data

Group Size	Frequency
1	10
2	32
3	15
4	9
5	7
Total	73

The group interarrival distributions were used to specify the number of simulated visitor group arrivals, by time of day, within the visitor use models for the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake. Thus, the visitor use models are designed to simulate the temporal pattern of visitor arrivals as observed through the visitor counts conducted at the study sites during the summer of 2008. Furthermore, group interarrival multipliers were included in the models to allow the user to "ramp up" or "ramp down" the number of simulated visitor group arrivals by specified percentages in order to simulate increases or decreases in visitor use at the study sites.

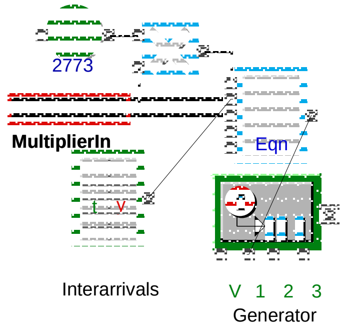
6.4.3 Model Algorithm and Programming

The computer simulation models of visitor use at the two study sites were developed using Extend 7.0.4 (2008) discrete-event systems simulation software. The structure of the models consists of hierarchical blocks (H-blocks) that: 1) simulate visitor use and behavior of the study sites, including arriving at access points, hiking on trails, lingering at attraction sites, and exiting to the Bear Lake shuttle service or other mode of transportation; and 2) monitor crowding-related indicators of quality (i.e., PAOT at attractions and PPV on selected sections of trail) throughout the course of simulated visitor use days. Each type of hierarchical block contained within the study models are described in the following paragraphs.

Access Point H-blocks are used within the study models to generate simulated visitor groups (Figure 6.10). The rate at which simulated visitor groups are generated within an access point is determined by the corresponding group interarrival distribution computed following procedures described earlier in this chapter.

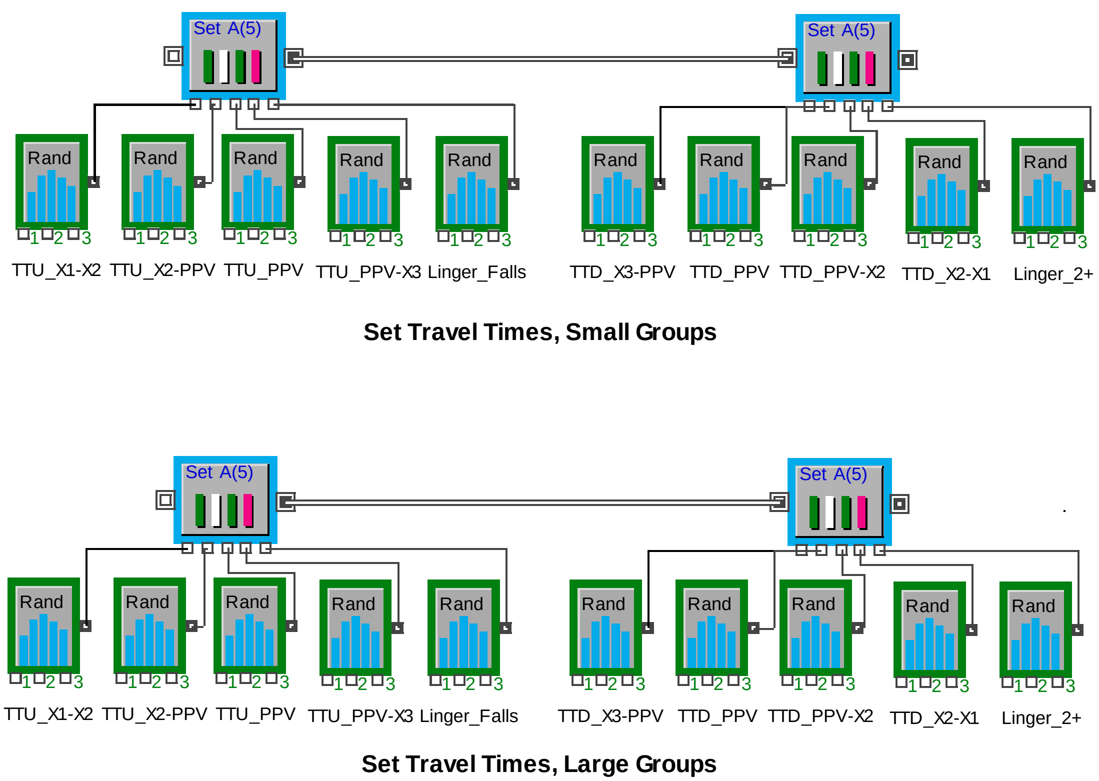
The rate of visitor arrivals can be "ramped up" or "ramped down" by changing the value of the multiplier contained within the Access Point H-blocks to simulate increases or decreases in daily visitation.

Figure 6.10 Sample Access Point H-Block



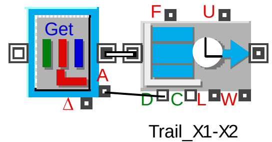
After being generated within Access Point H-blocks, simulated visitor groups are routed within the study models to Attribute H-blocks (Figure 6.11). Attribute H-blocks are designed to assign attribute values to simulated visitor groups, including values that define a simulated group's size and the amount of time they spend hiking on trails and lingering at attractions during their simulated visit to the study site. Distributions of attribute values used in the models to assign group sizes, hiking times, and lingering times are based on the hiking route survey data analysis results presented earlier in this chapter. For example, results of statistical tests conducted with the visitor survey data suggest that, on average, large groups spend a longer time lingering at Alberta Falls than small groups. Thus, separate distributions of lingering times with group size-specific means and standard deviations were specified within the Glacier Gorge Trail model. These distributions were used to assign hiking and lingering times separately to small and large simulated visitor groups (Figure 6.11).

Figure 6.11 Sample Attribute H-Block



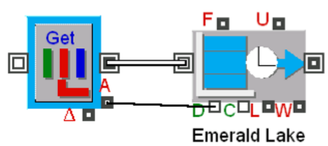
After receiving attribute values within Attribute H-blocks, the simulated visitor groups are directed to the trails and/or attractions within the study site. Trail Section H-blocks simulate visitor use and travel along the study sites' trails (Figure 6.12). The Trail Section H-blocks are designed to "hold" each simulated visitor group as they pass along the trail section on their simulated visit. The amount of time each simulated visitor group is held within a Trail Section H-block is determined by the value of the group's hiking time attribute that was assigned within the Attribute H-block.

Figure 6.12 Sample Trail Section H-Block



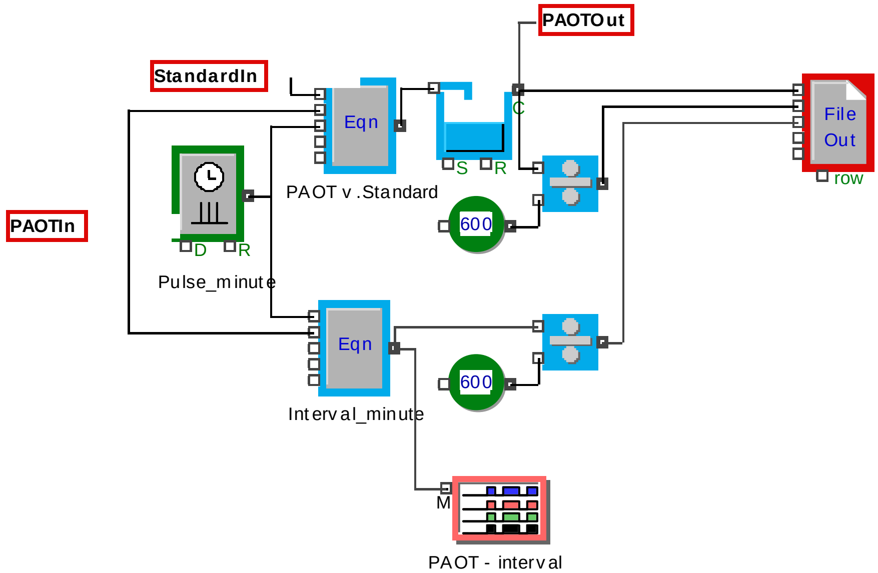
Attraction Area H-blocks simulate visitor use at attraction areas (e.g., Alberta Falls, Emerald Lake) within the study sites, and operate similarly to Trail Section H-blocks. When simulated visitor groups enter Attraction Area H-blocks, they are "held" within the block for an amount of time determined by the value of the group's lingering time attribute that was assigned within the Attribute H-block (Figure 6.13).

Figure 6.13 Sample Attraction Area H-Block



Within the study models, PPV Calculator H-blocks and PAOT Calculator H-blocks are connected to Trail Section H-blocks and Attraction Area H-blocks, respectively (Figure 6.14). The PPV Calculator H-blocks and PAOT Calculator H-blocks are designed to monitor the number of people on trails and at attractions at one minute intervals throughout the course of each simulated visitor use day. The PPV Calculator H-blocks and PAOT Calculator H-blocks contain File Output blocks that report to an ASCII text file the percentage of time within a simulated visitor use day user-specified standards of quality for PPV and PAOT are exceeded. The standards of quality specified for modeling and analysis conducted in this study are based on results of the visitor surveys described in Chapter 2. Thus, the PPV Calculator H-blocks and PAOT Calculator H-blocks are key components of the simulation analyses conducted within this study to estimate user capacities for the study sites.

Figure 6.14 Sample PAOT Calculator H-Block



To summarize, the sequence of processes that occurs within the study models is as follows:

1. Access point H-blocks generate simulated visitor groups based on group interarrival distributions and route them to Attribute H-blocks.
2. Attribute H-blocks assign each simulated visitor group a group size and transportation mode of arrival based on group size and mode frequency distributions constructed from the hiking route survey data. Subsequently, the Attribute H-blocks assign each simulated visitor group hiking and lingering times. The hiking and lingering times are drawn from distributions that account for group size, since statistically significant differences between small and large groups' hiking and lingering times were found within the analysis of hiking survey data.
3. Trail Section and Attraction Area H-blocks "hold" simulated visitor groups for amounts of time based on the hiking and lingering times assigned to them within the Attribute H-blocks.
4. PAOT and PPV Calculator H-blocks monitor PPV on trails and PAOT at attractions each minute of the simulated day, and compute the percentage of time user-specified standards for PPV and PAOT are violated during each run or replication of the model.
5. Trail and Attraction Area H-blocks route simulated visitor groups to exit the study site when their simulated visit is completed.

The processes described above are stochastic, meaning the outcomes vary with each replication of the model. For example, the number of arrivals generated in the Access Point H-blocks varies with each replication of the model, similar to the way actual visitation to the study sites varies from one day to another. Thus, mean values of outcome variables of interest (e.g., percentage of time PAOT and PPV standards are exceeded) are computed based on the results of multiple replications of the model. The method of independent replications was used to determine the number of replications needed to generate reliable model estimates[1]. Based on the results of the method of independent replications, outputs for the model of visitor use on the Glacier Gorge Trail to Alberta Falls were computed by averaging the results of 300 replications of the model. Outputs for the

[1] Kiser, B.C., Lawson, S.R., & Itami, R. (2008). Assessing the reliability of computer simulation for modeling low use landscapes. In R. Gimblett & H. Skov-Petersen (Eds.), *Monitoring, Simulation and Management of Visitor Landscapes*. Tucson, AZ: The University of Arizona Press.

model of visitor use on the Dream Lake Trail were computed by averaging the results of 425 replications of the model.

6.5 Simulation Analysis of Visitor Use and User Capacities

The visitor use models developed in this component of the ATPPL project were used to simulate baseline visitor use conditions on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake. Further, the visitor use models were used to simulate visitor use conditions at the study sites associated with alternative transportation scenarios focusing on shifting visitors from private vehicles to the park's shuttle bus system. Simulation results include estimates of visitor use on trails and at attractions in the two study sites resulting from existing and alternative transportation system operations.

Visitor use estimates from the computer simulations were compared with crowding-related standards of quality derived from visitor surveys described in Chapter 2 and presented in Table 6.15. The standards of quality include "Preference" and "Acceptability" standards for crowding-related indicators of quality. The "Preference" standards represent visitors' preferred levels of the corresponding indicators of quality, while the "Acceptability" standards represent the minimum acceptable conditions of the corresponding indicators of quality. All of the standards of quality are based on visitor survey sample means, thus, they represent the general tendency of visitors, but may not be representative of particularly crowding-sensitive or crowding-tolerant subgroups of visitors.

Table 6.15 Visitor-Based Standards of Quality Derived from 2008 Rocky Mountain NP User Capacity Studies

Standard of Quality	Glacier Gorge Trail [a]	Base of Alberta Falls [b]	Trail to Dream Lake [a]	Emerald Lake [a]
Preference	2	9	2	5
Acceptability	8	24	8	15

[a] Standards refer to number of people per viewscape (PPV) on a 50 meter section of the trail.
[b] Standards refer to number of people at one time (PAOT) in the area depicted in the visitor survey photographs.

Comparison of visitor use estimates from the computer model simulations with crowding-related standards quantify the extent to which crowding occurs on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake under existing and alternative visitation and transportation system operations scenarios. The series of simulations and comparisons with standards of quality are described in the following paragraphs.

6.5.1 Simulations of Visitor Use Resulting from Existing Visitation and Transportation Mode Choice

The first series of simulations was conducted to estimate the percentage of time visitor-based standards of quality are exceeded on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake under existing visitation and transportation system operations. The results of these simulations are presented in Table 6.16. These results suggest that "Preference" standards for PAOT at Alberta Falls and Emerald Lake are exceeded for the vast majority of the day under existing visitor use conditions. "Preference" standards for PPV on the Glacier Gorge Trail and Dream Lake Trail are exceeded just over 15% of the time under existing conditions. With respect to the "Acceptability" standards, the baseline vehicle mode mix results suggest that crowding is not prevalent on the study trails. However, the simulation results suggest that "Acceptability" standards for PAOT are exceeded about 20% of the time at Alberta Falls and about 50% of the time at Emerald Lake.

Table 6.16 Percentage of Time Visitor-based Standards of Quality are Violated, Assuming Existing Visitation and Transportation System Operations during Summer 2008 a

Standard of Quality	Glacier Gorge Trail 1,460 [b]	Alberta Falls 1,460 [b]	Dream Lake Trail 1,260 [b]	Emerald Lake 1,260 [b]
Preference	18.6% (+/- 0.19%)	81.7% (+/- 0.42%)	15.8% (+/- 0.16%)	76.1% (+/- 0.28%)
Acceptability	2.0% (+/- 0.07%)	20.1% (+/- 0.63%)	1.8% (+/- 0.06%)	51.7% (+/- 0.57%)

[a] Numbers in parentheses represent 95% confidence intervals for estimated percentages of time.
[b] Average daily trailhead visitation during summer 2008 visitor use counts.

Results of the visitor use model simulations of existing visitation and transportation system operations are presented graphically in Figure 6.15 through Figure 6.18. The graphs depict how the number of people at one time at attraction sites and the number of people per viewscape on the study trails varies throughout a "typical" day during summer 2008. The horizontal red line in each graph denotes the "Acceptability" standard for the corresponding crowding-related indicator. Thus, the graphs also provide a visual sense of the degree to which existing visitation exceeds the crowding-related "Acceptability" standards.

Figure 6.15 Visitor Use Model Estimate of People at One Time at Alberta Falls - Existing Visitation and Transportation System Operations

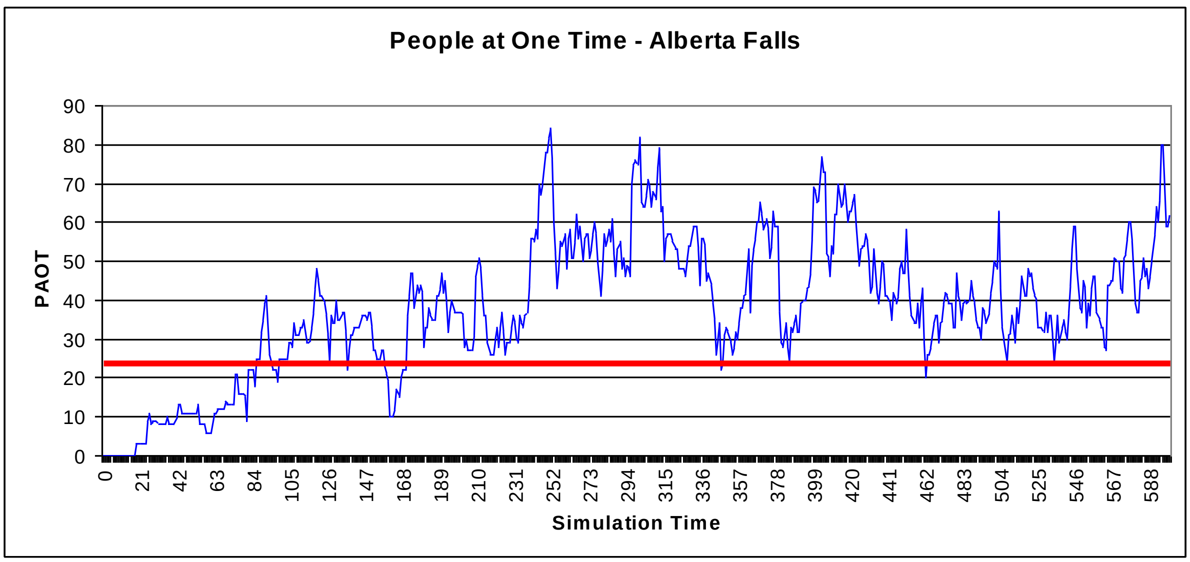


Figure 6.16 Visitor Use Model Estimate of People per Viewscape on the Glacier Gorge Trail - Existing Visitation and Transportation System Operations

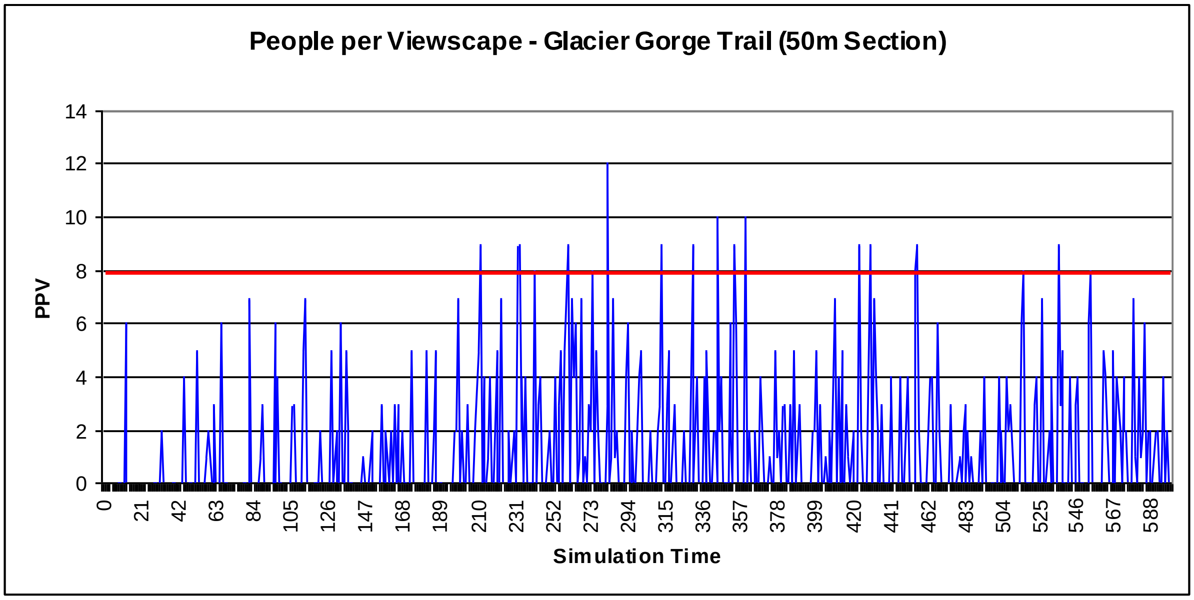


Figure 6.17 Visitor Use Model Estimate of People at One Time at Emerald Lake - Existing Visitation and Transportation System Operations

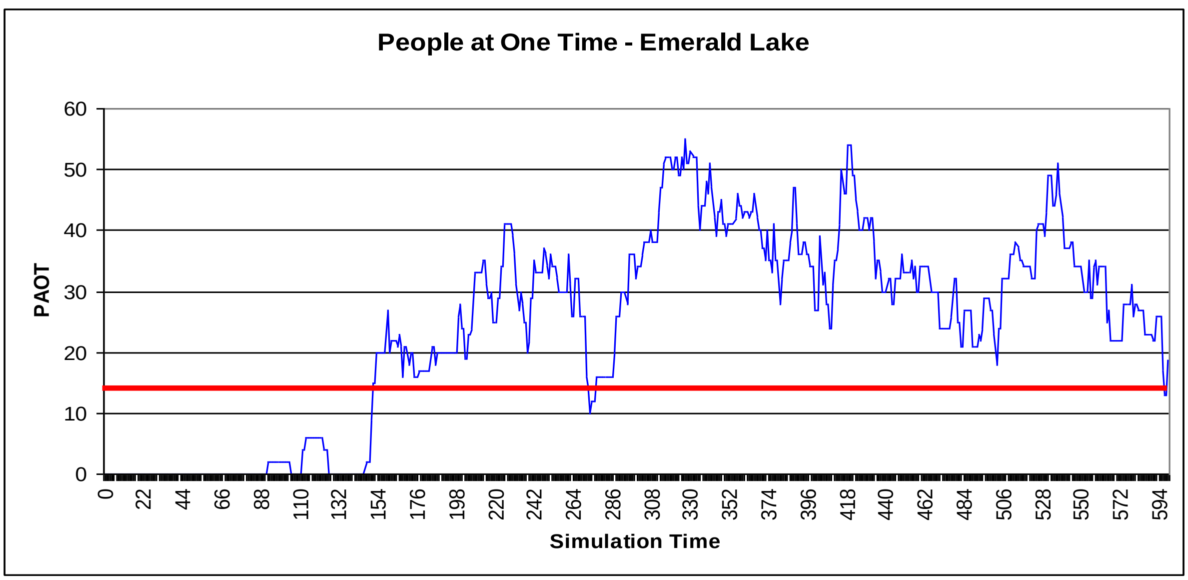
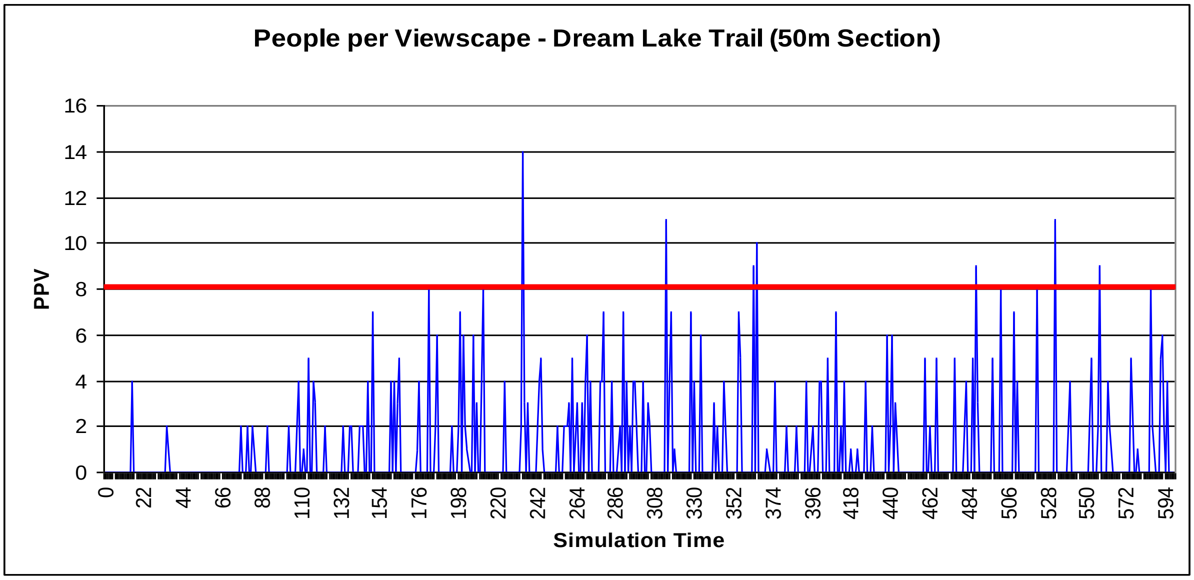


Figure 18. Visitor Use Model Estimate of People per Viewscape on the Dream Lake Trail - Existing Visitation and Transportation System Operations



6.5.2 Simulations of Visitor Use Resulting from Visitor Transportation "Mode Shifts"

Two additional series of simulations were conducted to estimate the extent to which crowding on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake would be affected by alternative transportation scenarios in which a greater proportion of visitors ride the Bear Lake shuttle bus to the study sites and fewer drive their personal vehicle than under existing conditions observed in 2008. In both of the scenarios modeled, it was assumed that the NPS would increase service for the Hiker Shuttle from Estes Park to the Bear Lake Park and Ride, with bus headways decreasing from 1 hour to 15 minutes, and implement an intelligent transportation system (ITS). The purpose of the ITS would be to persuade visitors to park their personal vehicles in Estes Park or the Bear Lake Park and Ride Lot and use the park's shuttle bus system to travel to their park destinations. The ITS was assumed to include signs positioned on the approach to Estes Park and the Bear Lake Park and Ride Lot, and include messages similar to the following:

Reduce your carbon footprint
Avoid traffic and parking congestion
Park here and ride the free park shuttle bus.

The scenarios assume that the ITS would be effective at creating a "transportation mode shift" among park visitors, resulting in an increasing proportion of visitors using the park shuttle bus system, rather than their personal vehicles, to travel to their park destinations. The two scenarios that were modeled differ in the degree to which this mode shift would occur; the first scenario assumes a 10% "capture rate" and the second scenario assumes a 25% "capture rate." In other words, the scenarios assume either 10% or 25% of visitors who travel in their personal vehicles from points east of the park to the Bear Lake Park and Ride under existing conditions would instead end their trips in Estes Park and become new passengers on the Hiker Shuttle. Similarly, the scenarios assume either 10% or 25% of visitors who travel in their personal vehicles beyond the Bear Lake Park and Ride toward the Bear Lake area under existing conditions would instead park at the Bear Lake Park and Ride and board the Bear Lake shuttle system.

The 10% capture rate and 25% capture rate mode shift scenarios were modeled in this project because there are intuitive advantages associated with them. For example, it is reasonable to expect that shifting visitors from personal vehicles to the park's shuttle bus system would reduce vehicle miles traveled in the park, parking congestion at popular destinations, and transportation-related air emissions. As described in Chapter 5, traffic simulation modeling was used to evaluate these potential advantages, and the results from these simulations verify that there are several advantages of the mode shift scenarios, with respect to transportation-related indicators.

While the traffic simulation results suggest that the transportation mode shift scenarios have substantive advantages, with respect to transportation-related indicators, there is some reason to expect that these scenarios could have a detrimental effect on crowding at popular destinations in the park. In particular, shifting visitors from personal vehicles to the park's shuttle bus system could create a "pulsing effect", with respect to the timing of visitor arrivals at popular trailheads and this could exacerbate crowding issues. Thus, personal vehicle and shuttle bus rider arrivals data from the results of the traffic simulations of the two transportation mode shift scenarios were incorporated into the visitor use models for the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake to assess the effects of the transportation mode shift scenarios on crowding at the two study sites.

The results of the visitor use model simulations of the transportation mode shift scenarios are presented in Table 6.17, along with results from the simulations of existing visitation and transportation system operations during summer 2008. These results suggest that, holding visitation constant at summer 2008 levels, shifting 10% or 25 % of visitors from their personal vehicles to the park's shuttle bus system to access the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake has no effect on crowding there. Thus, shifting visitors from their personal vehicles to the park's shuttle system has empirically verified advantages, with respect to parking congestion, vehicle miles traveled, transportation-related air emissions, and other factors, and such a transportation mode shift does not exacerbate crowding at popular visitor use destinations in the park, though it does not solve the crowding problems at these locations.

Table 6.17 Percentage of Time Visitor-based Standards of Quality are Violated, Assuming Existing Conditions During Summer 2008 and Transportation Mode Shift Scenarios [a]

Standard of Quality	Glacier Gorge Trail 1,460 [b]		Alberta Falls 1,460 [b]		Dream Lake Trail 1,260 [b]		Emerald Lake 1,260 [b]	
	Acceptability	Preference	Acceptability	Preference	Acceptability	Preference	Acceptability	Preference
Existing conditions during summer 2008	2.0% (+/- 0.07%)	18.6% (+/- 0.19%)	20.1% (+/- 0.63%)	81.7% (+/- 0.42%)	1.8% (+/- 0.06%)	15.8% (+/- 0.16%)	51.7% (+/- 0.57%)	76.1% (+/- 0.28%)
10% Shift to Shuttle Bus [c]	2.0% (+/- 0.07%)	18.6% (+/- 0.18%)	18.8% (+/- 0.72%)	82.4% (+/- 0.42%)	1.9% (+/- 0.06%)	15.9% (+/- 0.16%)	50.8% (+/- 0.57%)	76.0% (+/- 0.28%)
25% Shift to Shuttle Bus [c]	2.0% (+/- 0.07%)	18.9% (+/- 0.19%)	20.1% (+/- 0.70%)	82.6% (+/- 0.43%)	1.9% (+/- 0.06%)	16.1% (+/- 0.16%)	51.1% (+/- 0.57%)	77.3% (+/- 0.28%)

[a] Numbers in parentheses represent 95% confidence intervals for estimated percentages of time.
[b] Average daily trailhead visitation during summer 2008 visitor use counts.
[c] Modeling scenarios assuming varying proportions of visitors shift from private vehicle to shuttle bus use.

Simulations to Estimate User Capacity of Study Sites

In coordination with NPS officials at RMNP, it was assumed that when crowding-related standards of quality are exceeded on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake more than 15% of the time, it is not consistent with visitor experience objectives for these areas. Accordingly, the visitor use model simulation results noted suggest that existing levels of visitation on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake do not conform with visitor experience objectives for these areas. Thus, a series of simulations was conducted to estimate the maximum number of visitors that can be accommodated on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake without exceeding visitor-based standards of quality more than 15% of the time; these user capacity estimates are presented in Table 6.18.

Table 6.18 Daily User Capacity Estimates of Study Sites with Alternative Visitor-based Standards of Quality [a]

Standard of Quality	Glacier Gorge Trail to Alberta Falls	Dream Lake Trail to Emerald Lake
Preference	457 (+/-7.62)	195 (+/-7.27)
Acceptability	1318 (+/-7.93)	684 (+/-7.69)

[a] Daily user capacity estimates were calculated to allow standards of quality to be exceeded a maximum of 15% of the time (1.5 hours per 10-hour day). Numbers in parentheses represent 95% confidence intervals for daily user capacity estimates.

The user capacity estimates in Table 6.18 were compared to summer 2008 design day visitation levels. In particular, the user capacity estimates for the Glacier Gorge Trail to Alberta Falls were compared to the level of visitor use counted on July 20, 2008, which was the 6th busiest day of the summer 2008. Similarly, the user capacity estimates for the Dream Lake Trail to Emerald Lake were compared to the level of visitor use counted on July 12, 2008, which was the 8th busiest day of the summer 2008. The results of these comparisons suggest visitation to the Glacier Gorge Trail to Alberta Falls would need to be reduced by about 4% from summer 2008 levels to ensure crowding-related “Acceptability” standards were not exceeded more than 15% of the time (Table 6.19). Further, the user capacity estimates suggest visitation to the Dream Lake Trail to Emerald Lake would need to be reduced by more than one-third (38%) to ensure crowding-related “Acceptability” standards are not exceeded more than 15% of the time.

Table 6.19 Daily User Capacity Estimates of Study Sites as a Percentage of Design Day Visitation, with Alternative Visitor-based Standards of Quality [a]

Standard of Quality	Glacier Gorge Trail to Alberta Falls (Design Day Visitation = 1,367) [b]	Dream Lake Trail to Emerald Lake (Design Day Visitation = 1,099) [c]
Preference	-66.6%	-82.3%
Acceptability	-3.6%	-37.8%

[a] Daily user capacity estimates were calculated to allow standards of quality to be exceeded a maximum of 15% of the time (1.5 hours per 10-hour day).
[b] July 20, 2008; 6th busiest day of 2008 based on traffic counts at park entrance stations.
[c] July 12, 2008; 8th busiest day of 2008 based on traffic counts at park entrance stations.

Conversations with NPS officials at RMNP suggest that there are no plans to reduce the size of parking lots at the Glacier Gorge or Bear Lake Trailheads. Thus, any reductions in visitor use to the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake would be achieved, at least in the short-term, by reducing the number of visitors "delivered" by the park's shuttle system to the Glacier Gorge and Bear Lake Trailheads.

Using information from the hiking route survey about the proportion of visitors who use personal vehicles to access the two study sites, and assuming that there will be no reduction in the number of visitors who access these sites by personal vehicles, estimates were made of the number shuttle riders that would need to be displaced to conform with the user capacities in Table 6.18.

The results of this analysis suggest that even with no shuttle service to the Glacier Gorge and Bear Lake Trailheads, the user capacity estimates for the study sites based on "Preference" standards would be exceeded (Table 6.20). With respect to the user capacities based on the "Acceptability" standards, the analysis suggests that the Dream Lake Trail to Emerald Lake can sustain the existing number of visitors who access the site via personal vehicles. However, to conform with the site's user capacity based on the "Acceptability" standards, essentially 100% of existing shuttle bus riders who hike on the Dream Lake Trail would have to be displaced to other locations in the park. On the Glacier Gorge Trail to Alberta Falls, it is estimated that an average of about 50 shuttle bus riders per day, or roughly 7% of existing shuttle bus riders, would need to be displaced from the Glacier Gorge Trail to Alberta Falls to conform with the user capacity for this site based on "Acceptability" standards.

Table 6.20. Estimated Number and Percentage of Shuttle Bus Riders Needed to be Displaced to Conform With Crowding-Related User Capacities

	Glacier Gorge Trail to Alberta Falls (Design Day Personal Vehicle Use = 616)		Dream Lake Trail to Emerald Lake (Design Day Personal Vehicle Use = 692)	
Standard of Quality	Number of Displaced Shuttle Bus Riders	Percentage of Displaced Shuttle Bus Riders	Number of Displaced Shuttle Bus Riders	Percentage of Displaced Shuttle Bus Riders
Preference [a]	752	100%	407	100%
Acceptability	52	7%	407	100%

[a] User capacities based on "Preference" standards would be exceeded at both study sites, even with no shuttle bus riders present.

6.5.3 Simulations to Estimate Off-trail Visitor Use at Study Sites

Finally, information from the recreation ecology assessments described in Chapter 4 was incorporated with the visitor use models to estimate the volume of off-trail visitor use in the areas adjacent to Alberta Falls and Emerald Lake. Further, visitor use model results from the 10% and 25% capture rate scenarios were integrated with the recreation ecology data to assess whether the transportation mode shift scenarios affected the extent of off-trail visitor use at the two study sites. The results of this analysis suggest that more than 600 visitors per day travel off-trail in the area adjacent to Alberta Falls, including nearly 350 visitors per day that travel a relative far distance off-trail from Alberta Falls (

Table 6.21). Further, about 400 visitors per day are estimated to travel off-trail in the area adjacent to Emerald Lake, including over 200 visitors per day who travel a relative far distance off-trail from Emerald Lake (Table 6.22). The analysis results suggest that the volume of off-trail visitor use in the areas adjacent to Alberta Falls and Emerald Lake is not affected by the transportation mode shift scenarios.

Table 6.21. Number of visitors off trail in each use zone for Alberta Falls.

Zone	Number of Visitors Traveling Off Trail Baseline	Number of Visitors Traveling Off Trail 10% Capture	Number of Visitors Traveling Off Trail 25% Capture
Near	639	639	643
Far	347	347	350
Total	639	639	643

Table 6.22. Number of visitors off trail in each use zone for Emerald Lake.

Zone	Number of Visitors Traveling Off Trail Baseline	Number of Visitors Traveling Off Trail 10% Capture	Number of Visitors Traveling Off Trail 25% Capture
Near	403	405	410
Far North	142	143	145
Far South	95	95	96
Total	403	405	410

6.6 Summary of Results and Findings

This chapter provides a summary of study findings. The primary purposes of this study were to: 1) model visitor use on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake; 2) estimate the extent of crowding resulting from existing visitation and transportation system operations during summer 2008; 3) estimate daily user capacities for each of the two study sites; 4) estimate the volume of off-trail visitor use at the study sites; and 4) estimate the extent to which shuttle service to the Glacier Gorge Trail and Dream Lake Trail would need to be modified to maintain visitor use levels in accordance user capacity estimates for each site. The results of this study are intended to assist the NPS in managing visitor use, personal vehicle traffic, and shuttle service in the Bear Lake Corridor in a manner that accounts for user capacities on the Glacier Gorge and Dream Lake Trails.

6.6.1 Sampling Summary – Hiking Route Surveys and Visitor Counts

- At each study site, hiking route survey sampling occurred for a total of 4 days, including 2 weekend days and 2 weekdays.
- Hiking route survey response rates at both study sites were relatively high, with a 86.6% response rate at and a 83.7% response rate at El Capitan Meadow. These high response rates suggest that non-response bias within the hiking route survey data is unlikely.
- Visitor counts were conducted from 8:00 AM to 4:00 PM on three weekdays and two weekend days at each of the two study sites.
- Vehicle entry count data collected at the Beaver Meadows Entrance Station during summer 2008 suggest that the sampling dates on which visitor counts were conducted in this study span a representative range of park visitation levels. In particular, visitor counts were conducted on the Glacier Gorge Trail on the 4th, 6th, 12th, 37nd, and 40th busiest days of vehicle entries at the Beaver Meadows Entrance Station during the summer 2008. Similarly, visitor counts were conducted on the

Dream Lake Trail on the 8th, 10th, 19th, 34th, and 72nd busiest days of vehicle entries at the Beaver Meadows Entrance Station during the summer 2008.

6.6.2 Summary of Findings - Glacier Gorge Trail Visitor Counts and Hiking Route Survey

- The Glacier Gorge Trail to Alberta Falls received an average of 1,305 visitors per day (8:00 AM to 4:00 PM) during the 2008 visitor count sampling period.
- The maximum daily visitor observed on the Glacier Gorge Trail to Alberta Falls during the 2008 visitor count sampling period was 1,509 visitors; this level of visitation was observed on Saturday, July 19, 2008, which ranked as the 4th busiest day of vehicle entries at the Beaver Meadows Entrance Station during the 2008 summer season.
- The minimum daily visitor use observed on the Glacier Gorge Trail to Alberta Falls was 1,093 visitors; this level of visitation was observed on July 14, 2008, which ranked as the 49th busiest day of vehicle entries at the Beaver Meadows Entrance Station during the 2008 summer season.
- Approximately half (50%) of all visitor use on the Glacier Gorge Trail to Alberta Falls originates from the Glacier Gorge Trailhead and about half (50%) originates from the Bear Lake Trailhead. Accordingly, about equal proportions of visitors enter the Glacier Gorge Trail from the Glacier Gorge Trailhead and the Bear Lake Connector Trail.
- More specifically, roughly equal proportions of visitors on the Glacier Gorge Trail to Alberta Falls ride the park's shuttle bus system to the Glacier Gorge Trailhead (36%) or Bear Lake Trailhead (34%) and begin their hikes from there. Similarly, about equal proportions of visitors on the trail drive personal vehicles to the Glacier Gorge Trailhead (14%) or Bear Lake Trailhead (16%) and begin their hikes from there. About three-quarters (76%) of visitor use originating from the Glacier Gorge Trailhead (i.e., excluding those visitors how originate at the Bear Lake parking lot/shuttle bus stop) ride the park's shuttle bus system to the trailhead, while about one-quarter (24%) drive personal vehicles to the trailhead.
- Visitor use originating from the Glacier Gorge Trailhead begins to peak around 9:00 AM and is somewhat more intensive on weekend days than weekdays. Arrivals onto the trail from the Glacier Gorge Trailhead begin to decline around 11 AM, but remain high (nearly 100 visitors per hour) until about 1:30 PM and steady throughout the remainder of the day.
- Visitor arrivals onto the Glacier Gorge Trail from the Bear Lake Connector Trail begins to peak around 11:00 AM and remains steady through the remainder of the day; there does not appear to be a substantial difference in weekend day and weekday visitation patterns. Very little use on the Glacier Gorge Trail to Alberta Falls originates from the park's backcountry, with most of these arrivals onto the trail occurring in the afternoon.
- Almost all (90%) hikers on the Glacier Gorge Trail visit Alberta Falls and those who do spend an average of about 15 minutes lingering there.

6.6.3 Summary of Findings - Dream Lake Trail Visitor Counts and Hiking Route Survey

- The Dream Lake Trail to Emerald Lake received an average of 1,085 visitors per day (8:00 AM to 4:00 PM) during the 2008 visitor count sampling period.
- The maximum daily visitor observed on the Dream Lake Trail to Emerald Lake during the 2008 visitor count sampling period was 1,128 visitors; this level of visitation was observed on Tuesday, July 15,

2008, which ranked as the 34th busiest day of vehicle entries at the Beaver Meadows Entrance Station during the 2008 summer season.

- The minimum daily visitor use observed on the Dream Lake Trail to Emerald Lake during the 2008 visitor count sampling period was 1,033 visitors; this level of visitation was observed on July 11, 2008, which ranked as the 19th busiest day of vehicle entries at the Beaver Meadows Entrance Station during the 2008 summer season.
- Virtually all (97%) visitor use on the Dream Lake Trail to Emerald Lake originates from the Bear Lake Trailhead, with a very small minority (3%) originating from the Glacier Gorge Trailhead.
- More specifically, about two-thirds (62%) of visitors on the Dream Lake Trail drive personal vehicles to the Bear Lake Trailhead parking lot and begin their hikes from there; just over one-third (35%) ride the park's shuttle bus system to the Bear Lake Trailhead and begin their hikes there. The remainder (3%) of visitors ride the park's shuttle bus system to the Glacier Gorge Trailhead and hike to the Dream Lake Trail from there.
- The vast majority (97%) of visitors enter the Dream Lake from the Dream Lake Trailhead (X1), while very few (3%) enter from the Lake Hiyaha Trail.
- Visitor use originating from the Bear Lake Trailhead grows steadily and substantially beginning at about 8:00 AM, with arrivals onto the trail at the Dream Lake Trailhead peaking around 11:00 AM.
- Visitors who hike on the Dream Lake Trail spend an average of about 2 hours 15 minutes on the trail. Just under half (44%) of all hikers on the Dream Lake Trail visit Emerald Lake and those who do spend an average of about 30 minutes lingering at the lake.

6.6.4 Summary of Findings – Visitor Use Simulations and User Capacity Estimates

Simulations were conducted with the visitor use models to estimate the percentage of time visitor-based standards of quality are exceeded at the study sites under existing visitation and transportation system operations during summer 2008. The results of these simulations are summarized in the following bulleted list.

- Simulation results suggest that "Preference" standards for PAOT at Alberta Falls and Emerald Lake are exceeded for the vast majority of the day under existing visitor use conditions. "Preference" standards for PPV on the Glacier Gorge Trail and Dream Lake Trail are exceeded just over 15% of the time under existing conditions.
- With respect to the "Acceptability" standards, the results suggest that crowding is not prevalent on the study trails. However, the simulation results suggest that "Acceptability" standards for PAOT are exceeded about 20% of the time at Alberta Falls and about 50% of the time at Emerald Lake.

Two additional series of simulations were conducted to estimate the extent to which crowding on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake would be affected by alternative transportation scenarios in which a greater proportion of visitors ride the Bear Lake shuttle bus to the study sites and fewer drive their personal vehicle than under existing conditions observed in 2008. The scenarios assume that an ITS would be implemented and result in a "transportation mode shift" among park visitors. The two scenarios that were modeled differ in the degree to which this mode shift would occur; the first scenario assumes a 10% "capture rate" and the second scenario assumes a 25% "capture rate." In other words, the scenarios assume either 10% or 25% of visitors who travel in their personal vehicles to their park destinations under existing conditions would instead park in Estes Park or at the Bear Lake Park and Ride and use the park's shuttle bus system. The results of the visitor use model simulations of the transportation mode shift scenarios are summarized in the following bulleted list.

- The simulation results suggest that, holding visitation constant at summer 2008 levels, shifting 10% or 25 % of visitors from their personal vehicles to the park's shuttle bus system to access the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake has no effect on crowding there.
- Thus, shifting visitors from their personal vehicles to the park's shuttle system has empirically verified advantages, with respect to parking congestion, vehicle miles traveled, transportation-related air emissions, and other factors (see traffic model results in Chapter 5) and such a transportation mode shift does not exacerbate crowding at popular visitor use destinations in the park.

In coordination with NPS officials at RMNP, it was assumed that when crowding-related standards of quality are exceeded on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake more than 15% of the time, it is not consistent with visitor experience objectives for these areas. A series of simulations was conducted to estimate the maximum number of visitors that can be accommodated on the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake without exceeding visitor-based standards of quality more than 15% of the time; the results are summarized in the following bulleted list.

- The simulation results suggest visitation to the Glacier Gorge Trail to Alberta Falls would need to be reduced by about 4% from summer 2008 levels to ensure crowding-related "Acceptability" standards were not exceeded more than 15% of the time.
- The simulation results suggest visitation to the Dream Lake Trail to Emerald Lake would need to be reduced by more than one-third (38%) to ensure crowding-related "Acceptability" standards are not exceeded more than 15% of the time.

Using information from the hiking route surveys about the proportion of visitors who use personal vehicles to access the Glacier Gorge Trail to Alberta Falls and the Dream Lake Trail to Emerald Lake, and assuming that there will be no reduction in the number of visitors who access these sites by personal vehicles, estimates were made of the number shuttle riders that would need to be displaced to conform with the user capacities estimated in this study. Results of these analyses are summarized in the following bulleted list.

- On the Glacier Gorge Trail to Alberta Falls, it is estimated that an average of about 50 shuttle bus riders per day, or roughly 7% of existing shuttle bus riders, would need to be displaced from the Glacier Gorge Trail to Alberta Falls to conform with the user capacity for this site based on "Acceptability" standards.
- With respect to the user capacities based on the "Acceptability" standards, the study results suggests that the Dream Lake Trail to Emerald Lake can sustain the existing number of visitors who access the site via personal vehicles. However, to conform with the site's user capacity based on the "Acceptability" standards, essentially 100% of existing shuttle bus riders who hike on the Dream Lake Trail would have to be displaced to other locations in the park.

Information from the recreation ecology assessments described in Chapter 4 was incorporated with the visitor use models to estimate the volume of off-trail visitor use in the areas adjacent to Alberta Falls and Emerald Lake. Further, visitor use model results from the 10% and 25% capture rate scenarios were integrated with the recreation ecology data to assess whether the transportation mode shift scenarios affected the extent of off-trail visitor use at the two study sites. The results of these analyses are summarized in the following bulleted list.

- The simulation results suggest that more than 600 visitors per day travel off-trail in the area adjacent to Alberta Falls, including nearly 350 visitors per day that travel a relative far distance off-trail from Alberta Falls.
- About 400 visitors per day are estimated to travel off-trail in the area adjacent to Emerald Lake, including over 200 visitors per day who travel a relative far distance off-trail from Emerald Lake.
- The analysis results suggest that the volume of off-trail visitor use in the areas adjacent to Alberta Falls and Emerald Lake is not affected by the transportation mode shift scenarios.

Chapter 7: NOISE MODELING AND MAPPING

7.1 Introduction

This study is part of a transportation alternatives analysis that seeks to optimize shuttle operations while protecting visitor experience and resource conditions. The section of the report details sound level monitoring and surface transportation sound modeling of shuttle alternatives in the corridor to address visitor experience impacts. The study involved several tasks:

1) Collecting background sound levels at sensitive areas in the eastern part of the Park
2) Calibrating a surface transportation sound propagation model
3) Creating surface transportation noise maps for three alternative shuttle scenarios
4) Creating a surface transportation simulation program to model percentile levels and "time above" sound levels for specific locations
5) Creating a "Loudness" calculator
6) Comparing results to on-site observations of noise at various locations in the Park
7) Integrating the surface transportation noise map into other user-experience surveys and methods

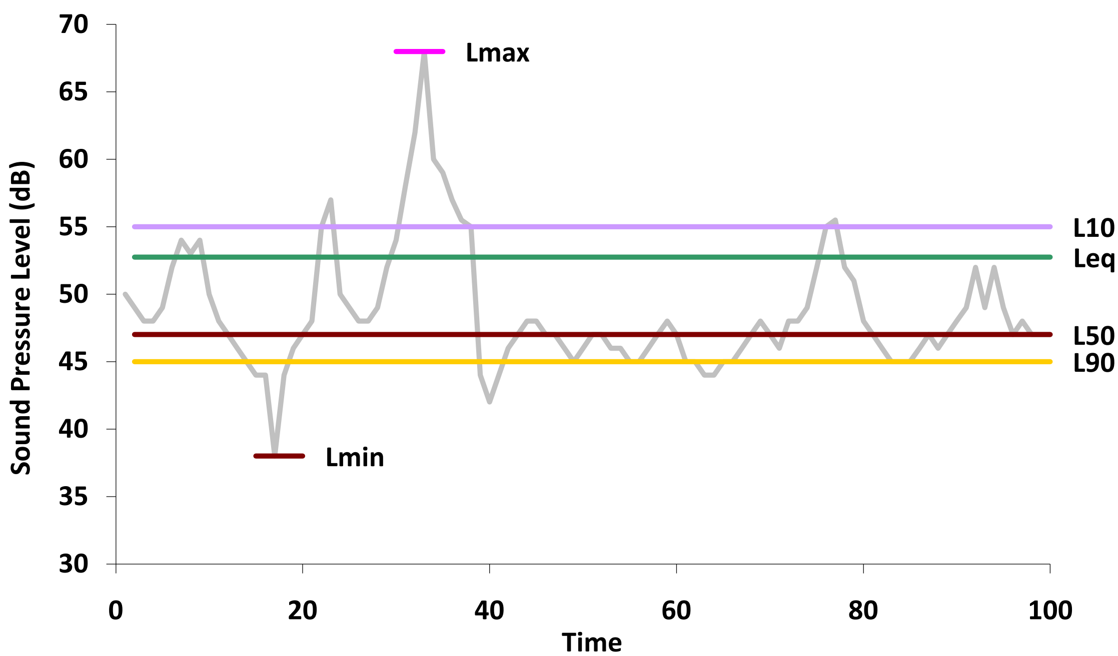
This section of the report summarizes the monitoring methodology, modeling, and results.

7.2 Description of terms

Sound can be measured in many different ways. Perhaps the simplest way is to take an instantaneous measurement, which gives the sound pressure level at an exact moment in time. The level reading could be 62 dB, but a second later it could be 57 dB. Sound pressure levels change constantly. For this reason, it makes sense to describe sound as a function of what it does over time.

The most common way to describe sound over time is in terms of various statistics. Take, as an example, the sound levels measured over time shown in Figure 7.1. Instantaneous measurements are shown as a ragged grey line. The sound levels that occur over this time can be described verbally, but it is much easier and more useful to describe the recorded levels statistically. This is done using a variety of "levels" which are described below.

Figure 7.1 Example of Noise Measurement over Time and Descriptive Statistics



Equivalent Average Sound Level - Leq

One of the most common terms used to describe noise levels is the continuous equivalent sound level (Leq). The Leq is the average of the sound pressure over an entire monitoring period and expressed as a decibel. The monitoring period could be for any amount of time, such as one second ($Leq_{1\text{-sec}}$), one hour ($Leq_{(1)}$), or 24 hours ($Leq_{(24)}$). Because Leq is a function of the logarithm of the average pressure, loud and infrequent sounds have a greater effect on the resulting level than quieter and more frequent noises. For example, in Figure 1, the median sound level is about 47 dBA, but the equivalent average sound level (Leq) is 53 dBA. Because it tends to weight the higher sound levels and is representative of sound that takes place over time, the Leq is the most commonly used descriptor in noise standards and regulations.

Similar to an $Leq_{(24)}$ is the day-night sound level, symbolized by Ldn, or DNL. For the day-night average level, a 10 dB penalty is applied to the nighttime Leq.

Percentile Sound Level - Ln

The percentile sound level, Ln, is the sound level exceeded *n* percent of the time. This type of statistical sound level, also shown in Figure 7.1 gives information about the distribution of sound levels over time. For example, the L10 is the sound level that is exceeded 10 percent of the time, while the L90 is the sound level exceeded 90 percent of the time. The L50 is the median sound level, exceeded half the time. The L90 is a residual base level which most of the sound exceeds, while the L10 is representative of the peaks and higher, but less frequent levels. When one is trying to measure a continuous sound, the L90 is often used to filter out other short-term environmental sounds that increase the level, such as dogs barking, vehicle passbys, wind gusts, and talking.

Minimum and Maximum Level – Lmin and Lmax

The absolute minimum and absolute maximum sound levels are often used as environmental noise descriptors. These are represented by Lmin and Lmax, respectively.

Loudness

Loudness is a function of the level of sound, and is proportional to the subjective magnitude as estimated by listeners. Therefore, a doubling of loudness represents a doubling of the perceived volume of sound. Loudness depends primarily upon the sound pressure although it also a function of the spectrum, bandwidth, and duration of the sound. Loudness is measured in units of sones. Loudness Level, which is measured in units of phons, is a related function, where 1 sone is equal to 40 phons. This level is perceived to be equally as loud as a 1,000 Hz pure tone at 40 dB.

7.3 Project Background

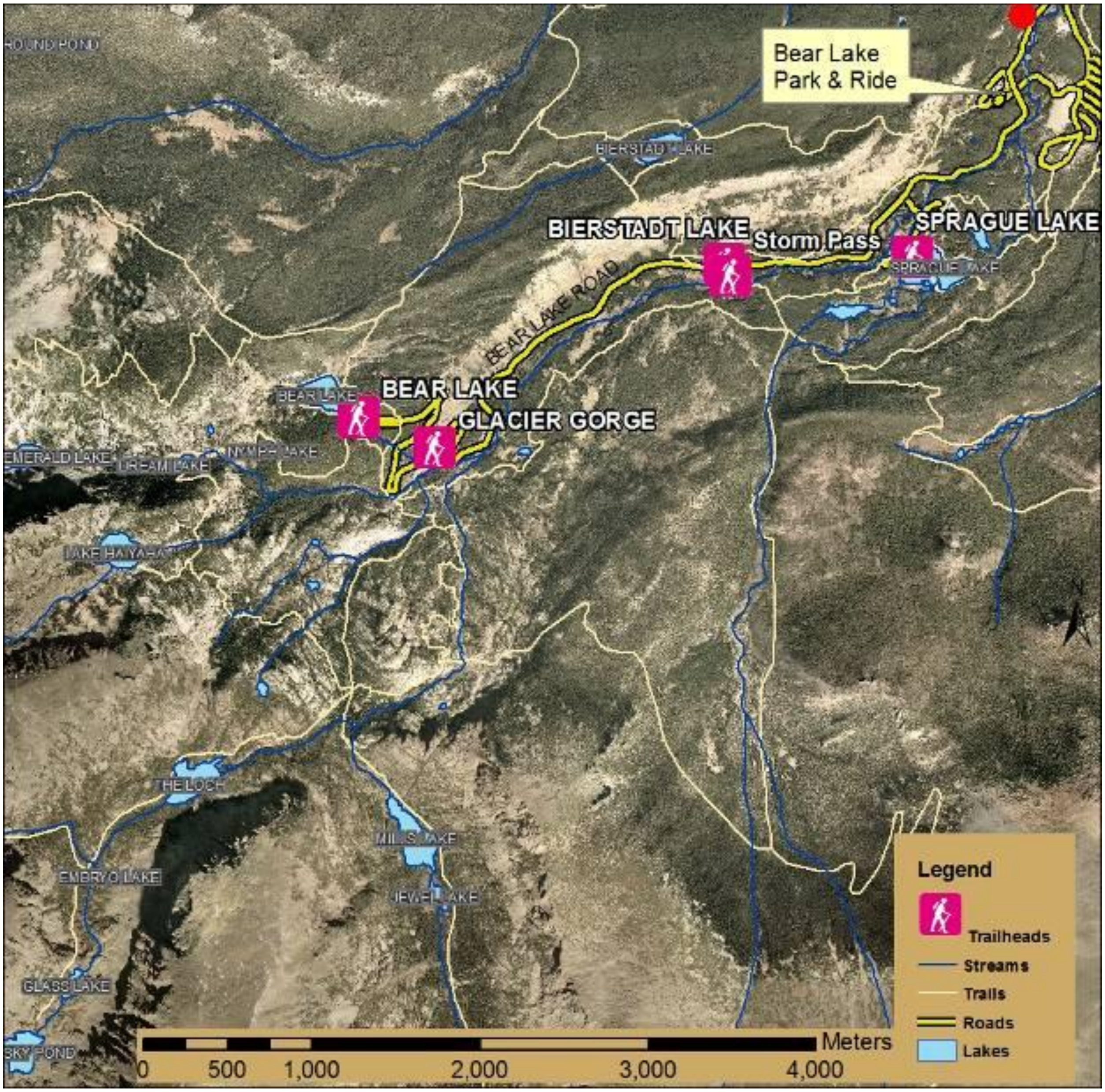
7.3.1 Site Description

Bear Lake Road is a popular destination located in the eastern half of the Rocky Mountain National Park in north-central Colorado. The road is 14.8 km (9.2 miles) long, starting near the Beaver Meadows entrance and running south to the trailhead near Bear Lake.

The road has two shuttle systems. The first runs from Estes Park to the Park & Ride lot, approximately 7 km (4.3 miles) from the Beaver Meadows park entrance along Bear Lake Road. The second shuttle runs from the Park & Ride, and stops at the Bierstadt Lake/Storm Pass and Glacier Gorge trailheads before arriving at the Bear Lake parking lot and trailhead. Bear Lake lies beneath the flanks of Hallet's Peak at an elevation of 9,450 feet. The Bear Lake shuttle runs at 10 to 15 minute headways during the day.

Popular destinations on Bear Lake Road include Bierstadt Lake, Emerald Lake, Lake Haiyaha, Sprague Lake, Alberta Falls, and the most popular, Bear Lake.

Figure 7.2 Bear Lake Corridor Study Area

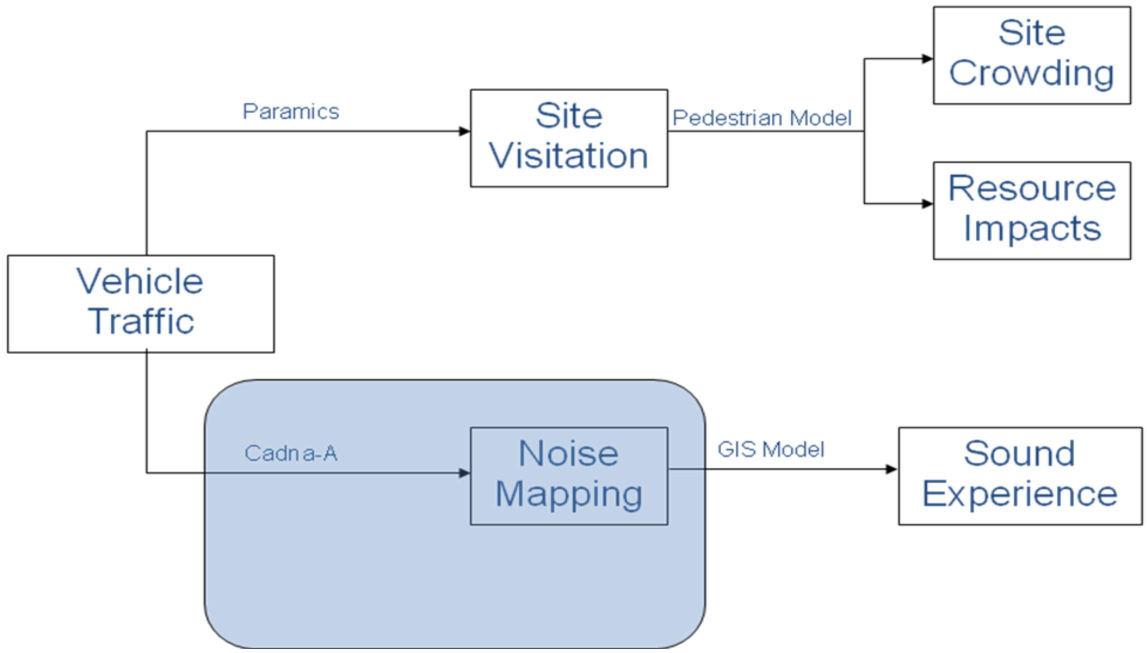


7.3.2 Project Context

The noise mapping and modeling described in this report are part of a larger Federal Transit Administration (FTA) Transit in Parks Program project to assess transit alternatives along the Bear Lake Road corridor. The project will look at a wide variety of impacts related to visitor experience, including vehicular traffic, site visitation and parking, leading to site crowding and resource impact assessment (

Figure 7.3). This portion of the project takes vehicle traffic estimates for each alternative and maps the sound from surface transportation, including cars, shuttle buses and other traffic, throughout the corridor. This information is then used to assess visitor experience with regard to noise impacts.

Figure 7.3 Project context diagram



With respect to noise, transit alternatives could potentially have a significant impact. A typical bus has a sound power of about 112 dBA at 70 km/hr. This compares with a sound power of about 105 dBA for a typical car. On a sound-energy basis, one bus is the equivalent to about eight cars (Figure 7.4). While the bus is louder, a full 40 passenger bus can replace roughly 20 cars (assuming a vehicle-occupancy of two per car). At the same time, a single bus is audible over an area about 5 times as large as a car (Figure 7.5). Just a 10 dB rise in sound level from the typical bus, such as from a motorcycle with a modified muffler, increases the audible area to roughly 60 times that of a single passenger car.

Figure 7.4 Sound Equivalencies: Typical Bus, Car, and Motorcycle

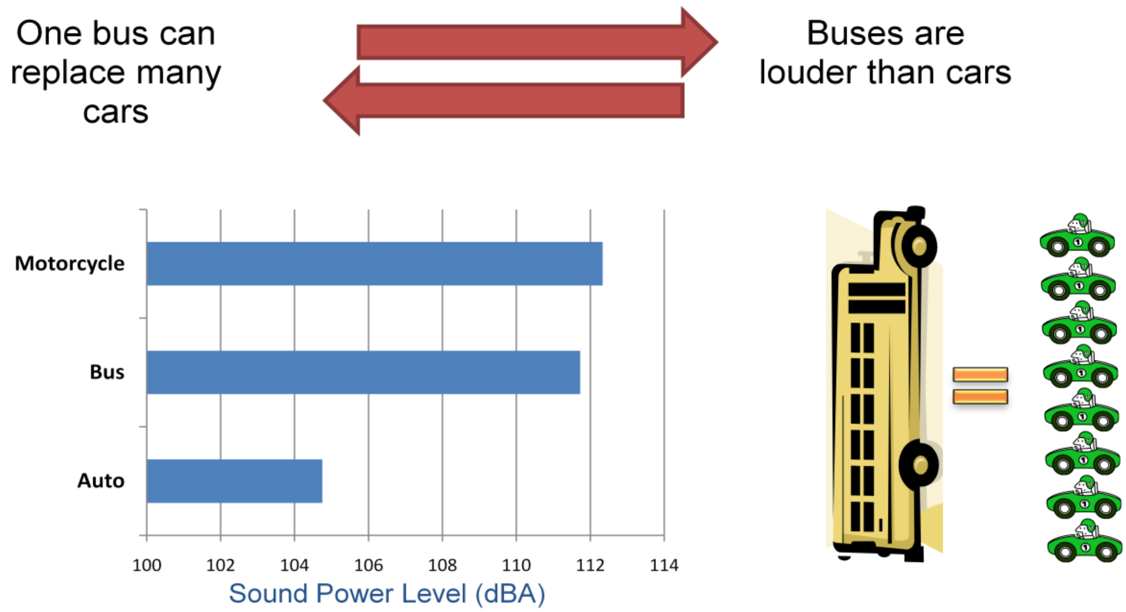
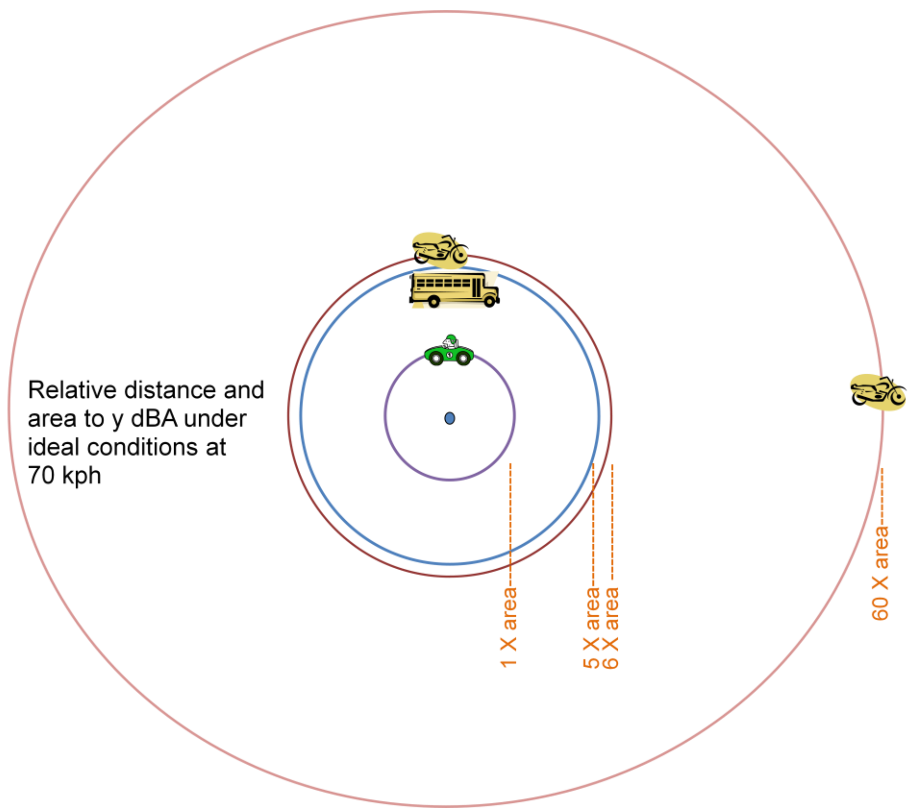


Figure 7.5 Area Equivalencies: Car, Bus, and Motorcycle



Therefore, the transportation policies have an effect on both the average level of sound, but also the visitor experience, especially away from trailheads. As a result, for a national park, it is important to consider sound both in terms of average levels and percent time audible for various policy alternatives.

7.4 Sound Level Monitoring

7.4.1 Equipment Description

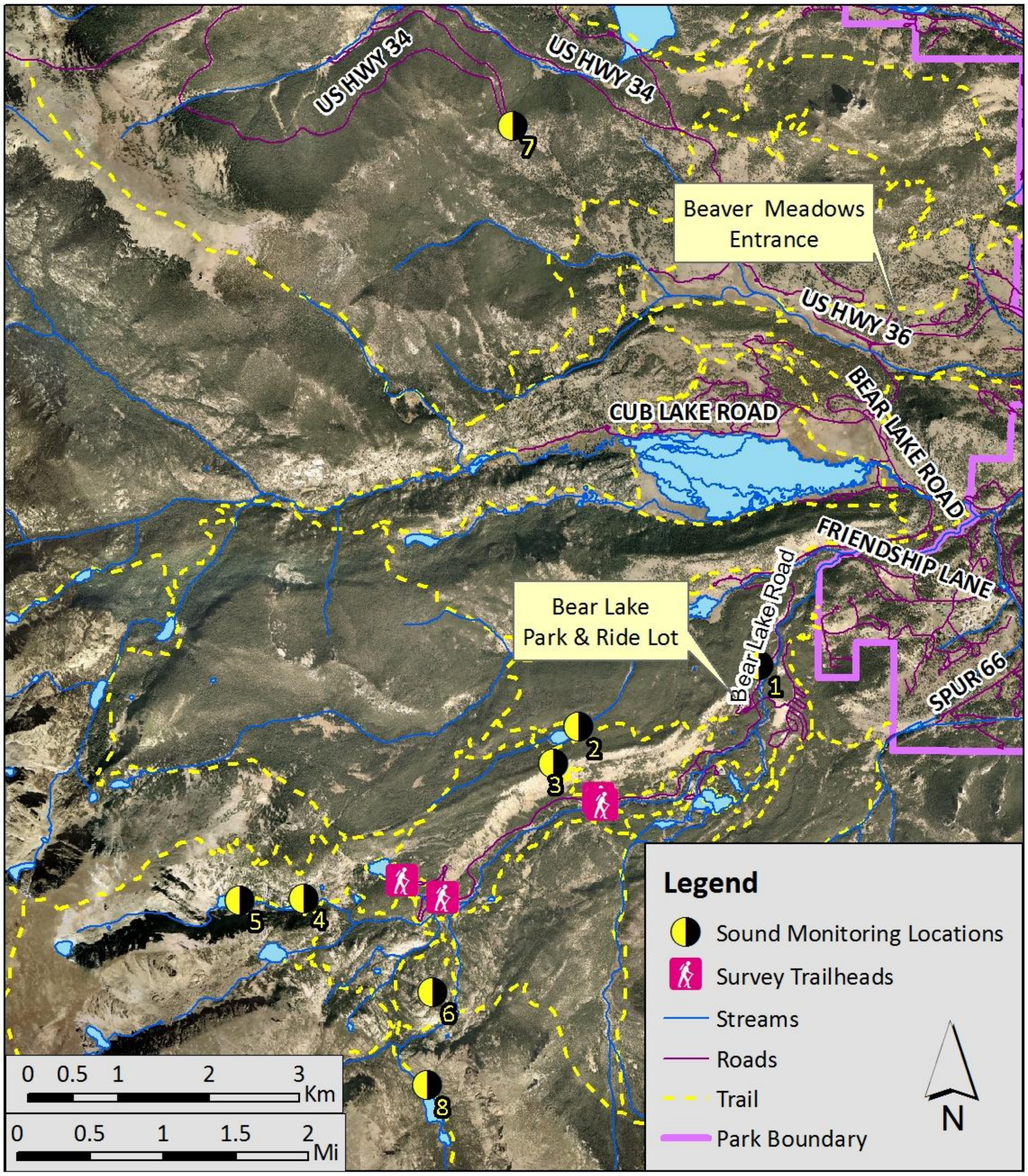
To determine the background sound levels at various sites, sound level meters were set up at various locations. Two sound level meters were set up near roadways; 1) one just north of the Bear Lake Park & Ride lot, used to calibrate the sound model, and 2) adjacent to US Highway 34 at Many Parks Curve to capture sound events during a motorcycle event (Figure 7.6).

The remaining sound level meters were set up at backcountry locations: Bierstadt Lake, Bierstadt Moraine, Dream Lake, Emerald Falls, Emerald Lake, Glacier Knob, and Mills Lake

Two types of sound level meters were used. Cesva SC310 ANSI Type 1 integrating sound level meters were set up to record the equivalent average sound pressure level (Leq) using one-third octave bands at one second intervals for several days. Some of these were equipped with Edirol R09 continuous audio recorders. Rion NL-22 ANSI Type 2 integrating sound level meters were also used. These recorded one-second A-weighted sound levels. Some were also equipped with interval and event audio recorders.

Each sound level meter's microphone was calibrated before taking measurements and then fitted with windscreens. Windscreens reduce the self-noise created by wind passing over the meters' microphones. The microphones were taped to wooden stakes approximately one meter above the ground. The sound level meters were enclosed in heavy-duty waterproof cases, and the microphone wires were fed through a small hole in the sides of the cases.

Figure 7.6 Monitoring Locations



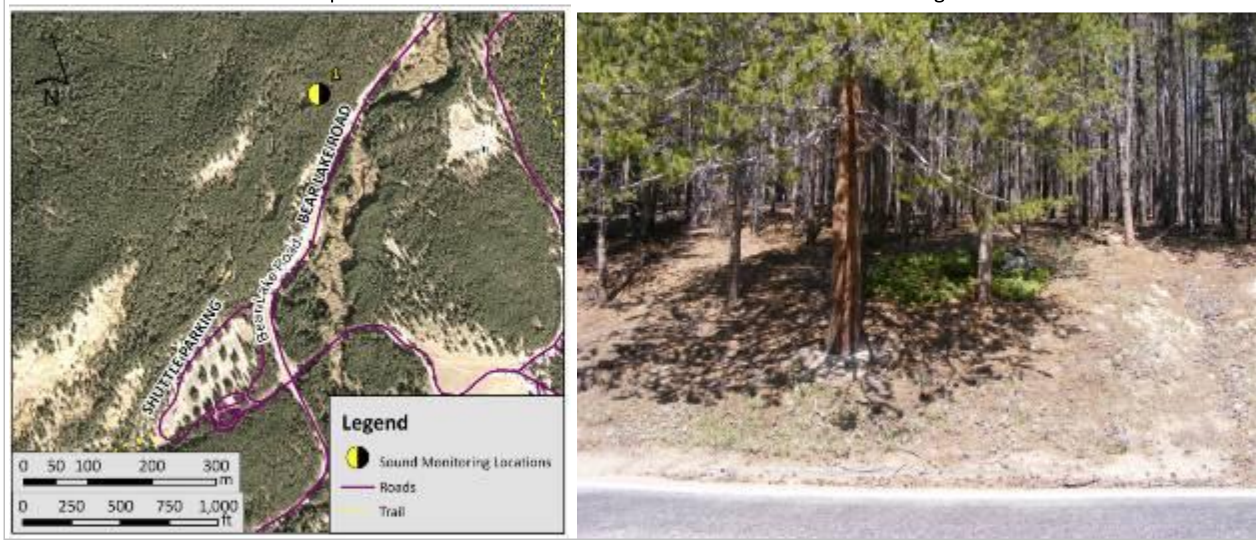
7.4.2 Monitoring Locations

Sound level monitoring stations were installed at the following eight locations: the Bear Lake Park & Ride, Bierstadt Lake, Bierstadt Moraine, Dream Lake, Emerald Lake, Glacier Knob, Many Parks Curve, and Mills Lake.

- Bear Lake Park & Ride (Position 1): A CESVA sound level meter was installed north of the Bear Lake Shuttle Parking Lot (Figure 7.7). The monitor ran from 12:19 pm on 1 July 2008 until 8:48 pm on 10 July 2008. The monitor was placed 165 feet from the edge of Bear Lake Road. At the same time, a traffic recorder recorded traffic volumes with 15-minute drops at three locations – Bear Lake Road north of the shuttle parking (near the sound level meter), Bear Lake Road south of the shuttle parking, and on Route 36, just west of the Park Headquarters. The counter near the Park Headquarters also recorded vehicle mix.

Figure 7.7 Pictures Illustrating Bear Lake Park & Ride (Position 1)

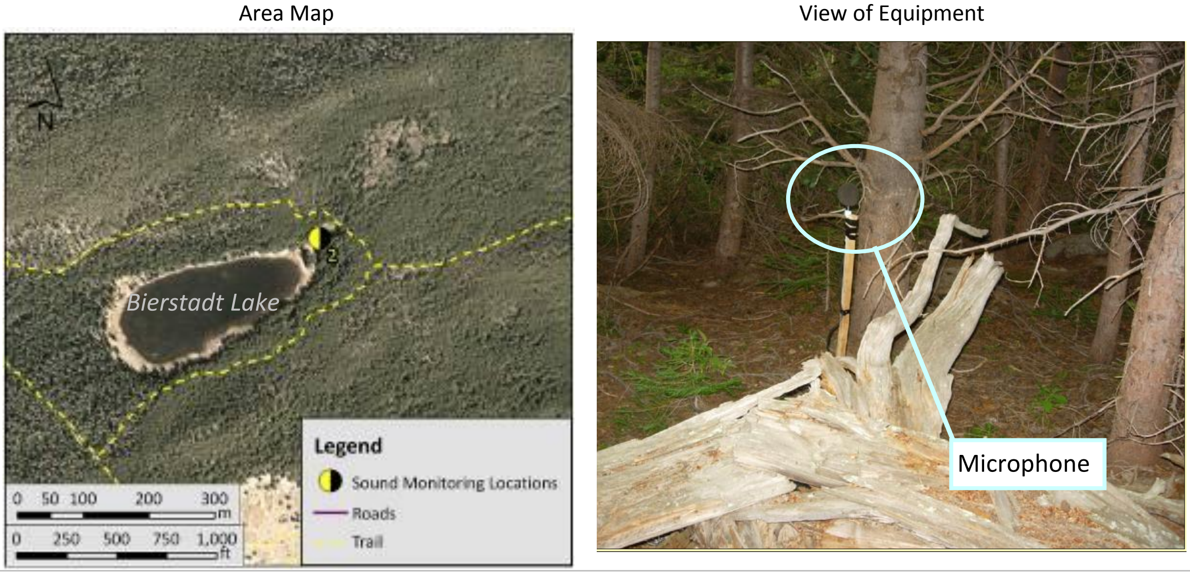
Area Map	Monitoring Location



- Bierstadt Lake (Position 2): A Rion NL-22 sound level meter was installed near the northeast corner of Bierstadt Lake (Figure 7.8). Due to faulty or damaged equipment, the monitor only ran from 8:40 pm to 8:41 pm on 26 August 2008 and is excluded from our analysis.

Figure 7.8 Pictures Illustrating Bierstadt Lake (Position 2)

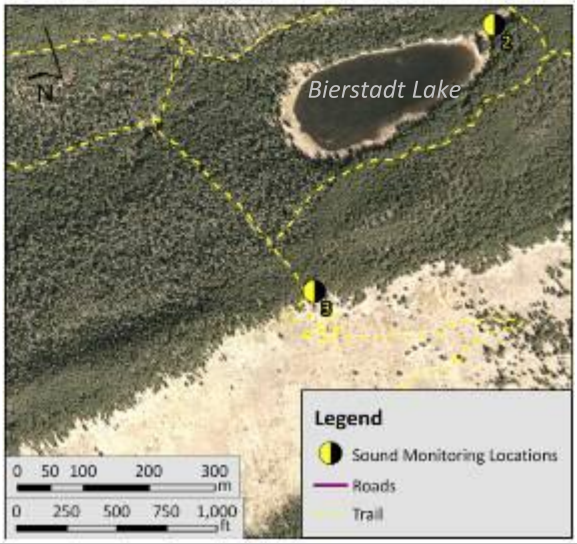
Area Map	View of Equipment



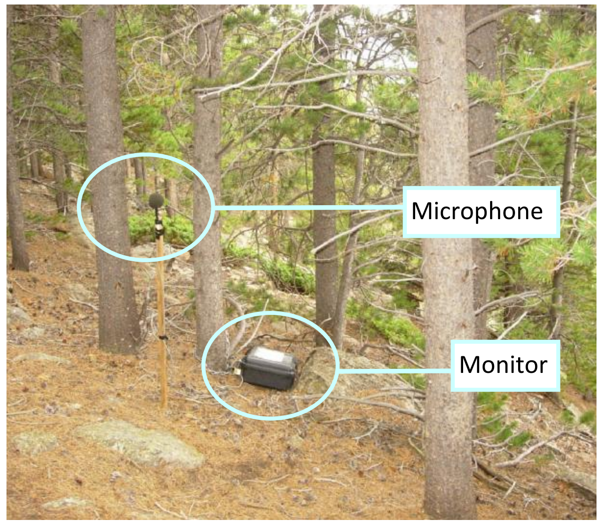
- Bierstadt Moraine (Position 3): A Cesva SC310 sound level meter and Edirol audio recorder were installed approximately 550 feet south of Bierstadt Lake (Figure 7.9). The sound monitor ran from 8:01 pm on 26 August 2008 until 5:35 am on 4 September 2008. The Cesva recorded 1-second 1/3 octave band sound levels

Figure 7.9 Pictures Illustrating Bierstadt Moraine (Position 3)

Area Map



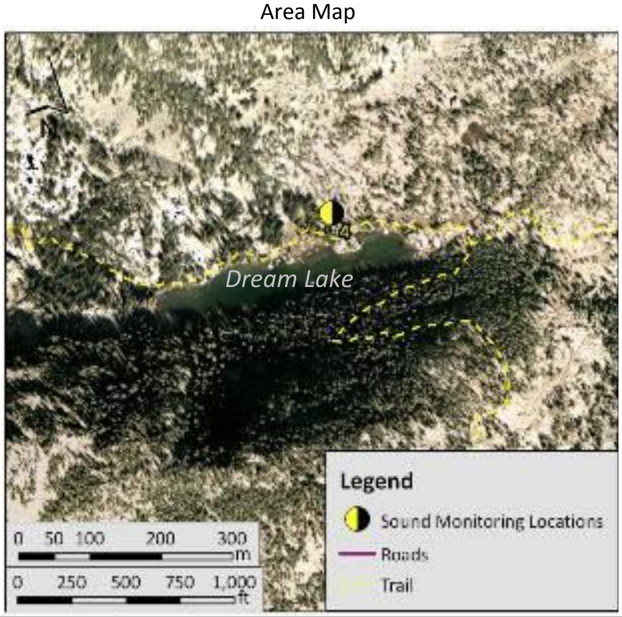
View of Equipment



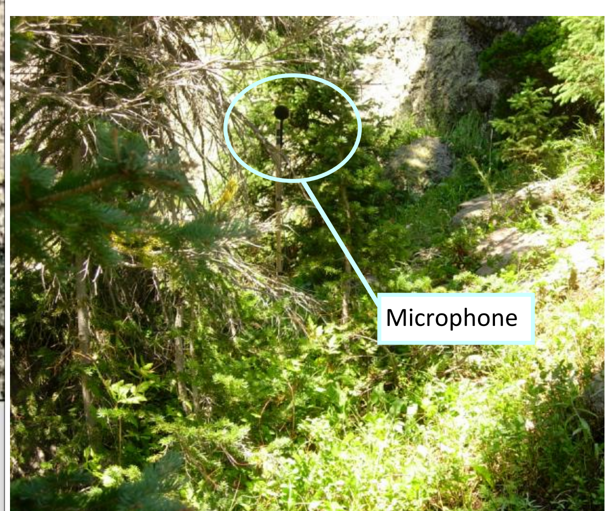
- Dream Lake (Position 4): A Cesva SC310 sound level meter was installed adjacent to a rocky cliff approximately 180 feet north of Dream Lake (Figure 7.10). The monitor ran from 2:35 pm on 26 August 2008 until 1:31 am on 9 September 2008. The Cesva recorded 1-second 1/3 octave band sound levels.

Figure 7.10 Pictures Illustrating Dream Lake (Position 4)

Area Map



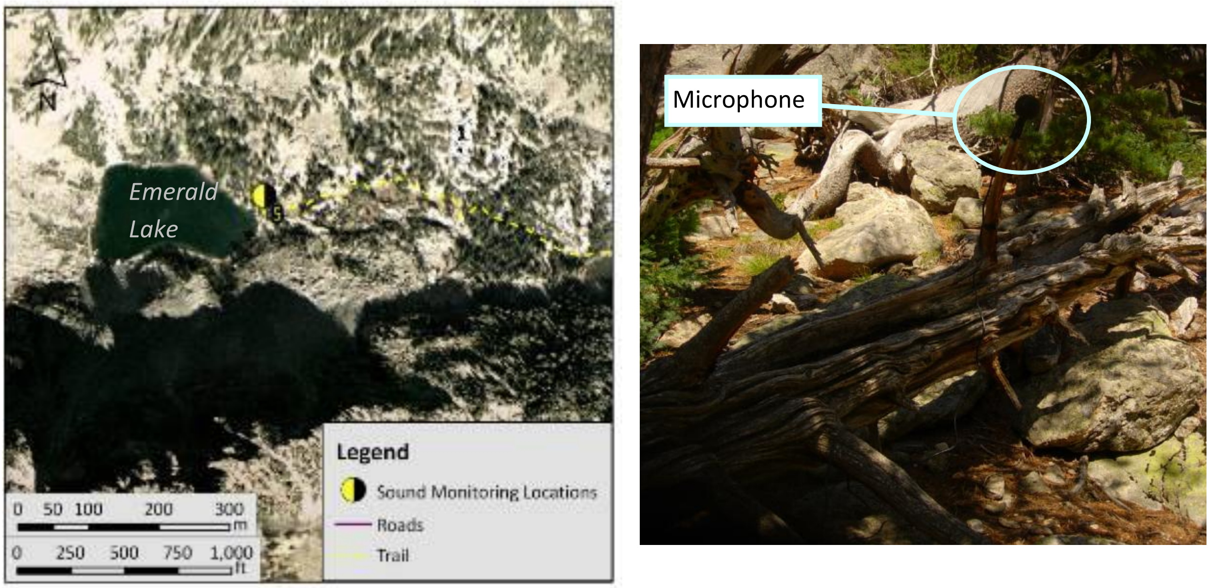
View of Equipment



Emerald Lake (Position 5): A Rion NL-22 sound level meter was installed next to a pine tree near Emerald Lake, approximately 50 feet north of the trail terminus (Figure 7.11). The meter ran from 3:30 pm on 26 August 2008 until 11:30 pm on 3 September 2008. The meter recorded one second A-weighted sound levels.

Figure 7.11 Pictures Illustrating Emerald Lake (Position 5)

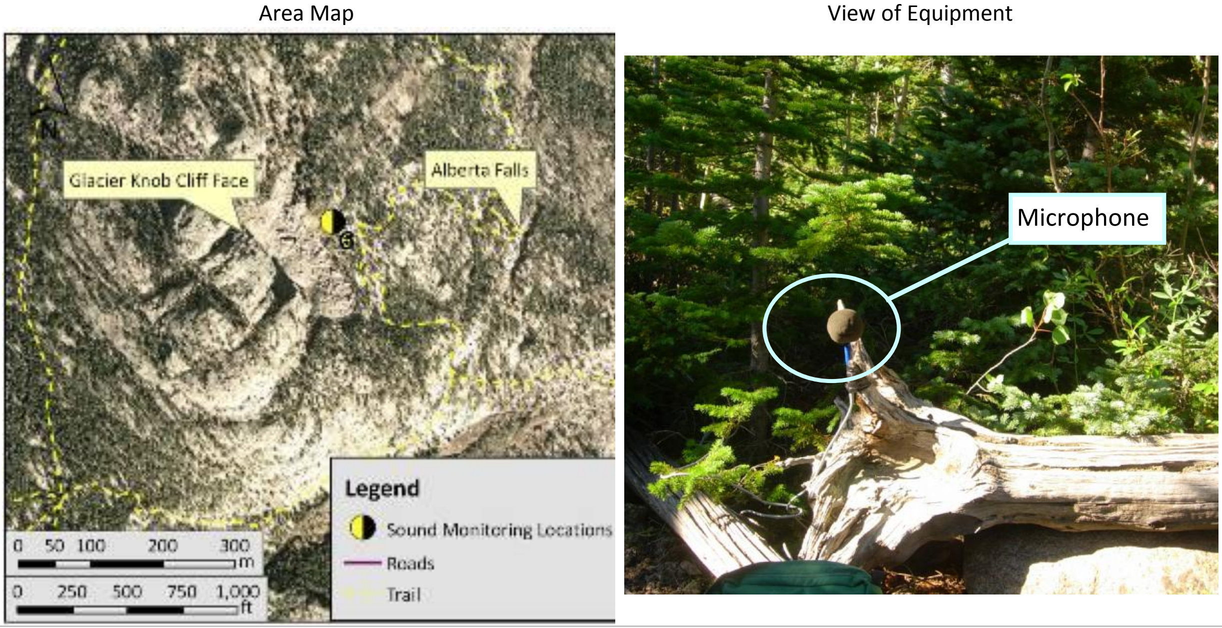
Area Map | View of Equipment



- Glacier Knob (Position 6): A Cesva SC310 sound level meter was installed near Glacier Knob cliff face (Figure 7.12). It was located northwest of the trail, approximately 0.3 miles from Alberta Falls. The monitor ran from 10:48 am on 26 August 2008 until 11:48 pm on 27 August 2008, and recorded 1-second 1/3 octave band sound levels.

Figure 7.12 Pictures Illustrating Glacier Knob (Position 6)

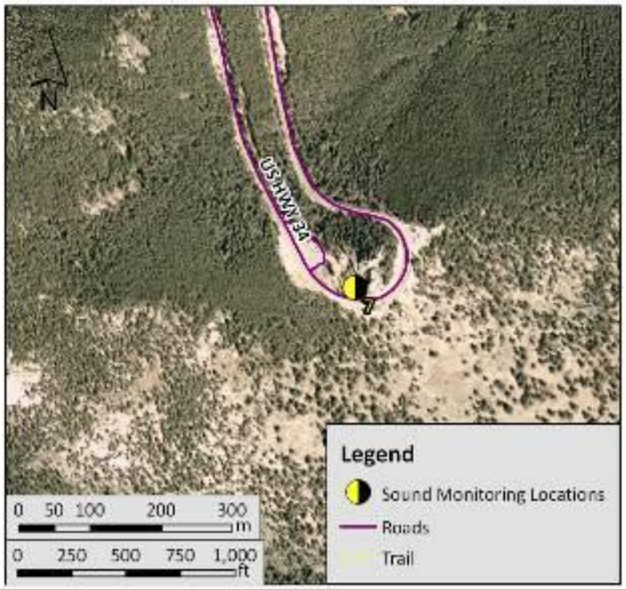
Area Map | View of Equipment



- Many Parks Curve (Position 7): A Rion sound level meter was installed along US Highway 34, approximately 4.3 miles northwest of the Bear Lake Park & Ride (Figure 7.13). The monitor ran from 9:25 am on 25 August 2008 until 5:35 am on 3 September 2008, and recorded one-second A-weighted sound levels.

Figure 7.13 Pictures Illustrating Many Parks Curve (Position 7)

Area Map



- Mills Lake (Position 8): A Rion sound level meter was installed below a rocky overhang approximately 90 feet northeast of the trail near Mills Lake (Figure 7.14). The monitor ran from 11:55 am on 26 August 2008 until 7:55 pm on 3 September 2008. The meter recorded one-second A-weighted sound levels and 15-second audio recordings every 30 minutes. It also recorded events exceeding 55 dBA.

Figure 7.14 Pictures Illustrating Mills Lake (Position 8)

Area Map

View of Equipment

7.5 Background Sound Level Monitoring Results

Results from the monitoring were used to determine background sound levels under existing traffic conditions. The graphed sound levels were consolidated to calculate the tenth, fiftieth, and ninetieth percentile and the equivalent average sound level for every 10-minute period. Overall sound levels for the summer monitoring period are shown in Table 7.1. Figure 7.15 through Figure 7.21 depict the sound pressure levels at each site throughout the monitoring period.

Table 7.1 Summary of Sound Pressure Level Statistics at All Monitoring Locations

	Daytime				Nighttime			
	L10	L50	L90	Leq	L10	L50	L90	Leq
Bear Lake Park & Ride (Position 1)	43	40	37	46	40	37	33	38
Bierstadt Lake (Position 2)*	-	-	-	-	-	-	-	-
Bierstadt Moraine (Position 3)	50	40	37	46	50	38	36	47
Dream Lake (Position 4)	52	40	31	49	52	32	27	50
Emerald Lake (Position 5)	46	39	34	42	42	33	32	38
Glacier Knob (Position 6)	57	46	43	55	57	45	42	54
Many Parks Curve (Position 7)	59	37	21	57	40	20	15	48
Mills Lake (Position 8)	47	33	28	45	48	32	29	46

*Faulty monitor – wire was broken or chewed through

Figure 7.15 Sound Pressure Levels at Bear Lake Park & Ride Monitoring Location (Position 1)

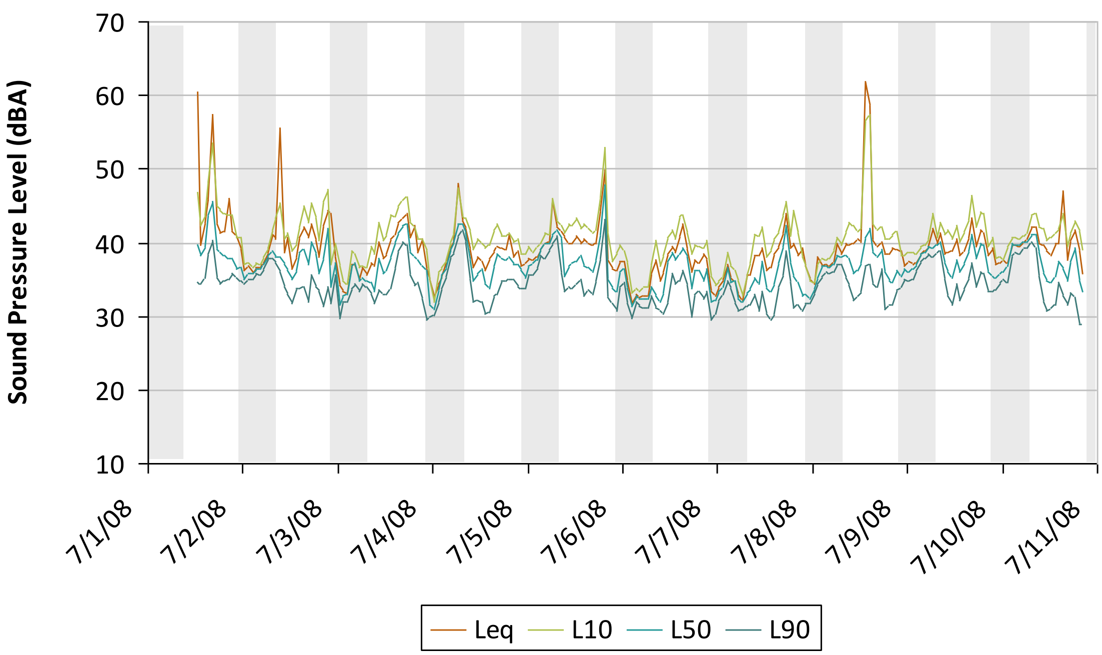


Figure 7.16 Sound Pressure Levels at Bierstadt Moraine Monitoring Location (Position 3)

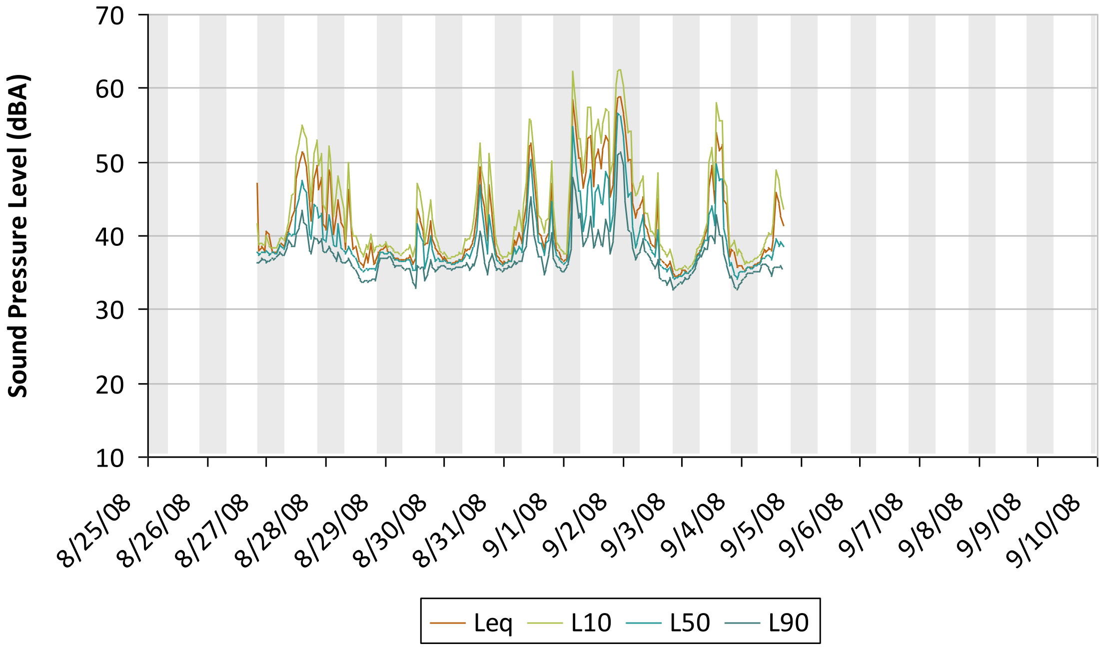


Figure 7.17 Sound Pressure Levels at Dream Lake Monitoring Location (Position 4)

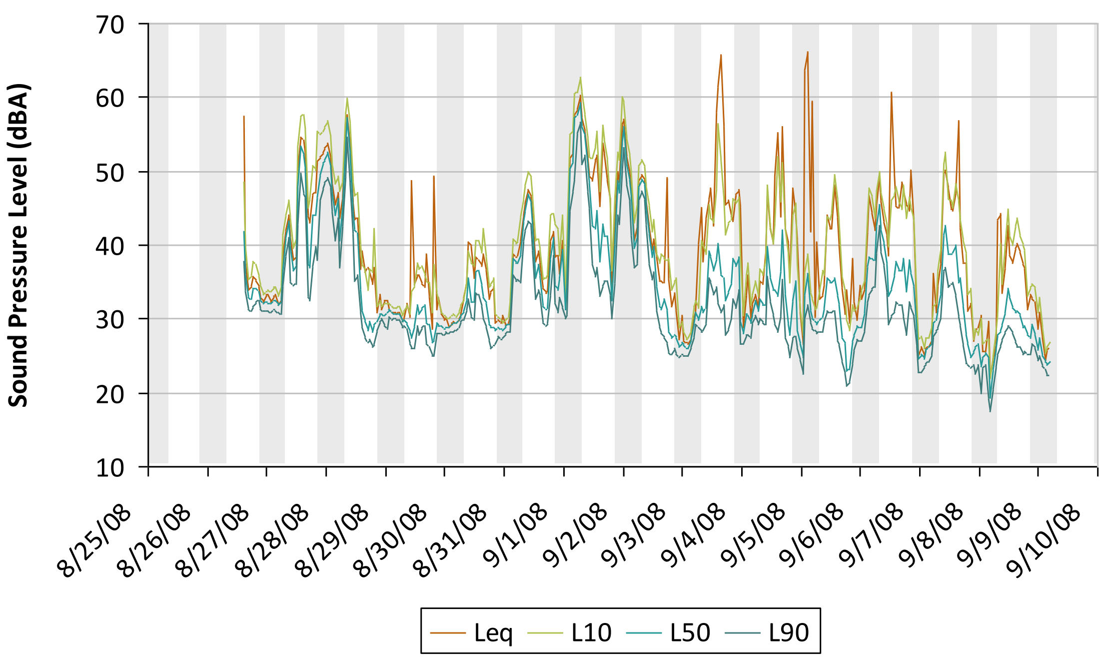


Figure 7.18 Sound Pressure Levels at Emerald Lake Monitoring Location (Position 5)

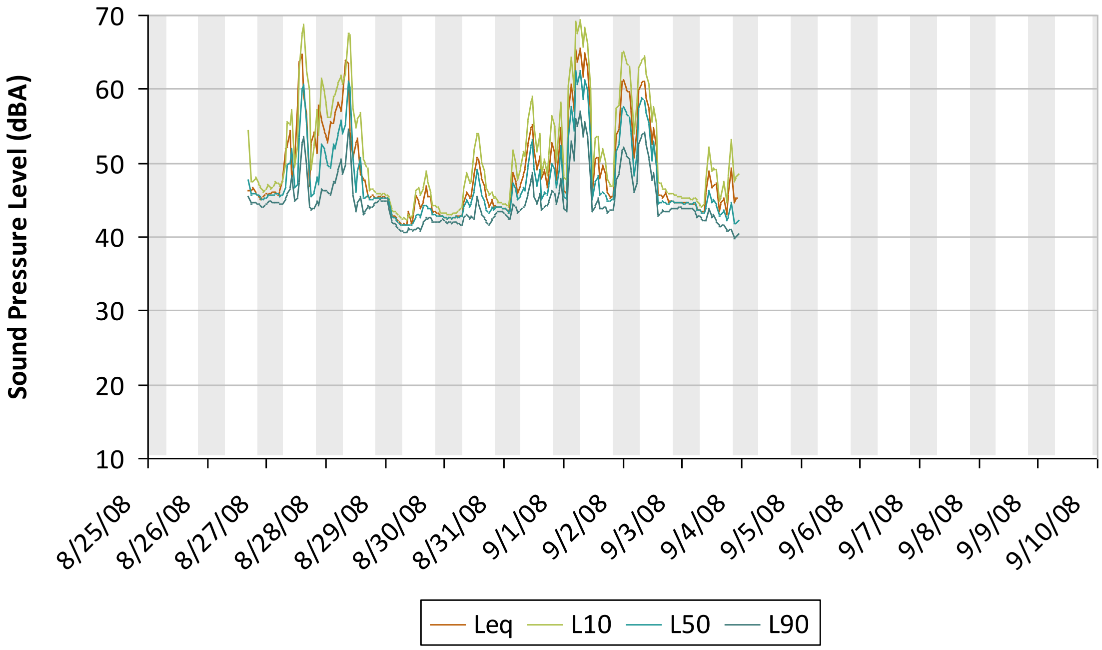


Figure 7.19 Sound Pressure Levels at Glacier Knob Monitoring Location (Position 6)

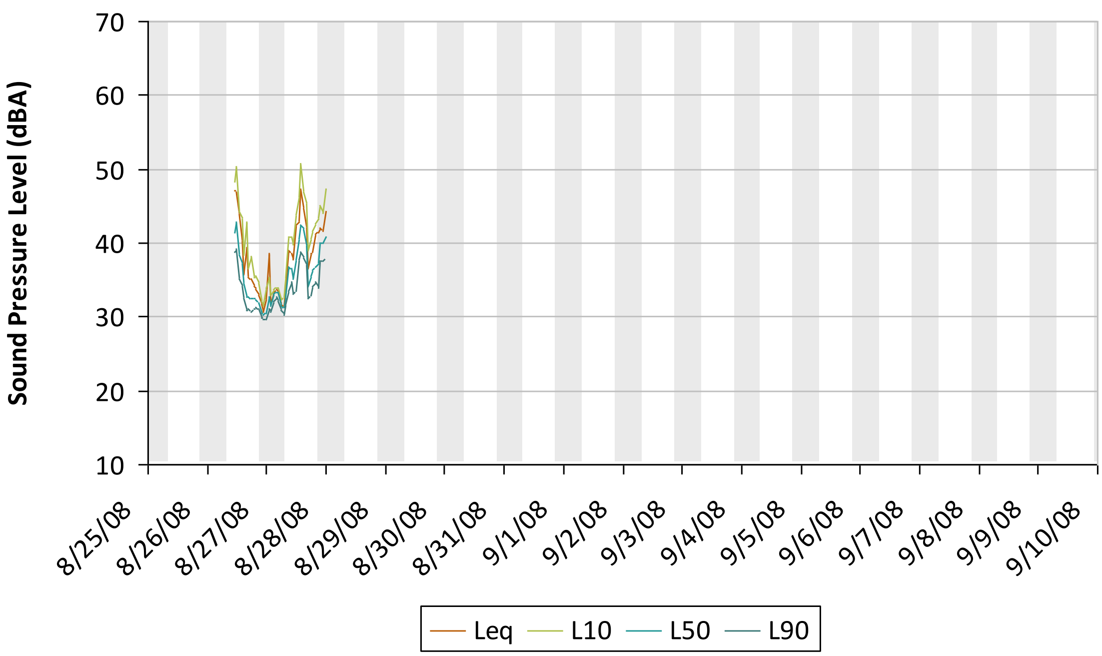


Figure 7.20 Sound Pressure Levels at Many Parks Curve Monitoring Location (Position 7)

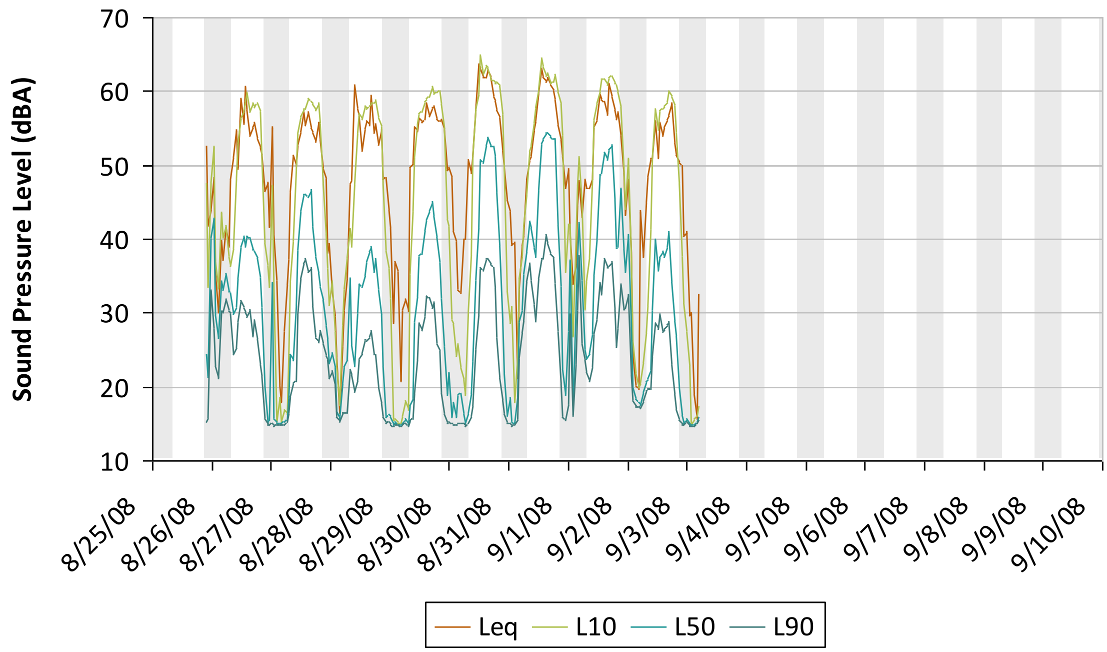
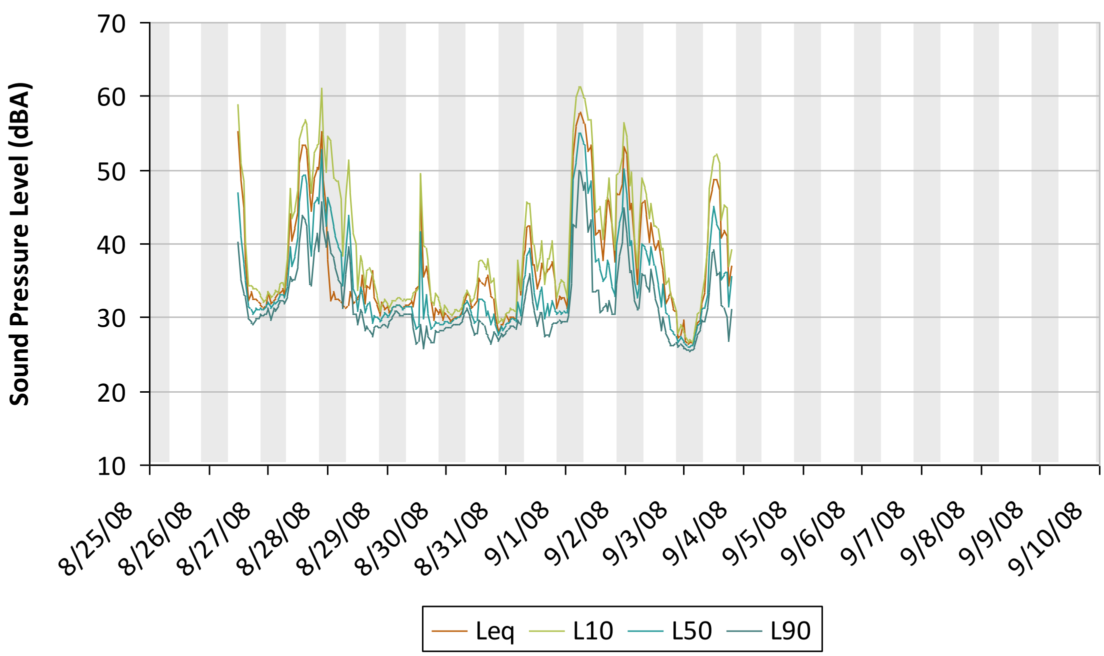


Figure 7.21 Sound Pressure Levels at Mills Lake Monitoring Location (Position 8)



7.6 Calibration Monitoring

As noted above, a sound level meter was set up 180 feet from Bear Lake Road, just north of the Park and Ride (Site 1). Data from the meter was used to develop a relationship between sound levels along the road and traffic volumes. Figure 7.22 compares the resulting average traffic volume on Bear Lake Road with the equivalent average hourly sound level from July 1 through July 10, 2008. As shown, the traffic volumes show a typical bell-curve pattern with almost no traffic late at night, with a peak hour of 383 vehicles per hour (vph) at 2:00 pm. The resulting sound levels follow no such pattern. While sound levels are lower during the night, at about 36 dBA after midnight, the average levels rise and fall considerably during the day. To investigate this further, we graphed the daily sound level in Figure 7.23. While there is considerable scatter between the days, the peaks shown on the average sound level in Figure 7.22 result from individual events on selected days.

Figure 7.22 Average Traffic Volume on Bear Lake Road (left) and Equivalent Average Sound Level (right) by Time of Day

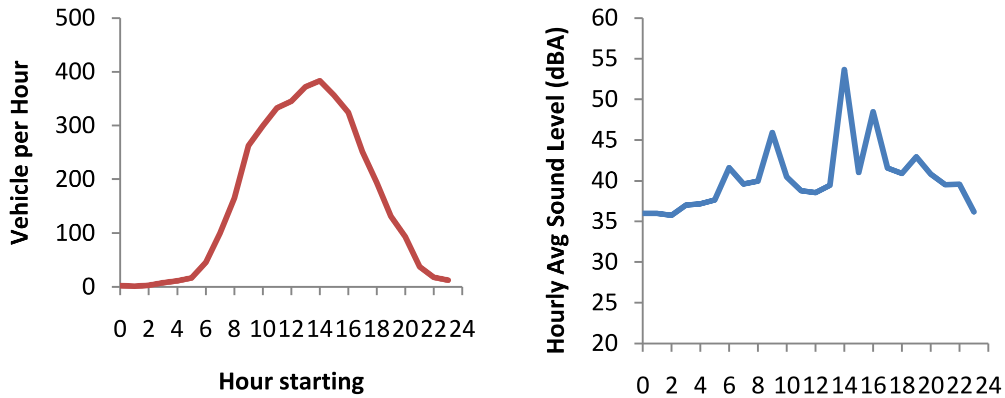
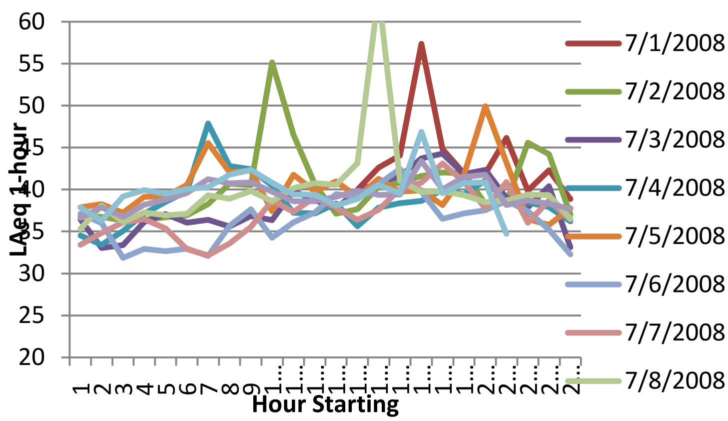
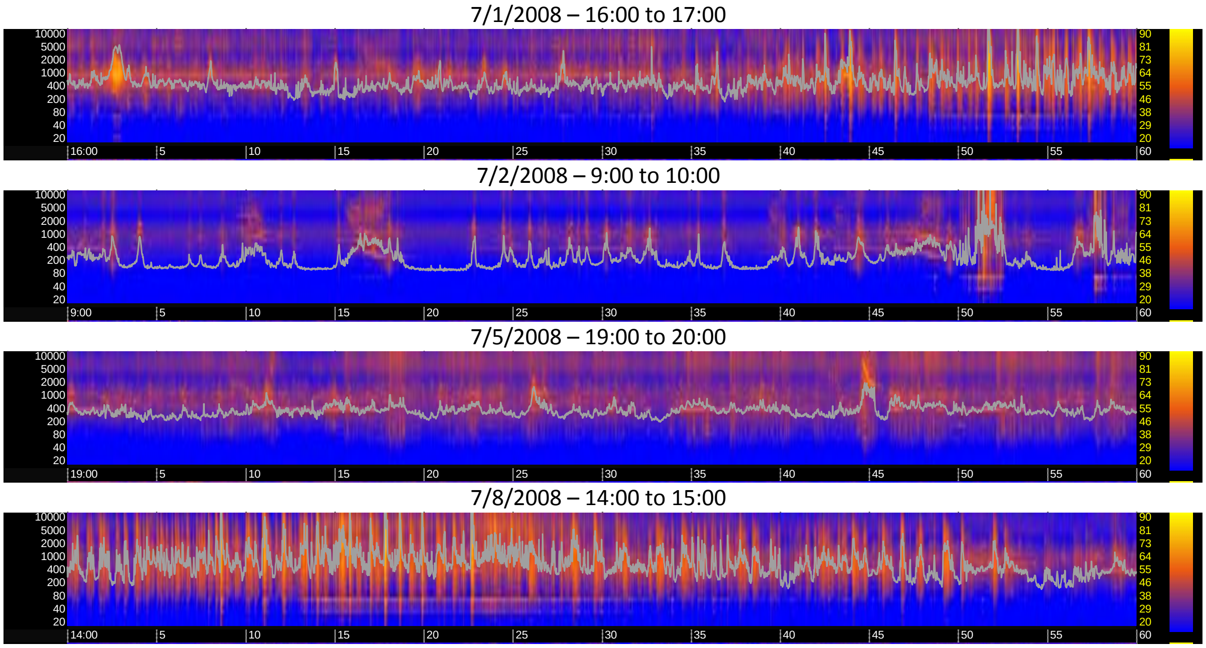


Figure 7.23 Hourly Sound Level on each Day from July 1 through July 10, 2008 at Bear Lake Road



These events could be due to either man-made or natural events. As an example, a motorcycle event occurred during this week, and it could be that motorcycles caused the spike. On the other hand, natural events, such as high winds or thunderstorms could also have played a major role. To investigate this further, we tested these events using long-term spectrograms (Figure 7.24). As shown, some events, such as those occurring on July 1 and 8 were most likely thunder storms, but others, such as those on July 2 and 5 may have been at least partly anthropogenic.

Figure 7.24 One-hour A-weighted spectrograms with A-weighted levels (grey line) of loud events



Finally, in analyzing Figure 7.22, the difference between the early morning hours and a majority of the daytime hours is small – on the order of about 5 dBA. This indicates that natural sounds dominate the area, either from wind or the river flowing in the valley.

Many Parks Curve

At the request of the Park, we placed a sound level meter at Many Parks Curve to evaluate the impact that the "Thunder in the Rockies" motorcycle event would have on noise at this scenic overlook. If we look at 1-second sound levels during that period (Figure 7.25), there is very little differentiation between the days. However, by evaluating the percentile levels from Figure 7.26 and Figure 7.27, we can see a 5 to 10 dB increase during the days of the motorcycle event. A 10 dB increase is roughly equivalent to a doubling of perceived loudness. Interestingly, Many Parks Curve had the quietest and loudest sounds of any monitored site. While the lookout is very close to the road, when no cars are passing, it can be very quiet.

Figure 7.25 1-second Sound Levels at Many Parks Curve

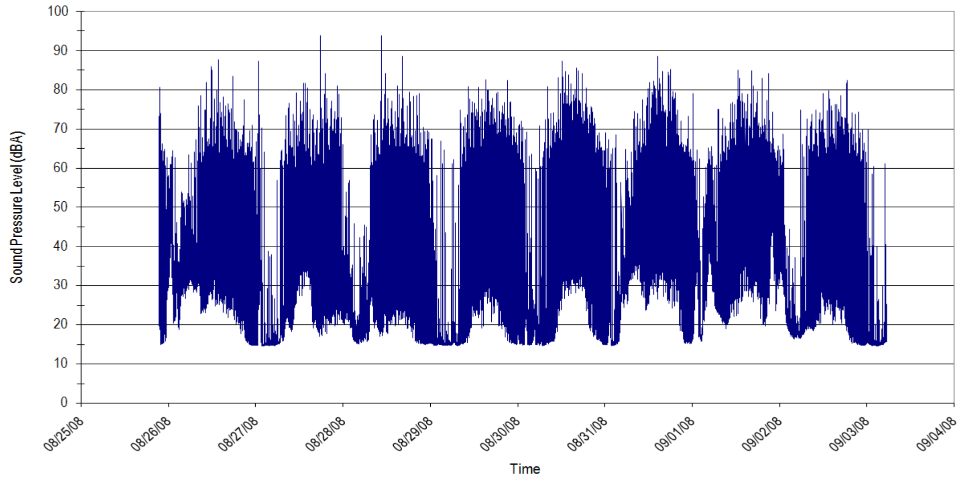


Figure 7.26 10-Minute Sound Levels at Many Parks Curve

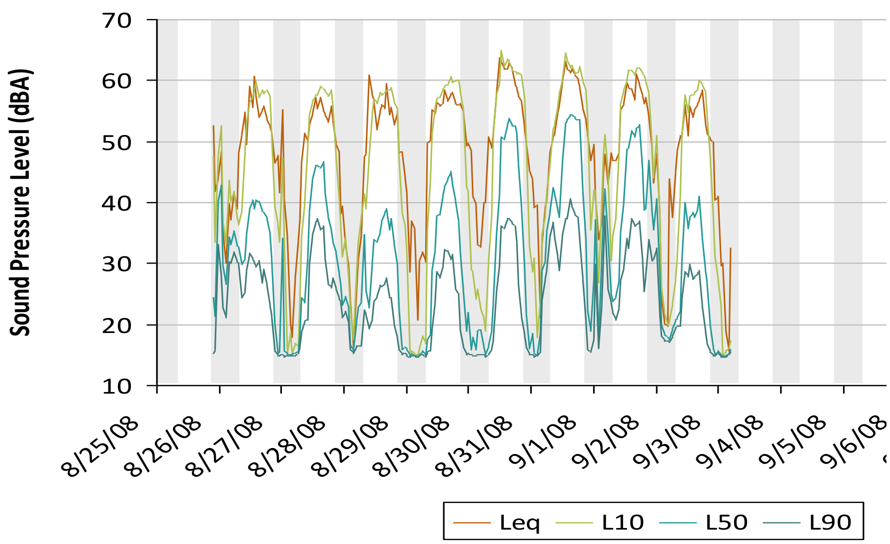
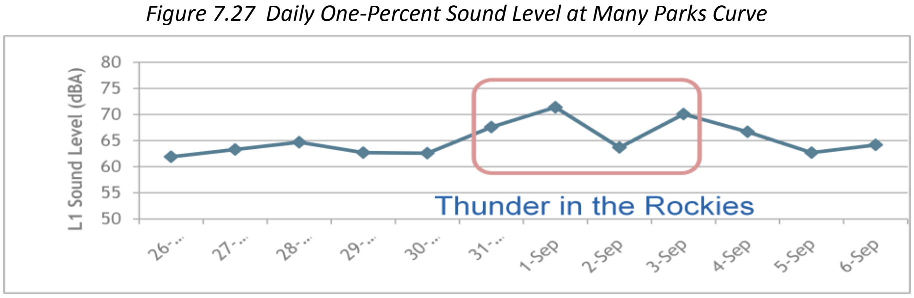


Figure 7.27 Daily One-Percent Sound Level at Many Parks Curve



7.7 Noise Mapping

The next task was to create surface transportation noise map for the baseline and two alternative transit scenarios. A noise map is a colored map showing sound levels over a large area. Noise maps are prevalent in the European Union, which requires noise mapping of large metropolitan areas to assess noise exposure and mitigation. In the United States, noise maps have been created for a few communities, including San Juan, Puerto Rico, San Francisco, California, and Burlington, Vermont. The noise maps are useful in that they can provide the level of exposure from noise for any source, whether they are moving or stationary.

For this component of the study, noise maps are limited to surface transportation only. The maps do not include aircraft overflights, natural, or biogenic noise.

7.7.1 Noise Map Components

The level of traffic noise at a particular location is dependent on characteristics of the roadway and the terrain between roadway and receiver. The roadway data is derived from counts or projections of traffic and vehicle mix. Surface information is derived from GIS layers of vegetation and topography.

Transportation Data

The basic components of the transportation data needed are:

- Highway geometry – All of the roads in the national park were derived from National Park Service and State of Colorado GIS roads data layers.
- Vehicle speed – In our model, a speed of 70 kph was used for the entire corridor.
- Grade – While grade will affect sound levels, we assumed a flat grade for the corridor. This is due to the fact that half the vehicles are travelling uphill and half are travelling downhill. The FHWA TNM model takes grade into account by lowering vehicle speed (and thus sound emissions) on upgrades. For example, a bus traveling up a 10% grade will have an approximately 4 dB lower sound level. While the net effect may be slightly lower overall sound levels, it is not relevant for this analysis, which focuses on a comparison between scenarios.
- Traffic volume – Traffic volumes were derived from vehicle counts, adjustments, and projections made as part of another segment of the overall funded project.
- Vehicle mix – Vehicle mix was derived from a continuous traffic count made just west of the Beaver Meadows park entrance between July 1 and July 10, 2008.
- Time-of-Day distribution – The time-of-day distribution for vehicles on Bear Lake Road was based on the average from the vehicle counters along the road. Two scenarios were analyzed: the peak hour of traffic and the average daytime hour.

Vehicle Sound Power

Sound power represents the emissions of sound energy from an object. The Federal Highway Administration has published coefficients to estimate sound power from cars, medium trucks, heavy trucks, motorcycles, and buses, under idle, cruise, and acceleration conditions as a function of speed and emissions height. These “reference energy mean emissions level” or REMEL coefficients are incorporated into FHWA Traffic Noise Model (TNM). We used these REMEL coefficients, along with the speed and vehicle mix data to estimate the roadway sound power per vehicle for each of five roadway segments:

1) Beaver Meadows park entrance to Bear Lake Road Intersection
2) Bear Lake Road/Route 36 intersection to Bear Lake Road Park & Ride lot
3) Park and Ride lot to Storm Pass trailhead parking lot
4) Storm Pass lot to Glacier Gorge trailhead parking lot
5) Glacier Gorge lot to Bear Lake trailhead parking lot

Sound power levels for cars and small trucks, medium/heavy trucks, buses, and motorcycles at 70 kph are 105 dBA, 112 dBA, 112 dBA, and 122 dBA, respectively, and have varying spectra. The mean weighted sound power level, taking into account vehicle and spectral mix, generally ranged from 107 to 108 dBA per vehicle, depending on the section and scenario.

Receivers

A grid of 492,000 receivers covering a 14 km by 14 km area was set up. In addition, discrete receivers were put in at the locations where attended listening surveys took place.

Terrain

Terrain can significantly affect propagation of sound from roadways. In this case, contour lines were created from U.S. Geologic Survey 30-meter digital elevation models. The Golden Software Surfer® program was used to convert the 30-meter elevation points to contour lines within the extent of four 7.5-minute quadrangles.

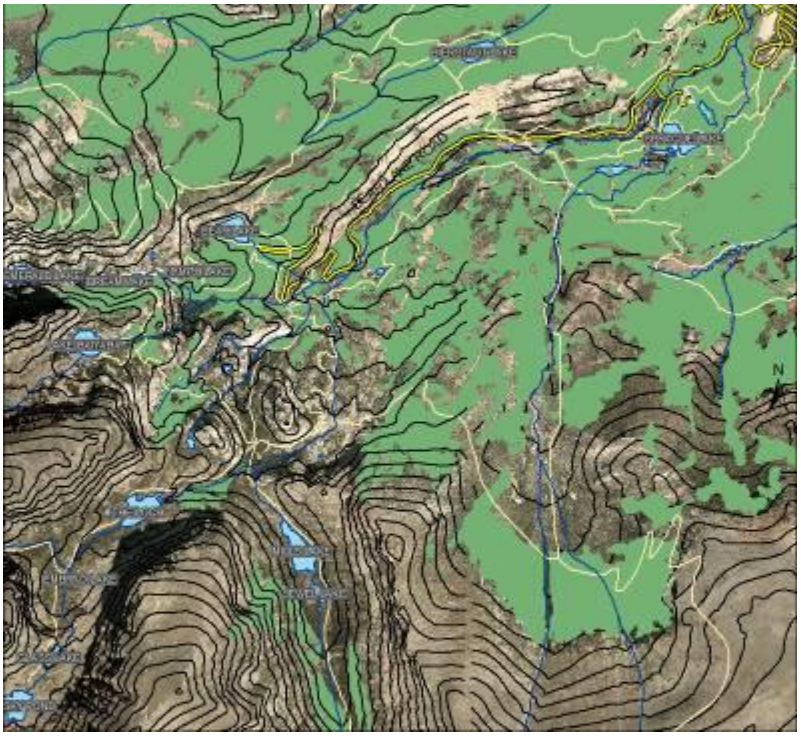
Aerial Photography

Aerial photography was used to confirm the location of roads, buildings, and land cover. Aerial photography was obtained from the National Park Service GIS office.

Land Cover

Dense forest will affect sound propagation. Ground-cover GIS data layers were obtained from the National Park Service. These data layers did not have “dense forest” categories. Therefore, several parameters were combined to come up with a single dense forest layer. These parameters included cover density, cover type, and average canopy height. The resulting dense forest layer is shown in Figure 7.28.

Figure 7.28 Dense forest cover layer



7.8 Sound Propagation Model and Methodology

Data from the sources just described were imported into the Cadna A sound propagation model. The model is made by Datakustik GmbH. Since it was developed primarily for the European market, it has many features that make it ideal for noise mapping.

While Cadna A incorporates the FHWA TNM model,[1] the TNM propagation algorithm is not appropriate for use over a large land area with complex terrain. Since TNM integrates over the terrain, the processing time and memory required for a run the size of the Bear Lake Road corridor makes a run not possible with current computing resources. As a result, we used the TNM/REMEL sound power levels for the roadway, but used the ISO 9613-2 methodology, "Acoustics – Attenuation of sound during propagation outdoors, Part 2: General Method of Calculation," as the sound propagation algorithm.

Data logged by the sound level meters was used to calibrate baseline noise maps for the Bear Lake Road corridor.

7.9 Baseline Noise Map

The Baseline noise map was based on the vehicle mix and traffic volumes shown in Table 7.2. The resulting sound power levels are shown in Table 7.3.

[1] The TNM implementation in Cadna A has not been approved for regulatory use by the Volpe Center at this time. We attempted to use the TNM model for noise mapping, however, due to the complex terrain and distances involved, the TNM propagation algorithm stalled beyond about 500 meters in complex terrain. While we ran several models as hybrids, TNM propagation close in to the road and ISO 9613-2 line source propagation outside, we found that the added accuracy was minimal compared with the time needed for additional processing.

We developed noise maps to depict equivalent average (LAeq) sound pressure levels under average (Figure 7.29) and peak (Figure 7.30) traffic conditions. Sound pressure levels are based upon the number of vehicle passbys per hour, their average speed, and their sound power levels.

Table 7.2 Vehicle mix and traffic volume by scenario for the Baseline Noise Map for Medium and Heavy Trucks (MT and HT), Buses, and Motorcycles (MC)

Scenario	Section	Section name	Autos	MT	HT	Bus	MC
Peak	a	Park Entrance to Bear Lake Rd Insxn	720	87	11	2	17
Peak	d	Insxn to Park & Ride	332	39	5	2	8
Peak	f	Park and Ride to Storm Pass	234	29	3	10	6
Peak	h	Storm Pass to Glacier Gorge	104	12	1	10	3
Peak	j	Glacier Gorge to Bear Lake Trailhead	92	11	1	10	2
Average	b	Park Entrance to Bear Lake Rd Insxn	506	61	8	2	12
Average	c	Insxn to Park & Ride	279	33	4	2	6
Average	e	Park and Ride to Storm Pass	194	22	3	13	5
Average	g	Storm Pass to Glacier Gorge	100	11	2	13	3
Average	i	Glacier Gorge to Bear Lake Trailhead	94	11	1	13	2

Table 7.3 Sound Power Levels (Lw) per Vehicle for the Baseline Noise Map by Frequency (in dB unless otherwise noted)

Scenario	Section name	32	63	125	250	500	1K	2K	4K	8k	Lw(A)	Lw
Peak	Park Entrance to Bear Lake Rd Insxn	110	109	107	105	104	102	100	94	87	107	115
Peak	Insxn to Park & Ride	110	109	107	105	104	102	100	94	87	107	115
Peak	Park and Ride to Storm Pass	110	109	107	106	104	103	100	94	88	107	115
Peak	Storm Pass to Glacier Gorge	111	109	108	106	104	103	101	95	89	108	116
Peak	Glacier Gorge to Bear Lake Trailhead	110	109	108	106	104	103	101	95	89	108	115
Average	Park Entrance to Bear Lake Rd Insxn	110	109	107	105	104	102	100	94	87	107	115
Average	Insxn to Park & Ride	110	109	107	105	104	102	100	94	87	107	115
Average	Park and Ride to Storm Pass	110	109	108	106	104	103	100	95	88	107	115
Average	Storm Pass to Glacier Gorge	111	109	108	107	104	103	101	95	89	108	116
Average	Glacier Gorge to Bear Lake Trailhead	109	109	108	106	104	103	101	95	89	108	115

The figures are color coded with green being the lowest sound levels and red being the highest. By comparing the sound levels to the background sound levels from Table 7.1, we can get a sense of the impact of surface transportation noise. In general, 50^{th} percentile sound levels from the backcountry monitoring sites ranged from 33 to 46 dBA, which are represented primarily by the yellows in the noise map. As a result, the green tinted areas have generally inaudible surface transportation noise, the red areas are readily audible, and the yellow areas depend more highly on local background noise.

From the noise maps, we can conclude that sound is highest nearest to the roadway. Terrain and vegetation have the greatest impact on propagation from the road. The eastern side of Bear Lake Road tends to have higher sound levels due to the fact that the terrain is more gradual. On the west side, the high sound levels along the treeless moraine drop off sharply at the top of the moraine due to the sharp cutoff at the high plateau around Bierstadt Lake.

The eastern portion of Bear Lake and western portions of Sprague Lake have the highest sound levels among the visitor attractions in the corridor. However, the western side of Bear Lake is blocked somewhat by terrain and exhibits surface transportation sound levels below 30 dBA. Most of the other backcountry attractions have very low surface transportation noise exposure. The exception is Glacier Knob (Point 6). However, that attraction is also attributed with the highest background sound level of 46 dB LA50, mostly due to wind and water.

Figure 7.29 Baseline Sound Pressure Levels (LAeq) under Average Traffic Conditions

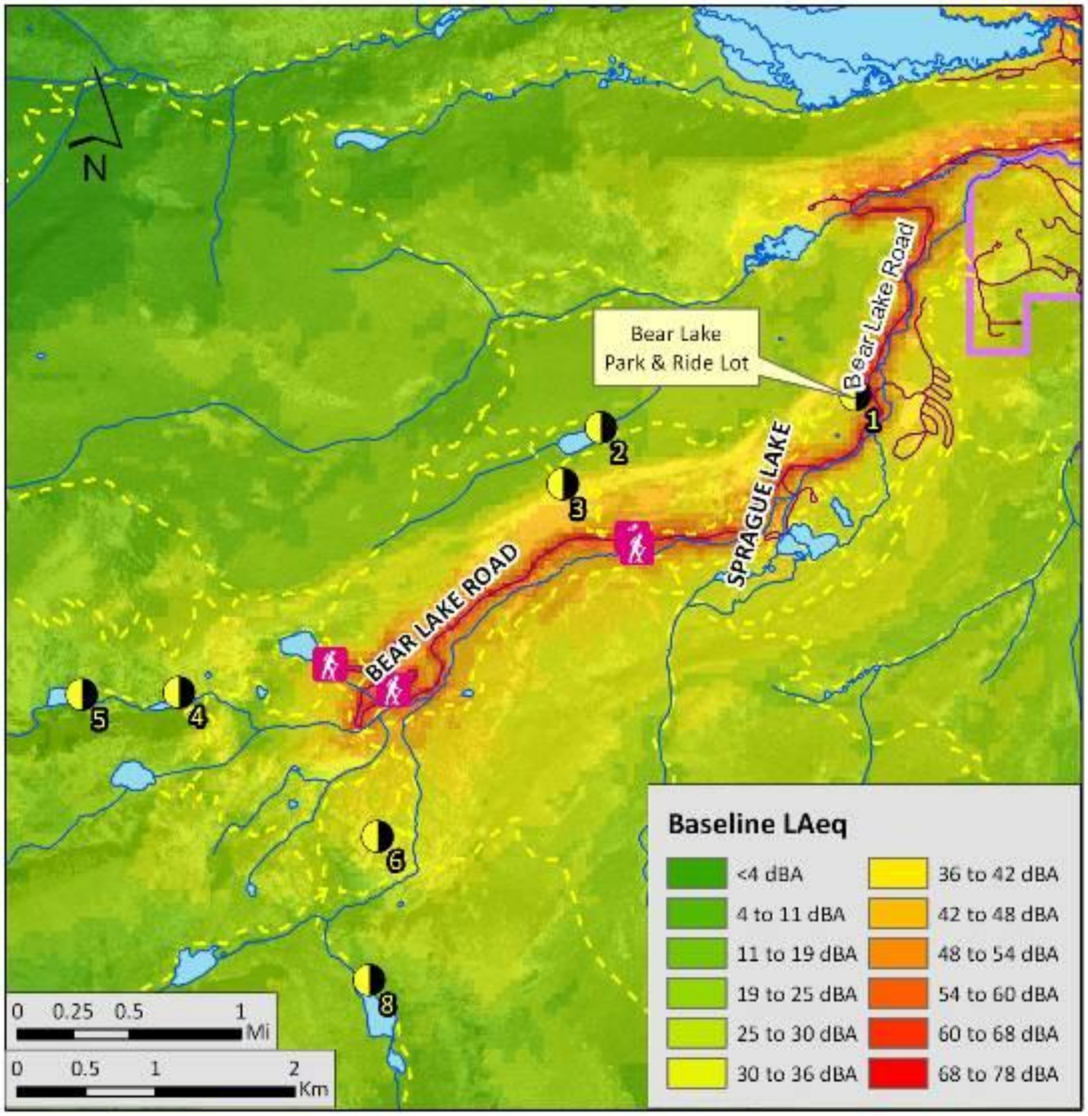
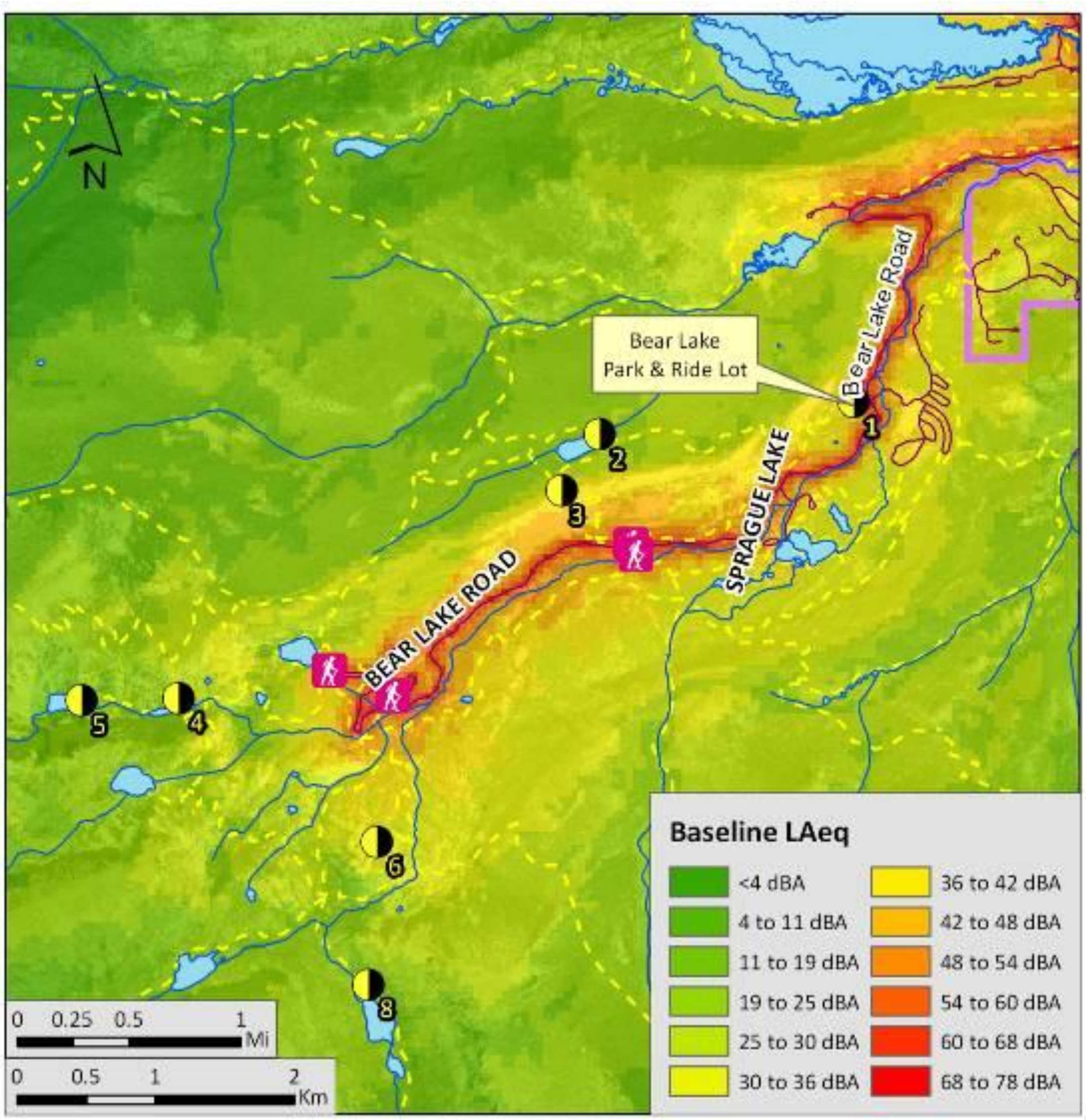


Figure 7.30 Baseline Sound Pressure Levels (LAeq) under Peak Traffic Conditions

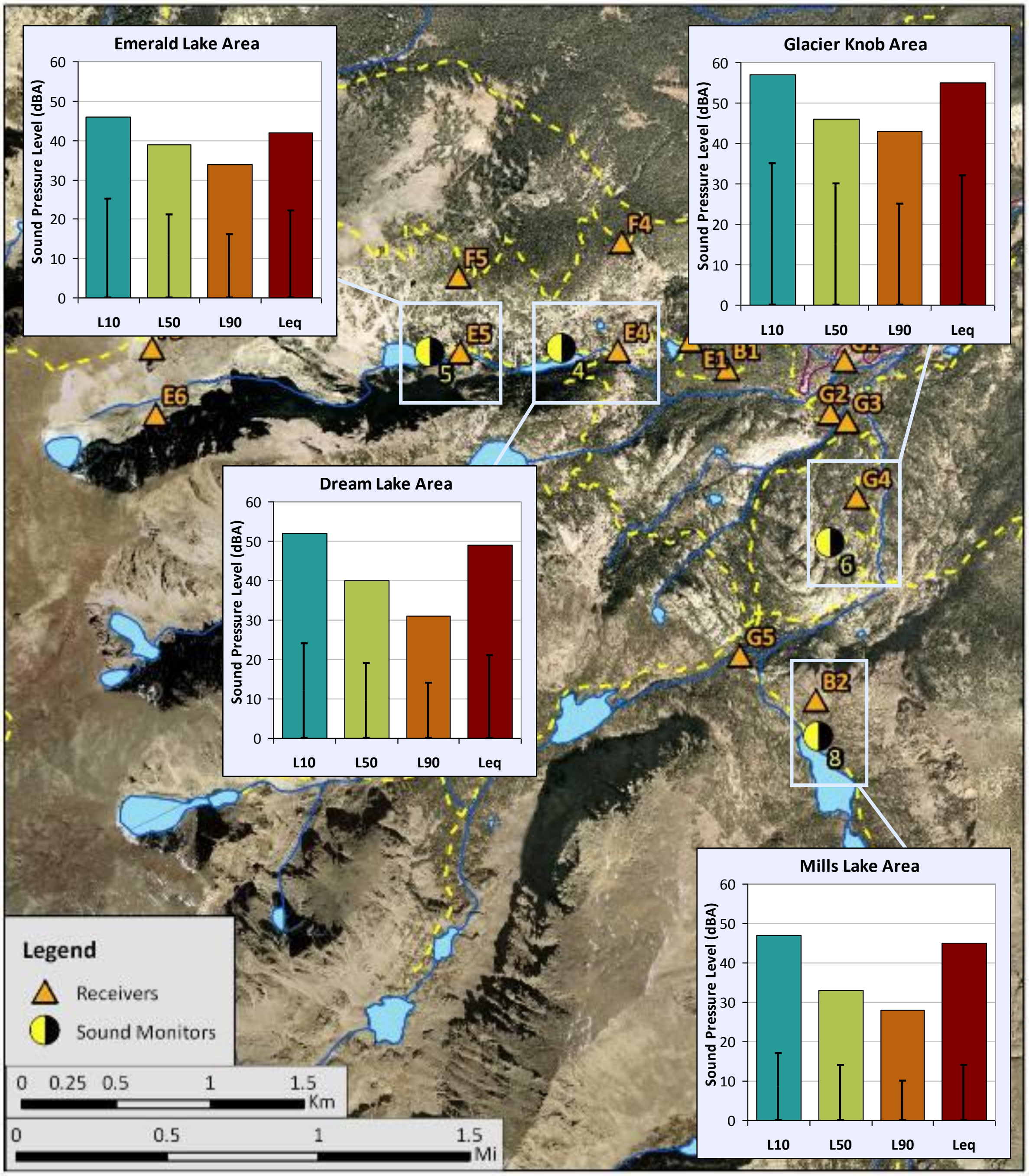


7.10 Comparison with Background Sound Levels

Figure *7.31* displays daytime background sound levels logged by sound monitors alongside discrete receiver results. Charts included in the map compare L10, L50, L90, and Leqs for 4 monitor/receiver pairs located in close proximity. These pairs are located in following areas: Emerald Lake (Position 5, R05), Mills Lake (Position 8, R22), Dream Lake (Position 4, R04), and Glacier Knob (Position 6, R16). Within the charts, the colored bars represent the daytime average sound pressure levels logged by the sound monitors. The black lines represent discrete receiver levels calculated for baseline average traffic conditions.

As indicated, the background sound levels are generally higher than the modeled levels, indicating other factors other than surface transportation noise contribute to overall sound levels. These could include aircraft overflights, wind, water, and other man-made or natural sounds.

Figure 7.31 Sound Pressure Level Comparisons at Select Monitor/Receiver Locations - Monitored sound levels are in colored bars and modeled sound levels are in underlying black lines



7.11 Alternatives Noise Maps

Two alternative traffic scenarios were evaluated. Under the alternative traffic scenarios, shuttle buses run more frequently between the Park & Ride Lot and the trailheads, displacing cars and low-occupancy vehicles. The number of vehicle passbys per hour decreases.

The first alternative exhibits a 10% capture rate. This means that 10% of vehicle trips traveling from points east of the Bear Lake Park & Ride are captured by the shuttle bus system, increasing the number of passengers on the Hiker Shuttle. The number of shuttle trips does not change. In addition, 10% of the vehicle trips heading beyond the Park & Ride toward the Bear Lake area (inclusive of the higher elevation areas around Bierstadt Lake, Glacier Gorge, etc.) are converted to add new passengers to the Bear Lake Shuttle. Under this scenario, average hourly passbys include 116 vehicles: 89 cars and small trucks, 12 medium/heavy trucks, 13 buses, and 2 motorcycles. Peak hourly passbys include 119 vehicles: 94 cars and small trucks, 13 medium/heavy trucks, 10 buses, and 2 motorcycles.

The second alternative exhibits a 25% capture rate. This means that 25% of vehicle trips traveling from points east of the Bear Lake Park & Ride are captured by the shuttle bus system, increasing the number of passengers on the Bear Lake Road Hiker Shuttle. In addition, 25% of the vehicle trips heading beyond the Park & Ride toward the Bear Lake area (inclusive of the higher elevation areas around Bierstadt Lake, Glacier Gorge, etc.) are converted to add new passengers to the Bear Lake Shuttle. Under this scenario, average hourly passbys include 100 vehicles: 75 cars and small trucks, 10 medium/heavy trucks, 13 buses, and 2 motorcycles. Peak hourly passbys include 111 vehicles: 88 cars and small trucks, 11 medium/large trucks, 10 buses, and 2 motorcycles.

Vehicle speeds were modeled at 70 kph (40 mph), consistent with the baseline models. Sound power levels also remained consistent with the baseline levels described above.

We modeled the equivalent average sound pressure levels (LAeq) for each alternative under average and peak traffic conditions. We then subtracted the baseline levels from these values in order to calculate the difference, in dBA, between the alternative and baseline scenarios.

Figure 7.32 through Figure 7.35 show these differences graphically throughout the Bear Lake corridor. These maps represent the increase or decrease in LAeq that would result from each alternative traffic scenario. As shown, there is virtually no change in sound levels in either the peak or average condition under the 10% and 25% capture scenarios. The reduction of vehicle trips is insignificant with respect to the overall roadway noise level.

Figure 7.32 Sound Pressure Differentials under Average Traffic Conditions, 10% Capture Alternative

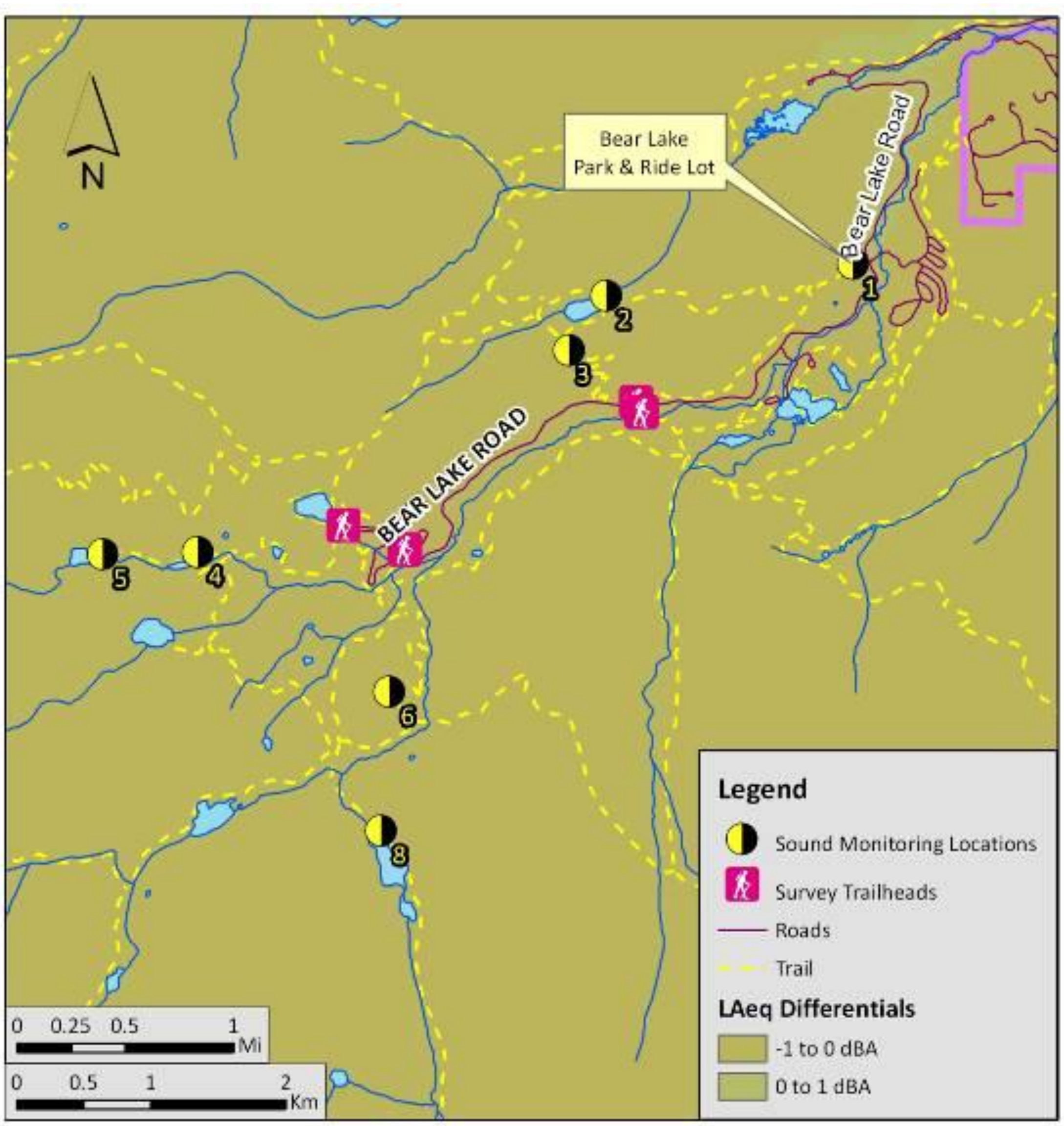


Figure 7.33 Sound Pressure Differentials under Peak Traffic Conditions, 10% Capture Alternative

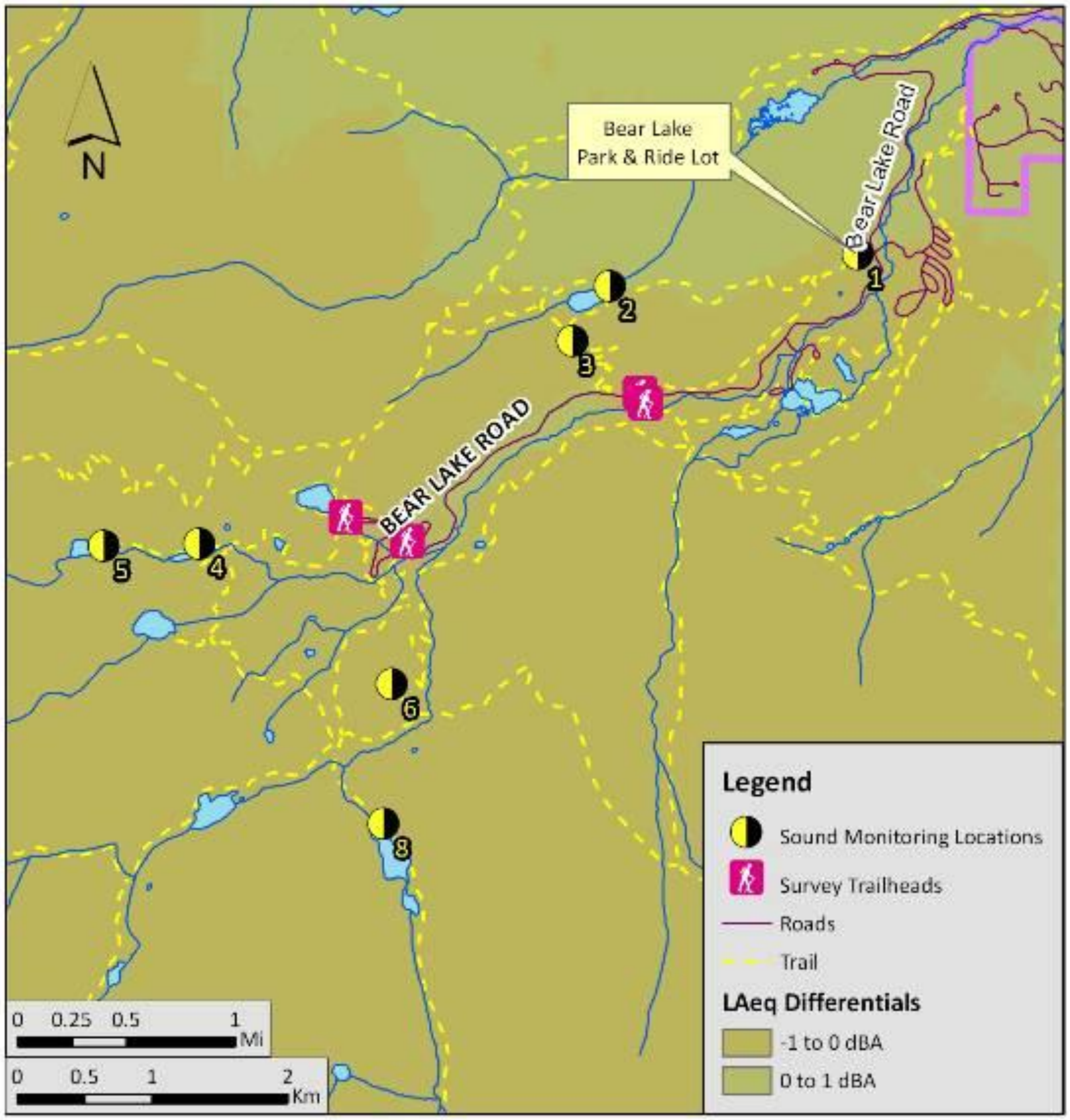


Figure 7.34 Sound Pressure Differentials under Average Traffic Conditions, 25% Capture Alternative

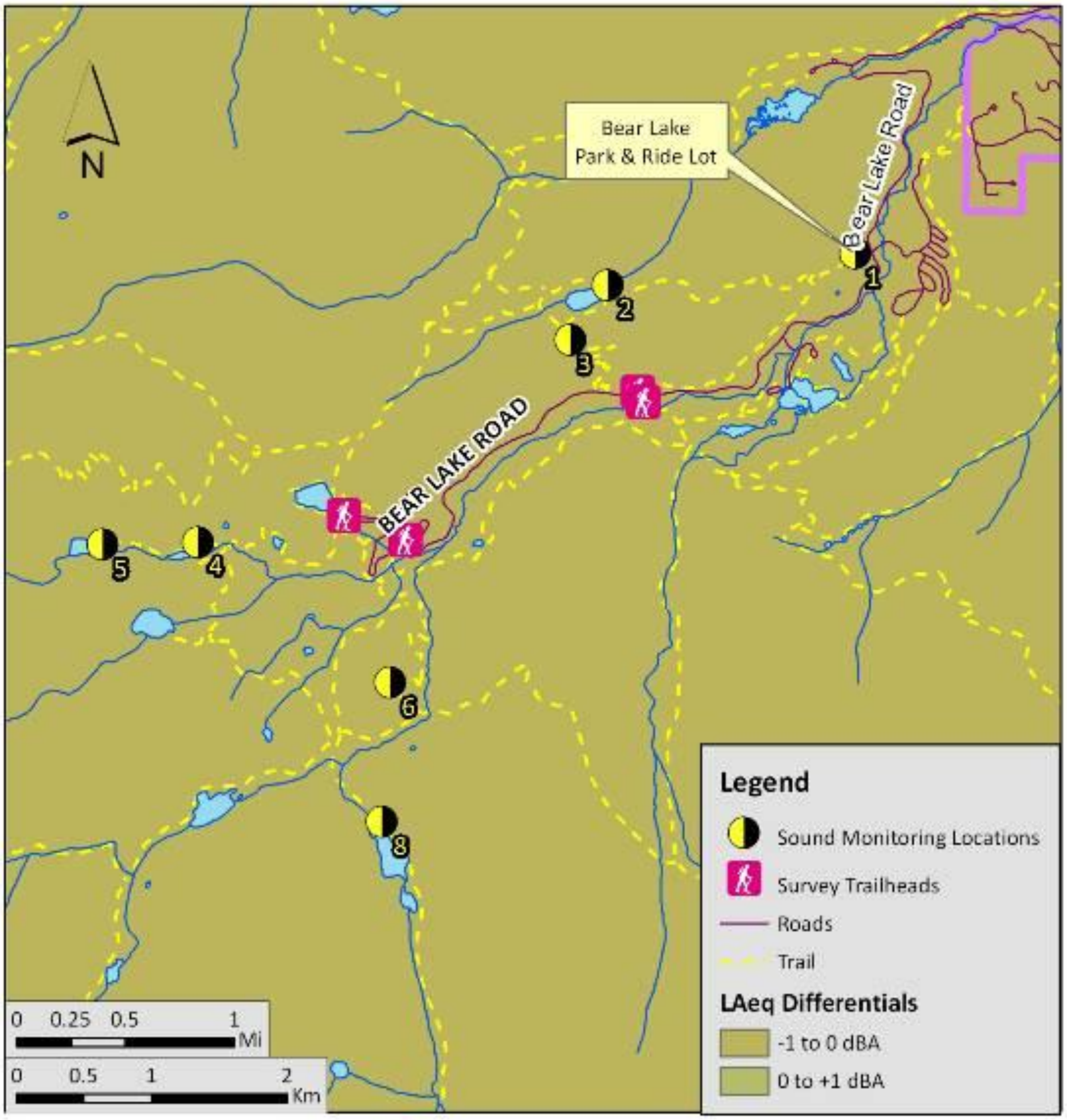
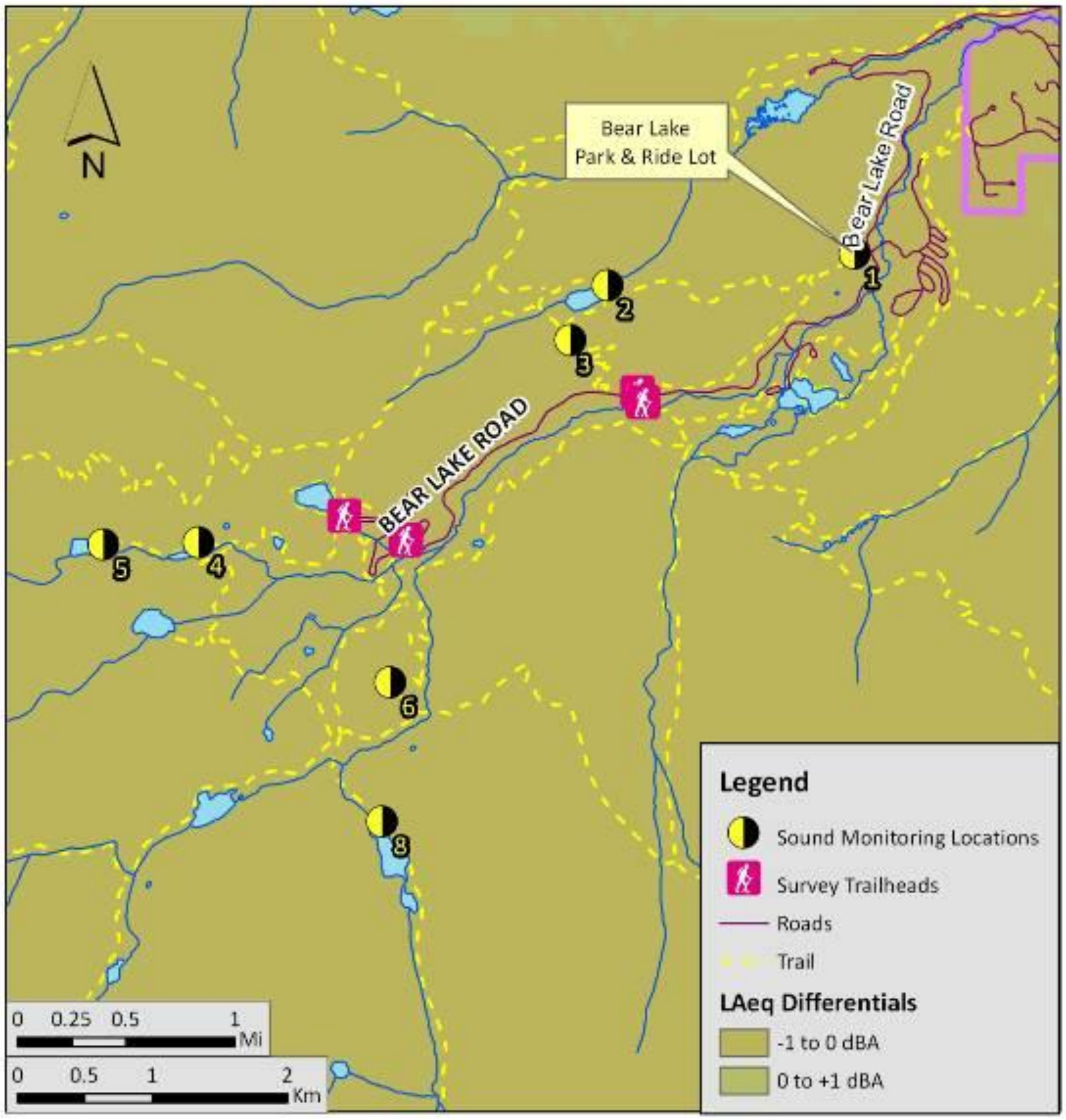


Figure 7.35 Sound Pressure Differentials under Peak Traffic Conditions, 25% Capture Alternative



7.12 Percentile and Time Above Sound Levels

One of the drawbacks of noise maps is that they present information about averages over a static time period. However, useful statistics for a park soundscape also include percentile levels and "time above" or the time the noise from surface transportation is above a certain threshold level.

To conduct this analysis, we must first model the movement of a vehicle as it moves along the roadway and a specific receiver point. We plot the vehicular sound level as a function of time. An example of this is shown in Figure 7.36. The figure represents the sound level of a vehicle with a sound power of 100 dB as it moves from the Bear Lake Park and Ride lot to the Bear Lake trailhead, from the perspective of an observer at the start of the Glacier Gorge Trail. As shown, the vehicle noise increases as it moves towards the receiver and decreases as it moves away.

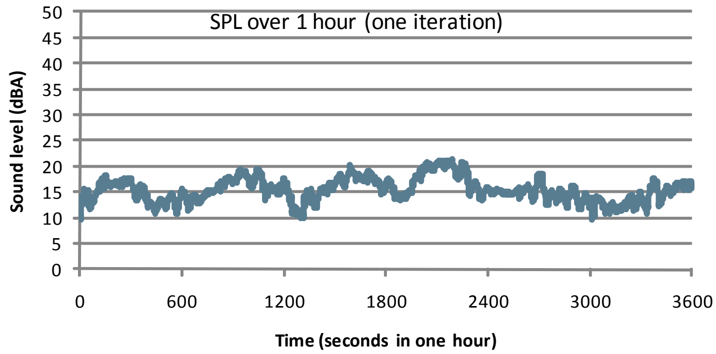
Figure 7.36 Sound Level from the Perspective of an Observer at Glacier Gorge Trail of a 100 dB Sound Power Vehicle as it Travels from the Park and Ride Lot to Bear Lake Trailhead

The next step is based on the understanding that noise heard by an observer is a combination of all the vehicles travelling on the road at any one time. These vehicles are in different places at different times, and may have different sound powers associated with them. Therefore, we can take a single passby event, and distribute it across an hour by randomizing its departure time and direction, then applying a sound power based on its vehicle type. This can be repeated for each vehicle using the corridor in an hour and each vehicle type.

Finally, we can sum up the sound level for each second, and calculate statistics for the hour. These could include percentile levels, such as L10, L50, and L90, averages such as Leq, and other statistics, such as "time above" (see Figure 7.37).

Figure 7.37 One Hour of Vehicle Traffic Noise at Glacier Receiver G1 under Baseline Conditions

Results



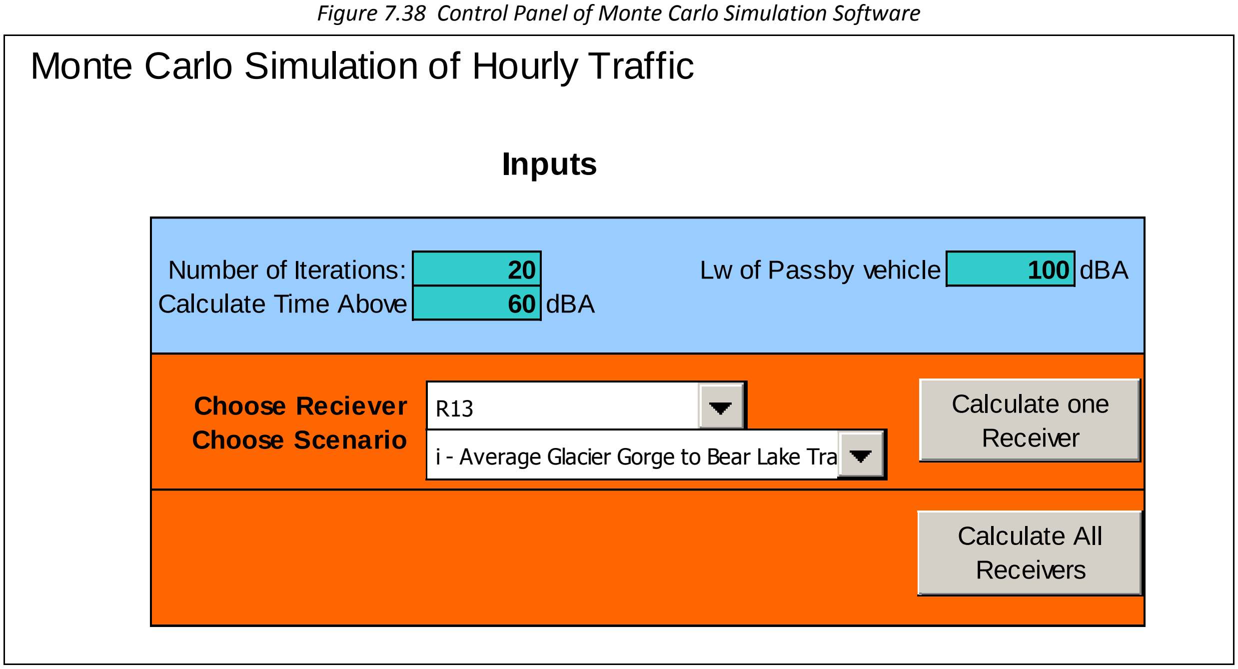
Single Scenario Result

Level	Results
L10	18
L50	16
L90	12
Leq	16
Time above 60 dBA	0

This approach is typically called a “Monte Carlo” analysis, in that it involves a stochastic randomized simulation of the movement of vehicles in the corridor. When the Monte Carlo analysis is repeated many times for the same hour, we converge on a solution.

Customized software using Microsoft Excel was used to create the Monte Carlo simulator (Figure 7.38). First, the time-domain sound levels for each receiver were entered. These were obtained from the Cadna A model using its “Passby Level” calculation feature. Then, the number of vehicles of each type (car, medium truck, heavy truck, bus, and motorcycle) is entered. Finally, the sound power of the vehicle used in the passby level runs is entered. The program then automatically calculates the appropriate adjustments for each vehicle type and sound power, and conducts the simulation for each iteration. We used 20 iterations. The program accumulates statistics and gives a final result after the final iteration is reached.

Figure 7.38 Control Panel of Monte Carlo Simulation Software



Baseline

We used the Monte Carlo program to evaluate 20 discrete receivers in the Bear Lake corridor. These correspond with the receivers used in Colorado State University's Attended Listening project. In this project, listening stations were set up at fixed intervals along trails. These trails included Emerald Lake, Mills Lake, Dream Lake, and Glacier Knob. Some of these stations were also near our sound monitoring stations. For example, background sound monitoring Site 5 was near attended-listening Station E5, monitoring Site 8 was near B2, monitoring Site 4 was near E4, and monitoring Site 6 was near G4 (see Figure *7.39*). During the attended listening exercise, the attendant recorded the percentage of time that traffic and other sounds were audible.

The results of the Monte Carlo analysis are shown in Table 7.4 and Table 7.5 for the average and peak conditions, respectively. For each receiver, the L10, L50, L90, Leq, and time above 35 dBA was calculated. 35 dBA was used as a placeholder for time audible, as it is representative of daytime sound levels in most of these areas.

As expected, as one moves away from the road (E1 to E5, F1 to F5, etc.), sound levels decline, and the difference between the Leq and L90 also declines. This is due to the fact that, as the sound becomes more continuous and less peaked as one moves away from the road. That is, when one is close to a highway, the individual passbys are pronounced, but as one moves further away, the highway sound is more continuous.

Alternatives

The same procedure as described in Section 0 was used to evaluate the 10% Capture and 25% Capture scenarios. To determine the change in sound levels resulting from the alternatives, the statistical levels under baseline conditions were subtracted from those under alternative conditions.

As shown in Table 7.4 and Table 7.5, the reduction in sound levels for each alternative is less than 3 dB. However, the time above 35 dBA is more significant at some locations. For example, at G4 (Glacier Gorge Trail) under Alternative 3, the time above 35 dBA is reduced by 8 minutes out of the hour.

Figure 7.39 Attended Listening and Background Sound Monitoring Locations

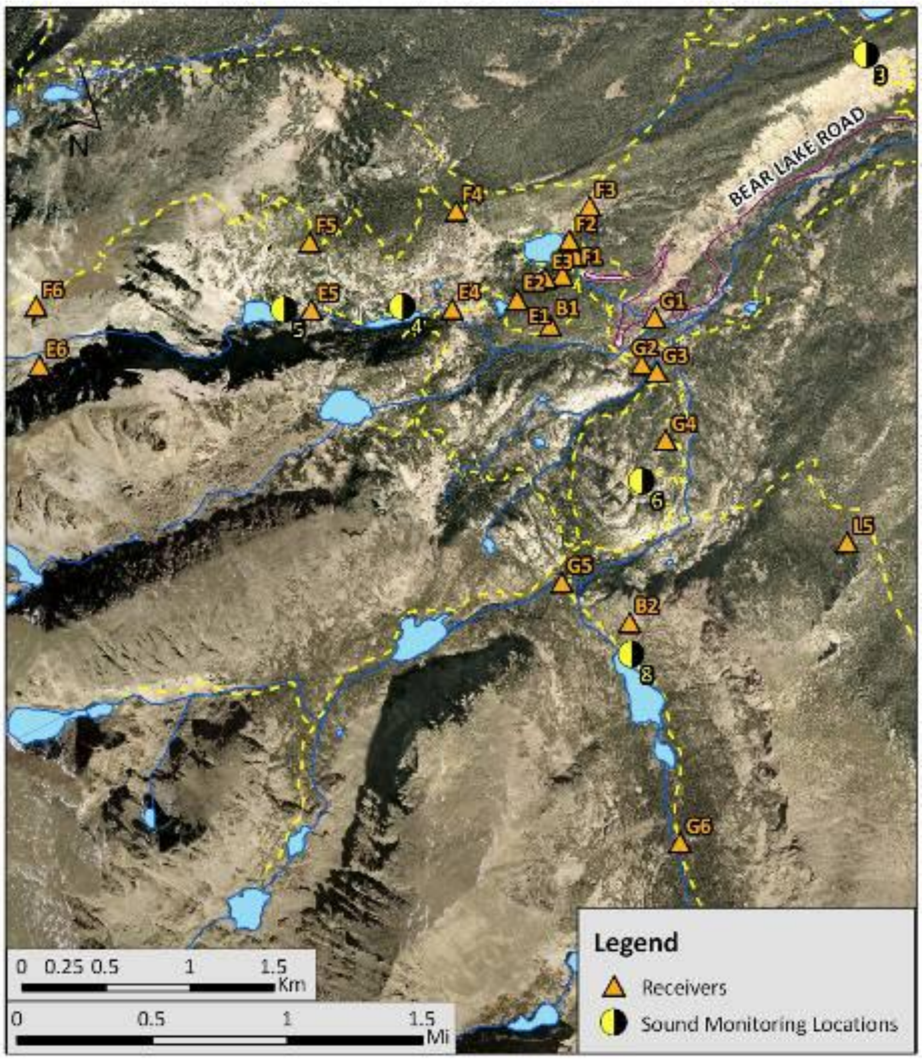


Table 7.4 Summary of Monte Carlo Results for Each Alternative for Average Traffic Conditions

						Differentials									
	Baseline Average					10% Capture Average					25% Capture Average				
Receivers	L10	L50	L90	Leq	Time Above 35 dBA	ΔL10	ΔL50	ΔL90	ΔLeq	Δtime (min)	ΔL10	ΔL50	ΔL90	ΔLeq	Δtime (min)
E1	38	25	19	34	19%	0	-1	-1	0	-0.9	-1	-2	-2	-1	-2.4
E2	28	22	16	24	0%	0	-1	0	0	+0	-1	-2	-2	-1	0
E3	24	20	16	21	0%	0	0	-1	0	0	-1	-1	-1	-1	0
E4	25	21	17	22	0%	0	-1	-1	0	0	-1	-1	-2	-1	0
E5	21	18	14	19	0%	0	0	-1	0	0	-1	-1	-2	-1	0
E6	13	10	5	10	0%	0	0	-1	0	0	-1	-1	-2	-1	0
F1	32	22	16	29	6%	0	-1	-1	0	-0.3	-2	-2	-2	-1	-0.7
F2	23	17	13	20	0%	0	-1	-1	0	0	-1	-1	-2	-1	0
F3	25	21	17	22	0%	0	0	0	0	0	-1	-1	-2	-1	0
F4	27	23	19	24	0%	0	-1	-1	0	0	-1	-1	-2	-1	0
F5	22	19	16	20	0%	0	0	-1	0	0	-1	-1	-2	-1	0
F6	14	11	7	12	0%	0	0	-1	0	0	-1	-1	-2	-1	0
G1	51	45	36	48	91%	0	-1	-3	0	-2.3	-1	-2	-7	-1	-4.8
G2	43	38	32	40	76%	0	0	-1	0	-2	-1	-1	-2	-1	-6.3
G3	42	38	32	39	75%	0	-1	0	0	-2.5	-1	-1	-2	-1	-8.3
G4	36	32	28	33	19%	0	0	-1	0	-1.2	-1	-1	-1	-1	-4.3
G5	21	18	14	18	0%	0	0	0	0	0	-1	-1	-1	-1	0
G6	16	14	10	14	0%	0	0	-1	0	0	-1	-1	-2	-1	0
L5	25	23	19	23	0%	0	0	0	0	0	-1	-1	-2	-1	0
L6	17	15	13	16	0%	0	0	-1	0	0	-1	-1	-2	-1	0

Table 7.5 Summary of Monte Carlo Results for Each Alternative for Peak Traffic Conditions

						Differentials									
	Baseline Peak					**10% Capture Peak**					**25% Capture Peak**				
Receivers	**L10**	**L50**	**L90**	**Leq**	**Time Above 35 dBA**	**ΔL10**	**ΔL50**	**ΔL90**	**ΔLeq**	**Δtime (sec)**	**ΔL10**	**ΔL50**	**ΔL90**	**ΔLeq**	**Δtime (sec)**
E1	38	25	18	34	18%	0	-1	0	0	-0.9	-1	-2	-1	-1	-1.7
E2	28	21	16	24	0%	0	0	-1	0	0	-1	-1	-1	-1	+0
E3	24	20	16	21	0%	0	0	0	0	0	-1	-1	-1	-1	0
E4	25	21	17	22	0%	0	0	-1	0	0	0	-1	-1	-1	0
E5	21	17	14	18	0%	0	0	-1	0	0	0	-1	-1	-1	0
E6	13	9	5	10	0%	0	0	-1	0	0	-1	-1	-1	-1	0
F1	32	22	15	29	5%	0	0	-1	0	-0.2	-2	-1	-2	-1	-0.4
F2	23	17	12	20	0%	0	0	0	0	0	-1	-1	-1	-1	0
F3	25	21	17	22	0%	0	0	-1	0	0	0	-1	-1	-1	0
F4	27	23	18	24	0%	0	0	-1	0	0	0	-1	-1	-1	0
F5	22	19	15	20	0%	0	-1	-1	0	0	0	-1	-1	-1	0
F6	14	11	6	11	0%	0	0	-1	0	0	0	-1	-2	-1	0
G1	51	44	33	47	88%	0	-1	-1	0	-0.6	-1	-1	-2	-1	-1.4
G2	43	38	31	39	74%	0	-1	-1	0	-2.7	0	-1	-2	-1	-4.8
G3	41	37	32	38	71%	0	0	-1	0	-3.2	0	-1	-2	-1	-6.1
G4	36	32	27	33	15%	0	-1	-1	0	-0.9	0	-1	-1	-1	-1.9
G5	20	17	13	18	0%	0	0	0	0	0	0	-1	-1	-1	0
G6	16	13	10	14	0%	0	0	-1	0	0	0	-1	-2	-1	0
L5	25	22	19	23	0%	0	0	-1	0	0	0	-1	-2	-1	0
L6	17	15	12	15	0%	0	0	-1	0	0	-1	-1	-1	-1	0

7.13 Loudness Calculator

As noted in Section 0, loudness is a sound descriptor related to the human perception of a sound. There are many procedures to calculate loudness and loudness level, with the most recent being codified in ANSI S3.4-2007, "Procedure for the Computation of Loudness of Steady Sounds."

The ANSI standard describes its applications as:

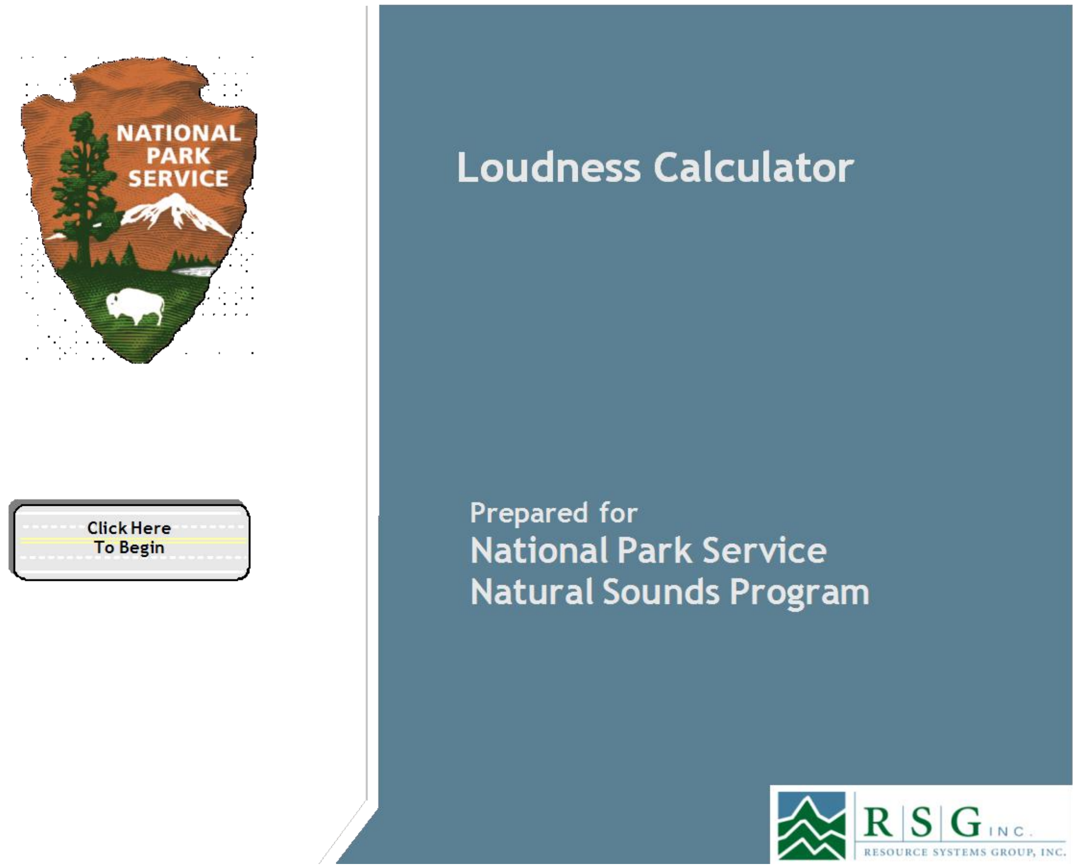
> "The current standard can be applied to sounds with sharp line spectral components, e.g., transformer hum or fan noise, as well as to sounds with broadband spectra. Provided the measurement of sound pressure levels is sufficiently precise, and subject to certain restrictions specified below, the recommended procedure may also be used to estimate loudness, or loudness level, with reasonable accuracy down to near threshold levels. Moreover, it enables the loudness of complex sounds containing spectral energy below 500 Hz to be determined."

The older standards for calculating loudness were based on lookup table calculations using equal loudness contours. The new method is computationally based and can only be done in software. As a result, the standard comes with an executable software program written in Fortran that can be used to calculate loudness.

The software is not intended to be user-friendly, but allows the user to confirm results of their calculations. In this case, we obtained the source code for the Fortran code from the author, to make sure that our implementation was entirely consistent with the software provided in the standard.

The software created for this project, starts with a splash screen (Figure 7.40). The program requires the use of macros, so, if the "Click Here to Begin" button does not take you to the next page, then the user's security settings must be changed to allow macros.

Figure 7.40 Splash Page for the Loudness Calculator



The next screen has the input and output (Figure 7.41). One-third octave band sound levels are entered from 25 Hz through 16,000 Hz, and "Free Field" or "Diffuse Field" is selected. For most National Parks, free field is used. The program then automatically calculates the A-, C-, and Z-weighted sound pressure levels, loudness in sones, and loudness level in phons.

If the sound levels are only available in 1/1 octave bands, then the user can click on "Convert 1/1 Octave Bands to 1/3 Octave. In that case, a dialog box comes up (Figure 7.42) where you enter the 1/1 octave bands, and the highway or other characteristics. It then calculates a 1/3 octave band based on the proper spectrum for the applied mix.

Figure 7.41 Input and Results page for the Loudness Calculator

NPS Loudness Calculator

Frequency (Hz)	Enter SPL in dB
25	-5.8
32	16.9
40	32.4
50	41.7
63	48.0
80	52.2
100	54.9
125	57.1
160	59.2
200	61.1
250	62.9
315	64.8
400	66.6
500	67.9
630	69.0
800	69.6
1,000	69.6
1,250	69.1
1,600	68.1
2,000	66.7
2,500	64.9
3,150	62.9
4,000	60.6
5,000	58.4
6,300	55.8
8,000	52.7
10,000	48.9
12,500	0
16,000	0

Select Field Type

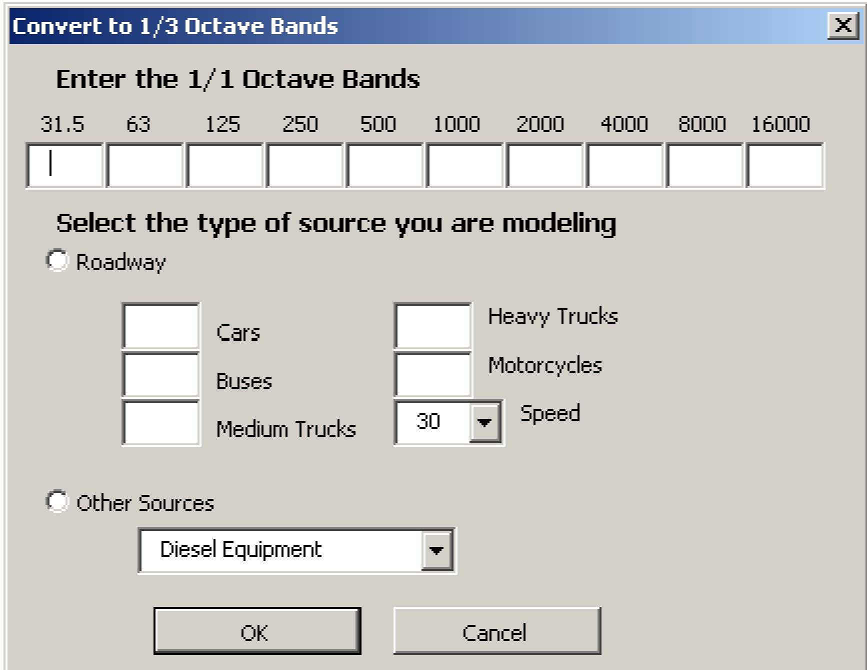
- (•) Free Field
- ( ) Diffuse Field

Results

sound pressure level	77.8 dBA
	78.5 dBC
	78.6 dBZ
loudness	48.34 sones
loudness level	95.0 phons

[Convert 1/1 octave bands to 1/3 octave]

Figure 7.42 Dialog box to convert 1/1 to 1/3 octave bands



7.14 Hiker Experience

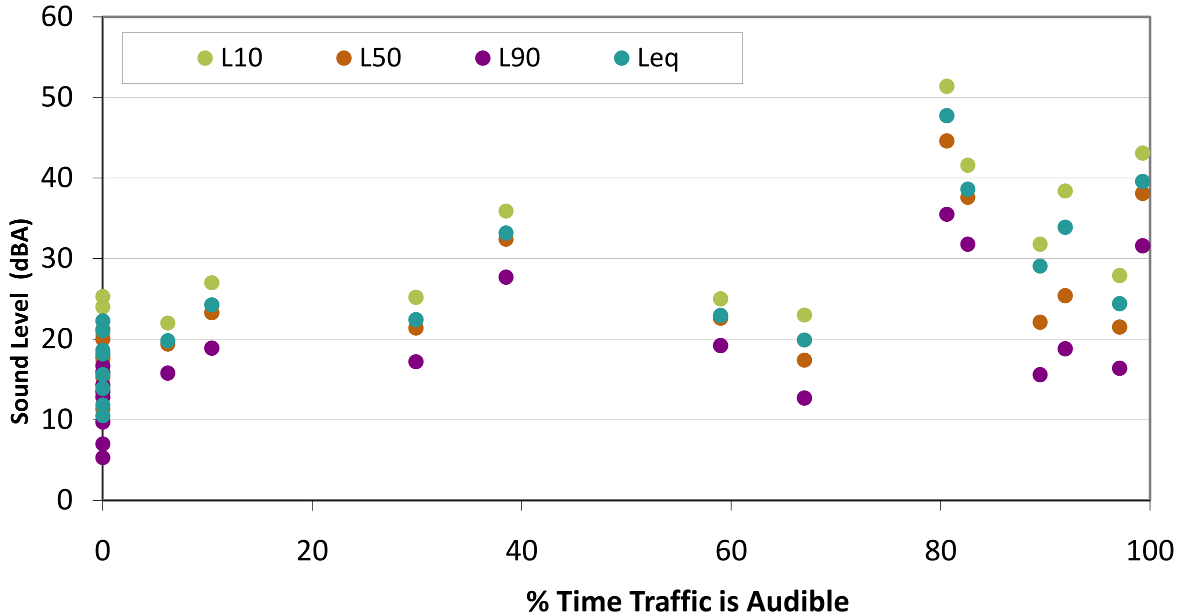
One of the goals of this study is to make use of noise information to contribute to our understanding of visitors to the Park. While the statistics and noise mapping presented above are useful, we can also integrate noise data with other user-experience survey methods.

7.14.1 Natural Background Sound

Twenty attended listening stations were set up over four trails leading from the Bear Lake Road corridor. The attendant recorded the percentage of time traffic, aircraft, and people were audible at different distances from the trailhead.

If we compare the modeled sound levels to the attended listening results, no clear pattern emerges (Figure 7.43). That is, the monitored percent time that surface transportation is audible has little relationship with the modeled surface transportation noise. This is because the background sound level in each location is different. In some areas with high surface transportation noise, background noise is also high (like Alberta Falls). In other areas with very low traffic noise, audibility may be high due to low natural background noise. However, we can use this fact to estimate what the natural background sound is.

Figure 7.43 Percentage of Time Traffic is Audible at Attended Listening Stations Compared to the Modeled traffic



To calculate the natural background sound in the absence of surface transportation noise (and assuming no other contributor to background noise other than natural sounds), we can assume that the modeled time-above level can be used as an approximate percent time audible. For example, if the attended listening survey found that transportation noise is audible 45% of the time at a location, we can run the Monte Carlo analysis at various time-above levels until we find one that results in that level being exceeded 45% of the time. The results of the analysis for each location, rounded up to the nearest 5 dB are shown in Figure 7.45.

Figure 7.44 Percent time audible compared to Time-Above modeling. The X-axis shows the attended listening location and the blue box shows the percent time traffic noise is audible at that location. The numbers in the graph show the time-above level. For example, taking the upper left-most value showing 15 – 100% of the time, the traffic noise level is above 15 dBA at E1, whereas traffic is recorded as being audible 92% of the time.

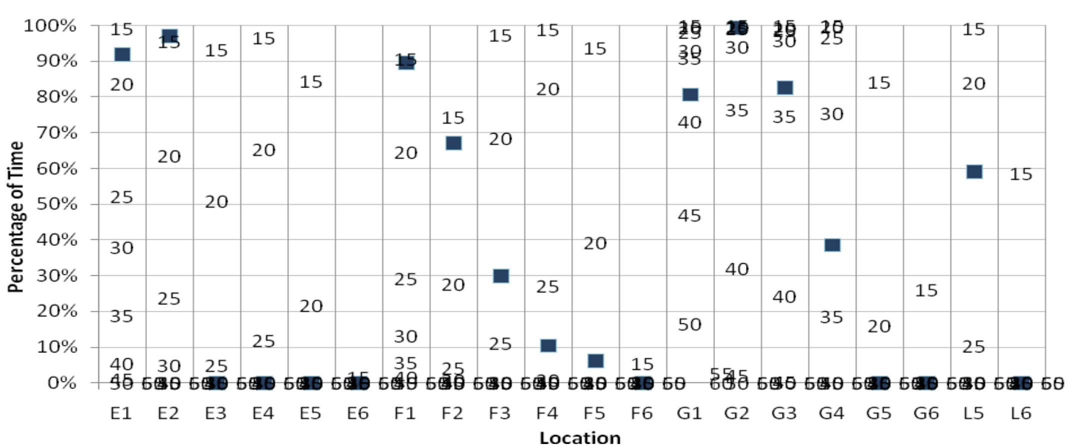


Figure 7.45 Monitored Percent Time Audible and Projected Natural Quiet Sound Levels Calculated at each Attended Listening Station

Receiver	Percent Time Audible from Attended Listening	Projected Natural Quiet Sound Level (dBA)
E1	92	15 to 20
E2	97	15 to 20
E3	0	30 to 35
E4	0	30 to 35
E5	0	25 to 30
E6	0	15 to 20
F1	90	15 to 20
F2	67	15 to 20
F3	30	20 to 25
F4	10	25 to 30
F5	6	20 to 25
F6	0	15 to 20
G1	81	35 to 40
G2	99	20 to 25
G3	83	30 to 35
G4	39	30 to 35
G5	0	20 to 25
G6	0	15 to 20
L5	59	20 to 25
L6	0	15 to 20

7.14.2 Hiker Experience Modeling

The analysis above has been done at discrete locations in the park, but does not, in and of itself, represent what a hiker may experience as they move from point to point along backcountry trails. To do this, we can integrate the noise mapping with Hiker GIS tracks to calculate hiker exposure to traffic noise as they use the National Park.

This analysis was conducted using the noise maps created in this report and hiker track data collected and analyzed by researchers at Southern Illinois University and Colorado State University. The results are published in the Winter 2009-2010 issue of Park Science, Volume 26, Number 3, as "Modeling and mapping hikers' exposure to transportation noise in Rocky Mountain National Park," (authors Logan Park, Steve Lawson, Kenneth Kaliski, Peter Newman, and Adam Gibson). Rather than repeating the analysis in this report, we refer the user to the paper at http://www.nature.nps.gov/ParkScience/index.cfm?ArticleID=348, incorporated here by reference.

In that paper, the authors used the noise maps to:

- Create time domain profiles of individual hiker noise exposure
- Calculate the hiking distance from each trailhead to various levels of transportation sound, ranging from 25 to 65 dBA.
- Calculate the percentage of hiking time visitors experience natural quiet by trailhead and level of natural quiet.
- Percentage of visitors who experience at least 15 minutes of natural quiet

7.15 Conclusions

This study evaluated the noise impacts of transportation alternatives in the Bear Lake corridor of the Rocky Mountain National Park. The study involved both sound monitoring and modeling to determine whether changes in the use of a hiker shuttle system would increase or decrease sound levels and affect visitor experience.

Several new tools and procedures were developed in this process. These included:

- Noise mapping of surface transportation noise of the park under various alternatives
- Integrating noise maps with GIS hiker tracks to evaluate visitor exposure to noise over time and to make noise exposure comparisons among trails.
- Creating a Monte Carlo simulation of vehicle traffic on Bear Lake Road to assess statistical sound levels, as well as the time spent above certain sound levels.
- Comparison of time-above levels to percent-time-audible field studies to estimate natural background sound level.
- Creation of a loudness calculator to assess loudness and loudness level as per ANSI 3.4 standards.

Overall, the study made the following main conclusions:

- Noise assessment of transportation alternatives is important to understanding the impact to a park visitor's experience. As natural quiet is an important park asset, it is useful for park management to understand the effect its actions may have on that resource.
- Noise impacts are difficult to assess using only average levels. While a bus may have the equivalent sound energy of eight cars, it is audible in an area that is roughly five times as large as a car. In addition, legal motorcycles have a similar audible area, but when fitted with alternative mufflers that create 10 dB more sound, are audible over about 60 times the area of a single car.
- The Many Parks Curve overlook recorded the highest and lowest sound levels. Sound levels during a motorcycle weekend increased the hourly L10 and daily L1 by 5 to 10 dB.
- Long term average sound levels near Bear Lake Road were changed very little with changing diurnal traffic volumes. The largest effect on long-term average levels in the corridor close to the road were rain and thunderstorms. Other than traffic noise, there were high volume events, likely due to anthropogenic sources, such as aircraft, that also impacted long term averages.
- Noise mapping of the Bear Lake Road corridor is feasible using FHWA REMEL noise coefficients, as used in their Traffic Noise Model (TNM). The maps are useful to show areas of both high and low surface transportation noise. As natural quiet is a park resource, these noise maps can be used as a resource for park visitors seeking quiet areas. By comparing noise maps between transportation alternatives, we found very little change – generally less than 1 dB - in average day and peak hour sound levels when an additional 10% and 25% of travelers use the Bear Lake shuttle (ie the 10% and 25% Capture scenarios).
- The noise mapping software can create time domain statistics of vehicle noise as well. Using stochastic modeling of vehicle noise passby levels, noise statistics for discrete locations can be created. This allows the user to evaluate statistical sound levels (Leq, L10, L50, L90), as well as the time traffic noise is above certain levels. Using this technique, we found a larger effect from the alternatives. In the most extreme case, the 25% Capture alternative led to an eight minute reduction per hour in the time the visitor is exposed to traffic noise levels above 35 dBA.
- The discrete statistics can also be used to assess the natural background sound by comparing calculated time-above sound levels of traffic noise to observed time-audible logs. In this study, the results were integrated into Colorado State University time-audible data from the summer of 2008

along the Emerald Lake, Mills Lake, Dream Lake, Glacier Gorge, and Longs Peak trails. The results showed natural background levels ranging from 15 dBA along the Emerald Lake trail to 40 dBA along the Glacier Gorge trail.

- Noise maps can also be used to assess visitor experience by integrating them with GIS hiker tracks. In an extension of this study, researchers at Southern Illinois University and Colorado State University calculated time-domain statistics relating to visitor experience relative to natural quiet. These included the percentage of time hikers experience natural quiet, the percentage of visitors experiencing at least 15 minutes of natural quiet, and the distance time and time needed to reach natural quiet from each trailhead. The research found that the Bear Lake trailhead offered the quickest way to reach natural quiet - on average 6.2 minutes for a natural quiet level of 30 dBA. In addition, they found that visitors to the Bear Lake trailhead experience traffic sound levels below 30 dBA 68.8% of the their visit. This compares with visitors to the Storm Pass trailhead that only experience 30 dBA or less traffic noise 20.1 percent of their hiking time.
- Loudness, as defined under the ANSI S3.4 standard, can be used to assess human reaction to noise, as it most closely follows the human perception of sound in varying levels and spectra. A loudness calculator was created to allow the Park Service to apply loudness analyses given continuous 1/3 octave band data.

Overall, the methods outlined in this study of the Bear Lake Road Corridor can be applied to other parks and many different types of transportation options. This can include other transportation sources, changes to park vehicles, restrictions on motorcycle noise, and other critical concerns related to the preservation of natural quiet in national parks.

7.16 Acknowledgements

This project was funded through Colorado State University through a grant from the Alternative Transportation in Parks Public Lands program of the Federal Transit Administration and National Park Service Natural Sounds Program. The projected involved the cooperate effort of a number of individuals, universities, and government entities. In particular, we would like to thank:

- Larry Gamble of the Rocky Mountain National Park
- The ATPPL program
- Karen Trevino, Frank Turina, Kurt Fristrup, Randy Stanley, Vicki McCusker and Damon Joyce of the NPS Natural Sounds Program
- Peter Newman and Adam Gibson –Colorado State University
- Logan Park – Virginia Tech and Southern Illinois University
- Chris Monz – Utah State University

Chapter 8: INTEGRATION

8.1 Choice Model

8.1.1 Introduction

National parks host millions of visitors each year (National Park Service, 2008) and traffic congestion and crowding have become a common occurrence. During peak periods of use, park visitors often wait in traffic and compete for limited parking to access popular attraction sites. Visitors who do find parking during periods of high use can experience crowded conditions along trails and at attraction sites. This high level of visitor use can negatively impact visitor experiences and lead to natural resource damage. For example, visitor experience may be impacted by limited opportunities to experience solitude or increased sound levels associated by large crowds of people and congested vehicle traffic conditions. Further, natural resources adjacent to official trails or at attraction sites may be impacted by visitors as they navigate around groups of other visitors. To alleviate these conditions, the National Park Service (NPS) is looking to alternative transportation systems (ATS) to provide visitors access to the national parks in a manner that potentially reduces traffic congestion, enhances visitors' experiences, and more effectively protects park resources. For example, shuttle bus systems can be scheduled that visitors are delivered to a trailhead at a known rate to ensure that visitor use levels do not create crowded conditions that negatively affect visitor experience or natural resource conditions.

Rocky Mountain National Park (RMNP) was one of the first national parks to adopt an alternative transportation system, initiating a shuttle bus system in the Bear Lake Road corridor in 1978 that continues to operate during the peak visitor use season. In 1999, RMNP initiated a transportation study to assess existing visitor use, transportation-related problems, and potential solutions (Parsons, Brinkerhoff, Quade, & Douglas, 2000). This study found that the shortage of parking spaces was the most significant transportation problem in the park, with 46% of summer visitors unable to find legal parking spaces at their destinations of choice. Study findings found that when parking lots were full, visitors often parked illegally causing safety concerns and resource damage. For example, visitors were found parking in spaces designated for visitors with disabilities creating unsafe situations by forcing visitors with disabilities to park and travel further distances or across challenging terrain to access their destination. Similarly, visitors were also found to park on road shoulders or on alpine tundra impacting natural resources by trampling vegetation adjacent to road areas and creating safety concerns by walking along busy roads to access destination areas. To address these parking congestion-related issues, while accommodating for increasing visitation, RMNP implemented an improved 10-vehicle fleet of shuttle busses in 2001. The shuttle service is staged from the main shuttle parking lot (Park-and-Ride) along Bear Lake Road, which has parking for a total of 334 vehicles. The shuttle operates from early June through early October and provides service to the Bear Lake and Fern Lake trailheads and several points in between. Prior to 2001, approximately 156,000 people rode the Bear Lake and Fern Lake shuttles annually. Transit service has been incrementally increased every year since then and in 2006 ridership increased to around 270,000 passengers. In 2006, the park expanded the shuttle service into the town of Estes Park. Park visitors can now leave their cars at the Estes Park Visitor Center and ride a shuttle bus to the Beaver Meadows Visitor Center, and from there, transfer to the Bear Lake shuttle.

With an increasing percentage of visitors accessing the Bear Lake area via the shuttle bus, rather than in private vehicles, the constraint to visitor use levels associated with parking lot capacities has essentially been eliminated. Thus, recreation sites and trails serviced by the park's shuttle bus system have witnessed increased visitor use levels. As a consequence, the demand for recreation use in the area increases the potential impacts to the visitor experience and park resources. For example, a recent visitor survey to estimate crowding at attraction sites in the Bear Lake area found that about 75% of visitors felt some level of crowding.

An associated recreation resources assessment has shown extensive social trail formation and off-trail visitor disturbance. (Monz et al. 2009)

Well-designed transportation systems can help to mitigate impacts to visitor experiences such as crowding and park resources like the proliferation of visitor created trail. Understanding visitor preferences, and the associated trade-offs visitors are willing to make about transportation mode choices, can provide important information to transportation planners. Much of the social science conducted in national parks has focused on visitors' experiences related to natural, cultural, and social conditions. However, few studies have examined the role transportation systems play in the visitor experience or the factors that influence national park visitors' choice of transportation mode. The purpose of this study is understand the factors that influence visitors' choice of transportation mode (i.e. the factors that influence visitor's decision to use or not use the shuttle bus service) and to quantify the proportions of visitors that can be expected to use the shuttle service given varying transit service options and associated resource and experiential conditions. A stated choice survey was administered at the Bear Lake trailhead to explore the trade-offs park visitors were willing to make about transportation mode choice in order to inform RMNP managers about visitor acceptance of potential transportation related management actions. For example, would visitors be more willing to use a shuttle bus system if it would provide greater opportunities for solitude? Likewise, does the level of traffic congestion influence the choice to use the shuttle bus service? This paper explores these and other questions and is organized as follows: 1) a review of previous research regarding national park visitors' perspectives towards ATS; 2) a brief overview of stated choice modeling and how it has been applied in outdoor recreation research; 3) data collection methods; 4) results of the stated choice analysis; and 5) a discussion of the implications of our findings for transportation planning in RMNP. The results from this study provide RMNP managers a tool to estimate/quantify the potential impacts on roadway traffic, parking congestion, and trailhead visitation associated with different transit service options. Furthermore, these results potentially inform the design of intelligent information systems designed to influence visitors' mode choice. The understanding of visitor transportation mode choice provided by this study will help RMNP managers optimize transit service in terms of transportation operations, resource protection, and visitor experiences.

National Park Visitors' Perspectives towards ATS

The amount of previous research that examines national park visitors' perspectives and attitudes about transportation systems is limited. Most previous social science about transportation in national parks has focused on visitor responses to transportation management policy change. These studies generally suggest that visitors are supportive of voluntary shuttle bus service but are less supportive of mandatory shuttle services because visitors perceive a loss of "freedom" when using shuttle bus services (Dilworth, 2003; Miller & Wright, 1999; Sims, Hodges, Fly, & Stevens 2005). Previous studies also indicate that acceptance of ATS are correlated to visitor demographics (Dilworth, 2003). In particular, older visitors are less accepting of ATS and prefer to use private vehicles instead of buses (Moscardo, Pearce, & Morrison, 2001; Prideaux, Wei, & Heins Ruys 2001; Dilworth 2003). The minimum age that defines "older" or "senior" visitors varies between 50 – 60 years among studies. Furthermore, older individuals tend to participate in activities that require less physical strength and endurance than younger visitors (Kelly, 1980; Lee, Graefe, Burns 2003; Moscardo, Pearce, & Morrison, 2001). For example, older individuals tend to participate in sightseeing activities while younger individuals tend to partake in recreational activities such as hiking, mountain biking, and camping (Lee, Graefe, Burns 2003; Moscardo, Pearce, & Morrison, 2001). These differences in activity preference may influence an individual's willingness to use alternative transportation, but this has not been examined in the current literature.

More recently, White (2007) indentified situational factors in park settings (i.e. convenience, access, flexibility of travel modes, type of visit, park use level) that influence how visitors perceived the Yosemite shuttle bus system. White (2007) suggests that immediate needs such as transporting recreational gear, traveling with children, severe traffic congestion, and parking shortages may act as choice heuristics, or shortcuts, in the travel mode choice decision process. For example, the need to transport recreation gear for a particular activity may influence a visitor's choice to drive a personal vehicle or ride a shuttle bus. Likewise, individual psychological factors (i.e. perceived freedom, environmental values, perceived crowding) were found to influence visitors' perceptions of the Yosemite shuttle bus service. For example, when respondents were asked to discuss the benefits of using private vehicles, personal freedom to determine their travel schedule was frequently cited. Perceived crowding was another important factor influencing visitors' perceptions of the Yosemite shuttle bus system. When asked about the benefits of using the shuttle bus service many respondents reported using the shuttle service in order to avoid traffic congestion. However, visitors also reported that crowded conditions on the park shuttle buses gave them the sense of an urban, rather than national park, experience.

This review of transportation literature about park visitor's perspectives towards transportation systems suggest that park visitors consider a number of factors when choosing among transportation mode options. Yet, the authors are aware of no previous studies designed to quantitatively model the influence of various factors on national park visitors' decisions about whether or not to use park shuttle service. This study uses stated choice modeling to explore the relative importance of transportation, resource, and visitor experience factors in visitors' decision-making process, with respect to using RMNP's shuttle service.

Stated Choice Models

Stated choice models rely on two theories of human behavior. First, an individual is assumed to choose an alternative from a set of alternatives that maximizes her utility (welfare). Second, random utility theory (Thurstone 1927) is invoked because of the limited abilities that researchers have to understand and model choice decisions by individuals (Ben-Akiva & Lerman, 1985). Consequently, choice models assume that while individuals make deterministic choices, researchers can only model choice as a probability.

Within the theory of random utility, preference for an alternative within a choice set is assumed to arise from the sum of the utilities of the attributes that describe the alternative. For example, the theory suggests that preference among park setting alternatives within a choice set is explained by the relative condition of the physical, managerial, social, and other attributes of the alternative park settings. Consequently, within choice experiments, the choice of a park setting as preferred among the alternatives represents preference for the corresponding "bundle" of park setting attributes over the other "bundles" described in the choice set (Lancaster 1966).

Researchers estimated the first choice models from observed, actual behavior (i.e., choices) and this method is referred to as revealed preference research (McFadden 1974). Louviere and Woodworth (1983) later demonstrated how researchers could estimate a model with intended or hypothetical choices (i.e., stated choices). The use of stated choices allows researchers to use experiments to control information about attributes that describe the alternatives and present individuals with attribute levels and even alternatives that do not currently exist (Louviere, Hensher, and Swait 2000).

In practice, stated choice surveys ask respondents to make a series of discrete choices among unique multi-attribute conditions. For example, respondents may be asked to choose their preferred option from among different modes of transportation, given varying travel times, parking conditions, and wait times at shuttle bus stops. Respondents are asked to choose their preferred alternative from a set of alternatives. The statistical analysis of the choices helps to identify the preferences of individuals for different descriptions (i.e., levels) of attributes. These preferences are used to predict choice probabilities for alternative transportation options.

Stated choice analysis has been largely developed to study urban travel demand (McFadden, 1974; Domenich & McFadden, 1974, Ben-Akiva & Lerman, 1985). In particular, stated choice analysis has been used to understand transportation mode choice. For example, Asensio (2005) examined commuter transportation mode choices in Barcelona, Spain and found that longer travel times were negatively associated with transportation mode choice. Similarly, Bhat (1996) found that reducing travel time for carpools increased the likelihood of ride sharing.

Recreation researchers have applied stated choice experiments to examine visitor preferences towards a variety of recreation-related issues in parks and protected areas (Boxall & Adamowicz, 2002; Bullock & Lawson, 2008; Lawson & Manning, 2002; Cahill, Marion, & Lawson, 2007; Lawson & Manning 2003; Newman, Manning, Dennis, & McKonly, 2005; Richardson & Loomis, 2005; Schroeder & Louviere, 1999). These studies show a progression of sophistication in stated choice survey design for outdoor recreation management. For example, Newman et al. (2005) and Bullock and Lawson (2008) used a visual approach to portray campsite and trail conditions that are difficult to describe using short narrative descriptions (e.g., amount of bare ground or the number of people on a section of trail).

The study presented here builds on previous outdoor recreation management research by examining visitor preferences towards transportation mode choice in national parks. Specifically, this study incorporates stated choice modeling techniques used in previous outdoor recreation management and transportation research to estimate trip attributes that influence visitors' transportation mode choices. The outcome of this research effort is an interactive, predictive model that allows RMNP managers to estimate visitors' transportation mode choices associated with alternative shuttle service operating scenarios and associated resource and experiential conditions in the park.

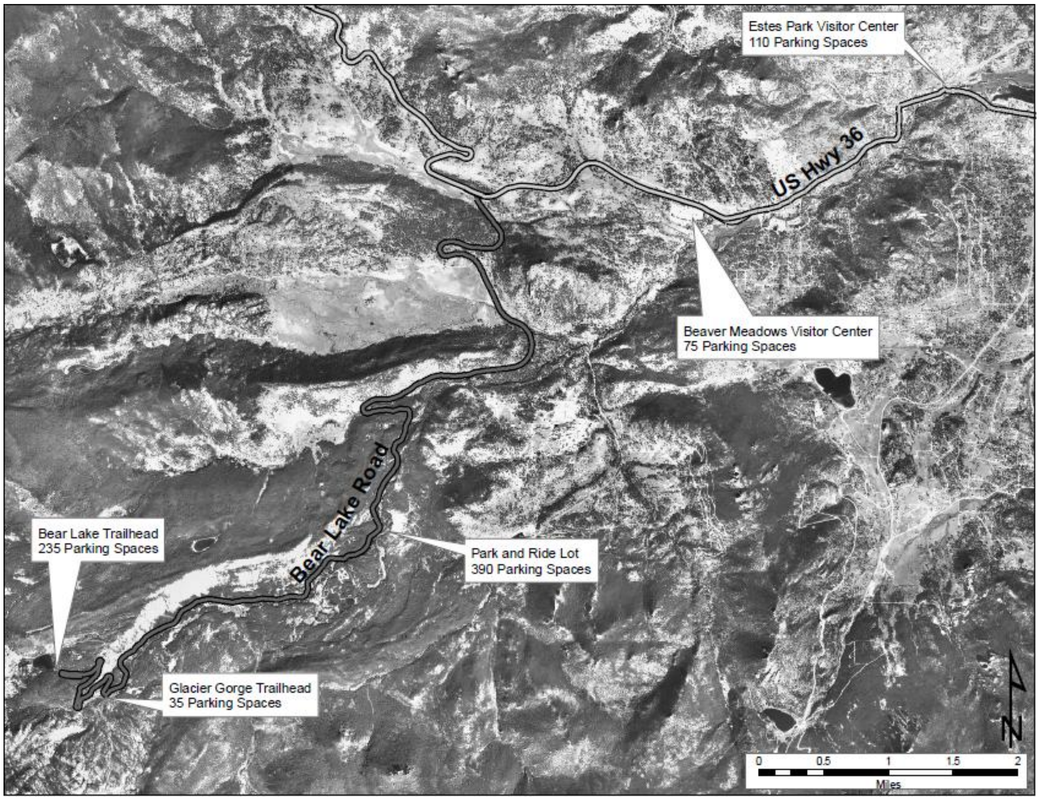
8.1.2 Methods

Study Area

Established in 1915, RMNP protects 265,758 acres of the southern Rocky Mountains of Colorado. The park is approximately 75 miles northwest of Denver, Colorado and ranges in elevation from 2,316 m near the town of Estes Park to the 4,345 m summit of Long's Peak. Some of the most spectacular scenery in the southern Rocky Mountains is preserved in RMNP. Views of Long's Peak and the Continental Divide are visible from numerous locations throughout the park, wildlife is abundant, and many visitors come to see elk, moose, bighorn sheep, and bears. RMNP also provides many outdoor recreation opportunities such as hiking, rock climbing, camping, and fishing. RMNP is a very popular park hosting approximately 3 million people per year and borders the gateway community of Estes Park (National Park Service, 2008).

Auto-touring is a popular activity in the park. Trail Ridge Road is one of the main attractions in the park and connects the east and west sides of the park. Trail Ridge Road crosses the Continental Divide and is the highest continuous paved road in the continental United States. The highest point on the road is 3,713 m. Bear Lake is another very popular location in the park that offers scenic views of the Continental Divide and easy access to a number of alpine lakes. The Bear Lake area is accessed via the Bear Lake Road, a 9 mile two-lane road that ends at Bear Lake (Figure 8.1).

Figure 8.1 RMNP's shuttle bus system from Estes Park to Bear Lake



Selection of Attributes and Levels

There are three different modes of transport visitors can choose to access Bear Lake: 1) drive your personal vehicle; 2) ride the Park-and-Ride shuttle bus; and 3) ride the shuttle bus from the town of Estes Park. Attributes to describe the trade-offs associated with each travel mode were chosen based on previous research related to transportation systems in national parks and consultation with outdoor recreation researchers, transportation planners, and RMNP park staff. Specifically, four multi-level attributes were selected to characterize transportation convenience, traffic congestion, and visitor use conditions, as follows: 1) destination convenience (describes trailhead parking availability or how often a shuttle bus picks up passengers); 2) traffic volume (the number of cars on a section of the Bear Lake Road; 3) visitor volume (the amount of time to find a parking space at the trailhead or the availability of shuttle bus seating); and 4) the probability of obtaining solitude (visibility of other people along a section of trail) (Table 8.1). Thus, the study supports modeling tradeoffs visitors prefer to make among convenience of transportation, traffic congestion, and opportunities for solitude while hiking.

Table 8.1 RMNP transportation option attributes and level

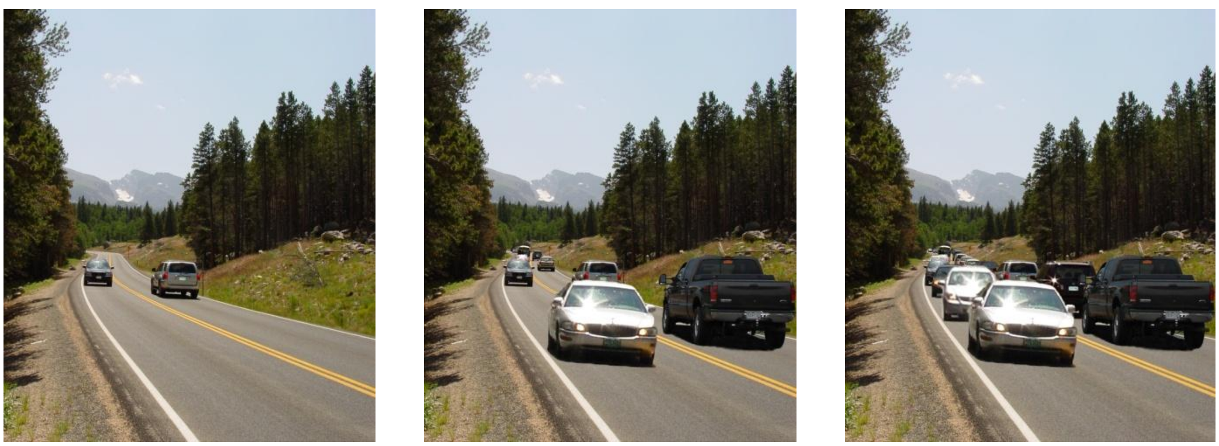
Attributes	A)	Drive Personal Vehicle	B)	Drive to Park-and-Ride and use Bear Lake Shuttle	C)	Shuttle Bus from Estes Park
1. Destination Convenience (Freedom)	1.	You find a parking space at trailhead	1.	Bus arrives every 5 minutes	1.	Bus arrives every 30 minutes
	2.	You cannot find parking at trailhead	2.	Bus arrives every 15 minutes	2.	Bus arrives every 1 hour
	3.	Driving personal vehicle is not an option	3.	Bus arrives every 30 minutes	3.	Bus arrives every 1 ½ hours
2. Traffic Volume	1	Photo showing 2 cars on road	1.	Photo showing 2 cars on road	1.	Photo showing 2 cars on road
	2	Photo showing 10 cars on road	2.	Photo showing 10 cars on road	2.	Photo showing 10 cars on road
	3	Photo showing 20 cars on road	3.	Photo showing 20 cars on road	3.	Photo showing 20 cars on road
3. Visitor Volume (by transportation mode)	1.	Once at the trailhead, you find a parking space in less than 1 min.	1.	Seats are available for everyone in my group	1.	Seats are available for everyone in my group
	2.	Once at the trailhead, you find a parking space in approximately 5 min.	2.	Seats are available for half of the people in my group, half of my group has to stand	2.	Seats are available for half of the people in my group, half of my group has to stand
	3.	Once at the trailhead, you find a parking space in approximately 10 min.	3.	No seats are available for the people in my group, all of my group has to stand	3.	No seats are available for the people in my group, all of my group has to stand

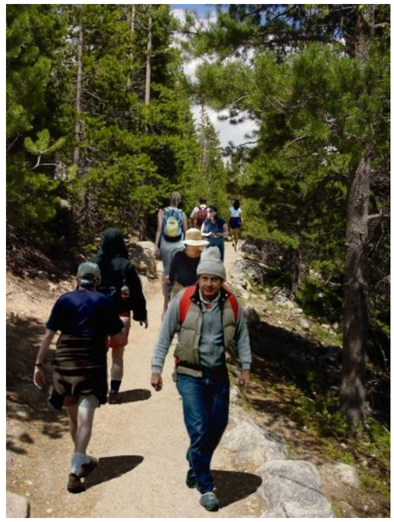
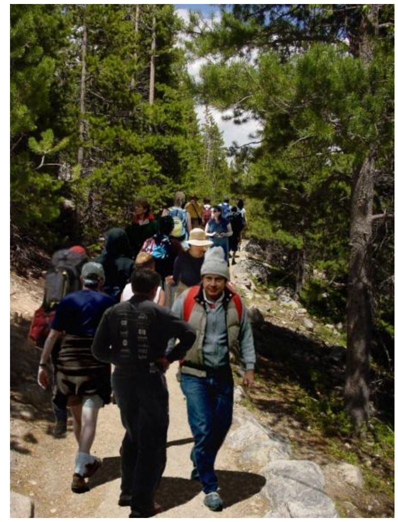
4. Probability of Solitude (visibility of other visitors during hike)	1. Photo showing 0 people on trail 2. Photo showing 8 people on trail 3. Photo showing 16 people on trail	1. Photo showing 0 people on trail 2. Photo showing 8 people on trail 3. Photo showing 16 people on trail	1. Photo showing 0 people on trail 2. Photo showing 8 people on trail 3. Photo showing 16 people on trail

Attribute levels were defined based on a reasonable range centered on existing conditions. For example, the Bear Lake shuttle bus currently picks up visitors every 15 minutes. Thus, the levels used to describe shuttle bus arrivals at the Park-and-Ride were centered on the existing condition of 15 minute arrivals, and included more frequent (i.e., bus arrives every 5 minutes) and less frequent (i.e., bus arrives every 30 minutes) levels. Likewise, the shuttle bus from Estes Park (i.e., the Hiker Shuttle) departs from the Estes Park Visitor Center every hour, and levels used to describe the Hiker Shuttle headways included 30 minutes, 60 minutes, and 90 minutes.

Visitors were asked to evaluate a series of choice sets, with each choice set containing the three transportation mode options described by varying degrees of convenience, traffic congestion, and opportunities for solitude while hiking. Within each choice set, respondents were also given, a “null alternative” defined as the option of leaving the area if they did not choose any of the travel mode offered.

Figure 8.2 Digitally edited photos to describe traffic volume and probability of solitude attributes



The destination convenience and visitor volume attributes were described using the narrative statements shown in Table 8.1. Digitally edited photographs were used to describe the traffic volume and probability of solitude attributes. Mixing narrative statements and photographs to describe attribute levels was used successfully in stated choice surveys by Newman et al. (2005) and Bullock and Lawson (2008) to describe natural resource conditions and visitor use levels.

Experimental Design

The authors designed the choice sets to estimate all parameters independently from one another. We used a shifted design (Ferini & Scarpa 2007) that required 27 choice sets. To provide for a balanced sampling design, a 28th choice set was constructed and respondents were provided with seven choice sets (i.e., four different survey versions were created). This 28th choice set was not, however, used to estimate the parameters. Instead, this choice set was used to validate the model developed from the 27 other choice sets. The final choice sets allowed variations in information for the attributes for all alternatives with one exception. Within each choice set, traffic volume was fixed across each of the transportation mode choices to provide for context validity.

Statistical Analyses

Visitor responses were analyzed with the conditional logit model shown in equation 1 (for a proof of how utility maximization and random utility theory results in a conditional logit see Ben-Akiva and Lerman 1985). The probability (<u>*P*</u>) of individual *n* selecting alternative *i* from a set of *J* alternatives, depends upon variables (**X**) that describe the attributes, parameter estimates or preferences (**β**) for the variables, and a scale factor (μ) that is related to the variance of utility.

$$P_{in} = \frac{\exp(\mu X_{in} \beta)}{\sum_{k=1}^{n} \exp(\mu X_{kn} \beta)} \quad (1)$$

The preferences are estimated from maximum likelihood estimation based on the stated choices provided by individuals for the 27 choice sets. A limitation with equation 1 is the assumption that all individuals have identical preferences for all of the variables. Based on the potential importance of visitor demographics as previously described, we estimated conditional logit models with potentially different preferences. Specifically, we developed models with different preferences based on gender, United States citizenship, past visitation, groups size, education, certainty of choice, 2 age groups (<50 yrs and 50+ yrs), and 3 age groups (less than 40 years, 40 to 59 years; and 60 or more years). The variable age with three groups is used here to demonstrate our approach. Here a conditional logit (see Equation 2) with potentially different preferences (*β_{40}* and *β_{60}*) for three age groups is estimated.

$$P_{in} = \frac{\exp\left(\mu X_{in}\beta + AGE40 * \left(\mu_{40} X_{in}\beta_{40}\right) + AGE60 * \left(\mu_{60} X_{in}\beta_{60}\right)\right)}{\sum_{k=1}^{n} \exp\left(\mu X_{jn}\beta + AGE40 * \left(\mu_{40} X_{jn}\beta_{40}\right) + AGE60 * \left(\mu_{60} X_{jn}\beta_{60}\right)\right)} \quad (2)$$

We used an effects-based contrast system whereby AGE 40 = 1 if age was less than 40 and AGE60 = 1 if age was more than 60. When age was 40 to 59, AGE40 = -1 and AGE60 = -1. In all other cases, AGE40 and AGE60 equaled zero. A likelihood ratio test was used to determine whether the age specific preferences (*β_{40}* and *β_{60}*) represented a statistical improvement from the assumption that all preferences were identical (equation 1).

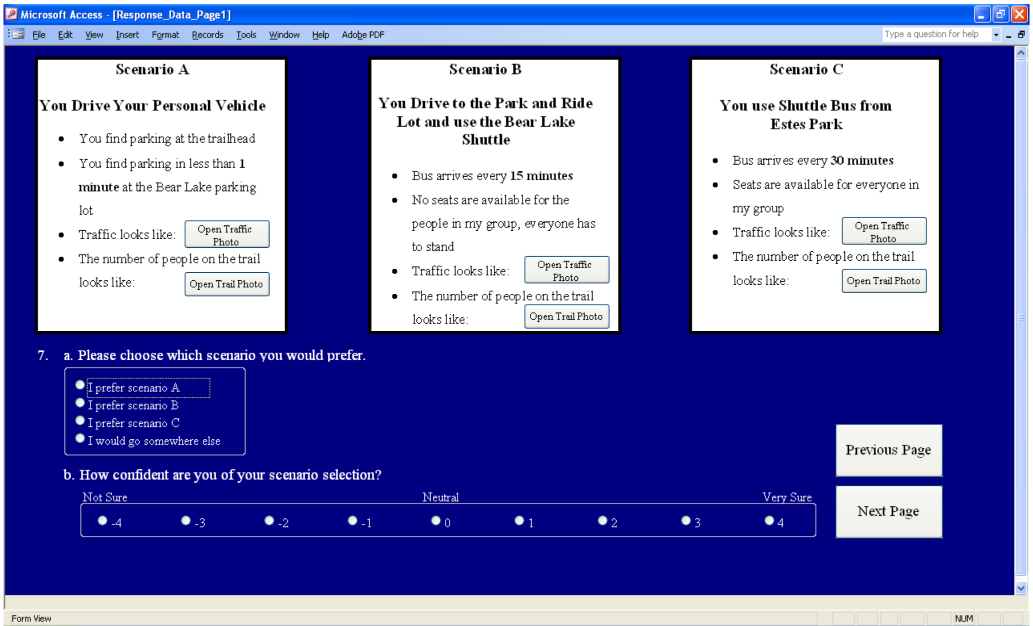
Survey Administration

The survey was administered on laptop computers because it was the most effective way to present the combination of narrative statements and photographs that described attribute levels for each scenario. Custom forms were created in Microsoft Access and responses stored in an electronic database. The survey was pilot tested on Colorado State University students and professors to ensure that questions were clear and comprehensible, attributes accurately described each transportation mode option, response burden associated with completing the survey was reasonable, and the electronic survey format was operating correctly and recording responses accurately. Responses from the pilot survey were positive and suggested that the electronic survey format was easy to navigate and understand.

Visitors were surveyed onsite at the Bear Lake trailhead after their visit to the area from July 28, 2008 – August 19, 2008. The survey was administered on 16 randomly selected days from this 23 day period. In addition, we used a stratified random approach in which we selected one of the four survey versions to administer on each selected sampling day. This ensured that each survey was administered over four days. Each survey version only differed in terms of stated choice model scenarios.

In the stated choice section of the survey, respondents were presented with instructions that included a brief discussion of the different transportation mode options to access the Bear Lake area. Respondents were then asked to evaluate seven scenarios. Descriptions of choice sets were presented on the following screens by clicking on the “Next Page” button. For each choice set, three scenarios were presented together on one screen. Respondents were asked to indicate: 1) the scenario they preferred; and 2) how sure they were of their response on a nine point scale with -4 indicating “Not Certain”, 0 indicating “Neutral”, and 4 indicating “Very Certain”. Figure 8.3 shows an example of a choice set from the survey. As noted, brief narrative statements were used to describe destination convenience and visitor volume attributes. Each scenario included buttons that respondents were instructed to click on to view photos depicting different levels of traffic volume and number of people on a section of trail.

Figure 8.3 Example of choice set presented to respondents.



8.1.3 Results

Response Rates

Of 870 people contacted, 514 completed the survey for a response rate of 59%. The number of surveys was balanced across all four versions of the survey resulting in 2,750 three-way comparisons. People most typically stated "no time" or "meeting people" for refusing to participate in the survey. Statistical tests suggest respondents were not different than non-respondents at the 95% confidence level regarding the type of transportation mode used to access Bear Lake (χ^2 = 3.013 p = 0.2217).

Stated Choice Model Results

Results for the aggregate model are presented in Table 8.2. This model included 13 variables and the estimated intercepts for each alternative including the option of leaving the Bear Lake area and going somewhere else. The destination convenience, visitor volume, and probability of solitude variables were effects coded and parameters were not estimated for one of the three levels of attributes. Instead, the third attribute is derived by calculating the negative sum of the other two attributes. For example, the coefficient for seeing 16 people along the trail is calculated as: -1 * (0.84 + -0.20) = -0.64. In addition, the traffic volume variable was entered as a continuous variable and was centered at 11 for all statistical analyses.

Table 8.2 Coefficients for aggregate stated choice model

Variable	β	Std. Error
Intercept		
Go somewhere else	0.07	0.09
Drive Personal Vehicle	1.97**	0.08
Take shuttle bus from Park-and-Ride	1.63**	0.07
Destination Convenience		
Shuttle bus from Park-and-Ride		
Bus arrives every 5 minutes	0.00	0.06
Bus arrives every 15 minutes	0.05	0.06
Shuttle bus from Estes Park		
Bus arrives every 30 minutes	0.31**	0.09
Bus arrives every 60 minutes	0.22*	0.09
Traffic Volume		
Number of Cars	-0.05**	0.01
Number of Cars*Private Vehicle	-0.02*	0.01
Number of Cars*Shuttle Bus	0.00	0.01
Visitor Volume		
Drive Personal Vehicle		
1 min to find parking	0.35**	0.08
5 min to find parking	0.04	0.07
Shuttle Busses		
Seats available for all	0.19**	0.05
Seats available for half	-0.03	0.05
Probability of Solitude		
0 people	0.84**	0.05
8 people	-0.20	0.04

* indicates $p < .05$; ** indicates $p < .001$

The coefficient estimates for the model specific intercepts suggest that, holding all variables constant, visitors prefer to drive their personal vehicle to Bear Lake over using either of the shuttle bus options. Similarly, the results suggest that visitors are more likely to choose to ride the shuttle bus from the Park-and-Ride instead of either riding the shuttle bus from Estes Park or choosing the option of going somewhere else. Furthermore, the coefficient estimates for the choice of going somewhere else and taking the shuttle bus from Estes Park are not statistically different indicating that visitors are as likely to go somewhere other than Bear Lake as they are to choose the shuttle bus service from Estes Park, holding all other variables constant.

As expected, probability of solitude was a statistically significant variable with less people seen on the trail being preferable over many people seen on the trail. The large value differences in coefficient estimates among the probability of solitude attribute levels indicate that this is the most influential attribute related to a visitor's choice of transportation mode. The coefficient estimate of 0.84 for seeing no other people on the trail is the largest estimated coefficient value in this study and is positively related to transportation mode choice whereas the coefficient estimate of -0.20 for seeing 8 people on the trail is negatively related to transportation mode choice. Furthermore, the calculated estimate of -0.64 for seeing 16 people on the trail has the strongest negative effect of any variable estimated in this analysis.

The results for the traffic volume show a negative relationship between traffic volume and transportation mode choice. In addition, there is a statistically significant negative interaction between traffic volume and choosing to drive a personal vehicle and indicates that visitors will take the shuttle bus in order to avoid driving in traffic. This suggests that visitors who are aware of traffic and parking congestion may be more inclined to ride the shuttle bus. Moreover, information about traffic conditions could persuade visitors to leave their personal vehicles behind and ride the bus.

With respect to visitor volume, the availability of parking or seating on the shuttle bus is positively correlated to transportation mode choice. However, the shuttle bus pick-up interval is not statistically significant for the Park-and-Ride suggesting that visitors are willing to wait up to 30 minutes for the shuttle bus at the Park-and-Ride if all individuals in their group are able to find seating. In contrast, the shuttle bus pick-up interval from Estes Park was statistically significant, with headways of 60 minutes or less significantly preferred to headways of longer than 60 minutes.

Next, we examined potentially different preferences among groups of respondents based on various demographic characteristics. Based on log-ratio tests, the model based on the three age groups produced the most improved model fit over the aggregate model (Log Ratio = 74.258, $p < .001$). Results from the conditional logit model based on three age groups (less than 40 years, 40 to 59 years; and 60 or more years) are presented in Table 3. Similar to the aggregate model, effects coding was used for the destination convenience, visitor volume, and probability of solitude variables. Traffic volume was entered as a continuous variable and centered at 11. In addition, the three age groups were effects coded and specific model parameters were estimated for main effects, the <40 year-old age groups, and the >60 year-old age group. To account for the interactions among age groups, the coefficients estimated for each specific age group are added to the main effect. For example, the intercept to drive personal vehicles for the <40 year-old age group is calculated as: 2.19 + (-0.51) = 1.68. Further, estimates for the 40-59 year-old age group are derived by calculating the negative sum of the <40 year-old and >60 year old age groups and adding this value to the value of the Main Effect. For example, the intercept for driving personal vehicles for the 40-59 year-old age group is calculated as: 2.19 + (-1 * (-0.51 + 0.67)) = 2.04. The intercept for riding the shuttle bus from the town of Estes Park was coded as 0 and thus the intercept for this choice is 0 for main effects and all three age groups.

Table 8.3 Coefficients for the stated choice model based on three age groups

Variable	β (std. error): Main Effect	β (std. error): <40 years	β (std. error): > 60 years
Intercept			
Go somewhere else	0.28* (0.12)	-0.28 (0.15)	0.54* (0.22)
Drive Personal Vehicle	2.19**(0.11)	-0.51**(0.14)	0.67**(0.20)
Shuttle bus from Park-and-Ride	1.95**(0.11)	-0.32* (0.13)	0.82**(0.19)
Destination Convenience			
Shuttle bus from Park- and-Ride			
Bus arrives every 5 minutes	0.03 (0.07)	-0.10 (0.10)	0.14 (0.12)
Bus arrives every 15 minutes	0.08 (0.07)	-0.07 (0.10)	0.09 (0.12)
Shuttle bus from Estes Park			
Bus arrives every 30 minutes	0.38*(0.13)	-0.04 (0.16)	0.10 (0.23)
Bus arrives every 60 minutes	0.09 (0.15)	0.09 (0.18)	-0.30 (0.28)
Traffic Volume			
Num. Cars	-0.05* (0.02)	0.02 (0.02)	<-0.01 (0.03)
Num. Cars*Private Vehicle	-0.01 (0.01)	-0.01 (0.02)	0.02 (0.03)
Num. Cars*Park and Ride Shuttle Bus	<0.01 (0.01)	-0.01 (0.02)	<0.01 (0.03)
Visitor Volume			
Drive Personal Vehicle			
1 min to find parking	0.34**(0.09)	-0.14 (0.12)	0.12 (0.15)
5 min to find parking	0.01 (0.08)	0.09 (0.11)	-0.16 (0.14)
Shuttle Busses			
Seats available for all	0.18* (0.06)	-0.07 (0.08)	0.01 (0.11)
Seats available for half	0.02 (0.07)	-0.01 (0.09)	0.10 (0.11)
Probability of Solitude			
0 people	0.82**(0.05)	0.17* (0.07)	-0.20*(0.09)
8 people	-0.22**(0.05)	0.07 (0.07)	-0.08 (0.09)

* indicates $p < .05$; ** indicates $p < .001$

The coefficient estimates for the model specific intercepts suggest that, holding all variables constant, the <40 year old age group is less inclined to drive personal vehicles than the 40-59 year-old age group or the >60 year-old age group (β =1.68, 2.02, and 2.86 respectively). However, coefficient estimates indicate that there is little difference between the <40 year-old age group's response to driving personal vehicles versus riding the shuttle bus from the park and ride lot (β =1.68 and 1.63 respectively). These estimates are the lowest for these two transportation mode choices among the three age groups and suggest that transportation mode choice for the <40 year-old age group is influenced by other variables in the model. In contrast, coefficient estimates indicate that there is a preference for the 40-59 year old age group towards driving personal vehicles versus riding the shuttle bus from the park and ride lot (β =2.02 and 1.45 respectively). The >60 year-old age group has a strong preference for driving personal vehicles compared to the other age groups but there is not much difference between this group's preferences to drive personal vehicles and ride the shuttle bus from the park and ride lot (β =2.86 and 2.76 respectively). The coefficient estimates for the >60 year-old age group are the highest for these two transportation choices and suggest that transportation mode choice is not highly influenced by other variables in the model for this age group. All of the model intercepts are positive values indicating that the choice to ride the shuttle bus from town (intercept = 0) is the least preferred transportation mode choice when all variables are held constant. However, riding the shuttle bus from the town is much less attractive to the >60 year-old age group than for the 40-59 year-old or the <40 year-old age groups based on the coefficient estimates to go somewhere else (β =0.82, 0.02, and <0.01 respectively).

Similar to the aggregate model, the probability of solitude attribute was a statistically significant variable with less people seen on the trail being preferable to more people seen on the trail. Coefficient estimates indicate that seeing no people on the trail is positively correlated to transportation mode choice for all groups and has the strongest effect for the <40 years-old age group followed by the 40-59 year-old age and >60 year-old age groups (β =0.99, 0.85, and 0.62 respectively). Seeing more people on the trail has a negative effect on transportation mode choice. Coefficient estimates for seeing 16 people on the trail indicate the strongest effect on the <40 years-old age group followed by the 40-59 year-old age and >60 year-old age groups (β =-0.84, -0.64, and -0.32 respectively). This suggests that visitors <40 years-old are more willing than the older age groups to make trade-offs among transportation options to enhance their chances of being on the trail with fewer other people at Bear Lake

With regard to traffic volume, more vehicles on the road are negatively correlated to choosing to drive a personal vehicles (β=-0.06) and ride the shuttle bus from the Park-and-Ride (β=-0.05) but are positively correlated to choosing to ride the shuttle bus from Estes Park (β=0.11). Coefficient estimates for the interactions among the three age groups are not statistically significant and suggests little preference difference among the three age groups about the number of vehicles on the road.

Results for the visitor volume attribute (wait time for parking or seat availability on bus) indicate a negative correlation between longer wait times for the shuttle bus ($\beta_{1\ minute}$= 0.34, $\beta_{5\ minutes}$= <0.01, and $\beta_{10\ minutes}$= -0.35) or lack of seat availability on the shuttle bus ($\beta_{seats\ for\ all}$= 0.18, $\beta_{seats\ for\ half}$= 0.02, and $\beta_{no\ seats}$= -0.16). Interactions for this attribute among the three age groups were not statistically significant indicating that little preference differences among the three age groups.

Results for the destination convenience attribute were inconsistent. Coefficient estimates indicate that wait time for the shuttle bus from the Park-and-Ride lot were inconsistent with no clear positive or negative correlation to transportation mode choice ($\beta_{5\ minutes}$= 0.03, $\beta_{15\ minutes}$= 0.08, $\beta_{30\ minutes}$= -0.11). However, these results are not statistically significant and suggest this is not an important factor in visitors' choices of transportation mode. Coefficient estimates indicate that wait times for the shuttle bus from Estes Park were negatively correlated to transportation mode choice ($\beta_{30\ minutes}$= 0.38, $\beta_{90\ minutes}$= 0.09, $\beta_{90\ minutes}$= -0.47). The main effects for this variable were statistically significant but the interaction effects among the three age groups were not statistically significant.

Discussion

As the NPS moves towards ATS options to alleviate crowded conditions and vehicle traffic congestion, there is an increasing need for national park managers to understand visitor choices about transportation mode. Little previous research has examined the factors that influence how national park visitors choose among transportation mode options. The use of stated choice analysis described in this paper provides important insights into visitors' choice process of transportation mode in national parks. Specifically, RMNP managers are challenged to convince visitors to use shuttle busses because visitors prefer to drive personal vehicles. However, there are significant and interacted relationships with shuttle bus use, visitor use, and vehicle traffic levels that provide RMNP managers opportunities to influence visitors' transportation mode choices.

The most noteworthy finding from this study was that visitors are most inclined to base their transportation mode choice in order to experience solitude. Results from both the aggregated and segmented model based on three age groups indicate that the probability of obtaining solitude was the most important attribute that influenced respondents' transportation mode choice. Furthermore, the segmented model indicated that younger visitors were more influenced by the probability of obtaining solitude in their transportation mode choice than older visitors. Another important finding from this study was that vehicle traffic was positively correlated to choosing to ride the shuttle bus from Estes Park. Both of the other transportation options (drive personal vehicle to Bear Lake or take bus from the Park-and-Ride) involved driving a personal vehicle and were negatively correlated with traffic volumes. This result indicates that visitors would use ATS if they are aware of vehicle traffic conditions along the Bear Lake Road. Additionally, wait times for busses and available seating on busses were important factors affecting visitors' transportation mode choice. These, results suggest that accessibility and comfort are important factors that influence visitor's perceptions of ATS.

Intelligent transportation systems (ITS) can be developed in RMNP and Estes Park to provide visitors with real time information about vehicle traffic and parking conditions, bus schedules, and visitor use levels along specific trail segments before they enter the park in order to persuade visitors to use the shuttle bus system. NPS managers are beginning to use ITS systems to inform visitors about traffic and parking conditions. For example, a recent survey in Acadia NP indicated that ITS (e.g. electronic signs displaying real-time parking information and ATS schedule information) improved visitors' ability to get around the park and avoid vehicle traffic and parking congestion (Daigle & Zimmerman, 2004a, 2004b; Zimmerman, 2003). RMNP managers may consider experimenting with this type of messaging in order to persuade visitors to use the bus shuttle service from Estes Park. Results from this study suggest that visitors would be willing to use the shuttle bus systems to improve other aspects of their trip (e.g. to avoid vehicle traffic and parking congestion). RMNP's proximity to the town of Estes Park provides unique opportunities to develop an alternative transportation program that satisfies the needs of park visitors. This will require further promotion and expansion of shuttle bus ridership from town. This could be facilitated, in part, by providing real time traffic and parking conditions at the Estes Park visitor center where visitors can a board bus. In addition, RMNP may need to partner with local organizations, like the local YMCA, that have large parking areas to accommodate visitors who want to leave their vehicles outside of the park. These actions can potentially provide visitors with the recreation opportunities they seek while leaving their vehicles outside of the park.

RMNP managers may also consider management actions to enhance visitors' opportunities to find solitude in order to persuade visitors to use shuttle busses. For example, RMNP managers may consider actions to promote "purposeful displacement": well planned management actions to change the spatial and/or temporal distribution of visitor's recreation activities more evenly across larger geographic areas and longer periods of time. The concept idea behind "purposeful displacement" is to provide visitors with attractive alternatives to current transportation options. To be successful, transportation alternatives need to fulfill visitor expectations, motivations, and practical needs (i.e. transporting gear, accessibility-"getting to where you want when you want", parking options). A recent survey in Acadia NP suggested that ITS systems influenced where and when visitors chose to visit the park and can achieve such management goals (Daigle and Zimmerman, 2004). In addition to ITS, RMNP managers may consider modifying the current routes of the Bear Lake shuttle in order to provide visitors more destination options. The following paragraphs offer two examples management actions to promote "purposeful displacement".

The current hiker shuttle could extend a stop at Sprague Lake in the Bear Lake road corridor. Sprague Lake has been developed to accommodate high levels of visitor use with hardened trail surfaces and developed viewing areas but receives relatively low levels of visitor use during the peak season. Moreover, this area is a very scenic spot offering views of the Continental Divide and is connected to Bear Lake area trail network. Sprague Lake offers many photographic opportunities, is relatively close to the Park-and-Ride lot, and would allow visitors to spend more time at a recreation site instead of in their cars. This action has the potential to improve the experience for visitors while removing vehicles from road.

Similarly, RMNP could promote hiking at other areas besides Bear Lake. There are many other areas to hike in the park other than Bear Lake. For example, Bierstadt Lake is in the Bear Lake road corridor but receives very few visitors compared to locations accessed from Bear Lake. The Bierstadt Lake trail is a more strenuous hike than most trails out of Bear Lake but accesses views of a very scenic high alpine lake and the Continental Divide. In addition, the Bierstadt Lake trail is connected to the Bear Lake trail system and hikers can end their trip at Bear Lake where they can ride the shuttle for their return trip.

Study Limitations

Although this study provides important insights about visitor use preferences towards alternative transportation, this study is not without limitations. First, it is common to examine differences in the study population by identifying groups of people with different preferences. In this study, we did not identify groups a priori, thus we examined differences between groups of visitors using empirical tests and found differences based on age. However, segmenting the population by age was not based on theoretical foundations, thus, further research is needed to test if these results are generalizable or simply limited to RMNP visitors.

Second, the use of photographs and narrative statements in combination to describe attribute levels has been used successfully in previous research using stated choice models. However, it is difficult to determine if photo-based attributes and narrative statements are evaluated equally by respondents. Results from this study suggest that respondents considered both methods equally to describe attributes. For example, all main effects in the model based on age groups were statistically significant, except for destination convenience for the shuttle bus from the Park-and-Ride option. However, only the interactions for the probability of solitude, an attribute described by a photo, were statistically significant. Traffic volume, the other attribute described by a photo, had no statistically significant interactions. Certainly, this is not definitive evidence that respondents did not evaluate attributes described by photographs and narratives differently, but there do not appear to be any trends in our results that suggest otherwise.

Finally, we based the wait times for the shuttle bus from Estes Park on the 2007 shuttle bus service where buses departed the Estes Park visitor center once per hour (Hanon, personal communication). However, the shuttle service from the Estes Park visitor center increased service in 2008 to departures every 30 minutes. The authors were unaware of this change at the time this study was being developed and were not able to change the survey design in time to reflect this change. Thus, the design of the survey does not consider the influence of wait times for the shuttle bus from Estes Park shorter than the current conditions (30 minutes). Based on our results, one can reasonably assume that wait times less than 30 minutes for the shuttle bus from Estes Park would be positively correlated with its use.

8.1.4 Conclusion

The choice process of national park visitors towards alternative transportation has received little attention. The results from this study provide insight into national park visitor preferences towards alternative transportation and the factors that influence their decision process about using alternative transportation. Our results show that visitors prefer to use personal vehicles to access the Bear Lake area but are willing to use the shuttle bus service to avoid traffic congestion and crowds of people on the trail. RMNP managers can use this information to design management strategies that enhance these aspects of the visitor experience in order to persuade visitors to use ATS instead of personal vehicles. In this paper we suggested that RMNP managers consider ITS and “purposeful displacement” as management actions to influence visitors’ choice of transportation mode. The findings in this paper suggest that such actions will increase bus ridership potentially reducing the number of personal vehicles in the Bear Lake area. If RMNP managers choose to develop an ITS or other management strategy to promote ATS, future research should be conducted to evaluate the effectiveness of messaging and the effect on traffic and parking conditions.

8.1.5 References

Asensio, J. (2002). Transport Mode Choice by Commuters to Barcelona's CBD. *Urban Studies*, 39(10), 1881-1895.

Ben-Akiva, M. & Lerman, S. (1985). Discrete Choice Analysis. Cambridge, MIT Press, 1985.

Bhat, C. (1996). *Accommodating Variations in Responsiveness to Level-of-Service Measures in Travel Mode Choice Modeling.* Working Paper, Department of Civil Engineering, University of Massachusetts Amherst.

Bichis-Lupas, M., & Moisey, R.N. (2001). A benefit segmentation of rail-trail users: Implications for marketing by local communities. *Journal of Park and Recreation Administration, 19*(3) 78-92.

Boxall, P.C., & Adamowicz, W.L. (2002). Understanding heterogeneous preferences in random utility models: a latent class approach. *Environmental and Resource Economics, 23*(421-446).

Bullock, S.D., & Lawson, S.R. (2008). Managing the commons on Cadillac Mountain: A stated choice analysis of Acadia National Park Visitors' Preferences. *Leisure Sciences, 30*, 71-86.

Cahill, K.L., Marion, J.L., & Lawson, S.R. (2007). Enhancing the interpretation of stated choice tradeoff analysis through the application of a verbal protocol assessment. *Journal of Leisure Research, 39*(2), 201-221*.*

Dilworth, V.A. (2003). *Visitor perceptions of alternative transportation systems and intelligent transportation systems in national parks.* Department of Parks, Recreation, and Tourism Sciences, Texas A&M University, College Station, Texas.

Domenich, T.A., & McFadden, D. (1975). *Urban travel demand: A behavioral analysis: A Charles River Associates research study* (Contributions to economic analysis No. 93). Amsterdam, Netherlands: North-Holland Publishing.

Ferrini, S., & Scarpa, R. (2007). Designs with a priori information for nonmarket valuation with choice experiments: A Monte Carlo study. *Journal of Environmental Economics and Management, 53*(2007), 342-363.

Haab, T.C., & Hicks, R.L. (1997). Accounting for choice set endogeneity in ransom utility models of recreation demand. *Journal of Environmental Economics and Management, 34*, 127-147.

Hausman, J.A., Leonard, G.K., & McFadden, D. (1995). A utility-consistent, combined discrete choice and data model assessing recreational use losses due to natural resource damage. *Journal of Public Economics, 56*, 1-30.

Kelly, J. (1980). Outdoor recreation participation: A comparative analysis. *Leisure Sciences, 2*(2), 129-154.

Lancaster, K.J. (1966). A new approach to consumer theory. *The Journal of Political Economy, 74*(2), 132-157.

Lawson, S.R., & Manning, R.E. (2002). Tradeoffs among social, resource, and management attributes of the Denali Wilderness experience: A contextual approach to normative research. *Leisure Sciences, 24*, 297-312.

Lawson, S.R., & Manning, R.E. (2003). Research to guide management of backcountry camping at Isle Royale National Park: Part II – prescriptive research. *Journal of Park and Recreation Administration, 21*(3), 43-56.

Lee, B.D., Graefe, A.R., & Burns, R.C. (2003). *Older adults: a unique market for the Columbia River Gorge National Scenic Area.* Proceedings of the 2003 Northeastern Recreation Research Symposium.

Louviere, J.J., & Woodworth, G. (1983). Design and analysis of simulated consumer choice or allocation experiments: An approach based on aggregate data. *Journal of Marketing Research, 20*(4), 350-367.

Louviere, J.J., Hensher, D.A., & Swait, J.D. (2000). *Stated choice methods: Analysis and application.* Cambridge, UK: Cambridge University Press.

Mackenzie, J. (1993). A comparison of contingent preference models. *American Journal of Agricultural Economics, 75*, 593-603.

Manning, R.E. (1999). *Studies in outdoor recreation*. Corvalis, OR: Oregon State University Press.

McFadden, D.L. (1974). Conditional logit analysis of qualitative choice behavior. In P. Zambreka (Ed.), *Frontiers in econometrics*, New York: Academic Press.

McFadden, D.L. (1981). Econometrica models of probabilistic choice. In C. Manski and D. Mcfadden (Eds.), *Structural analysis of discrete data with econometric applications*, Cambridge, MA: MIT Press.

Miller, C.A., & Wright, G.R. (1999). An assessment of visitor satisfaction with public transportation services at Denali National Park and preserve. *Park Science, 19, 18-21*.

Moscardo, G., Pearce, P., & Morrison, A. (2001). Evaluating different bases for market segmentation: A comparison of geographic origin versus activity participation for generating tourist market segments. Journal of Travel & Tourism Marketing, 10(1) 29 – 49.

National Park Service (2008). *NPS stats, National Park Service public use statistics office.* Retrieved December 1, 2008 from http://www.nature.nps.gov/stats/

Newman, P., Manning, R., Dennis, D. & McKonly, W. (2005). Informing carrying capacity decision making in Yosemite National Park, USA using stated choice modeling. *Journal of Park and Recreation Administration, 23*(1), 75-89.

Parsons, Brinkerhoff, Quade, & Douglas. (2000). *Rocky Mountain National Park transportation plan.* Estes Park, CO: Rocky Mountain National Park.

Prideaux, B. (2001). The senior drive tour market in Australia. *Journal of Vacation Marketing. 7(*3), 209-219.

Richardson, R.B., & Loomis, J.B. (2005). Climate change and recreation benefits in an Alpine

National Park. *Journal of Leisure Research, 37*(3), 307-320.

Schroeder, H.W., & Louviere, J. (1999). Stated choice models for predicting the impact of user fees at public recreation sites. *Journal of Leisure Research, 31*(3), 300-324.

Sims, C.B., Hodges, J.M., Fly, & Stephens, B. (2005). Modeling acceptance of a shuttle system in the Great Smoky Mountains National Park. *Journal of Park and Recreation Administration, 23*, 25-44.

Thurstone, L. (1927). A law of comparative judgement. *Psychological Review, 34*(4), 272-286.

White, D.D. (2007). An interpretive study of Yosemite National Park visitors' perspectives toward alternative transportation in Yosemite Valley. *Environmental Management, 39*, 50-62.

White, D. D. & Aquino, J. F. (2008). *Visitor perspectives toward transportation issues in Yosemite National Park.* Report for Yosemite National Park. Phoenix, AZ: Arizona State University.

Chapter 9: VISITOR MANAGEMENT/EDUCATION

9.1 Leave No Trace Day-User Beliefs

9.1.1 Introduction

To a large degree, learning to leave no trace is about preserving our own integrity, stability, and beauty, as individuals and as a society.

--- Dave Harmon

Resource degradation due to depreciative behaviors continues to be a concern for park and protected area managers. Park management must maintain a delicate balance between use and preservation amidst increasing visitation, specifically in heavily-used frontcountry destinations. Visitor education has become a prominent and often successful indirect management technique used to curb depreciative behaviors (Hammit & Cole, 1998; Hendee and Dawson, 2002; Lucas, 1983; Manning, 1999, 2003; Marion and Reid, 2001). In national parks and most protected areas, interpretive education concerning Leave No Trace practices is perhaps the most commonly-used method of encouraging correct behavior and discouraging depreciative behavior. This report addresses day-user visitor knowledge, behavior and beliefs concerning Leave No Trace practices in the Bear Lake corridor of Rocky Mountain National Park. The study findings offer insight pertaining to improved educational messaging concerning depreciative behaviors that could be applied to the Bear Lake corridor and similar frontcountry, predominantly day-user destinations in other national parks.

Leave No Trace

Although there have been several different varieties of minimum-impact ethics in the outdoors, Leave No Trace is perhaps the most well-established and globally recognized. Leave No Trace derived from worries concerning perceived overuse of our pristine wild lands in the 1960s, but became more mainstream as consumerism and marketing took hold of the outdoor enthusiast community in the 1970s and 80s (Turner, 2002). U.S. Forest Service employee, Jim Bradley's influential paper in 1979 further encouraged the Leave No Trace movement. His paper stated that a purely regulatory approach in managing recreation impacts actually antagonized the public rather than gaining their support, and he thought that most impacts were the result of lack of knowledge, not malicious intent. He believed that an educational campaign would be more appropriate because regulation could not occur everywhere at all times (Bradley, 1979). This acknowledgement that educational programs would better serve the purpose of reducing impact, led to an interagency coordination in the late 80s between the U.S. Forest Service, the National Park Service and the Bureau of Land Management, to develop an educational pamphlet titled "Leave No Trace Land Ethics" (Marion & Reid, 2001). In the late 1980s and early 90s it became evident that the land agencies were not collaborating effectively in promoting the message, so they combined forces with the National Outdoor Leadership School (NOLS), and began implementing a science-based approach to minimum impact recreation. Additionally, several publications emerged describing minimum impact practices (Hampton & Cole, 1988; Harmon, 1997; Hodgson, 1991; Marion & Reid, 2001; McGivney, 1998).

In 1994, the Leave No Trace campaign gained additional credibility, becoming a registered nonprofit organization, with the assistance of the federal land agencies and various outdoor businesses (Hammitt & Cole, 1998; Marion & Reid, 2001). Leave No Trace has continued to gain strength as the organization--now known as the Leave No Trace Center for Outdoor Ethics--has been adopted internationally, and not only advocates that their ethics be applied in the backcountry but also focuses upon minimum impacts in frontcountry. Currently the organization boasts the following mission: "The Leave No Trace Center for outdoor ethics is an educational, nonprofit organization, dedicated to the responsible enjoyment and active stewardship of the outdoor s by all people, worldwide" (http://lnt.org/aboutUs/index.php).

Figure 9.1 Principles of Leave No Trace

The seven principles of Leave No Trace are:

1. Plan Ahead and Prepare
2. Travel and Camp on Durable Surfaces
3. Dispose of Waste Properly
4. Leave What You Find
5. Minimize Campfire Impacts
6. Respect Wildlife
7. Be Considerate of Other Visitors

Source: http://lnt.org/programs/principles.php

Previous Research

Previous Leave No Trace literature had largely focused upon the historical perspectives of minimum-impact practices (Hampton & Cole, 1988; Marion & Reid, 2001; Turner, 2002), knowledge, information diffusion and educational processing (Cole, 1995, 1998; Cole, et al., 1997; Confer, et al., 1999; Daniels & Marion, 2005; Hammitt & Cole, 1998; Leung & Marion, 2000; Manning, 2003; Marion & Reid, 2007; Monz, et al., 1994; Newman, et al., 2003), educational messaging and communication (Fazio, 1979; Fazio & Gilbert, 1986; Hendee & Dawson, 2002; Manning, 2003) and theories related to norms and attitudes involving Leave No Trace behaviors (Confer, et al., 1998; Ham, 2007; Ham & Krumpe, 1996; Harding, et al., 2000; Monz, et al., 2006). Most of the previous research had focused on overnight recreationist or backcountry visitors. However, recently, emphasis has been placed upon effective LNT messaging to frontcountry, day-users in an attempt to meet the growing demand of this recreationalist demographic. This has led the LNT Center for Outdoor Ethics to create frontcountry protocols and principles that specifically address day-user visitor behavior. These principles follow the same guidelines as the original seven, but they are tailored more specifically to behaviors associated with day-use (http://lnt.org/programs/frontcountry.php). In 2004, Jones and Bruyere studied frontcountry visitor knowledge and educational messaging at Boulder, Colorado Open Space and Mountain Parks, and in 1995, Kernand and Drogin studied verbal interpretation and compliance to follow minimum-impact hiking practices with day-users in Mount Rainier National Park. The following study builds upon previous research because the majority of recreationists in the Bear Lake corridor are frontcountry or day-users.

Previous Leave No Trace related studies have predominantly focused upon norms and attitudes, in an attempt to address behavior. Although this line of research has proven valuable in addressing factual knowledge concerning this ethic, research investigating the importance of an individual's beliefs has been limited. It has been proven that individual knowledge of a given subject is not a good indicator of intention. However, theory suggests that beliefs are the fundamental component leading attitudes toward a specific behavior. Assessment of the subjective knowledge of a given individual's beliefs surrounding the Leave No Trace ethic could be of more practical importance than that of focusing upon factual knowledge. The Theory of Planned Behavior (TPB) implies that by targeting beliefs, we can discover why visitors of protected area maintain particular attitudes, norms and ultimately, behaviors (Ajzen, 1991; Ajzen & Fishbein, 1980; Ballantyne & Packer, 2005; Fishbein & Ajzen, 1975; Fishbein & Manfredo, 1992; Ham & Krumpe, 1996; Ham, 2007).

This study addressed particular beliefs concerning Leave No Trace by asking day-users questions derived from the Theory of Planned Behavior. Respondents were asked specific questions concerning the appropriateness of certain frontcountry related behaviors and the effectiveness and difficulty of specific LNT guidelines. Visitors were also asked to indicate whether or not they currently practice specific LNT suggested principles or plan to do so in the future. Finally, visitors were asked to indicate their level of agreement with statements regarding both positive and negative interpretations of LNT, and how social norms play a role in their beliefs.

9.1.2 Methods

This study took place in the highly-visited, predominately day-user area of the Bear Lake corridor in Rocky Mountain National Park, specifically targeting respondents at Glacier Gorge and Bear Lake Trailheads. However, first a qualitative elicitation study was conducted at Bear Lake on May 27-28, 2009, yielding an overall response rate of 87.5% and a total N = 20, so that the authors could evaluate the research direction for the quantitative study. The survey instrument asked respondents to indicate both advantages and disadvantages seen in a series of 8 photos (Appendix S). Each of the photos demonstrated frontcountry or day-user behavioral practices in the Bear Lake corridor that went either with or against Leave No Trace Center for Outdoor Ethics established principles. Photos consisted of activities such as walking off established trails, feeding wildlife, approaching wildlife to take photos and walking around muddy areas on existing trails. Analysis indicated that certain photographs inhibited salient responses which resulted in behavioral belief indicator items that were developed for this study.

Researchers from Colorado State University also consulted with the Leave No Trace Center for Outdoor Ethics and their Education Board to construct the survey instrument used in this study. Additionally, the researchers adapted several backcountry indicator concepts based upon previous research (Powell, Wright & Vagias, 2008; Vagias, 2009; Vagias & Powell, 2010 – In Draft) to specifically focus upon the frontcountry demographic addressed in this study. Finally, six of the seven Leave No Trace principles were chosen for use in this study, including #1 “Plan Ahead and Prepare,” #2 “Travel on Durable Surfaces,” #3 “Dispose of Waste Properly, #5 “Leave What You Find,” #6 “Be Considerate of Other Visitors” and #7 “Respect Wildlife.” Principle #4 “Minimize Campfire Impacts” was not included in the instrument due to the park regulations concerning fire use in frontcountry areas. Various aspects pertaining to awareness, perceived effectiveness and difficulty, and respondent demographics were also addressed in the study instrument. Ultimately, this survey instrument was analyzed and approved by the Leave No Trace Center for Outdoor Ethics, NPS Wilderness Stewardship Division , and Rocky Mountain National Park’s research and permitting division.

This study took place during the dates of July 15 – August 15, 2009, and respondents were asked to complete a 15-minute on-site “visitor opinion” survey (Appendix 0), which yielded an overall response rate of 74% with a total N = 390.

9.1.3 Study Sites

The purpose of this study was to analyze visitor knowledge, attitudes, awareness, and perceived effectiveness and difficulty of practicing Leave No Trace in Rocky Mountain National Park.

This study took place at the highly visited Bear Lake Trailhead and Glacier Gorge Trailhead located in the Bear Lake corridor. These trailheads are perhaps the most heavily trafficked areas in the Bear Lake corridor and perhaps the entire park, due to the personal vehicle parking options, convenient park shuttle service, proximity to the park entrance and sheer beauty of the area. These trailheads were sampled on stratified days between July 15 – August 15, 2009.

9.1.4 Data Collection

Visitor surveys were administered during the summer of 2009 at Bear Lake and Glacier Gorge trailhead to address various aspects of day-user interactions with Leave No Trace concepts. The purpose of the visitor surveys was to collect information needed to develop baseline knowledge and improve educational messaging in the area. The survey instrument was used to address various concepts related to Leave No Trace, including: 1) visitor demographics and knowledge base concerning LNT 2) attitudes pertaining to LNT practices; 3) perceived effectiveness and difficulty of practicing LNT; 4) current and future intentions to practice LNT; 5) beliefs associated with LNT. This chapter of the report describes the visitor survey administration.

Visitor Surveys

Researchers from Colorado State University and Utah State University approached potential respondents as they were exiting the Bear Lake and Glacier Gorge Trailhead. Researchers used a stratified random sampling procedure and asked visitors if they would be willing to participate in an “visitor opinion study” during the dates of July 15 – August 15, 2009. If a visitor declined to participate, surveyors used a Survey Log (Appendix P), to record the time in which they spoke to the individual or group and the number in the party, and finally thanked them for their consideration.

The study locations at both sites were near several park interpretive signs that listed the Leave No Trace principles. For instance, at Bear Lake, respondents completed the survey less than forty feet from the interpretive messaging and at Glacier Gorge respondents were no more than sixty feet from the messaging. For this reason, two methodological adjustments were made. First, the phrase “Leave No Trace” was not seen in the survey until the last few questions. Second, researchers only approached potential respondents that were exiting the trailheads, so that they would not have recently viewed the signage.

At both Bear Lake and Glacier Gorge trailhead, sampling was stratified so as to take place over 16 days, segmented equally between weekday and weekend A.M. and P.M. sampling times.

The overall response rate was 74% with a total N = 390 (Table 9.1). Thus, there were too few refusals to conduct robust statistical tests for non-response bias. The high response rates suggest that the visitor survey data are not likely to be biased due to systematic differences between study participants and visitor groups who did not participate in the study. There were no significant differences found between Bear Lake and Glacier Gorge results. Therefore, responses will be combined in the following report chapters.

Table 9.1 Overall Visitor Survey Response Rate

	Overall
Acceptance Rate	74%
Refusal Rate	26%

9.1.5 Visitor Demographics and Leave No Trace Knowledge Results

The majority of respondents were female, (53%), with only 47% male respondents (Table 9.2).

Table 9.2 Respondent Sex

	Percentage	Frequency	N
Male	46.9	181	386
Female	53.1	205	

The average age of respondents was 48% (Table 9.3).

Table 9.3 Respondent Age

Avg. Age	N
47.8	386

The majority of respondents, (98%), indicated that they were *White or Caucasian* (Table 9.4).

Table 9.4 Respondent Race

	Percentage	Frequency	N
White or Caucasian	98.2	374	381
Asian	1.3	5	
Black or African American	.3	1	
American Indian or Alaskan Native	.3	1	

The majority of respondents, over 96%, were from the United States (Table 9.5).

Table 9.5 Respondent Nationality

	Percentage	Frequency	N
United States	96.4	375	388
Canada	.8	3	
Germany	.8	3	
Great Britain	.8	3	
Scotland	.3	1	
China	.3	1	
France	.3	1	
Thailand	.3	1	

Nearly 38% indicated that they had completed a *Masters, Doctoral or Professional Degree*, and 27% indicated that they had completed a *College, Business or Trade School Degree* (Table 9.6). 73% of the respondents had completed at least a college degree.

Table 9.6 Respondent Education

	Percentage	Frequency	N
Masters, Doctoral or Professional Degree	37.6	146	385
Some Graduate School	8.2	32	
College, Business or Trade School Graduate	26.8	104	
Some College, Business or Trade School	20.4	79	
High School Graduate or GED	5.9	23	
Some High School	.3	1	

Over 34% indicated that they were *Not at all Familiar* with the LNT Center for Outdoor Ethics (Table 9.7). The mean score was nearly 3, indicating that respondents on average were only *Slightly Familiar* with the Center. However, nearly 25% indicated that they were *Extremely Familiar* with the Center.

Table 9.7 Level of Familiarity with the LNT Center for Outdoor Ethics

N	Mean	S.D.	Percentage						
			Not at all Familiar	Slightly Familiar		Moderately Familiar	Quite Familiar		Extremely Familiar
			0	1	2	3	4	5	6
384	2.87	2.48	34.4%	4.4%	7.3%	9.9%	6.5%	12.8%	24.7%

Mean scores increased to approximately 3.5, when respondents were asked to rate their level of knowledge concerning LNT (Table 9.8). Nearly 11% indicated that they were *Not at all Familiar*, while nearly 60% indicated that they were *Quite Familiar* to *Extremely Familiar* with LNT.

Table 9.8 Level of Self-described Knowledge Concerning LNT

N	Mean	S.D.	Percentage						
			No Knowledge	Very Limited	Limited	Average	Above Average	Extensive	Expert
			0	1	2	3	4	5	6
384	3.45	1.74	10.7%	6.8%	7.3%	16.7%	26.6%	25%	7%

Respondents were asked how they first learned about LNT and interestingly, 18% learned from an *Info kiosk or Park literature,* and 21% learned from *Park personnel or an interpretive talk* (Table 9.9). However, over 40% indicated that they first learned about LNT through other sources (Table 9.10).

Table 9.9 Method of First Leaning about LNT

	Percentage	Std. Deviation = 1.65	N = 347
Leave No Trace Website	2%		
Info kiosk or Park literature	18.2%		
Popular media	16.7%		
Course or seminar	1.7%		
Park personnel or interpretive talk	21%		
Other	40.3%		

Respondents that chose *Other*, were asked to list how they first learned about LNT (Table 9.10). Only 18% indicated that they learned from *Other People*, while 13% indicated that they learned through *Boy* or *Girl Scouts*. Interestingly, nearly 13% indicated that they had *Always Known* about LNT or that it was *Common Sense*, and nearly 11% indicated that they first learned about LNT by taking the survey.

Table 9.10 Other Ways LNT was Learned

Other Methods	Percentage	Frequency
Other People	18.2%	26
Boy/Girl Scouts	13.3%	19
Always Known/Common Sense	12.6%	18
This Survey	10.5%	15
Family	7.7%	11
Experience	4.2%	6
Organizations (Sierra Club, YMCA)	3.5%	5
School	2.8%	4
Guides	2.1%	3
Websites	2.1%	3
Currently Practicing LNT	1.4%	2
Signs	1.4%	2
Work	1.4%	2
Books	1.4%	2
Don't Know	10.5%	15

9.1.6 Behavioral Control and Attitudes Pertaining to Leave No Trace

Prior to measuring beliefs concerning LNT, the study used the following series of statements to gather information about the respondents' level of behavioral control. Behavioral control is one aspect of behavior. The majority of respondents, indicating mean scores over 6, imply *How I act while in RMNP is*, *The way I act while on the trail in RMNP is* and *My Recreation practices in RMNP*, were completely under their control (Table 9.11). However, *The way the individuals in my group act while in RMNP is* received a lower mean rating near 5. This indicates that respondents were less likely to take responsibility for those individuals in their group.

Table 9.11 Personal and Social Perceived Behavioral Control

	N	Mean	S.D.	Percentage						
Please indicate your level of agreement with the following statements…				Not at all under my control 1	2	3	Sometimes 4	5	6	Completely under my control 7
a. How I act while in RMNP is…	386	6.47	.94	.3%	.5%	.8%	3.6%	7%	21.2%	66.6%
b. The way I act while on the trail in RMNP is…	388	6.44	.99	.5%	.8%	1.3%	1.8%	8.2%	22.2%	65.2%
c. My recreation practices in RMNP are…	387	6.21	1.21	1.6%	.3%	2.1%	5.4%	9.8%	23.8%	57.1%
d. The way the individuals in my group act while in RMNP is…	385	5.15	1.64	5.5%	2.3%	5.5%	18.2%	20.8%	22.6%	25.2%

Attitudinal statements were developed to analyze how visitors felt towards LNT frontcountry tailored practices. Results can also be used to evaluate visitor knowledge concerning certain practices. Results, (Table 9.12), signify that many respondents thought that *Taking a break at the edge of the trail* was *Appropriate* with mean ratings of approximately 5.5, which indicates that this aspect of Principle #7, Be Considerate of Other Visitors, may not be fully understood. Similarly, *Carry all litter back out, leaving only food scraps behind* also resulted in high mean scores of approximately 5, demonstrating that respondent attitudes concerning Principle #3, Dispose of Waste Properly may be misguided. *Walk around muddy spots on the trail* also revealed a misunderstanding of that particular aspect of Principle #2, Travel on Durable Surfaces with mean scores near 4.5. Interestingly, results indicated that *Drop food on the ground to provide wildlife a food source*, reflecting Principle #6 resulted in the lowest mean rating near 1, signifying that many respondents appropriately understood this concept. Respondents also seemed knowledgeable concerning the aspect of Principle #3 concerning human waste, *Use the bathroom in a lake, river or stream if there are no public* facilities to be an inappropriate behavior with mean scores of approximately 1.5.

Table 9.12 Attitudes Toward Frontcountry LNT Practices

	N	Mean	S.D.	Percentage						
Please indicate how INAPPROPRIATE or APPROPRIATE you think the following activities are for a visitor to do in Rocky Mtn. National Park…				Very Inappropriate 1	2	3	Neutral 4	5	6	Very Appropriate 7
#1 Plan Ahead and Prepare										
a. Experience nature by not preparing for all types of weather or hazards before I get on a trail	388	2.51	1.9	45.9%	18.8%	11.1%	6.7%	5.7%	3.9%	8%
b. Schedule my trip during times of high use to reduce overall impact	383	3.61	1.7	15.7%	12.5%	11%	38.9%	6%	9.4%	6.5%
#2 Travel and Camp on Durable Surfaces										
c. Travel off trail to experience the natural environment	388	2.62	1.9	43%	17.5%	9.3%	11.3%	8.2%	4.9%	5.7%
d. Walk around muddy spots on the trail	385	4.48	2.0	11.2%	10.6%	7%	20.5%	11.9%	18.4%	20.3%
#3 Dispose of Waste Properly										
e. Use the bathroom in a lake, river or stream if there are no public facilities	386	1.69	1.4	71.5%	11.1%	6.2%	6%	1.3%	.8%	3.1%
f. Carry all litter back out, leaving only food scraps behind	388	4.64	2.7	26.8%	6.4%	5.4%	3.1%	3.4%	4.9%	50%
#5 Leave What You Find										
g. Keep a single item like a rock, plant, stick or feather as a souvenir	388	2.25	1.6	48.7%	16.5%	11.9%	11.3%	4.6%	3.4%	2.6%
h. Move rocks and/or logs to make a resting location more comfortable	387	2.12	1.5	50.9%	19.1%	12.9%	9%	2.6%	3.1%	2.3%
#6 Respect Wildlife										
i. Drop food on the ground to provide wildlife a food source	388	1.43	1.2	82.2%	9.8%	1.5%	2.1%	.8%	1%	2.6%
k. Approach wildlife to take a photo	388	2.30	1.6	44.6%	20.9%	12.6%	11.1%	5.9%	2.8%	2.1%
#7 Be Considerate of Other Visitors										
l. Hike side by side with members of my group on existing trails	387	3.37	1.8	18.6%	18.6%	14%	24.8%	9.8%	8.3%	5.9%
m. Take a break along the edge of the trail	387	5.48	1.6	3.4%	3.4%	4.7%	14.5%	13.2%	27.1%	33.9%

9.1.7 Perceived Effectiveness and Difficulty of Practicing Leave No Trace

Respondents were asked to rate whether a series of statements derived from Leave No Trace principles reduced impact in the park. *Perceived effectiveness* is valuable because actions that are perceived as ineffective will less likely be practiced. Those principles that are perceived as ineffective may be of most importance for educational messaging. Most, (mean scores exceeding 6), of the principles were perceived as reducing impact every time, except for *Schedule trips to avoid times of high use* and *Walk single file in the middle of the trail, even when wet or muddy* both with mean ratings of approximately 5 and *Take breaks away from the trail and other visitors*, with the lowest average mean at approximately 4.5 (Table 9.13). Analysis indicates that these three principles are believed to be less effective in reducing impact.

Table 9.13 Perceived Level of Effectiveness of Practicing LNT

	N	Mean	S.D.	Percentage						
Participating in the following activities in Rocky Mountain National Park would reduce impact…				Never 1	2	3	Sometimes 4	5	6	Every time 7
<u>#1 Plan Ahead and Prepare</u>										
a. Prepare for all types of weather, hazards, emergencies before I get on the trail	387	6.02	1.16	.8%	0%	.8%	13.1%	14.4%	23.2%	47.7%
b. Schedule trips to avoid times of high use	386	5.15	1.34	2.1%	2.1%	3.1%	26.9%	22%	26.6%	17.3%
<u>#2 Travel and Camp on Durable Surfaces</u>										
c. Stay on designated or established trails	382	6.38	.97	.5%	0%	1.3%	4.2%	10.2%	21.7%	62.1%
d. Walk single file in the middle of the trail, even when wet or muddy	386	5.02	1.63	4.4%	4.7%	6.5%	20.2%	20.2%	22.5%	21.8%
<u>#3 Dispose of Waste Properly</u>										
e. Carry out all litter, even crumbs, peels, or cores	386	6.65	.71	.3%	.3%	0%	2.1%	3.1%	9.3%	85%
<u>#5 Leave What You Find</u>										
f. Never remove objects from the area, not even a small item like a rock, plant, stick, or feather	387	6.05	1.51	3.4%	1.3%	2.3%	10.3%	6.7%	16.5%	59.5%
<u>#6 Respect Wildlife</u>										
g. Never approach, feed, or follow wildlife	388	6.19	1.54	4.6%	1.8%	.8%	5.9%	4.6%	15.9%	66.3%
<u>#7 Be Considerate of Other Visitors</u>										
h. Take breaks away from the trail and other visitors	387	4.57	1.9	10.1%	7.5%	8.5%	20.6%	15.2%	20.1%	18%

Respondents were asked to rate the level of difficulty the same actions and behaviors previously stated would be to perform in RMNP. If particular actions or behaviors are perceived as difficult, then they are less likely to perform those principles. Relatively few of the stated principles were perceived as being extremely difficult. However, mean scores indicate that several principles were perceived as being more difficult than others (Table 9.14). For instance, *Schedule trips to avoid times of high use* with mean ratings of just over 3, with 45% of respondents indicating that action to be *Moderately Difficult* and 10% indicating it to be *Extremely Difficult*. Also, *Prepare for all types of weather, hazards, emergencies before I get on the trail*, with mean ratings near 3 was perceived as more difficult, as well as, *Walk single file in the middle of the trail, even when wet or muddy* with mean ratings near 2.5 and *Take breaks away from the trail and other visitors* with mean ratings just beyond 2.

Table 9.14 Perceived Level of Difficulty for Practicing LNT

	N	Mean	S.D.	Percentage						
Please indicate how DIFFICULT you think each of the following activities would be for a visitor to do in Rocky Mountain National Park…				Not at all Difficult 1	2	3	Moderately Difficult 4	5	6	Extremely Difficult 7
#1 Plan Ahead and Prepare										
a. Prepare for all types of weather, hazards, emergencies before I get on the trail	387	2.65	1.56	32.7%	20.6%	13.1%	21.6%	7%	3.4%	1.5%
b. Schedule trips to avoid times of high use	387	3.39	1.57	17.8%	13.4%	13.7%	34.5%	10.6%	8.5%	1.5%
#2 Travel and Camp on Durable Surfaces										
c. Stay on designated or established trails	383	1.62	1.14	65.6%	20.3%	7.6%	2.9%	.8%	2.1%	.8%
d. Walk single file in the middle of the trail, even when wet or muddy	383	2.39	1.53	40.1%	22.1%	14.6%	11.5%	7.6%	2.6%	1.6%
#3 Dispose of Waste Properly										
e. Carry out all litter, even crumbs, peels, or cores	386	1.41	.96	78.3%	11.6%	4.9%	2.8%	1.3%	.5%	.5%
#5 Leave What You Find										
f. Never remove objects from the area, not even a small item like a rock, plant, stick, or feather	386	1.52	1.10	73.8%	14%	4.1%	4.9%	1.6%	.8%	.8%
#6 Respect Wildlife										
g. Never approach, feed, or follow wildlife	387	1.61	1.22	70.9%	13.9%	7.2%	3.6%	1.3%	1.8%	1.3%
#7 Be Considerate of Other Visitors										
h. Take breaks away from the trail and other visitors	386	2.12	1.39	49.1%	18.9%	11.9%	14.2%	3.9%	1.3%	.8%

9.1.8 Current and Future Intentions to Practice Leave No Trace

Using the same actions or behaviors, respondents were asked to indicate whether or not they *Never*, *Sometimes* or *Always* practiced the stated principles. As Table 9.15 demonstrates, large percentages of respondents admitted only *Sometimes* to *Schedule trips to avoid times of high use* (76%), *Walk single file in the middle of the trail, even when wet or muddy* (66%) and *Take breaks away from the trail and other visitors* (63%). Interestingly, 16% of respondents indicated that they *Never*, *Take breaks away from the trail and other visitors*, and 13% *Never*, *Schedule trips to avoid times of high use*. Additionally 14% admitted that they *approach, feed, or follow wildlife*, while 9% admitted that they *remove objects from the area*.

Table 9.15 Current Behaviors Related to Practicing LNT

	N	Mean	S.D.	Percentage of Respondents that Currently Do This		
Do you do this now?				Never 1	Sometimes 2	Always 3
<u>#1 Plan Ahead and Prepare</u>						
a. Prepare for all types of weather, hazards, emergencies before I get on the trail	369	2.53	.54	2.4%	43%	54.6%
b. Schedule trips to avoid times of high use	369	1.97	.49	13.2%	76.2%	10.3%
<u>#2 Travel and Camp on Durable Surfaces</u>						
c. Stay on designated or established trails	366	2.76	.44	.5%	23.2%	76%
d. Walk single file in the middle of the trail, even when wet or muddy	363	2.20	.55	7.1%	65.9%	26.6%
<u>#3 Dispose of Waste Properly</u>						
e. Carry out all litter, even crumbs, peels, or cores	358	2.92	.30	.8%	6.4%	92.5%
<u>#5 Leave What You Find</u>						
f. Never remove objects from the area, not even a small item like a rock, plant, stick, or feather	358	2.59	.65	9.2%	22.8%	67.4%
<u>#6 Respect Wildlife</u>						
g. Never approach, feed, or follow wildlife	360	2.52	.73	13.9%	20.3%	65.3%
<u>#7 Be Considerate of Other Visitors</u>						
h. Take breaks away from the trail and other visitors	360	2.04	.61	16.3%	62.6%	20.8%

Using the same actions or behaviors, respondents were asked how likely they were to practice the stated principles in the future. Similar actions or behaviors were indicated in this analysis (Table 9.16). Again, *Schedule trips to avoid times of high use*, *Take breaks away from the trail and other visitors* and *Walk single file in the middle of the trail, even when wet or muddy* all with mean ratings of approximately 5, were less likely to be practiced in the future.

Table 9.16 Behavioral Intentions to Practice LNT

	N	Mean	S.D.	Percentage Likelihood of Doing this in the Future						
Please indicate how LIKELY you are to do the following activity in the future…				Not at All Likely			Moderately Likely		Extremely Likely	
				1	2	3	4	5	6	7
#1 Plan Ahead and Prepare										
a. Prepare for all types of weather, hazards, emergencies before I get on the trail	384	5.95	1.34	.8%	1.3%	2.3%	14.8%	11.4%	18.7%	50.6%
b. Schedule trips to avoid times of high use	382	4.76	1.48	3.7%	3.4%	6%	35%	18.8%	18.8%	14.4%
#2 Travel and Camp on Durable Surfaces										
c. Stay on designated or established trails	382	6.22	1.18	.5%	1%	1.3%	9.9%	7.6%	20.9%	58.7%
d. Walk single file in the middle of the trail, even when wet or muddy	379	5.03	1.57	2.6%	5.8%	5.3%	25.8%	15.8%	23.4%	21.3%
#3 Dispose of Waste Properly										
e. Carry out all litter, even crumbs, peels, or cores	378	6.70	.89	.8%	0%	1.6%	2.9%	1.8%	8.2%	84.7%
#5 Leave What You Find										
f. Never remove objects from the area, not even a small item like a rock, plant, stick, or feather	379	6.09	1.60	3.9%	2.6%	1.6%	9.5%	5%	11.3%	65.8%
#6 Respect Wildlife										
g. Never approach, feed, or follow wildlife	380	6	1.74	6.6%	2.1%	2.1%	6.3%	5.8%	14.4%	62.5%
#7 Be Considerate of Other Visitors										
h. Take breaks away from the trail and other visitors	380	4.87	1.79	7.6%	5.2%	5.2%	23.1%	18.1%	16.3%	24.4%

9.1.9 Outcome Beliefs of Practicing Leave No Trace

Finally, respondents were asked a series of belief statements to target particular beliefs towards practicing LNT. Four particular belief orientations were addressed including Negative Beliefs towards LNT, Positive Beliefs towards LNT, Social Normative Beliefs towards LNT and Global Efficacy concerning LNT. Negative Beliefs towards LNT include statements A – D (Table 9.17). Overall, respondents indicated that they *Strongly Disagree* with the Negative Belief statements. Similarly, respondents indicated that they *Strongly Agree* with the Positive Belief statements E – G. However, Social Normative Beliefs, statements H – L, yielded lower mean scores and percentages, but nothing falling below mean ratings of approximately 5. Global Efficacy results, statements M – P, were high with mean ratings above 6.

Table 9.17 Outcome Beliefs about Practicing LNT

	N	Mean	S.D.	Percentage						
Please indicate how strongly you AGREE or DISAGREE with the following statements…				Strongly Disagree 1	2	3	Neutral 4	5	Strongly Agree 6	7
<u>Negative Belief</u>										
a. Sometimes it is too difficult to practice “Leave No Trace.”	384	2.29	1.57	42.9%	26.2%	8.6%	10.9%	6%	3.6%	1.8%
b. Practicing “Leave No Trace” takes too much time.	385	1.76	1.23	60.1%	22.8%	6%	7.3%	1.6%	1.3%	1%
c. Practicing “Leave No Trace” violates the rights of an individual to do as they please in the outdoors.	380	1.69	1.40	70.3%	14.7%	2.9%	6.8%	1.6%	.5%	3.1%
d. Practicing “Leave No Trace” does not reduce the environmental harm caused by travel in the Park.	384	1.92	1.70	67.3%	13.5%	2.1%	7.5%	2.1%	2.3%	5.2%
<u>Positive Belief</u>										
e. Practicing “Leave No Trace” effectively protects the environment so that future generations may enjoy it.	385	6.15	1.68	6.2%	1.6%	1%	5.4%	2.8%	14%	68.9%
f. Practicing “Leave No Trace” enhances my outdoor experience.	385	6.03	1.58	4.1%	2.1%	.8%	9.6%	6.5%	17.1%	59.8%
g. It is important that all visitors practice “Leave No Trace.”	384	6.24	1.54	4.9%	1.3%	.3%	5.5%	3.1%	15.8%	69.1%
<u>Social Norms</u>										
h. It is important that Park regulations require all visitors to practice “Leave No Trace.”	385	6.10	1.60	4.9%	1.6%	.5%	7.5%	6.5%	15.3%	63.6%
i. The people I recreate with believe it is important to practice “Leave No Trace.”	385	6.03	1.49	2.8%	2.6%	1%	9.8%	4.4%	23.8%	55.4%
j. In general, the opinions of others have little effect on my practicing “Leave No Trace.”	384	5.42	2.06	9.4%	6.2%	2.6%	11.2%	3.9%	18.2%	48.6%

	N	Mean	S.D.	Percentage						
Please indicate how strongly you AGREE or DISAGREE with the following statements…				Strongly Disagree 1	2	3	Neutral 4	5	6	Strongly Agree 7
k. I practice "Leave No Trace" because the people I recreate with believe it is important.	385	4.98	1.91	8%	5.2%	3.9%	26.7%	8.8%	14.5%	32.9%
l. I practice "Leave No Trace" because the Park regulations state that I should do so.	386	4.63	2.03	12.1%	6.5%	4.7%	26.9%	10.3%	10.9%	28.7%
<u>Global Efficacy</u>										
m. It is important to practice "Leave No Trace" techniques when in the Park.	384	6.51	1.13	1.8%	.3%	.5%	4.9%	3.6%	12.7%	76.1%
n. If I learned my actions in the Park damaged the environment, I would change my behavior.	384	6.5	1.16	1.8%	.5%	.3%	6.2%	1.8%	13.5%	75.8%
o. I get upset when I see other individuals in the Park not following "Leave No Trace" practices.	386	6.30	1.20	1.6%	.8%	.3%	7.0%	8%	18.7%	63.7%
p. I insist that "Leave No Trace" practices are followed by all members of my group.	386	6.0	1.38	1.8%	1.6%	1%	12.7%	9.1%	22.8%	51%

9.1.10 Summary

Visitor Demographics:

The majority of respondents were women, (53%), with only 47% men. The average age of study respondents was 48 years, and the majority of respondents were Caucasian, (98%), and from the United States, more than 96%. The majority of the respondents were highly educated, as 72% indicated that they had completed a college degree.

Visitor Knowledge:

More than 34% of respondents indicated that they were *Not at all Familiar* with the LNT Center for Outdoor Ethics, while ~55% stated that they were *Moderately* to *Extremely Familiar*. However, when asked to report their level of self-perceived knowledge of LNT, ~11% indicated that they had *No Knowledge,* while nearly 60% indicated that their knowledge was *Above Average* to *Expert*.

Interestingly, 18% of respondents indicated first learning about LNT from an *Info kiosk* or *Park literature*, and 21% learned from *Park personnel or an interpretive talk*. This indicates that nearly 40% of respondents received some educational messaging concerning minimum impact practices from park related educational messaging. Additionally, approximately 17% learned about LNT from *Popular media*. Interestingly, 40% indicated learning from another method, which predominantly included learning from *Others*, (18%), while more than 13% listed that they learned through *Boy* or *Girl Scouts*, and approximately 13% indicated that it was *Common Sense*. However, nearly 11% indicated that they first learned about LNT through interactions with this study.

Attitudinal statements concerning inappropriate frontcountry behaviors were presented to respondents to assess whether they thought these statements were *Very Inappropriate* or *Very Appropriate*. If respondents' responses inclined towards *Very Appropriate*, their knowledge of that particular LNT related principle was low or not fully understood. Results indicate that many respondents, over 74%, thought that *Taking a break at the edge of the trail* was *Appropriate*. Similarly, 58% indicated that it was *Appropriate* to *Carry all litter back out, leaving only food scraps behind*. Also, approximately 51% indicated that it was *Appropriate* to *Walk around muddy spots on the trail*. Interestingly, 19% of respondents indicated that it was *Appropriate* to *Travel off trail to experience the natural environment*.

Visitor Behaviors:

Respondents were asked the extent to which their behaviors were under their own control. Respondents largely agreed that their behavior in the park was completely under their own control. However, when asked if *The way the individuals in their group act while in RMNP* was under their control, percentages decreased.

Perceived effectiveness is valuable because actions or behaviors that are perceived as ineffective will less likely be practiced. Those principles that are perceived as ineffective should be targeted by the park. Most of the principles were thought to reduce impact *Every time*; however, *Schedule trips to avoid times of high use*, *Walk single file in the middle of the trail, even when wet or muddy* and *Take breaks away from the trail and other visitors*, had the lowest average scores. Analysis indicates that these three principles are believed to be less effective in reducing impact, and should be educationally targeted by the park and the LNT Center for Outdoor Ethics.

Perceived difficulty is also valuable because actions or behaviors that are perceived as difficult will less likely be practiced. Relatively few of the LNT principles were perceived as being extremely difficult. However, several principles were perceived as being more difficult than others. For instance, *Schedule trips to avoid times of high use* with 45% of respondents indicating that action to be *Moderately Difficult* and 10% indicating it to be *Extremely Difficult*, and *Prepare for all types of weather, hazards, emergencies before I get on the trail* as well as, *Walk single file in the middle of the trail, even when wet or muddy* and *Take breaks away from the trail and other visitors* were perceived as more difficult.

Respondents were asked the extent to which they currently practice LNT principles and most indicated that they *Always* follow the guidelines. However, large percentages of respondents admitted only *Sometimes* to *Schedule trips to avoid times of high use* (76%), *Walk single file in the middle of the trail, even when wet or muddy* (66%) and *Take breaks away from the trail and other visitors* (63%). Approximately 16% of respondents indicated that they *Never*, *Take breaks away from the trail and other visitors*, and 13% *Never*, *Schedule trips to avoid times of high use*. Additionally 14% admitted that they *approach, feed, or follow wildlife*, while 9% admitted that they *remove objects from the area*.

Using the same actions or behaviors, respondents were asked how likely they were to practice the stated principles in the future. Similar actions or behaviors were indicated in this analysis. Again, *Schedule trips to avoid times of high use*, *Take breaks away from the trail and other visitors* and *Walk single file in the middle of the trail, even when wet or muddy* were less likely to be practiced in the future.

Visitor Beliefs:

Finally, respondents were asked a series of belief statements to target particular beliefs towards practicing LNT. Four particular belief orientations were addressed including Negative Beliefs towards LNT, Positive Beliefs towards LNT, Social Normative Beliefs towards LNT and Global Efficacy concerning LNT. Most respondents disagreed with the statements that referred to LNT in a negative way (Negative Beliefs). However, more than 11% indicated that they *Strongly Agree* that *Sometimes it is too difficult to practice "Leave No Trace".* Similarly, approximately 10% indicated that they *Strongly Agree* that *Practicing "Leave No Trace" does not reduce the environmental harm caused by travel in the Park*. Most respondents agreed with the statements that referred to LNT in a positive way (Positive Beliefs). However, nearly 9% indicated that they *Strongly Disagree* that *Practicing "Leave No Trace" effectively protects the environment so that future generations may enjoy it.* Social Normative Beliefs towards LNT resulted in slightly different conclusions. For instance, more than 23% of respondents indicated that they *Strongly Disagree* with the statement *I practice "Leave No Trace" because the Park regulations state that I should do so*, and 18% strongly disagreed with the statement, *In general, the opinions of other have little effect on my practicing "Leave No Trace".* Similarly, 17% indicated that they *Strongly Disagree* with the statement *I practice "Leave No Trace" because the people I recreate with believe it is important*. Global Efficacy concerning LNT was well received by the majority of respondents with average scores indicating that respondents *Strongly Agree* with the importance of practicing LNT.

Recommendations

Despite the LNT messaging on the signage less than fifty yards from the study location, not all respondents were familiar with the Leave No Trace concept, and the majority were unfamiliar with the Center for Outdoor Ethics. The park and the Center might consider focusing on additional ways to message LNT in day-user areas, so that various mediums may draw awareness of LNT practices.

While nearly 40% of respondents learned LNT from park sources, many visitors are learning from other forms of education. The park and the LNT Center for Outdoor Ethics should consider making sure that messaging is consistent across all mediums so that misunderstanding will be minimal.

Visitors may not fully understand some of the LNT concepts. The park and the LNT Center for Outdoor Ethics should consider specifically focusing upon guidelines concerning being courteous to other visitors, carrying all litter back out (including food scraps), avoiding erosion and trail impact by walking around puddles and the importance of staying on trail.

Schedule trips to avoid times of high use, *Walk single file in the middle of the trail, even when wet or muddy* and *Take breaks away from the trail and other visitors*, were the practices that were perceived to be the least effective, while *Schedule trips to avoid times of high use, Prepare for all types of weather, hazards, emergencies before I get on the trail*, *Walk single file in the middle of the trail, even when wet or muddy* and *Take breaks away from the trail and other visitors* were perceived as being more difficult practices. These guidelines could be messaged in a manner that emphasizes the importance and the potential consequences of not practicing these principles. Messaging that can change the beliefs concerning how effective and difficult these practices are will be the most successful in curbing these depreciative actions.

While many respondents knew that they should follow LNT guidelines, they admitted to *Sometimes* to *Scheduling trips to avoid times of high use*, *Walking single file in the middle of the trail, even when wet or muddy* and *Taking breaks away from the trail and other visitors* (63%). Several respondents admitted that they *Never*, *Take breaks away from the trail and other visitors* or *Schedule trips to avoid times of high use*, while some admitted that they *approach, feed, or follow wildlife* or even *remove objects from the area*. Clearly, knowledge is not always an indicator of current behavior or behavioral intention. Additional educational messaging may consider addressing and explaining the resource degradation that occurs from not following these guidelines.

9.1.11 Literature Cited

Ajzen, I. (1991). *The Theory of Planned Behavior. Organizational Behavior and Human Performance, 50*: 179-211.

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice-Hall.

Ballantyne, R. and Packer, J. (2005) Promoting Environmentally Sustainable Attitudes and Behaviour Through Free-Choice Learning Experiences: What Is The State of the Game?. *Environmental Education Research*, *11*(3): 281-295.

Bradley, J.A. (1979). A human approach to reducing wildland impacts. In Ittner, R.,

Potter, D. R., Agee, J. K. & Anschell, S. (eds). *Proceedings: Recreational Impact on*

Wildlands. Portland, OR, USDA Forest Service, Pacific Northwest Region, 222-226.

Cole, D.N. (1995). Group size limits: Can they work? *LNT Master Network, 10*(3): 15.

Cole, D. N. (1998). Written appeals for attention to low impact messages on wilderness trailside bulletin boards: Experimental evaluations of effectiveness. *Journal of Park and Recreation Administration, 16*(1): 65-79.

Cole, D. N. (2001). *Day users in Wilderness: How different are they?* USDA Forest Service Research Paper RMRS-RP-31.

Cole, D. N., Hammond, T. P. and McCool, S. F. (1997). Information quantity and communication effectiveness: Low-impact messages on wilderness trailside bulletin boards. *Leisure Sciences, 19*(1): 59-72.

Confer, J., Absher, J., Graefe, A., & Hille, A. (1998). *Relationship between visitor knowledge of "leave no trace" minimum impact practices and attitudes toward selected management actions.* Paper presented at the 1998 Northeastern Recreation Research Symposium, Bolton Landing, New York.

Confer, Mowen, Graefe, Absher. (1999). "Magazines as wilderness information sources: Assessing users' general wildernesss knowledge and specific Leave No Trace knowledge. In D. Cole, McCool, Borrie, O'Loughlin eds. Proceedings –National Wilderness Science Conference: A Time of Change U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station Proceedings RMRS-P-14-VOL4. Fort Collins, Colorado. 193-197.

Creswell, J. W. (2009). Research design: Qualitative, quantitative and mixed methods approaches (3rd Edition). Thousand Oaks, CA: Sage Publications, Inc.

Daniels, M., & Marion, J. (2005). Communicating leave no trace ethics and practices: Efficacy of two day trainer courses. *Journal of Park and Recreation Administration, 23*(4), 1-19.

Fazio, J. R. (1979). *Communicating with the wilderness user*. Moscow, ID: Bulletin

Number 28. University of Idaho, College of Forestry, Wildlife and Range Experiment Station.

Fazio, J.R. and Gilbert, D.L. (1986). Public relations and communications for natural resource mangers (2nd ed.) Dubuque, IA: Kendall/Hunt Publishing Company.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Fishbein, M., & Manfredo, M., J. (1992). A theory of behavior change. In M. Manfredo, J. (Ed.), *Influencing human behavior: Theory and application in recreation, tourism, and natural resources management*. Champaign, IL: Sagamore Publishing Inc.

Ham, S. H. (2007). From interpretation to protection: Is there a theoretical basis? *Journal of the Association for Heritage Interpretation, 12*(3), 20-23.

Ham, S. H., & Krumpe, E. E. (1996). Identifying audiences and messages for nonformal environmental education - A theoretical framework. *Journal of Interpretation Research, 1*(1), 11-23.

Hammitt, W.E., & D.N. Cole. (1998). *Wildland Recreation: Ecology and Management*. New York: John Wiley & Sons.

Hampton, B., & Cole, D. N. (1988). *Soft Paths*. Harrisburg, PA: Stackpole Books.

Harding, J. A., Borrie, W. T., & Cole, D. N. (2000). Factors That Limit Compliance With Low-Impact Recommendations. *USDA Forest Service Proceedings RMRS-P-15-VOL-4.*

Harmon, W. (1997). *Leave no trace: Minimum impact outdoor recreation*. Helena, MT: Falcon Publishing, Inc.

Hendee, J. C., & Dawson, C. (2002). *Wilderness management: Stewardship and protection of resources and values* (third ed.). Golden, CO: Fulcrum Publishers.

Hodgson, M. (1991). *The basic essential of minimizing impact on the wilderness*. Merrillville, IN: ICS Books, Inc.

Jones, M. K. and Bruyere, B. (2004). Frontcountry Leave no trace program evaluation, city of Boulder open space and mountain parks. International Symposium on Society and Resource Management. Keystone, CO.

Kernan, A., & Drogin, E. (1995). *The effect of a verbal interpretive message on day user impacts at Mt. Rainier National Park.* Paper presented at the Northeastern Recreation Research Symposium. Bolton Landing, NY. USDA Forest Service, General Technical Report NE-198, 127-129.

Lucas, R. C. (1983). The role of regulations in recreation management. *Western Wildlands, 9*(2), 6-10.

Leave No Trace Center for Outdoor Ethics. (n.d.). *Leave No Trace mission statement*. Retrieved April 27, 2009, from http://lnt.org/aboutUs/index.php

Leave No Trace Center for Outdoor Ethics. (n.d.). *Leave No Trace Principles*. Retrieved April 27, 2009, from http://lnt.org/programs/principles.php

Leave No Trace Center for Outdoor Ethics. (n.d.). *Leave No Trace Frontcountry Principles*. Retrieved February, 2, 2010, from http://lnt.org/programs/frontcountry.php

Leung, Y. & Marion, J.L. (2000). Recreation impact and management in wilderness: a state-of-knowledge review. In: Cole, D.N., McCool, S.F., Borrie, W.T., and O'Loughlin, J. (comps.) *Wilderness Science in a Time of Change Conference.* Vol. 5. *Wilderness Ecosystems, Threats and Management.* Proceedings RMRS-P-15-VOL-5. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, Utah, 23-48.

Manning, R. E., (2003). Emerging principles for using information/education in wilderness management. *International Journal of Wilderness*, 9(1): 20-28.

Manning, R.E. (1999). *Studies in Outdoor Recreation: Search and Research for Satisfaction*.

Corvallis, OR: Oregon State University Press.

Marion, J. Reid, S. (2001). Development of the United States Leave No Trace program: A historical perspective. In M. B. Usher, (ed)*., Enjoyment and Understanding of the Natural Heritage*. Edinburgh, Scotland: The Staionery Office Ltd., 81-92.

Marion, J.L., and Reid, S.E. (2007). Minimizing visitor impacts to protected areas: The efficacy of low impact education programs. *Journal of Sustainable Tourism, 15*: 5–27.

McGivney, A. (1998). *Leave no trace: A guide to the new wilderness etiquette*. Seattle, WA: The Mountaineers.

Monz, C. A., Henderson, C., & Brame, R. A. (1994). Perspectives on the integration of wilderness research, education and management. In *6th National Wilderness Conference Proceedings: The Spirit Lives*.

Newman, P., Manning, R., Bacon, J., Graefe, A., & Kyle, G. (2003). An evaluation of Appalachian Trail hikers' knowledge of minimum impact skills and practices. *International Journal of Wilderness, 9*(2), 30-34.

Papenfuse, M. K., Roggenbuck, J. W. and Hall, T. E. (2000). The rise of the day visitor in wilderness: Should managers be concerned? USDA Forest Service Proceedings RMRS-P-15-Vol-4.

Turner, J. (2002). From Woodcraft to 'Leave No Trace': wilderness, consumerism, and

environmentalism in twentieth-century America.

Environmental History, *7*(3), 462-484.

Powell, R.B., Wright, B.A., & Vagias, W. (2008). Preliminary evaluation of recreational skills and ethics training programs occurring on public lands: The Leave No Trace Visitor Education Program. Technical Report, Leave No Trace Center for Outdoor Ethics, Clemson University and the National Park Service.

Vagias, W.M. (2009) An examination of the leave no trace visitor education program in two U.S. national park service units. PhD Dissertation. Clemson, SC: Clemson University.

Vagias, W.M. and Powell, R.B. (2010 – In Draft) NPS backcountry visitors' attitudes toward 22 common backcountry camping behaviors. *International Journal of Wilderness.*

Surveyor Use Only
ID: 1______
Date: / / 2008
Time:__________ AM/PM

OMB # 1024-0224 (NPS # 08-028)
Expiration Date: 12/31/2008
IRB ID# 08-107H

Rocky Mountain National Park

Alberta Falls Survey

1. **Including this visit, approximately how many times have you visited Rocky Mountain National Park?**

   Number of visits: ___________

2. **On the scale below, please indicate how familiar you are with Rocky Mountain National Park ? (Circle one number.)**

1	2	3	4	5	6	7	8	9
Not at all familiar								Extremely familiar

3. **Have you visited Alberta Falls before? (Check one.)**

   □ Yes (CONTINUE TO QUESTION 4)
   □ No (SKIP TO QUESTION 5)

4. **Including this time, approximately how many times have you visited Alberta Falls?**

   Number of visits:_______

1

5. **On your trip today, at which trailhead did you begin your hike? (Check one.)**

☐ Glacier Gorge Trailhead
☐ Bear Lake Trailhead
☐ Don't know
☐ Other: ______________________________

6. **On your hike today, which locations did you visit? (Check all that apply.)**

☐ Alberta Falls
☐ Mills Lake
☐ Black Lake
☐ Loch Vale
☐ Sky Pond
☐ Dream Lake
☐ Emerald Lake
☐ Nymph Lake
☐ None of the above
☐ Don't know
☐ Other: ______________________

7. **Approximately what time did you start your hike to Alberta Falls today?**

_______________AM/PM

OR

☐ Don't know

8. **In general, how did the encounters you had with other people at Alberta Falls today affect your overall enjoyment of your hiking experience? (Please check one response, even if you did not see other people.)**

☐ Greatly added to my enjoyment
☐ Somewhat added to my enjoyment
☐ Had no effect
☐ Somewhat reduced my enjoyment
☐ Greatly reduced my enjoyment

2

9. A We would like to know how many other people you think you could encounter at Alberta Falls without feeling too crowded. To help judge this, please rate each of the photographs by indicating how acceptable you find it based on the number of people in the photo. (Circle one number for each photo)

	Very Unacceptable								Very Acceptable
Photo 1	-4	-3	-2	-1	0	1	2	3	4
Photo 2	-4	-3	-2	-1	0	1	2	3	4
Photo 3	-4	-3	-2	-1	0	1	2	3	4
Photo 4	-4	-3	-2	-1	0	1	2	3	4
Photo 5	-4	-3	-2	-1	0	1	2	3	4

B Which photograph looks most like the number of people you saw at Alberta Falls today?

- □ Photo 1
- □ Photo 2
- □ Photo 3
- □ Photo 4
- □ Photo 5

C Which photograph looks most like the number of people you would prefer to see at Alberta Falls?

- □ Photo 1
- □ Photo 2
- □ Photo 3
- □ Photo 4
- □ Photo 5

10. How crowded did you feel while you were at Alberta Falls today? (Circle one number.)

1	2	3	4	5	6	7	8	9
Not at all Crowded		Slightly Crowded			Moderately Crowded		Extremely Crowded	

3

11. **How much of a problem were each of the following items for you at Alberta Falls today? (Check one box for each item.)**

	Not a Problem	Small Problem	Big Problem	Don't Know/No Opinion
Difficulty locating the trailhead	☐	☐	☐	☐
Lack of available parking at the trailhead	☐	☐	☐	☐
Not enough information provided at the trailhead about how to prepare for a hike on the trail	☐	☐	☐	☐
Not enough signs with information about the natural and cultural history of the area	☐	☐	☐	☐
Not enough directional signs along the trail	☐	☐	☐	☐
Trails are too wide	☐	☐	☐	☐
Trails are too eroded (e.g. exposed roots, rocks, channeling)	☐	☐	☐	☐
Litter along the trail	☐	☐	☐	☐
Improperly disposed human waste evident on or near the trail	☐	☐	☐	☐
Too many people on the trail	☐	☐	☐	☐
Off-trail trampling around Alberta Falls	☐	☐	☐	☐
Sound from aircraft	☐	☐	☐	☐
Sound from large groups of visitors	☐	☐	☐	☐
Sound from other visitors	☐	☐	☐	☐
Sound from NPS maintenance	☐	☐	☐	☐
Sound from vehicles (e.g. cars, buses, motorcycles)	☐	☐	☐	☐
Other: ____________________	☐	☐	☐	☐

12. **What did you like best about your trip to Alberta Falls today?**

Response:

13 **What did you like least about your trip to Alberta Falls today?**

Response:

4

14. **We would like to know how you feel about using different kinds of transportation in Rocky Mountain National Park. For each statement below:**

1. Rate how much you agree or disagree that the statement describes traveling in Rocky Mountain National Park in your *personal vehicle*
then
2. Rate how much you agree or disagree that the statement describes traveling using the Rocky Mountain National Park *shuttle bus*. <u>Please answer this part even if you have not yet used the shuttle bus system.</u>

Statements	Your Personal Vehicle 1= Strongly Agree 2= Agree 3= Disagree 4= Strongly Disagree				Park Shuttle 1= Strongly Agree 2= Agree 3= Disagree 4= Strongly Disagree			
You have easy access to your personal belongings (such as recreation equipment)	1	2	3	4	1	2	3	4
You have an opportunity to learn about the park while traveling	1	2	3	4	1	2	3	4
Travel is affordable or low cost	1	2	3	4	1	2	3	4
You have opportunities to see wildlife	1	2	3	4	1	2	3	4
It is easy to find your way around the park	1	2	3	4	1	2	3	4
You have pleasant interactions with other visitors	1	2	3	4	1	2	3	4
It takes too long to get where you want to go	1	2	3	4	1	2	3	4
You feel safe	1	2	3	4	1	2	3	4
You have little impact on park's natural environment	1	2	3	4	1	2	3	4
You connect with the natural environment	1	2	3	4	1	2	3	4
You hear natural sounds	1	2	3	4	1	2	3	4
You have easy access to different areas of the park	1	2	3	4	1	2	3	4
You hear the sounds of traffic	1	2	3	4	1	2	3	4
It is easy to get to scenic overlooks/vistas	1	2	3	4	1	2	3	4
You experience a sense of freedom	1	2	3	4	1	2	3	4
You feel stressed while traveling through the park	1	2	3	4	1	2	3	4
You have trouble finding parking	1	2	3	4	1	2	3	4
You can go "where you want, when you want"	1	2	3	4	1	2	3	4
You experience conflict with visitors using other kinds of transportation	1	2	3	4	1	2	3	4
You avoid traffic congestion	1	2	3	4	1	2	3	4
You feel crowded by other visitors	1	2	3	4	1	2	3	4

5

15. How did you get to the trailhead today?

☐ Personal vehicle
☐ Shuttle bus
Other: _______________

16. What is your sex? (Check one.)

☐ Male
☐ Female

17. In what year were you born?

Year born: 19____

18. Do you live in the United States? (Check one.)

☐ Yes - What is your zip code? _________
☐ No - In what country do you live? __________________________

19. What is the highest level of formal education you have completed (Check one.)

☐ Some high school
☐ High school graduate or GED
☐ Some college, business or trade school
☐ College, business or trade school graduate
☐ Some graduate school
☐ Master's, doctoral or professional degree

20. Are you Hispanic or Latino? (Check one)

☐ Yes
☐ No

21. What is your race? (Check one or more.)

☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
☐ Native Hawaiian or other Pacific Islander
☐ White

Thank you for your help with this survey!
Please return the completed questionnaire to the survey administrator.

APPENDIX B-CROWDING STUDY SURVEY LOG

Survey Log Pg ___ of ___

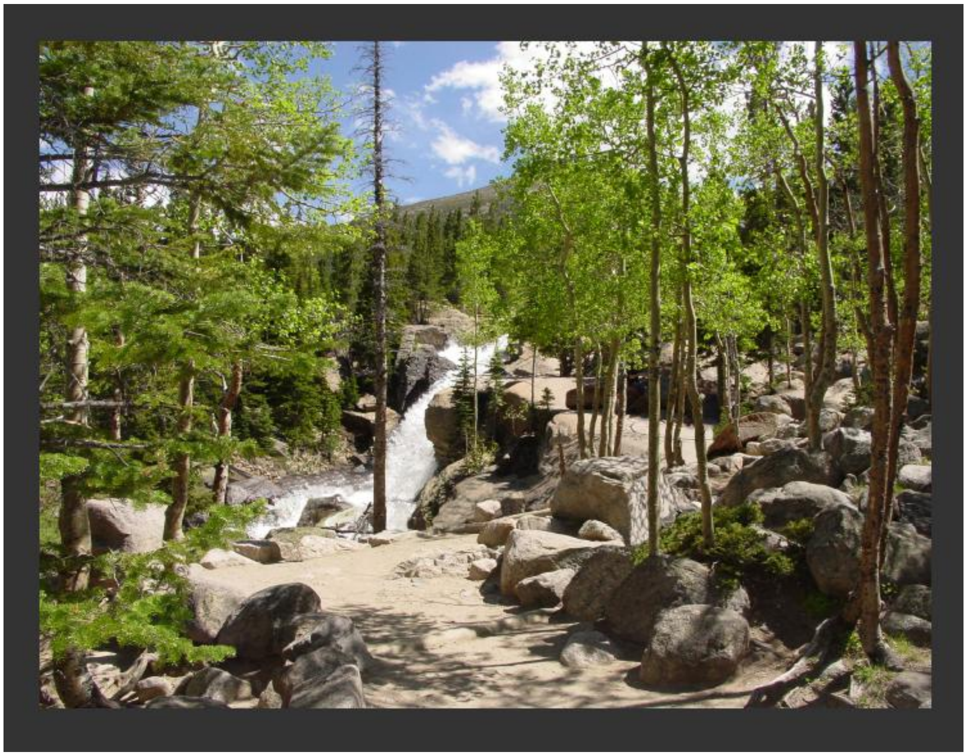
RMNP Survey Log

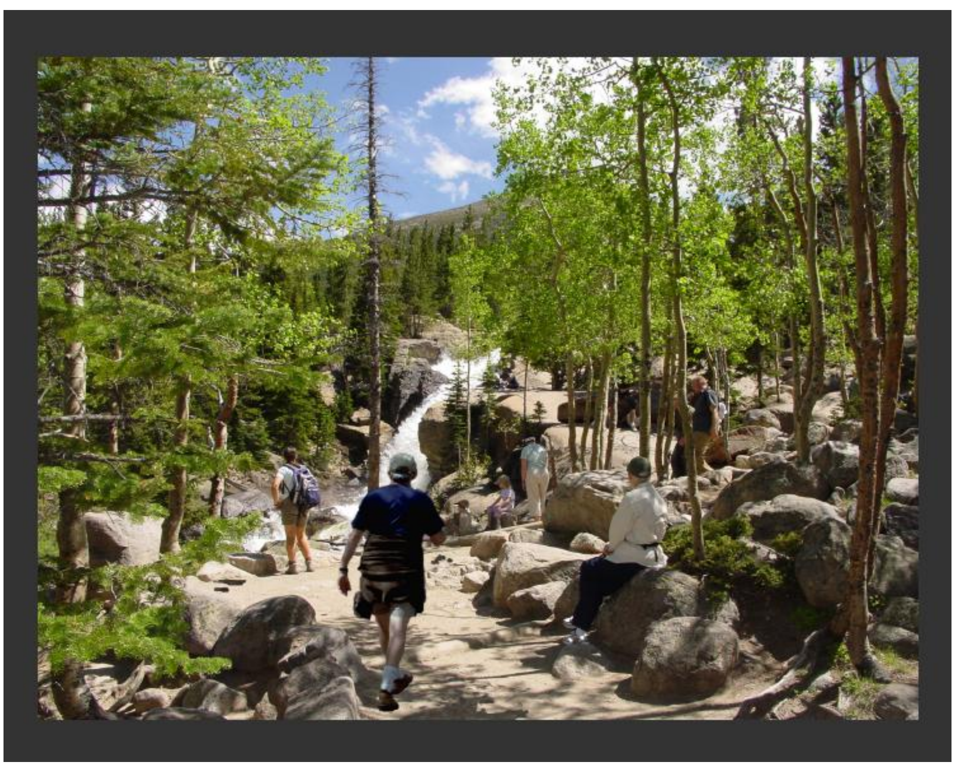
Location______________ Date___________ Day of Week______

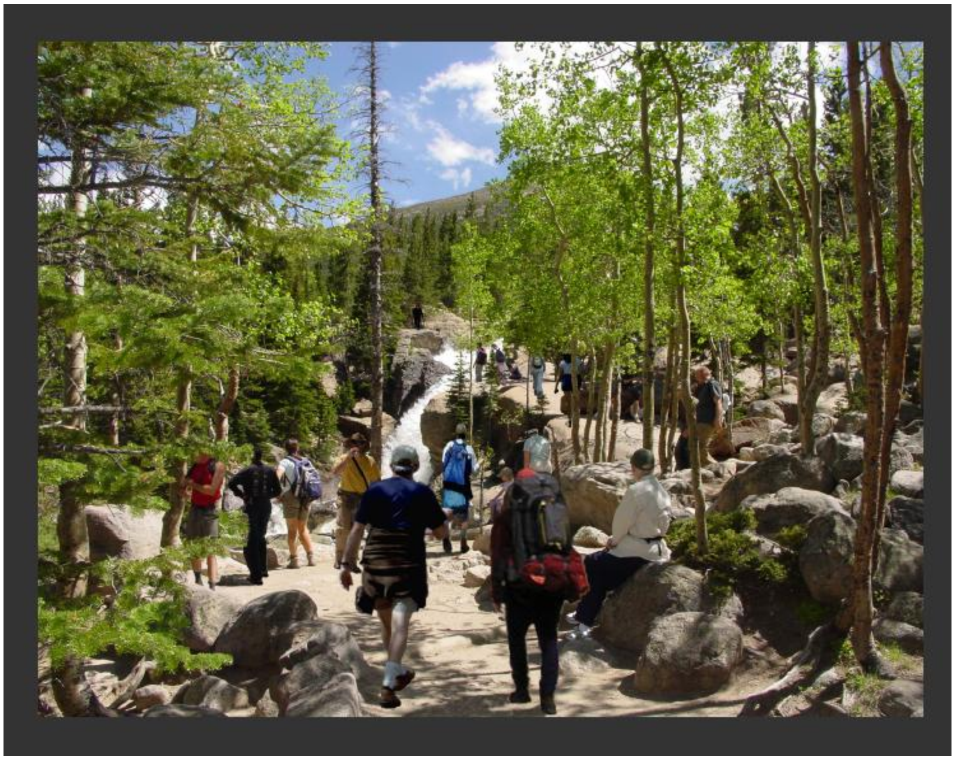
Time Arrive________ Time Leave_________ Name____________

Time	Group #	# Adults	#Children (<15yrs)	# Not Given	Personal Vehicle (PV) or Park Shuttle (PS)	Survey #'s	Comments

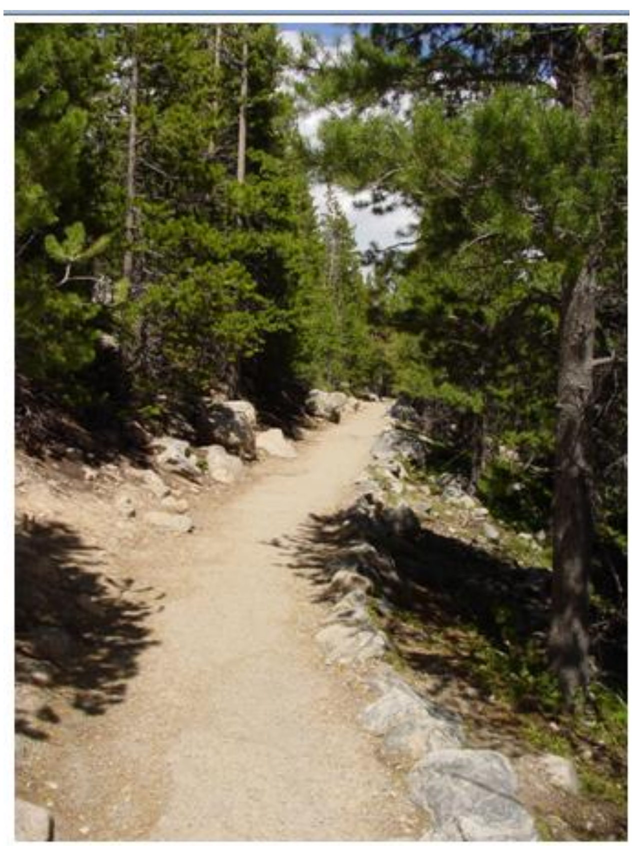
Alberta Falls

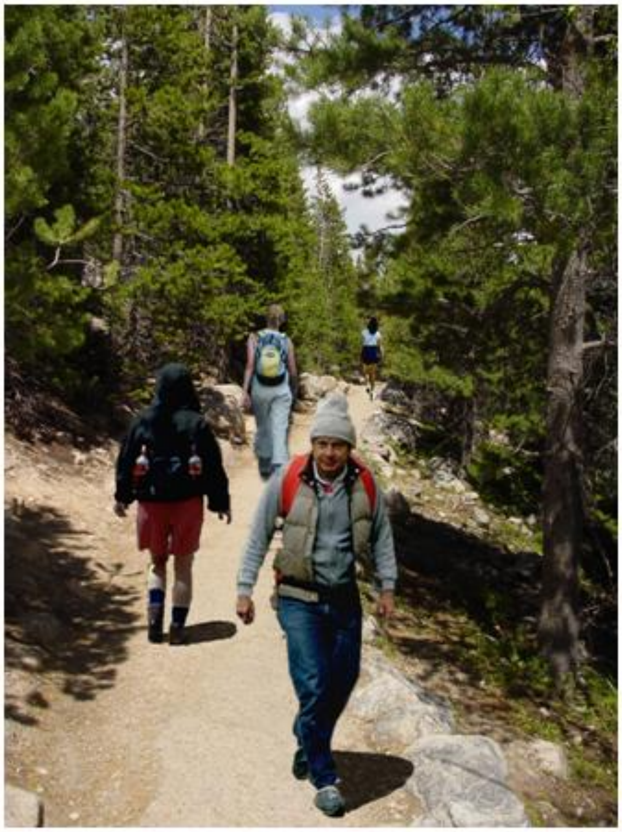


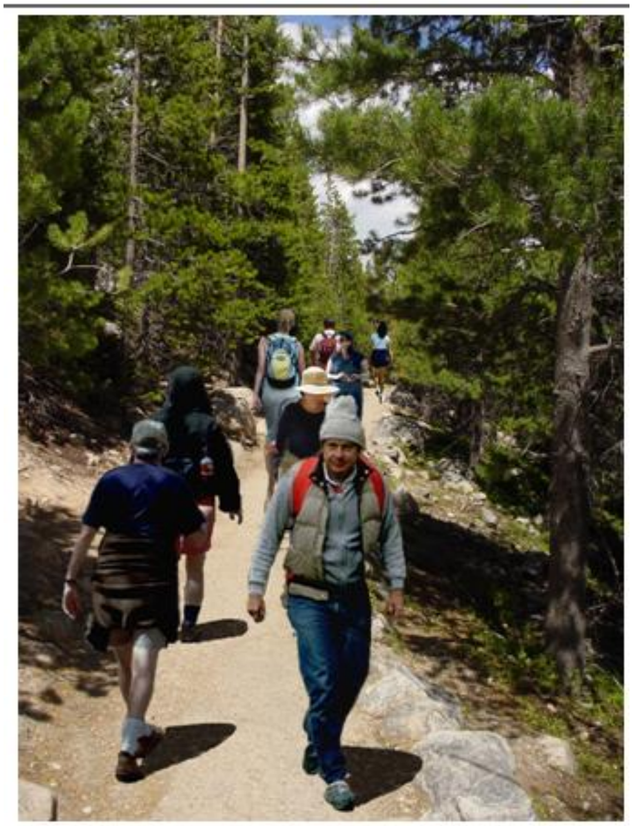


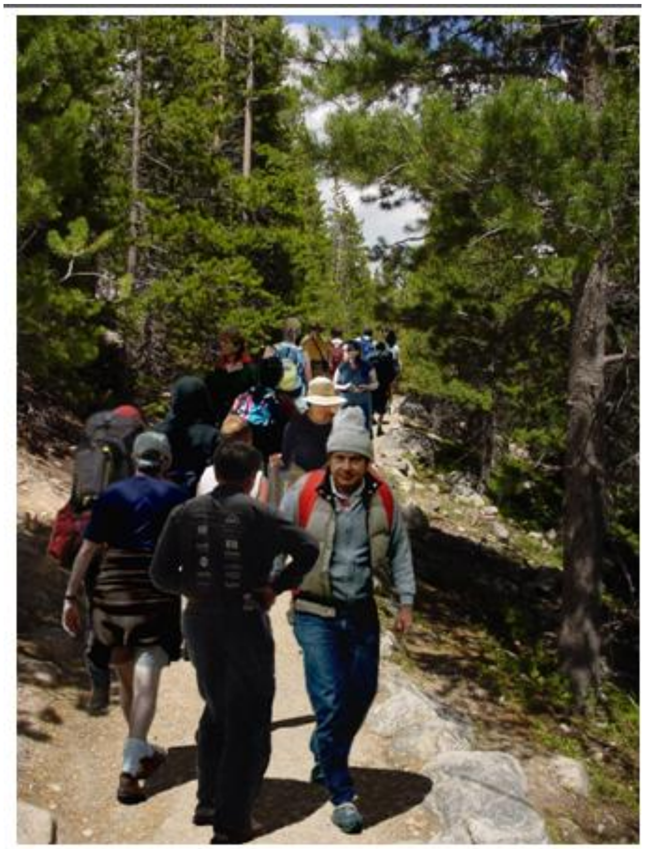


Dream Lake









Emerald Lake

Glacier Gorge

Rocky Mountain National Park:
Bear Lake Corridor Visitor Survey

Section A: Past Experience and Use History

We would like to know more about your experience at and use of Rocky Mountain National Park. Please answer the following questions to the best of your ability.

1. **Including this visit, approximately how many times have you visited Rocky Mountain National Park?**

   Number of visits: ____________

2. **On the scale below, please indicate how important Rocky Mountain National Park is to you? (Circle one number.)**

1	2	3	4	5
Unimportant		Important		Highly important

4. **Including this visit, approximately how many times have you visited to *Bear Lake Corridor* (Bear Lake Trailhead, Bierstadt Lake Trailhead, or Glacier Gorge Trailhead) of Rocky Mountain National park?**

   Number of visits: ____________

4. **What was the primary destination of your hike today?**

Primary hiking destination: ____________________

5. Have you visited your primary hiking destination before today?

☐ Yes (CONTINUE TO QUESTION 6)
☐ No (SKIP TO QUESTION 7)

6. Including this visit, approximately how many times have you visited your primary hiking destination?

Number of visits: ____________________

7. During your visit today, at which trailhead did you begin your hike? (Check one.)

☐ Glacier Gorge Trailhead
☐ Bear Lake Trailhead
☐ Do not know
☐ Other: ________________________________

8. On your hike today, which locations did you visit? (Check all that apply.)

☐ Bear Lake
☐ Bierstadt Lake
☐ Flattop Mountain
☐ Alberta Falls
☐ Mills Lake
☐ Jewel Lake
☐ Black Lake
☐ Loch Vale
☐ Sky Pond
☐ Lake Hiayaha
☐ Dream Lake
☐ Emerald Lake
☐ Nymph Lake
☐ None of the above
☐ Do not know
☐ Other: _________________________

Section B: Knowledge of Natural History and Ecological Issues

1. **We would like to know more about your knowledge of the *natural history* of Rocky Mountain National Park. For each natural history topic below, please rank your knowledge of this topic *as it relates to Rocky Mountain National Park* by checking the appropriate box.**

Topic	No Knowledge	Some Knowledge	Proficient Knowledge
a. Wildlife			
b. Plants			
c. Insects			
d. Water			
e. Geology			
f. Alpine Ecology			

2. **We would like to know more about your knowledge of some *ecological issues* in Rocky Mountain National Park. For each ecological issue below, please rank your knowledge of this topic *as it relates to Rocky Mountain National Park* by checking the appropriate box.**

Topic	No Knowledge	Somewhat Familiar	Well Informed
a. Elk Management			
b. Vegetation Management			
c. Fire Management			
d. Air Quality			
e. Water Quality			
f. Mountain Pine Beetle			
g. Nonnative Species			

Definitions for the remaining questions in the survey

Designated trail: The hiking trail constructed by the National Park Service for visitor use; those that are found on National Park Service maps.

Visitor created trail: A trail not constructed, nor maintained, by the National Park Service which was created by repeated use of persons hiking away from the designated trail.

Section C: Knowledge of Hiking and Camping Practices

We would like to know more about your knowledge of hiking and camping practices. Please answer the following questions to the best of your ability by checking the box next to the correct answer.

1. In preparation for a hike in Rocky Mountain National Park, which of the following is correct?

- ☐ Plan to start your hike later in the day to avoid being above tree line during a storm.
- ☐ Learn about the hike you will be attempting by reading guide books and studying maps.
- ☐ Carry as little as possible to allow for faster hiking.
- ☐ Leave your rain jacket at home; it is not necessary during summer months.

2. When hiking in Rocky Mountain National Park, which of the following best practices should you do?

- ☐ Travel in large groups.
- ☐ Talk loudly, sing, or yell while hiking to scare away bears.
- ☐ Always stay on the designated trail.
- ☐ Travel along visitor created trails.

3. You have just finished eating lunch along the trail, which of the following can be disposed of in the woods?

- ☐ Fruit and vegetation scraps such as orange peels and apple cores.
- ☐ Any food item that will decompose.
- ☐ Meat or fish scraps.
- ☐ None of the above.

4. When you are hiking on a trail with wildflowers, which of the following should you do?

- ☐ Walk off of the trail and pick a flower no one can see.
- ☐ Stay on the trail and pick only one flower.
- ☐ Do not pick any flowers.
- ☐ Pick only dry, wilted flowers and leave the healthy plants alone.

5. When having a campfire at your campsite, which of the following should you do?

- ☐ Make sure the fire is completely extinguished before leaving your campsite.
- ☐ Build the fire as large as possible for maximum heat.
- ☐ Burn your trash and food scraps in the fire.
- ☐ Leave large pieces of partially burnt wood for others to use.

6. When viewing wildlife, which of the following should you do?

- ☐ Get as close as possible for a great photograph.
- ☐ Feed the wildlife, especially during winter when food may be scare.
- ☐ Try to scare the wildlife away from other visitors.
- ☐ Respectfully observe the wildlife from a safe distance.

7. When stopping to rest during your hike, which of the following should you do?

- ☐ Stand in the middle of the designated trail.
- ☐ Sit on a rock or log.
- ☐ Use a visitor created trail to find a quiet place away from the designated trail.
- ☐ Find a shady spot beneath a tree and rest there.

Section D: Perceptions of Resource Conditions

1. We would like to know how you feel about your experience today at the Bear Lake Corridor of Rocky Mountain National Park; both during your hike and at your primary hiking destination. For each statement below:

1. Rate how much you agree or disagree that the statement describes your experience *during your hike* to your primary hiking destination in the Bear Lake Corridor.

2. Rate how much you agree or disagree that the statement describes your experience *at your primary hiking destination* in the Bear Lake Corridor.

Statements	During your hike					At your primary hiking destination				
	1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree					1 = Strongly disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree				
a. I noticed eroded trails.	1	2	3	4	5	1	2	3	4	5
b. I expected to see eroded trails.	1	2	3	4	5	1	2	3	4	5
c. The amount of erosion that I observed affected me.	1	2	3	4	5	1	2	3	4	5
d. I noticed areas where vegetation had been stepped on or trampled.	1	2	3	4	5	1	2	3	4	5
e. I expected to see trampled vegetation.	1	2	3	4	5	1	2	3	4	5
f. The amount of trampled vegetation that I observed affected me.	1	2	3	4	5	1	2	3	4	5
g. I noticed trails that had been created by visitors.	1	2	3	4	5	1	2	3	4	5
h. I expected to see visitor created trails.	1	2	3	4	5	1	2	3	4	5
i. The amount of visitor created trails that I observed affected me.	1	2	3	4	5	1	2	3	4	5
j. I noticed other visitors hiking off of the designated trail.	1	2	3	4	5	1	2	3	4	5
k. I expected to see visitors hiking off of the designated trail.	1	2	3	4	5	1	2	3	4	5
l. The amount of people that I observed hiking off of the designated trail affected me.	1	2	3	4	5	1	2	3	4	5
m. I noticed tree damage.	1	2	3	4	5	1	2	3	4	5
n. I expected to see tree damage.	1	2	3	4	5	1	2	3	4	5
o. The amount of tree damage that I observed affected me.	1	2	3	4	5	1	2	3	4	5
p. I experienced solitude.	1	2	3	4	5	1	2	3	4	5

q. I expected to experience solitude.	1	2	3	4	5	1	2	3	4	5
r. The degree of crowding that I experienced affected me.	1	2	3	4	5	1	2	3	4	5

2. We would like to know more about how the various resource conditions that you may have experienced today impacted your visit to the Bear Lake Corridor. For each resource condition below, please rank how you feel the *resource condition* influenced your *overall experience* today in the Bear Lake Corridor.

Resource Condition	Detracted from Experience	No Effect on Experience	Added to Experience
a. Eroded trails	1	2	3
b. Trampled vegetation	1	2	3
c. Visitor created trails	1	2	3
d. People hiking off of the designated trail	1	2	3
e. Tree damage	1	2	3
f. Degree of crowding	1	2	3

3. We would like to know how you feel about resource conditions at the Bear Lake Corridor of Rocky Mountain National Park. For each statement below, rate how much you agree or disagree that the statement describes your feelings about *resource conditions* in the Bear Lake Corridor.

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
a. Erosion of trails appears to be a problem.	1	2	3	4	5
b. Trampling of vegetation appears to be a problem.	1	2	3	4	5
c. The proliferation of visitor created trails appears to be a problem.	1	2	3	4	5
d. People hiking off of the designated trail appears to be a problem.	1	2	3	4	5
e. Tree damage appears to be a problem.	1	2	3	4	5
f. The lack of opportunities for solitude appears to be a problem.	1	2	3	4	5

Section E: Visitor Standards of Resource Conditions

1. **We would like to know more about your view of *resource conditions* in the Bear Lake Corridor. Please rate each of the photographs found in the associated binders by indicating how acceptable you find the photograph based on the amount of resource condition change that you observe. (Circle one number for each photo)**

Photo Group 1:

	Very Unacceptable								Very Acceptable
Photo 1	-4	-3	-2	-1	0	1	2	3	4
Photo 2	-4	-3	-2	-1	0	1	2	3	4
Photo 3	-4	-3	-2	-1	0	1	2	3	4
Photo 4	-4	-3	-2	-1	0	1	2	3	4
Photo 5	-4	-3	-2	-1	0	1	2	3	4

Photo Group 2:

	Very Unacceptable								Very Acceptable
Photo 1	-4	-3	-2	-1	0	1	2	3	4
Photo 2	-4	-3	-2	-1	0	1	2	3	4
Photo 3	-4	-3	-2	-1	0	1	2	3	4
Photo 4	-4	-3	-2	-1	0	1	2	3	4
Photo 5	-4	-3	-2	-1	0	1	2	3	4

Section F: Background Information

We would like to collection some background information. Please answer the following questions to the best of your ability.

1. What is your gender? (Check one.)

□ Male

□ Female

2. In what year were you born?

Year born: 19_____

3. Do you live in the United States? (Check one.)

□ Yes - What is your zip code? __________

□ No - In what country do you reside? ______________________________

4. What is the highest level of formal education that you have completed? (Check one.)

□ Some high school

□ High school graduate or GED

□ Some college (Associate's or Bachelor's level), business or trade school

□ College (Associate's or Bachelor's degree), business or trade school graduate

□ Some graduate school (Master's, Doctoral, or Professional degree level)

□ Master's, Doctoral or Professional degree

Thank you very much for your help with this survey!

Please use the back of this page for any additional information or comments.

When completed, please return the survey to a survey administrator.

APPENDIX E-RECREATION RESOURCE IMPACT PHOTOS FOR VISUAL RESEARCH METHODS

Vegetation Loss Photo 1

Vegetation Loss Photo 2

Vegetation Loss Photo 3

Vegetation Loss Photo 4

Vegetation Loss Photo 5

Proliferation of Visitor Created Trails Photo 1

Proliferation of Visitor Created Trails Photo 2

Proliferation of Visitor Created Trails Photo 3

Proliferation of Visitor Created Trails Photo 4

Proliferation of Visitor Created Trails Photo 5

APPENDIX F-SURVEY LOG FORM FOR VISITOR PERCEPTIONS OF RECREATION RESOURCE IMPACTS SURVEY

Bear Lake Corridor Visitor Perceptions Survey

Trailhead: ___________

Date: ______________

Time: am/pm

Researcher: _________

Survey ID	Time	Accept/Reject	Comments

APPENDIX G-CALCULATION OF SUSCEPTIBILITY RATINGS AND POTENTIAL FOR CHANGE SCORES

Table 0.1: Susceptibility rating for Emerald Lake

Category	Score	Description
Low	0 - 16	Rock, Soil, Lichen
Medium	17 - 42	Soil, Grasses, Forbs
High	41 - 65	Forbs, Mosses, Shrubs

Table 0.2: Susceptibility rating for Alberta Falls

Category	Score	Description
Low	13 - 75	Rock, Soil, Lichen
Medium	76 - 123	Soil, Grasses, Forbs
High	124 - 222	Forbs, Mosses, Shrubs

Note: Overall – Emerald Lake has lower susceptibility ratings because of the higher percentage of rock in the area. However, some areas at Emerald Lake had a comparatively high percentage of forbs and shrubs for the area. In order to create the categories – I used natural breaks in the data to make them specific to the context of the site. At Alberta Falls, the only area that is significantly rocky is right next to the falls. The rest is mostly forbs and grasses and a higher percentage compared to Emerald Lake.

Interpretation of scores for Areas of Potential Resource Change:

2 = Low Density and Low Susceptibility

3 = Low Density and Medium Susceptibility or Medium Density and Low Susceptibility

4 = Medium Density and Medium Susceptibility

5 = Medium Density and High Susceptibility or High Density and Medium Susceptibility

6 = High Density and High Susceptibility

Some Explanation:

At Emerald Lake the areas of highest potential for change are the areas behind the very rocky areas right next to the lake. These areas are still receiving a medium to high amount of use but have a high percentage of grasses, forbs, and shrubs compared to the rest of the Emerald Lake area which is dominated by rocks.

At Alberta Falls the areas if highest potential for change are those with high densities of visitors using areas dominated by forbs (especially the spot where the polygon of dispersed use begins to overlap the designated trail as it turns back towards the falls). The areas with medium potential for change are areas in the polygon and buffer which are dominated by mostly forbs but are receiving medium use. At Alberta Falls, most of the use is confined to the area right next to the falls which is all rock.

APPENDIX H-DETAILS ON INTEGRATION WITH VISITOR STANDARDS AS DETERMINED BY VISUAL RESEARCH METHODS.

Notes on Standards:

Sites:

53% Cover percent cover is minimum acceptable level of cover loss

Relative Percent Veg Loss	Condition
0 – 35	In standard
36 – 53	Approaching standard
54 – 97	Out of standard

Trails:

5.7% area impacted by informal trails is the minimum acceptable level of impact.

Photo 2, the first photo rated as unacceptable, contained 2 informal trails.

The radius used to calculate trail density in ArcMap was 10 meters.

Because of the scale at which the density was calculated in ArcMap the units used were km/km^2. 114km trail/km^2 is equal to 5.7% on an area basis assuming an average trail width of 0.5 m.

Length of Trail (km/km^2)	Condition
1 – 90	In standard
91 – 114	Approaching standard
115 – 300	Out of standard

APPENDIX I-GLACIER GORGE TRAIL HIKING ROUTE SURVEY

Glacier Gorge Trail Visitor Survey 2008 Date: ______________

1. Group Size: ______________ Card no.____________

2. From what location did you start your hike today? (Refer to the park map as needed and check one.)

   ❑ Bear Lake Trailhead ❑ Don't Know/Not Sure

   ❑ Glacier Gorge Trailhead ❑ Other:_______________________

3. What type of transportation did you use to travel to the starting location of your hike? (Check one.)

   ❑ Personal vehicle → _____ # of vehicles

   ❑ Shuttle bus

   ❑ Other: ____________________

4. Which of the following is your primary activity today? (Check one.)

   ❑ Hiking ❑ Fishing ❑ Other: _______________________

   ❑ Backpacking ❑ Rock climbing

OMB # 1024-0224 (NPS # 08-021)

APPENDIX J-DREAM LAKE TRAIL HIKING ROUTE SURVEY

Bear Lake Trail Visitor Survey 2008[1] Date: ______________

1. Group Size: ______________ Card no.____________
2. From what location did you start your hike today? (Refer to park map as needed and check one.)
   ❑ Bear Lake Trailhead (continue to Q3) ❑ Don't Know/Not Sure (skip to Q5)
   ❑ Glacier Gorge Trailhead (skip to Q5) ❑ Other: _______________ (skip to Q5)
3. Which of the following best describes your route from the Bear Lake Trailhead parking lot/shuttle bus stop to this location?
   ❑ Walked directly from Bear Lake Trailhead parking lot/shuttle bus stop to this location
   ❑ Visited Bear Lake before arriving at this location
   ❑ Other: ______________________________
4. Time passed since group left the Bear Lake Trail parking lot/shuttle stop:
   ______________ (minutes) - or - ❑DK
5. What type of transportation did you use to travel to the starting location of your hike? (Check one.)
   ❑ Personal vehicle → _______ # of vehicles
   ❑ Shuttle bus ❑ Other:__________________________
6. Which of the following is your primary activity today? (Check one.)
   ❑ Hiking ❑ Fishing ❑ Other: __________________________
   ❑ Backpacking ❑ Rock climbing

OMB # 1024-0224 (NPS # 08-021)

7. Entering Location: ❑ X1 ❑ X2 ❑ X3 Entering Time:______:______:______
   - If X2/X3: Entry Type? ❑ True -or- ❑ Re-entry→ Earlier exit location: ❑ X2 ❑ X3 ❑DK
     - Time passed since group exited earlier? ___________ (minutes) -or- ❑DK

Location: ❑ X1 ❑ X2 ❑ X3 ❑ X4 Time: _____:_____:_____
Location: ❑ X1 ❑ X2 ❑ X3 ❑ X4 Time: _____:_____:_____
Location: ❑ X1 ❑ X2 ❑ X3 ❑ X4 Time: _____:_____:_____
Location: ❑ X1 ❑ X2 ❑ X3 ❑ X4 Time: _____:_____:_____
Location: ❑ X1 ❑ X2 ❑ X3 ❑ X4 Time: _____:_____:_____
Location: ❑ X1 ❑ X2 ❑ X3 ❑ X4 Time: _____:_____:_____
Location: ❑ X1 ❑ X2 ❑ X3 ❑ X4 Time: _____:_____:_____
Location: ❑ X1 ❑ X2 ❑ X3 ❑ X4 Time: _____:_____:_____

❑ Went toward Lake Hiayaha & returned to X3

Exiting Location: ❑ X1 ❑ X2 ❑ X3 Exiting Time: _______:_______:_______

8. Do you intend to ride the shuttle bus at the end of your hike?
   ❑ Yes, at Bear Lake Trailhead ❑ Yes, at Glacier Gorge Trailhead ❑ No

Thank you for your help with this important study!

[1] Bear Lake Visitor Survey 2008 refers to the hiking route survey administered on the Dream Lake Trail to Emerald Lake.

APPENDIX K-HIKING ROUTE SURVEY RESPONSE LOG

Rocky Mountain National Park Extend Modeling Survey Log – 2008

Trail:_______________ Location on Trail:_______________ Name:___________________________

Date:_______________ Sampling Start Time:_____________ Sampling End Time :________________

Participant ? (Y or N)	Time	Group Size	Transportation Mode *	Survey ID # (If accept)	Comments

* Transportation Mode to Trailhead: P=personal vehicle; S=Shuttle; O=Other

APPENDIX L-GLACIER GORGE TRAIL HIKING ROUTE SURVEY CODEBOOK

Refers to *Hiking Route Survey Data and Analysis\Data Analysis - GGT.xls*

Variable	Description	Origin	Values
Date	Date of intercept	Card Front	dd/mm/yy
Card_Num	Unique card number	Card Front	#
Group_Size_Raw	Number in group	Card Front	#
Group_Size_Extreme	Number in group, excluding extreme outliers	Calculated	#
Group_Size_Mild	Number in group, excluding mild outliers	Calculated	#
Group_Size_Extreme_Recode	Small/Large Groups	Calculated	1 = Small Group (3 or less) 2 = Large Group (4 or more)
Group_Size_Mild_Recode	Small/Large Groups	Calculated	1 = Small Group (3 or less) 2 = Large Group (4 or more)
Start_Loc	Location where started hike for the day	Card Front	1 = BLT 2 = GGT 3 = DK/NS 4 = Other
Start_Loc_Other	Other start location	Card Front	2 = Park and Ride 3 = Hollowell 4 = Pullout below GGT Parking Lot 6 = Storm Pass 8 = Roadside Lot/Parked on Road
Mode	Mode to start location	Card Front	1 = Personal Vehicle 2 = Shuttle Bus 3 = Dropped off
Mode_Recode	Mode to start location, re-coded	Calculated	1 = Personal Vehicle 2 = Shuttle Bus or Dropped Off
Vehicles	Number of vehicles, if Mode = 1	Card Front	#
Activity	Primary activity today	Card Front	1 = Hiking 2 = Backpacking 3 = Fishing 4 = Rock Climbing 5 = Other or Multiple Given
Activity_Other	Other primary activity today	Card Front	1 = Photography 2 = Birdwatching 3 = Hiking and Fishing 4 = Hiking and Rock Climbing 5 = Hiking and Photography
Enter_Loc	Intercept location where entered study site	Card Back	1 = X1 2 = X2 4 = X4
Lot_Time	Time to intercept from parking lot/shuttle stop, if Enter_Loc = 1	Card Back	Minutes; Blank if DK
Lot_Time_Extreme	Time to intercept from parking lot/shuttle stop, if Enter_Loc = 1, excluding extreme outliers	Calculated	Minutes; Blank if DK

Variable	Description	Origin	Values
Lot_Time_Mild	Time to intercept from parking lot/shuttle stop, if Enter_Loc = 1, excluding mild outliers	Calculated	Minutes; Blank if DK
Enter_Type	True entry or re-entry	Card Back	1 = True Entry 2 = Re-Entry
Earlier_Exit_Loc	Location where exited study site earlier today, if Enter_Type = 2	Card Back	2 = X2 3 = Fire Trail 4 = X4
Time_Earlier_Exit	Time passed since earlier exit if Enter_Type = 2	Card Back	Enter time in minutes Blank if "DK"
X1_Up_Time	Time when heading uphill at X1 (entering system)	Card Back	hh:mm:ss (military); if entered at different location leave blank
X2_Up_Time	Time when heading uphill at X2; could be entry time	Card Back	hh:mm:ss (military); leave blank if does not apply
X3_Up_Time	Time when heading uphill at X3	Card Back	hh:mm:ss (military); leave blank if does not apply
X4_Up_Time	Time when heading uphill at X4; system exit time	Card Back	hh:mm:ss (military); leave blank if does not apply
X4_Down_Time	Time when heading downhill at X4; system entry time	Card Back	hh:mm:ss (military); leave blank if does not apply
X3_Down_Time	Time when heading downhill at X3	Card Back	hh:mm:ss (military); leave blank if does not apply
X2_Down_Time	Time when heading downhill at X2; could be exit time	Card Back	hh:mm:ss (military); leave blank if does not apply
X1_Down_Time	Time when heading downhill at X1; system exit time	Card Back	hh:mm:ss (military); leave blank if does not apply
Exit_Loc	Exiting intercept location	Card Back	1 = X1 2 = X2 4 = X4
Shuttle	Intend to ride shuttle bus at end of hike?; if Exit_Loc = 1	Card Back	1 = Yes 0 = No
Shuttle_Group	Type of Shuttle Group	Calculated	1 = GGT-Starter Arrived via Private Vehicle 2 = GGT-Starter Arrived via Shuttle/Dropped Off 3 = Non-GGT-Starter Arrived via Any Mode
Exit_Type	True exit or planning to return	Card Back	1 = True Exit 2 = Plan to return to X2 4 = Plan to return to X4
X1Up	Order of route stop (higher numbers occurred first)	Calculated	Rank Order
X2Up	Order of route stop (higher numbers occurred first)	Calculated	Rank Order
X3Up	Order of route stop (higher numbers occurred first)	Calculated	Rank Order
X4Up	Order of route stop (higher numbers occurred first)	Calculated	Rank Order
X4Down	Order of route stop (higher numbers occurred first)	Calculated	Rank Order
X3Down	Order of route stop (higher numbers occurred first)	Calculated	Rank Order

Variable	Description	Origin	Values
X2Down	Order of route stop (higher numbers occurred first)	Calculated	Rank Order
X1Down	Order of route stop (higher numbers occurred first)	Calculated	Rank Order
RouteLoc1	First stop	Calculated	Rank Order
RouteLoc2	Second stop	Calculated	Rank Order
RouteLoc3	Third stop	Calculated	Rank Order
RouteLoc4	Fourth stop	Calculated	Rank Order
RouteLoc5	Fifth stop	Calculated	Rank Order
RouteLoc6	Sixth stop	Calculated	Rank Order
RouteLoc7	Seventh stop	Calculated	Rank Order
RouteLoc8	Eighth stop	Calculated	Rank Order
RouteCheckEnter	Checks whether route stop pairings are logical: EnterLoc and Route Loc1	Calculated	0 = Logical 1 = Error
RouteCheck1	Checks whether route stop pairings are logical: RouteLoc1 and Route Loc2	Calculated	0 = Logical 1 = Error
RouteCheck2	Checks whether route stop pairings are logical: RouteLoc2 and Route Loc3	Calculated	0 = Logical 1 = Error
RouteCheck3	Checks whether route stop pairings are logical: RouteLoc3 and Route Loc4	Calculated	0 = Logical 1 = Error
RouteCheck4	Checks whether route stop pairings are logical: RouteLoc4 and Route Loc5	Calculated	0 = Logical 1 = Error
RouteCheck5	Checks whether route stop pairings are logical: RouteLoc5 and Route Loc6	Calculated	0 = Logical 1 = Error
RouteCheck6	Checks whether route stop pairings are logical: RouteLoc6 and Route Loc7	Calculated	0 = Logical 1 = Error
RouteCheck7	Checks whether route stop pairings are logical: RouteLoc7 and Route Loc8	Calculated	0 = Logical 1 = Error
RouteCheckExit	Checks whether route stop pairings are logical: Last Stop and Exit Loc	Calculated	0 = Logical 1 = Error
Valid Route	Determines if entire route is valid	Calculated	Valid or Invalid
Invalid Explanation	Explains why the route is invalid	Calculated	Text
TT_X1Up_X2Up	Travel time X1Up to X2Up	Calculated	minutes
TT_X1Up_X1Down	Travel time X1Up to X1Down	Calculated	minutes
TT_X2Up_X3Up	Travel time X2Up to X3Up	Calculated	minutes
TT_X2Up_X2Down	Travel time X2Up to X2Down	Calculated	minutes
TT_X3Up_X4Up	Travel time X3Up to X4Up	Calculated	minutes
TT_X3Up_X3Down	Travel time X3Up to X3Down	Calculated	minutes
TT_X4Up_X4Down	Travel time X4Up to X4Down	Calculated	minutes
TT_X4Down_X4Up	Travel time X4Down to X4Up	Calculated	minutes
TT_X4Down_X3Down	Travel time X4Down to X3Down	Calculated	minutes
TT_X3Down_X3Up	Travel time X3Down to X3Up	Calculated	minutes
TT_X3Down_X2Down	Travel time X3Down to X2Down	Calculated	minutes
TT_X2Down_X2Up	Travel time X2Down to X2Up	Calculated	minutes

Variable	Description	Origin	Values
TT_X2Down_X1Down	Travel time X2Down to X1Down	Calculated	minutes
TT_X1Down_X1Up	Travel time X1Down to X1Up	Calculated	minutes
AF_Lingering_Time	Lingering time at Alberta Falls	Calculated	minutes
TT_X2Up_PPVUp	Travel time X2Up to PPVUp	Calculated	minutes
TT_PPVUp	Travel time PPVUp	Calculated	minutes
TT_PPVUp_X3Up	Travel time PPVUp to X3Up	Calculated	minutes
TT_X3Down_PPVDown	Travel time X3Down to PPVDown	Calculated	minutes
TT_PPVDown	Travel time PPVDown	Calculated	minutes
TT_PPVDown_X2Down	Travel time PPVDown to X2Down	Calculated	minutes
TT_X1Up_X2Up_Extreme	Travel time X1Up to X2Up, excluding extreme outliers	Calculated	minutes
TT_X1Up_X1Down_Extreme	Travel time X1Up to X1Down, excluding extreme outliers	Calculated	minutes
TT_X2Up_X3Up_Extreme	Travel time X2Up to X3Up, excluding extreme outliers	Calculated	minutes
TT_X2Up_X2Down_Extreme	Travel time X2Up to X2Down, excluding extreme outliers	Calculated	minutes
TT_X3Up_X4Up_Extreme	Travel time X3Up to X4Up, excluding extreme outliers	Calculated	minutes
TT_X3Up_X3Down_Extreme	Travel time X3Up to X3Down, excluding extreme outliers	Calculated	minutes
TT_X4Up_X4Down_Extreme	Travel time X4Up to X4Down, excluding extreme outliers	Calculated	minutes
TT_X4Down_X4Up_Extreme	Travel time X4Down to X4Up, excluding extreme outliers	Calculated	minutes
TT_X4Down_X3Down_Extreme	Travel time X4Down to X3Down, excluding extreme outliers	Calculated	minutes
TT_X3Down_X3Up_Extreme	Travel time X3Down to X3Up, excluding extreme outliers	Calculated	minutes
TT_X3Down_X2Down_Extreme	Travel time X3Down to X2Down, excluding extreme outliers	Calculated	minutes
TT_X2Down_X2Up_Extreme	Travel time X2Down to X2Up, excluding extreme outliers	Calculated	minutes
TT_X2Down_X1Down_Extreme	Travel time X2Down to X1Down, excluding extreme outliers	Calculated	minutes
TT_X1Down_X1Up_Extreme	Travel time X1Down to X1Up, excluding extreme outliers	Calculated	minutes
AF_Lingering_Time_Extreme	Lingering time at Alberta Falls, excluding extreme outliers	Calculated	minutes
TT_X2Up_PPVUp	Travel time X2Up to PPVUp, excluding extreme outliers	Calculated	minutes
TT_PPVUp	Travel time PPVUp, excluding extreme outliers	Calculated	minutes
TT_PPVUp_X3Up	Travel time PPVUp to X3Up, excluding extreme outliers	Calculated	minutes
TT_X3Down_PPVDown	Travel time X3Down to PPVDown, excluding extreme outliers	Calculated	minutes
TT_PPVDown	Travel time PPVDown, excluding extreme outliers	Calculated	minutes
TT_PPVDown_X2Down	Travel time PPVDown to X2Down, excluding extreme outliers	Calculated	minutes
TT_X1Up_X2Up_Mild	Travel time X1Up to X2Up, excluding mild outliers	Calculated	minutes

Variable	Description	Origin	Values
TT_X1Up_X1Down_Mild	Travel time X1Up to X1Down, excluding mild outliers	Calculated	minutes
TT_X2Up_X3Up_Mild	Travel time X2Up to X3Up, excluding mild outliers	Calculated	minutes
TT_X2Up_X2Down_Mild	Travel time X2Up to X2Down, excluding mild outliers	Calculated	minutes
TT_X3Up_X4Up_Mild	Travel time X3Up to X4Up, excluding mild outliers	Calculated	minutes
TT_X3Up_X3Down_Mild	Travel time X3Up to X3Down, excluding mild outliers	Calculated	minutes
TT_X4Up_X4Down_Mild	Travel time X4Up to X4Down, excluding mild outliers	Calculated	minutes
TT_X4Down_X4Up_Mild	Travel time X4Down to X4Up, excluding mild outliers	Calculated	minutes
TT_X4Down_X3Down_Mild	Travel time X4Down to X3Down, excluding mild outliers	Calculated	minutes
TT_X3Down_X3Up_Mild	Travel time X3Down to X3Up, excluding mild outliers	Calculated	minutes
TT_X3Down_X2Down_Mild	Travel time X3Down to X2Down, excluding mild outliers	Calculated	minutes
TT_X2Down_X2Up_Mild	Travel time X2Down to X2Up, excluding mild outliers	Calculated	minutes
TT_X2Down_X1Down_Mild	Travel time X2Down to X1Down, excluding mild outliers	Calculated	minutes
TT_X1Down_X1Up_Mild	Travel time X1Down to X1Up, excluding mild outliers	Calculated	minutes
AF_Lingering_Time_Mild	Lingering time at Alberta Falls, excluding mild outliers	Calculated	minutes
TT_X2Up_PPVUp	Travel time X2Up to PPVUp, excluding mild outliers	Calculated	minutes
TT_PPVUp	Travel time PPVUp, excluding mild outliers	Calculated	minutes
TT_PPVUp_X3Up	Travel time PPVUp to X3Up, excluding mild outliers	Calculated	minutes
TT_X3Down_PPVDown	Travel time X3Down to PPVDown, excluding mild outliers	Calculated	minutes
TT_PPVDown	Travel time PPVDown, excluding mild outliers	Calculated	minutes
TT_PPVDown_X2Down	Travel time PPVDown to X2Down, excluding mild outliers	Calculated	minutes
X1_to_BLT_Freq	First time through or Through Previously, X1 to Bear Lake Junction	Calculated	1 = First Time Through 2 = Through Previously
X1_to_BLT TM	Next location after X1 to Bear Lake Junction	Calculated	X1, X2, or X4
X2_to_BLT_Freq	Not Yet Visited Falls or Visited Falls, X2 to Bear Lake Junction	Calculated	1 = Not Yet Visited Falls 2 = Visited Falls
X2_to_BLT TM	Next location after X2 to Bear Lake Junction	Calculated	X1, X2, or X4
X3_to_BLT_Freq	First time through or Through Previously, X3 to Bear Lake Junction	Calculated	1 = First Time Through 2 = Through Previously
X3_to_BLT TM	Next location after X3 to Bear Lake Junction	Calculated	X1, X2, or X4
X3_to_AF_Freq	Not Yet Visited Falls or Visited Falls, X3 to Alberta Falls	Calculated	1 = Not Yet Visited Falls 2 = Visited Falls

Variable	Description	Origin	Values
X3_to_AF TM	Next location after X3 to Alberta Falls	Calculated	X1, X2, or X4
X4_to_AF_Freq	Not Yet Visited Falls or Visited Falls, X4 to Alberta Falls	Calculated	1 = Not Yet Visited Falls 2 = Visited Falls
X4_to_AF TM	Next location after X4 to Alberta Falls	Calculated	X1, X2, or X4
Comments	Comments		Text

Appendix M-Dream Lake Trail Hiking Route Survey Codebook

Refers to *Hiking Route Survey Data and Analysis\Data Analysis - DLT.xls*

Variable	Description	Origin	Values
Date	Date of intercept	Card Front	dd/mm/yy
Card #	Unique card number	Card Front	#
Group_Size_Raw	Number in group	Card Front	#
Group_Size_Extreme	Number in group, excluding extreme outliers	Calculated	#
Group_Size_Extreme_Recode	Small/Large Groups	Calculated	1 = Small Group (3 or less) 2 = Large Group (4 or more)
Start_Loc	Location where started hike for the day	Card Front	1 = BLT 2 = GGT 3 = BL parking lot to Connector to GGT
Start_Route	Route to intercept from parking lot/shuttle stop, if Q2 = 1	Card Front	1 = Direct from BL parking lot (i.e., no visit BL) 2 = Visited BL first
Mode	Mode to start location	Card Front	1 = Personal Vehicle 2 = Shuttle Bus 3 = Other
Mode_Recode	Mode to start location, re-coded	Calculated	1 = Personal Vehicle 2 = Shuttle Bus
Vehicles	Number of vehicles, if Mode = 1	Card Front	#
Activity	Primary activity today	Card Front	1 = Hiking 2 = Backpacking 3 = Fishing 4 = Rock Climbing 5 = Other or Multiple Given
Activity_Other	Other primary activity today	Card Front	1 = Hiking and Fishing 2 = Hiking and Photography 3 = Hiking and Scavenger Hunt 4 = Bouldering
Lot_Time	Time to intercept from parking lot/shuttle stop, if Q2 = 1	Calculated	Time in minutes; Leave blank if DK; If range of time was given by respondent, the midpoint was entered
Lot_Time_Extreme	Time to intercept from parking lot/shuttle stop, if Enter_Loc = 1, excluding extreme outliers	Calculated	Minutes; Blank if DK
Enter_Loc	Intercept location where entered study site	Card Back	1 = X1 2 = X2 3 = X3
Enter_Type	True entry or re-entry	Card Back	1 = True Entry 2 = Re-Entry
Earlier_Exit_Loc	Location where exited study site earlier today, if Enter_Type = 2	Card Back	2 = X2 3 = X3 99 = Don't Know
Time_Earlier_Exit	Time passed since earlier exit if Enter_Type = 2	Card Back	Enter time in minutes; Blank if "DK"; If range of time was given by respondent, the midpoint was entered

Variable	Description	Origin	Values
Hiayaha_Return	Have a card and exited toward Lake Hiayaha; Do they plan to return to X3?	Card Back	1 = Yes
X1_Up_Time	Time when heading uphill at X1 (entering system)	Card Back	hh:mm:ss (military); if entered at different location leave blank
X2_Up_Time	Time when heading uphill at X2	Card Back	hh:mm:ss (military); leave blank if does not apply
X3_Up_Time	Time when heading uphill at X3; could be entry time or exit time	Card Back	hh:mm:ss (military); leave blank if does not apply
HiayahaUp_Time	Time exiting to Hiayaha	Card Back	hh:mm:ss (military); leave blank if does not apply
HiayahaDown_Time	Time returning to system from Hiayaha (re-entry)	Card Back	hh:mm:ss (military); leave blank if does not apply
X4_Up_Time	Time when heading uphill at X4; system exit time	Card Back	hh:mm:ss (military); leave blank if does not apply
X4_Down_Time	Time when heading downhill at X4	Card Back	hh:mm:ss (military); leave blank if does not apply
X3_Down_Time	Time when heading downhill at X3; could be exit time	Card Back	hh:mm:ss (military); leave blank if does not apply
X2_Down_Time	Time when heading downhill at X2	Card Back	hh:mm:ss (military); leave blank if does not apply
X1_Down_Time	Time when heading downhill at X1; system exit time	Card Back	hh:mm:ss (military); leave blank if does not apply
Exit_Loc	Exiting intercept location	Card Back	1 = X1 2 = X2 3 = X3
Shuttle	Intend to ride shuttle bus at end of hike?	Card Back	1 = Yes, BLT Shuttle 2 = Yes, GGT Shuttle 3 = No 4 = Yes, Bierstadt Lake Trailhead
Shuttle_Group	Type of Shuttle Group	Calculated	1 = GGT-Starter Arrived via Private Vehicle 2 = GGT-Starter Arrived via Shuttle/Dropped Off 3 = Non-GGT-Starter Arrived via Any Mode
Hiking_Route	Hiking route	Calculated	1 = Did not make it to Nymph 2 = Only made it to Nymph 3 = Only hiked to Dream 4 = Hiked all the way to Emerald 5 = Hike included trip to Hiayaha or beyond (This code trumps all others; so, if hiked to Dream and Hiayaha, code as Hiayaha.)
X1Up	Order of route stop (lower numbers occurred first)	Calculated	#
X2Up	Order of route stop (lower numbers occurred first)	Calculated	#
X3Up	Order of route stop (lower numbers occurred first)	Calculated	#
HiayahaUp	Order of route stop (lower numbers occurred first)	Calculated	#
HiayahaDown	Order of route stop (lower numbers occurred first)	Calculated	#

Variable	Description	Origin	Values
X4Up	Order of route stop (lower numbers occurred first)	Calculated	#
X4Down	Order of route stop (lower numbers occurred first)	Calculated	#
X3Down	Order of route stop (lower numbers occurred first)	Calculated	#
X2Down	Order of route stop (lower numbers occurred first)	Calculated	#
X1Down	Order of route stop (lower numbers occurred first)	Calculated	#
RouteLoc1	First stop	Calculated	Location
RouteLoc2	Second stop	Calculated	Location
RouteLoc3	Third stop	Calculated	Location
RouteLoc4	Fourth stop	Calculated	Location
RouteLoc5	Fifth stop	Calculated	Location
RouteLoc6	Sixth stop	Calculated	Location
RouteLoc7	Seventh stop	Calculated	Location
RouteLoc8	Eighth stop	Calculated	Location
RouteLoc9	Ninth stop	Calculated	Location
Hiking_Route_1_Check	Checks route order based on Hiking_Route 1	Calculated	0 = Logical 1 = Error
Hiking_Route_2_Check	Checks route order based on Hiking_Route 2	Calculated	0 = Logical 1 = Error
Hiking_Route_3_Check	Checks route order based on Hiking_Route 3	Calculated	0 = Logical 1 = Error
Hiking_Route_4_Check	Checks route order based on Hiking_Route 4	Calculated	0 = Logical 1 = Error
Hiking_Route_5_Check	Checks route order based on Hiking_Route 5	Calculated	0 = Logical 1 = Error
RouteCheckEnter	Checks whether route stop pairings are logical: EnterLoc and Route Loc1	Calculated	0 = Logical 1 = Error
RouteCheck1	Checks whether route stop pairings are logical: RouteLoc1 and Route Loc2	Calculated	0 = Logical 1 = Error
RouteCheck2	Checks whether route stop pairings are logical: RouteLoc2 and Route Loc3	Calculated	0 = Logical 1 = Error
RouteCheck3	Checks whether route stop pairings are logical: RouteLoc3 and Route Loc4	Calculated	0 = Logical 1 = Error
RouteCheck4	Checks whether route stop pairings are logical: RouteLoc4 and Route Loc5	Calculated	0 = Logical 1 = Error
RouteCheck5	Checks whether route stop pairings are logical: RouteLoc5 and Route Loc6	Calculated	0 = Logical 1 = Error
RouteCheck6	Checks whether route stop pairings are logical: RouteLoc6 and Route Loc7	Calculated	0 = Logical 1 = Error
RouteCheck7	Checks whether route stop pairings are logical: RouteLoc7 and Route Loc8	Calculated	0 = Logical 1 = Error
RouteCheck8	Checks whether route stop pairings	Calculated	0 = Logical

Variable	Description	Origin	Values
	are logical: RouteLoc8 and Route Loc9		1 = Error
RouteCheck9	Checks whether route stop pairings are logical: RouteLoc9 and Route Loc10	Calculated	0 = Logical 1 = Error
RouteCheckExit	Checks whether route stop pairings are logical: Last Stop and Exit Loc	Calculated	0 = Logical 1 = Error
Valid Route	Determines if entire route is valid	Calculated	0 = Valid 1 = Invalid
TT_X1Up_X1Down	Travel time X1Up to X1Down	Calculated	minutes
TT_X1Up_PPVUp	Travel time X1Up to PPVUp	Calculated	minutes
TT_PPVUp	Travel time PPVUp	Calculated	minutes
TT_PPVUp_X2Up	Travel time PPVUp to X2Up	Calculated	minutes
TT_X2Up_X2Down	Travel time X2Up to X2Down	Calculated	minutes
TT_X2Up_X3Up	Travel time X2Up to X3Up	Calculated	minutes
TT_X2Up_HiayahaUp	Travel time X2Up to HiayahaUp	Calculated	minutes
TT_X2Up_X3UpHiayahaUp	Travel time X2Up to either X3Up or HiayahaUp (Combination)	Calculated	minutes
TT_X3Up_HiayahaUp	Travel time X3Up to HiayahaUp	Calculated	minutes
TT_X3Up_X3Down	Travel time X3Up to X3Down	Calculated	minutes
TT_X3Up_HiayahaUpX3Down	Travel time X3Up to either HiayahaUp or X3 Down (Combination)	Calculated	minutes
TT_X3Up_X4Up	Travel time X3Up to X4Up	Calculated	minutes
TT_HiayahaDown_X4Up	Travel time HiayahaDown to X4Up	Calculated	minutes
TT_X3UpHiayahaDown_X4Up	Travel time from either X3Up or HiayahaDown to X4Up (Combination)	Calculated	minutes
TT_HiayahaUp_HiayahaDown	Travel time HiayahaUp to HiayahaDown	Calculated	minutes
TT_HiayahaDown_X3Down	Travel time HiayahaDown to X3Down	Calculated	minutes
TT_X4Up_X4Down	Travel time X4Up to X4Down	Calculated	minutes
TT_X4Down_X3Down	Travel time X4Down to X3Down	Calculated	minutes
TT_X4Down_HiayahaUp	Travel time X4Down to HiayahaUp	Calculated	minutes
TT_X4Down_X3DownHiayaha Up	Travel time from X4Down to X3Down or HiayahaUp (Combination)	Calculated	minutes
TT_HiayahaDown_X2Down	Travel time HiayahaDown to X2Down	Calculated	minutes
TT_X3Down_X2Down	Travel time X3Down to X2Down	Calculated	minutes
TT_HiayahaDownX3Down_X2 Down	Travel time from either Hiayaha Down or X3Down to X2Down (Combination)	Calculated	minutes
TT_X2Down_PPVDown	Travel time X2Down to PPVDown	Calculated	minutes
TT_PPVDown	Travel time PPVDown	Calculated	minutes
TT_PPVDown_X1Down	Travel time PPVDown to X1Down	Calculated	minutes
TT_X1Up_X1Down_Extreme	Travel time X1Up to X1Down, excluding extreme outliers	Calculated	minutes
TT_X1Up_PPVUp_Extreme	Travel time X1Up to PPVUp, excluding extreme outliers	Calculated	minutes
TT_PPVUp_Extreme	Travel time PPVUp, excluding extreme outliers	Calculated	minutes
TT_PPVUp_X2Up_Extreme	Travel time PPVUp to X2Up, excluding extreme outliers	Calculated	minutes

Variable	Description	Origin	Values
TT_X2Up_X2Down_Extreme	Travel time X2Up to X2Down, excluding extreme outliers	Calculated	minutes
TT_X2Up_X3UpHiayahaUp_Extreme	Travel time X2Up to either X3Up or HiayahaUp (Combination), excluding extreme outliers	Calculated	minutes
TT_X3Up_HiayahaUpX3Down_Extreme	Travel time X3Up to either HiayahaUp or X3 Down (Combination), excluding extreme outliers	Calculated	minutes
TT_X3UpHiayahaDown_X4Up_Extreme	Travel time from either X3Up or HiayahaDown to X4Up (Combination), excluding extreme outliers	Calculated	minutes
TT_HiayahaUp_HiayahaDown_Extreme	Travel time HiayahaUp to HiayahaDown, excluding extreme outliers	Calculated	minutes
TT_HiayahaDown_X3Down_Extreme	Travel time HiayahaDown to X3Down, excluding extreme outliers	Calculated	minutes
TT_X4Up_X4Down_Extreme	Travel time X4Up to X4Down, excluding extreme outliers	Calculated	minutes
TT_X4Down_X3DownHiayahaUp_Extreme	Travel time from X4Down to X3Down or HiayahaUp (Combination), excluding extreme outliers	Calculated	minutes
TT_HiayahaDownX3Down_X2Down_Extreme	Travel time from either Hiayaha Down or X3Down to X2Down (Combination), excluding extreme outliers	Calculated	minutes
TT_X2Down_PPVDown_Extreme	Travel time X2Down to PPVDown, excluding extreme outliers	Calculated	minutes
TT_PPVDown_Extreme	Travel time PPVDown, excluding extreme outliers	Calculated	minutes
TT_PPVDown_X1Down_Extreme	Travel time PPVDown to X1Down, excluding extreme outliers	Calculated	minutes
TT X3 to Dream Lake	Travel time from X3 to Dream Lake, excluding extreme outliers (Combination)	Calculated	minutes
TT X3 to Dream Lake Grouping	Travel time from X3 to Dream Lake, excluding extreme outliers Grouping	Calculated	1 = Before going to Lake Hiayaha 2 = After going to Lake Hiayaha 3 = Before and after going to Lake Hiayaha
X2UpRoutingFrom	The location groups came from immediately before X2 Up	Calculated	Location
X2UpRoutingTo	The location groups went to immediately after X2 Up	Calculated	Location
X2DownRoutingFrom	The location groups came from immediately before X2 Down	Calculated	Location
X2DownRoutingTo	The location groups went to immediately after X2 Down	Calculated	Location
X3UpRoutingFrom	The location groups came from immediately before X3 Up	Calculated	Location
X3UpRoutingTo	The location groups went to immediately after X3 Up	Calculated	Location
X3DownRoutingFrom	The location groups came from immediately before X3 Down	Calculated	Location

Variable	Description	Origin	Values
X3DownRoutingTo	The location groups went to immediately after X3 Down	Calculated	Location
X4UpRoutingFrom	The location groups came from immediately before X4 Up	Calculated	Location
X4UpRoutingTo	The location groups went to immediately after X4 Up	Calculated	Location
X4DownRoutingFrom	The location groups came from immediately before X4 Down	Calculated	Location
X4DownRoutingTo	The location groups went to immediately after X4 Down	Calculated	Location
Comments	Comments		Text

APPENDIX N-TIMESTAMP DATA EVENT CODES

All timestamp data collected during summer 2008 are contained within the file *RMNP visitor count data_2008.zip*. Names of site-specific files contained within this zip file are noted below.

Glacier Gorge Trail Timestamp Data 2008: Event Codes

Timestamp data used to compute arrivals and interarrivals are contained within the file *GGT timestamp_ 2008.zip*.

Arrival Data – X1

"A" = Arriving Visitor, from Parking Lot

"B" = Departing Visitor, toward Parking Lot

Arrival Data – X2

"A" = Arriving Visitor, Southbound from X1 toward X3

"B" = Departing Visitor, Northbound from X3 to X1

"C" = Departing Visitor, Northbound from X3 toward Bear Lake

"D" = Departing Visitor, Southbound from X1 toward Bear Lake

"E" = Arriving Visitor, from Bear Lake toward X3

"F" = Arriving Visitor, from Bear Lake toward X1

Arrival Data – X4

"A" = Arriving Visitor, Northbound toward X3

"B" = Departing Visitor, Southbound toward Backcountry

All other event codes represent key stroke errors.

Dream Lake Trail Timestamp Data 2008: Event Codes

Timestamp data used to compute arrivals and interarrivals are contained within the file *DLT timestamp_ 2008.zip*.

Arrival Data – X1

"A" = Arriving Visitor, from Bear Lake Trailhead toward X2

"B" = Arriving Visitor, from Glacier Gorge Trailhead toward X2

"C" = Departing Visitor, Eastbound

Arrival Data – X2

"A" = Arriving Visitor, Westbound toward X3

"B" = Arriving Visitor, Eastbound toward X1

"C" = Departing Visitor, from X1 departing toward Fire Road

"D" = Departing Visitor, from X1 departing toward Fire Road

"E" = Arriving Visitor, from Fire Road toward X1

"F" = Arriving Visitor, from Fire Road toward X3

Arrival Data – X3

“A” = Arriving Visitor, Westbound from X2 toward X4

“B” = Arriving Visitor, Eastbound from X4 toward X2

“C” = Departing Visitor, from X2 departing toward Lake Hiayaha

“D” = Departing Visitor, from X4 departing toward Lake Hiayaha

“E” = Arriving Visitor, from Lake Hiayaha toward X2

“F” = Arriving Visitor, from Lake Hiayaha toward X4

All other event codes represent key stroke errors.

APPENDIX O-LEAVE NO TRACE SURVEY INSTRUMENT

Surveyor Use Only
ID: ______ Date: / / 2009
Time: __________ AM/PM

Colorado State University

1. Please indicate your level of agreement with the following statements using the scale '1' NOT AT ALL UNDER MY CONTROL to '7' COMPLETELY UNDER MY CONTROL. ***Circle the number of your response for each statement.***

	Not at all under my control			Neutral			Completely under my control
a. How I act while in Rocky Mountain National Park is…	1	2	3	4	5	6	7
b. The way I act while on the trail in Rocky Mountain National Park is…	1	2	3	4	5	6	7
c. My recreation practices in Rocky Mountain National Park are…	1	2	3	4	5	6	7
d. The way the individuals in my group act while in Rocky Mountain National Park is…	1	2	3	4	5	6	7

2. Please indicate how INAPPROPRIATE or APPROPRIATE you think each of the following activities is for a visitor to do in Rocky Mountain National Park. ***Circle the number of your response for each statement.***

Activities	Very Inappropriate			Neutral			Very Appropriate
a. Experience nature by not preparing for all types of weather or hazards before I get on a trail	1	2	3	4	5	6	7
b. Schedule my trip during times of high use to reduce overall impact	1	2	3	4	5	6	7
c. Travel off trail to experience the natural environment	1	2	3	4	5	6	7
d. Walk around muddy spots on the trail	1	2	3	4	5	6	7
e. Use the bathroom in a lake, river or stream if there are no public facilities	1	2	3	4	5	6	7
f. Carry all litter back out, leaving only food scraps behind	1	2	3	4	5	6	7
g. Keep a single item like a rock, plant, stick or feather as a souvenir	1	2	3	4	5	6	7
h. Move rocks and/or logs to make a resting location more comfortable	1	2	3	4	5	6	7
i. Drop food on the ground to provide wildlife a food source	1	2	3	4	5	6	7
j. Approach wildlife to take a photo	1	2	3	4	5	6	7
k. Hike side by side with members of my group on existing trails	1	2	3	4	5	6	7
l. Take a break along the edge of the trail	1	2	3	4	5	6	7

3. Please indicate the level at which you think each of the following activities would reduce negative impacts and improve visitor experiences in the Park. ***Circle the number of your response for each statement.***

Participating in the following activities in Rocky Mountain National Park would reduce impact…	Never			Sometimes			Every time
a. Prepare for all types of weather, hazards, or emergencies before I get on a trail	1	2	3	4	5	6	7
b. Schedule trip to avoid times of high use	1	2	3	4	5	6	7
c. Stay on designated or established trails	1	2	3	4	5	6	7
d. Walk single file in the middle of the trail, even when wet or muddy	1	2	3	4	5	6	7
e. Carry out all litter, even crumbs, peels, or cores	1	2	3	4	5	6	7
f. Never remove objects from the area, not even a small item like a rock, plant, stick, or feather	1	2	3	4	5	6	7
g. Never approach, feed, or follow wildlife	1	2	3	4	5	6	7
h. Take breaks away from the trail and other visitors	1	2	3	4	5	6	7

4. The same activities are listed below. Regardless of how effective you think each of the following activities are, please indicate how DIFFICULT you think each of the following activities would be for a visitor to do in Rocky Mountain National Park. ***Circle the number of your response for each statement.***

Activities	Not at all Difficult			Moderately Difficult			Extremely Difficult
a. Prepare for all types of weather, hazards, or emergencies before I get on a trail	1	2	3	4	5	6	7
b. Schedule trip to avoid times of high use	1	2	3	4	5	6	7
c. Stay on designated or established trails	1	2	3	4	5	6	7
d. Walk single file in the middle of the trail, even when wet or muddy	1	2	3	4	5	6	7
e. Carry out all litter, even crumbs, peels, or cores	1	2	3	4	5	6	7
f. Never remove objects from the area, not even a small item like a rock, plant, stick, or feather	1	2	3	4	5	6	7
g. Never approach, feed, or follow wildlife	1	2	3	4	5	6	7
h. Take breaks away from the trail and other visitors	1	2	3	4	5	6	7

5. The same activities are listed below. In COLUMN A tell us if you DO each activity by ***circling*** **NEVER, SOMETIMES or ALWAYS.**
In COLUMN B, please indicate how LIKELY are you to do the activity in the future by ***circling the number of your response for each statement.***

Column A				Column B How Likely Are You To Do This In The Future?						
Activities	Do You Do This Now?			Not at all Likely			Moderately Likely			Extremely Likely
a. Prepare for all types of weather, hazards, or emergencies before I get on a trail	Never	Sometimes	Always	1	2	3	4	5	6	7
b. Schedule trip to avoid times of high use	Never	Sometimes	Always	1	2	3	4	5	6	7
c. Stay on designated or established trails	Never	Sometimes	Always	1	2	3	4	5	6	7

Activities	Do You Do This Now?			Not at all Likely			Moderately Likely			Extremely Likely
d. Walk single file in the middle of the trail, even when wet or muddy	Never	Sometimes	Always	1	2	3	4	5	6	7
e. Carry out all litter, even crumbs, peels, or cores	Never	Sometimes	Always	1	2	3	4	5	6	7
f. Never remove objects from the area, not even a small item like a rock, plant, stick, or feather	Never	Sometimes	Always	1	2	3	4	5	6	7
g. Never approach, feed, or follow wildlife	Never	Sometimes	Always	1	2	3	4	5	6	7
h. Take breaks away from the trail and other visitors	Never	Sometimes	Always	1	2	3	4	5	6	7

6. How FAMILIAR are you with the Leave No Trace Center for Outdoor Ethics? ***Please circle only one number.***

Not at all Familiar		Slightly Familiar		Moderately Familiar		Quite Familiar		Extremely Familiar
0		1		2	3	4	5	6

7. How would you describe your current knowledge of "Leave No Trace" practices? ***Please circle only one number.***

No Knowledge	Very Limited	Limited	Average	Above Average	Extensive	Expert
0	1	2	3	4	5	6

8. Please indicate how strongly you AGREE or DISAGREE with the following statements. ***Circle the number of your response for each statement.***

Activities	Strongly Disagree			Neutral			Strongly Agree
a. Sometimes it is too difficult to practice "Leave No Trace."	1	2	3	4	5	6	7
b. Practicing "Leave No Trace" takes too much time.	1	2	3	4	5	6	7
c. Practicing "Leave No Trace" violates the rights of an individual to do as they please in the outdoors.	1	2	3	4	5	6	7
d. Practicing "Leave No Trace" does not reduce the environmental harm caused by travel in the Park.	1	2	3	4	5	6	7
e. Practicing "Leave No Trace" effectively protects the environment so that future generations may enjoy it.	1	2	3	4	5	6	7
f. Practicing "Leave No Trace" enhances my outdoor experience.	1	2	3	4	5	6	7
g. It is important that all visitors practice "Leave No Trace."	1	2	3	4	5	6	7
h. It is important that Park regulations require all visitors to practice "Leave No Trace."	1	2	3	4	5	6	7
i. The people I recreate with believe it is important to practice "Leave No Trace."	1	2	3	4	5	6	7
j. In general, the opinions of others have little effect on my practicing "Leave No Trace."	1	2	3	4	5	6	7

Activities	Strongly Disagree			Neutral			Strongly Agree
k. I practice "Leave No Trace" because the people I recreate with believe it is important.	1	2	3	4	5	6	7
l. I practice "Leave No Trace" because the Park regulations state that I should do so.	1	2	3	4	5	6	7
m. It is important to practice "Leave No Trace" techniques when in the Park.	1	2	3	4	5	6	7
n. If I learned my actions in the Park damaged the environment, I would change my behavior.	1	2	3	4	5	6	7
o. I get upset when I see other individuals in the Park not following "Leave No Trace" practices.	1	2	3	4	5	6	7
p. I insist that "Leave No Trace" practices are followed by all members of my group.	1	2	3	4	5	6	7

9. How FREQUENTLY in the past 3 months, did you do any of the following activities related to "Leave No Trace?"
Circle the number of your response for each statement.

Activities	Not at All			Often			Very Frequently
a. Talk with others	1	2	3	4	5	6	7
b. Read articles and books	1	2	3	4	5	6	7
c. Take courses or attend meetings	1	2	3	4	5	6	7
d. Teach others	1	2	3	4	5	6	7
e. View websites ("Leave No Trace," Facebook, YouTube or Twitter)	1	2	3	4	5	6	7

Other (Please specify): ______________________________

10. Where did you first learn about "Leave No Trace?" ***Please check only one answer.***
- ☐ Leave No Trace website
- ☐ Course or seminar
- ☐ Information kiosk/ Park literature
- ☐ Park personnel/interpretive talk
- ☐ Popular media (magazines, books)
- ☐ Other (Please specify): ____________

11. What is your gender? ☐ Male ☐ Female

12. In what year were you born? _________

13. Do you live in the United States?
- ☐ Yes – What is your zip code? ____________
- ☐ No – In what country do you live? __________________

14. What is the highest level of education you have completed?
- ☐ Some high school
- ☐ High school graduate or GED
- ☐ Some college, business, or trade school
- ☐ College, business, or trade school graduate
- ☐ Some graduate school
- ☐ Master's, doctoral, or professional degree

15. What is your race? (Check one or more)
- ☐ American Indian or Alaskan Native
- ☐ Asian
- ☐ Black or African American
- ☐ Native Hawaiian or Pacific Islander
- ☐ White or Caucasian

Thank you for participating in this survey. Your input is very important to Colorado State University and Rocky Mountain National Park.

APPENDIX P-LNT SURVEY LOG

RMNP Survey Log   Pg __ of __

Location______________ Date___________ Day of Week______

Time Arrive________ Time Leave_________ Name____________

Time	Group #'s	Adults #'s	#Children (<15yrs)	Refuse/ Accept	LNT Survey #'s	Crowding Survey #'s	Language Barrier Y/N	Comments

APPENDIX Q-LNT ELICITATION STUDY SURVEY INSTRUMENT

Surveyor Use Only
ID: ______
Date: / / 2009
Time: _______ AM/PM

Colorado State University

1. In Part A., please indicate the ADVANTAGES or DISADVANTAGES you see in each photo. If DISADVANTAGES are discovered, in Part B., indicate what action you would take as a manager of this area to alleviate the stated DISADVANTAGE.

Photo 1:

a. Advantage ______________________________

Or

Disadvantage ______________________________

b. Action to alleviate Disadvantage ______________________________

Photo 2:

a. Advantage ______________________________

Or

Disadvantage ______________________________

b. Action to alleviate Disadvantage ______________________________

Photo 3:

a. Advantage ______________________________

Or

Disadvantage ______________________________

b. Action to alleviate Disadvantage ______________________________

Photo 4:

a. Advantage ______________________________

Or

Disadvantage ______________________________

b. Action to alleviate Disadvantage ______________________________

Photo 5:

a. Advantage ____

____

Or

Disadvantage ____

____

b. Action to alleviate Disadvantage____

____

Photo 6:

a. Advantage ____

____

Or

Disadvantage ____

____

b. Action to alleviate Disadvantage____

____

Photo 7:

a. Advantage ____

____

Or

Disadvantage ____

____

b. Action to alleviate Disadvantage____

____

Photo 8:

a. Advantage ____

____

Or

Disadvantage ____

____

b. Action to alleviate Disadvantage____

____

2. List everything that you know to be true about "Leave No Trace" in the boxes provided below. As an example, this might include the advantages and disadvantages that you associate with "Leave No Trace." Please write only 1 belief in each box. If you have less than 7 beliefs to list, leave the remaining box(es) blank.

a.

b.

c.

d.

e.

f.

g.

Thank you for participating in this survey. Your input is very important to Colorado State University and Rocky Mountain National Park.

APPENDIX R-ELICITATION STUDY LOG

Survey Log

RMNP Leave No Trace Elicitation Survey Log

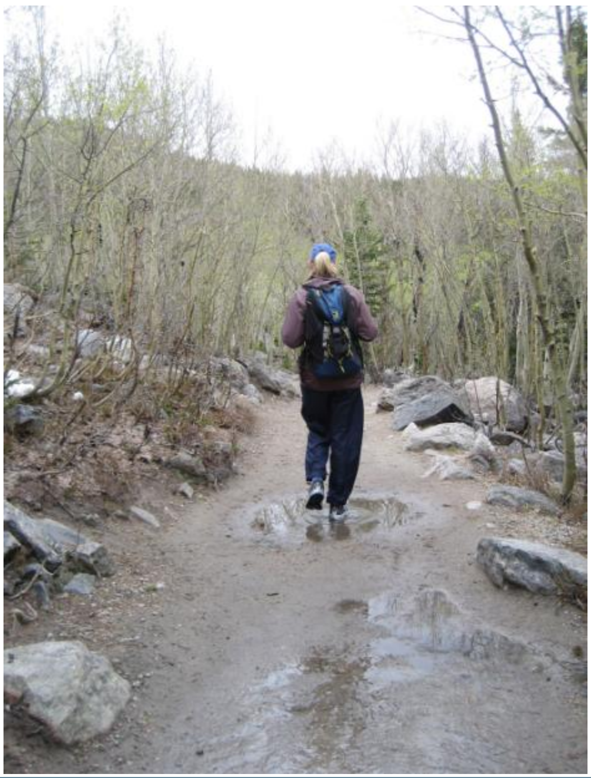
Location______________ Date___________ Day of Week______

Time Arrive________ Time Leave_________ Name____________

Time	Group #	# Adults	#Children (<15yrs)	# Not Given	Survey #'s	Comments

APPENDIX S-ELICITATION STUDY SURVEY PHOTOS


Protect
WILD
UTAH



APPENDIX T-CONDITION CLASS DEFINITIONS FOR SITE AND TRAIL ASSESSMENT

Visitor Site Condition Class Definitions and Categories

Condition Class	Definition
1	Site barely distinguishable; slight loss of vegetation cover and /or minimal disturbance of organic litter.
2	Campsite obvious; vegetation cover lost and/or organic litter pulverized in primary use areas
3	Campsite obvious; vegetation cover and organic litter lost in primary use areas, bare soil present in primary use areas.
4	Nearly complete or total loss of vegetation cover and organic litter, bare soil widespread.
5	Soil erosion obvious, as indicated by exposed tree roots and rocks and/or gullying.

Informal Trail Condition Class Definitions

Condition Class	Definition
1	Trail distinguishable; slight loss of vegetation cover and/or minimal disturbance of organic litter.
2	Trail obvious; > 50% vegetation cover lost primary use areas; slight loss of organic litter
3	Nearly complete or total loss of vegetation cover and organic litter within the tread, bare mineral soil prevalent
4	Complete or total loss of vegetation cover and organic litter within the tread, some erosion present indicated by exposed roots and rocks and/or gullying
5	Soil erosion severe, as indicated by exposed roots and rocks and gullying exceeding 25cm in depth.