THESIS

ESTIMATING VISITOR USE IN THE BACKCOUNTRY OF ROCKY MOUNTAIN NATIONAL PARK

Submitted by

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ABSTRACT

ESTIMATING VISITOR USE IN THE BACKCOUNTRY OF ROCKY MOUNTAIN NATIONAL PARK

This study estimated the number of visitors to the backcountry areas of Rocky Mountain National Park (ROMO), using an active infrared monitoring system. Techniques for conducting this type of visitor use estimation in not only a national park, but also in rugged wilderness areas are presented and include; proper placement of field equipment and the calibration to correct monitor error.

Conducted during the summer and fall seasons of 2002, 2003 and 2004 the use estimation study utilized active infrared monitors placed at 59 locations along the major trails leading into the backcountry and other locations of interest to park staff. Monitors operated continuously during data collection. The highest visitor numbers were recorded in the Bear Lake area totaling 287,125 with most of this use occurring at the Alberta Falls area (140,083). Other areas of interest include the Longs Peak area where use at the trailhead was estimated at approximately 42,000 visitors while use at the summit via the Keyhole Route was approximately 11,600. Visitor numbers on the western side of ROMO were considerably lower only accounting for roughly 13% of total visitors recreating in the parks' backcountry. Results from this study provided park staff with actual backcountry visitor numbers allowing them to make informed decisions regarding the Park's trail systems. Further, this study provided a model for ROMO to replicate for future use estimation. Results from the three year use estimation study conducted at ROMO are discussed with implications for the park and other protected areas.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1 BACKGROUND AND PROBLEM STATEMENT

Study Area

Rocky Mountain National Park (ROMO) straddles the Continental Divide and is bordered by two national forests (Arapaho and Roosevelt), and four Wilderness areas (Comanche Peak, Indian Peaks, Neota and Never Summer). The communities of Estes Park and Grand Lake, Colorado provide gateways to the park on the east side and west side respectively. Park elevations range from 8,000 feet for the meadow areas and valleys up to 14,259 feet for Longs Peak, the highest point in the park. Among the diversity of recreational opportunities are five frontcountry campgrounds and over 200 backcountry campsites. Trail Ridge Road winds 48 miles between Estes Park on the east of the Park and Grand Lake on the west, provides spectacular scenery to visitors from the comfort of their vehicle as it approaches its high point at 12,183 feet elevation. In addition, the park has a total of 359 miles of trails offering opportunities for hiking, backpacking and horseback riding (www.romo.gov, 2011). Other recreational opportunities can include wildlife viewing as the park is home to larger animals such as elk, mule deer, moose, bighorn sheep, black bears, coyotes and cougars. Rock and ice climbing, fishing and enjoying wildflowers add to the diversity of recreational opportunities that can be found throughout the park.

Park Visitation

In 2012 an estimated 3.2 million people visited Rocky Mountain National Park (www.nps.gov/romo, 2014). Park visitation has been approximately 3.0 million annually since 2008, peaking at 3.2 million visitors in 2012. These estimates are calculated from the number of visitors passing through the gate from Jan 1 to December 30 using an average number of people per vehicle (www.nps.gov/romo, 2011). While this technique may address overall park

visitation it does not account for visitors in the backcountry. Backcountry visitors must obtain a permit from the Park's Backcountry Office for overnight stays in the Park. According to Barry Sweet (personal communication, 2011) approximately 6,500 permits were issued in 2010 for overnight stays in ROMO. These permits are a good source of information about visitors who camp in the backcountry and can be used as an additional source of information about Park visitation, but lack in two major areas. First the permit is issued to the trip leader no matter how many people are in the group and more importantly these permits do not account for day users who do not overnight in the backcountry.

Problem Statement

Recreation research has uncovered a wealth of information regarding visitor motives, behaviors, and attitudes, but we often know less about site-specific levels of recreational use and changes in that use over time (Hall & Shelby, 1998). Managers of parks and protected areas can use scientific measures of visitor characteristics, volume, flow, location of use, and in some cases sound and environmental impacts to guide their decision making process (Eagles, McLean & Stabler, 2000). Data about visitor numbers are essential for selecting appropriate management strategies and the effects of recreational activities on vegetation, monitoring visitor compliance to regulations, the scheduling of maintenance and allocation of management resources (Arnberger, Haider & Brandenburg, 2005; Davenport, Thompson & Anderson, 2003).

Previous visitor research at ROMO has examined the characteristics of the visitor, the visit, and the impacts recreationists can have on both frontcountry and backcountry experiences (Brooks & Titre, 2003; Schuster, Johnson & Taylor, 2004; Vaske, Donnelly, & Lehto, 2002; Wallace, Brooks & Bates, 2004). These studies explored visitor motives, crowding perceptions, place attachment, and reactions to existing and potential management actions. Accurate

information on visitor numbers allows comparison over time, which in turn allows managers to focus on areas with potential problems (Hall & Shelby, 1998).

The more accurate the measurement, the better understanding managers have in regards to those decisions (Eagles, McLean & Stabler, 2000). Accuracy regarding visitor numbers can be enhanced with the use of active infrared monitors, but few studies have described how to use the equipment and the effectiveness of using such systems in backcountry areas where visitor data tends to be more problematic to gather. There is a need for information to help park and protected area officials understand the technical aspects of effective infrared monitor calibration, data downloading, data handling and how to obtain accurate estimates of visitor numbers (Eagles, McLean & Stabler, 2000).

For ROMO visitor estimates have traditionally relied on a combination of backcountry permits issued to overnight visitors, trailhead registers, parking lot observations and in some cases traditional automated monitoring systems. Estimates of day use are often less accurate because trailhead registers are only moderately successful at providing estimates, varying according to register location, the ease of filling out the registration form and visitor compliance and parking lot counts require more labor to administer and are constrained by the sampling time frames selected for observation. Considerable effort is required by observers to obtain a reliable estimate with parking lot counts (Watson, Cole, Turner & Reynolds; 2000). Automated trail monitoring systems (i.e. seismic or magnetic detectors) are cumbersome, labor intensive to install, use, and require careful adjustment to ensure accurate numbers (Watson, Cole, Turner & Reynolds; 2000).

In 2002, Park staff identified a need to account for backcountry visitor numbers and was interested in using an accurate, efficient and low cost system that could be replicated by park staff or other researchers in the future.

CHAPTER 2 REVIEW OF RELATED LITERATURE

Methods used to estimate recreational use by land managers have been inconsistent and often have yielded results of questionable validity (English, Kocis, Zarnoch & Arnold, 2002). Moreover, a survey of over 400 US wilderness managers in multiple agencies (McClaran & Cole 1993) found that 63% relied on "best guess" estimates of visitor use and 21% used "frequent field observation". Only the 16% using permits had any systematic procedure for deriving their use-level estimates (McClaren & Cole, 1993). Effective monitoring and management of public lands cannot happen with insufficient information and knowledge of visitor numbers (Cole, 2004). It is difficult to imagine how these decisions could be made in the absence of information describing current levels and patterns of visitor use (Vande Kamp, 2009).

After conducting a visitor study (James, 1969) the authors came to these conclusions: "The things that we need to know a great deal about are becoming more numerous and more complex because more people engage in more activities more frequently on more developed sites and more classified areas with more kinds of facilities costing more money and occupying more land and more water under more intensive management while stringent budgetary requirements demand more specific information to satisfy more public interest in more types of programs coordinated with more agencies involved in more efforts."

Policymakers invariably regard acquiring visitor numbers as a basic management task (Kacynski & Crompton, 2003). Unfortunately, this task can be a complicated and difficult challenge. There are three aspects managers need to consider in confronting this challenge: the human, the logistical and the technical (Kacynski & Crompton, 2003).

Some park managers may be tempted to inflate visitor numbers in order to acquire maximum resources for their parks. Howard and Crompton (1980) note that: "Since attendance

is used for evaluation and is frequently considered as a factor in the budgetary decision-making process, there is every incentive for managers to abuse the system".

Logistical challenges of obtaining accurate visitation counts include the appropriate placement, positioning and maintenance of mechanical counters in an area with multiple access points. A single visitor may trigger a mechanical counter several times during the course of a single day. However mechanical counters tend to have a high level of accuracy when positioned correctly and accompanied with visual observations or calibrations to determine errors such as double counting (Watson et. al 2000). Where the potential for double counting exists, sampling studies must be done to estimate the extent of monitor error (Kacynski & Crompton, 2003; Titre, Bates & Gumina, 2004; Bates, Wallace & Vaske, 2006).

The technical aspect refers to how the raw data from the mechanical counters are transformed into visitor estimates. Transforming raw data into visitor estimates involves a few steps. The data are captured on the counter and then downloaded into a data collector. Once the downloaded data is stored on the data collector it has to be transferred to a computer for initial analyses. Only after the initial analyses can the process of calculating visitor estimates begin.

Obtaining accurate and usable visitor estimates in backcountry and wilderness settings continues to be problematic for resource managers because of the dispersed use in these areas and the high cost of equipment (Hollenhorst, Whisman & Ewert, 1992) such as seismic detectors and loop counters. Managers must decide on the most appropriate observation strategy and most suitable methods for identifying visitor characteristics, like the type and size of user groups, for estimating the total recreational use in an area, or for describing the short and long-term temporal distribution of use. Consequently, comprehensive knowledge about the many technical and

methodological options, their costs, and their respective advantages and disadvantages is a prerequisite for this process (Arnberger, Haider & Brandenburg, 2005).

The advantages of using active infrared monitors far outweigh the disadvantages. These units are highly portable, highly accurate and very easy to use and maintain (Yuan et. al. 1995; Watson et. al. 2000). There are certain limitations with these monitors, like being prone to vandalism, limited placement options in the high, rocky terrain above tree line and the need to determine potential sources of monitor error. These limitations can be overcome by careful camouflage to hide the monitors, careful coordination with staff regarding placement and careful calibrations to determine sources of error. By following these procedures reliable data can be collected to determine visitor estimates (Watson et. al. 2000).

The more reliable the data for visitor use estimation, the better the outcomes from its applications in processes such as visitor flow modeling, visitor impact assessment and the development of management policies. Without accurate, reliable data, no matter how good a visitor-flow or impact-assessment model is, the old saying always applies – 'garbage in-garbage out' (Cessford & Muhar, 2003). Only accurate traffic and visitor counts can meet these demands (Buenen, Jaarsma & Kramer, 2004).

CHAPTER 3 PROJECT METHODS

Study Objectives

The objectives of this study were: 1) to provide ROMO with visitor numbers for backcountry trails throughout the park using active infrared trail monitors and 2) evaluate the use of these monitors for gathering data on backcountry visitation. Results could provide baseline data on backcountry visitor numbers that can inform management actions addressing the ecological and social impacts associated with visitation and help establish needed infrastructure, trail maintenance, and visitor management priorities (i.e. ranger patrols).

Methods

Sampling Strategy

Sampling occurred on frequently used trails, on trails where other visitor studies had been conducted, and locations of specific interest to ROMO. Sampled trails had monitors placed near the trailhead, prior to or after sites of interest (i.e. Alberta Falls) and at trail junctions to capture patterns of visitor use. Data were collected over a three-year sampling period. Specific sampling locations are listed in Table 1.

Table 1. Permanent sampling locations for visitor use estimation at ROMO.

Park Area	Year Sampled	Trail or Location
Bear Lake	2002	Alberta Falls, Dream Lake, Nymph Lake, Loch Vale, Mills Lake, Lake Haiyaha, Flattop
Highway 7 Corridor	2002	Longs Peak Trailhead and Summit, Twin Sisters, Storm Pass
Moraine Park	2002	Cub Lake, The Pool
Wild Basin	2003	Copeland Falls, Calypso Cascades, Ouzel Falls, Bluebird, North St. Vrain, Thunderlake, Campground Cutoff, Allenspark, Finch Lake and Sandbeach
Western ROMO	2003	East Inlet, North Inlet, Green Mountain, Tonahutu, Onahu, Big Meadows Cascade Falls, Granite Falls
Northeastern ROMO	2004	Gem Lake, Cow Creek, North Boundary, Black Canyon, and Dunraven
Trail Ridge & Fall River Roads	2004	Lawn Lake, Deer Mountain, Ute Trail, Chapin Pass, Milner Pass, and Poudre River Trail
Western ROMO	2004	Colorado River, Timber Lake, Lulu City, Red Mountain, Corral Creek, and La Poudre Pass

In addition to these "permanent" monitor locations listed in Table 1, in 2002 "roaming" monitors were used to gather a limited amount of data at selected areas that also had visitor activity (i.e. the Service Trail, Hollowell Park, Glacier Creek, Stormy Peaks, Wind River, and Boulder Brook). Depending upon the specific site, these monitors were in place between 15 and 53 days.

Equipment

The Trailmaster™ 1550 active infrared monitor system was used to collect study data. These monitors differed from other active infrared monitors by firing pulses from the transmitter to the receiver, rather than using a continuous beam from the transmitter to receiver, conserving

battery life and allowing the monitors to collect data up to 10 months in field conditions. The combined transmitter and receiver with batteries weighed approximately 2 pounds (Figures 1 and 2) allowing researchers to carry several units at one time for installation in the field. These rugged units are waterproof and capable of functioning in temperatures from -40° F to 130° F making them ideal for the type of weather conditions found at ROMO. Furthermore each receiving unit dates and time stamps individual events (counts) providing a greater level of detail than other systems.

Figure 1.Trailmaster 1550 Transmitter

Figure 2. Trailmaster 1550 Receiver

Monitor Location and Installation

Once a sampling strategy was agreed upon, locations for monitor placement were determined through discussions with park staff, reviews of topographic maps for the area and finally field visits. Monitor locations were initially selected using topographic maps and then verified by field visits. In some instances monitor placement was not possible at the desired location, due to the lack of available trees or other suitable surfaces, or the possibility of the equipment being highly visible potentially detracting from visitor experience. In these cases, monitoring equipment was placed as close to the desired location as possible or not at all.

Once the sites were selected, monitors were temporarily mounted with tie down straps and tested for accuracy (i.e. transmitter and receiving units aligned). After alignment, the transmitters were "hard mounted" and tested again. Monitors were securely attached to a tree or other permanent object using half inch metal banding to deter theft and vandalism at approximately three feet in height to account for most visitors. In addition, monitoring equipment was camouflaged to blend into the surrounding vegetation. Most visitors were not aware of the monitors except during calibrations and data downloads. The location of each unit was recorded using a handheld GPS unit to enable sites to be used for future monitoring and mapping applications. After installation, the receiver was programmed with the correct date, time of day and a security password to minimize tampering with the data.

Data Collection

Data stored on the field units were downloaded into a Trailmaster ™ Data Collector which plugged into the receiving unit and is capable of storing up to 16,000 events from multiple units. During 2002, the first year of the study, it was necessary to download data from monitors on popular trails (i.e. Alberta Falls, Nymph Lake, and Dream Lake) twice a week to accommodate high count levels. During 2003 and 2004, data were generally downloaded weekly from each field unit. For the Longs Peak summit monitor and other remote locations (i.e. Thunderlake, Granite Falls, Corral Creek), where the number of visitors did not exceed the monitor's memory capacity, data were retrieved monthly.

The collected data from the Trailmaster units provided the number of daily counts at each location, the date and time of each event, and the total number of counts for a particular day. The data were initially imported into Excel by location, reformatted to break the date into month, day and year, and exported into the Statistical Package for Social Sciences (SPSS) for further

analyses, including calculating mean daily counts by location, mean monthly counts by location and times of highest trail visitation.

Monitor Count Calibrations

Monitor calibrations were conducted to ensure accurate and reliable data. For example, actual visitor counts (as observed by the researcher) were compared with the counts recorded by the monitor to determine the percentage of events not recorded (over counting rarely occurred). During the first year of the study, the researcher calibrated each monitor three times over the course of the data collection period. During study years two and three, calibration of monitors in remote locations was based on the performance of the other monitors at similar sites. This human calibration included observations of the monitor's performance in the morning, afternoon and evening. The direction of visitor travel (entering or leaving) and weather conditions were also recorded (Appendix B). At the end of a calibration period, the researcher downloaded the monitor's data and reset the instrument.

To adjust for inaccuracies in the count data (i.e. undercounting), a monitor's total count was inflated by a ratio calculated for that site to estimate use (Table 2). Ratios were based on the researcher's observations. For example, during calibrations it was noted that monitors were sensitive to weather conditions and that groups of visitors were more likely to be under represented than individuals passing by in single file. The performance of monitors also varied depending on their location; monitors closer to trailheads undercounted to a greater degree than those located further into the backcountry. The calibration data were also used to calculate an approximate margin of error at each location and study year (Table 2). The Standard Error for the Ratio inflator also becomes important for calculating the final estimate for a location (Table 2), as discussed later in this document.

Table 2. Ratio inflators by Park area and year.

Study Area	Year	Ratio Inflator	Standard Error Ratio Inflator
Bear Lake Area	2002	1.26	0.03710
Wild Basin & Grand Lake Areas	2003	1.25	0.04789
Trail Ridge Road & Northern Areas	2004	1.39	0.07133

Estimating Visitor Use and Use Terminology

In interpreting results it is necessary to understand the use estimation terminology used for this study. The *monitor counts* were used to estimate *visitor use.* Terms like *counts, visits,* and *visitors* are sometimes incorrectly used interchangeably. For example, a count is simply a record of a visitor passing the monitor. A visitor, however, may pass the monitor entering and exiting a trail (i.e. count = 2) and may make multiple visits to ROMO.

Given that the data for this study were derived from monitor counts (not visitor surveys), the number of visits that a given individual may have made to ROMO in a given year cannot be determined and is less important to managers since visitor use overall has more implications. To adjust for multiple counts (i.e. a visitor passing a given counter more than once) and estimate visitor use, we used a formula that was created for assessing visitor numbers at Boulder Open Space and Mountain Parks (Titre, Bates, & Gumina, 2004). In addition to understanding the differences in counts and visits, it is also necessary to understand the causes of monitor error, which can be broken into counting errors and estimation errors described in more detail below.

Recognizing Measurement Error

Although active infrared monitors provide numerous advantages (i.e. low maintenance, continuous operation, portability), over other monitoring systems such as passive infrared monitors, measurement error can occur. The accuracy and reliability of the data can be influenced by errors associated with the counts obtained from the monitors, and the procedures used in estimating visitor numbers from the count data (Deland, 1976; Hornback & Eagles, 1999; O'Rourke, 1994; Watson et. al., 2000). The methodology employed in this study attempted to account for these potential sources of measurement error through monitor calibrations.

Counting Errors

1. Placement of monitoring equipment is critical; miscounts can occur if the receiving "eye" is struck by direct sunlight low on the horizon during sunrise or sunset.
2. Improper alignment of the transmitter and receiver can result in inaccurate counts or lower than average counts.
3. Soil, dust or frost on the recorder or receiver can lead to undercounting visitors.

Estimation Errors

1. On linear trail systems where visitors enter and exit at the same location, an adjustment (division by two) is required to avoid double counting.
2. If a monitor is installed to accommodate an average human waist height of three feet, children under 36-inches may not be included in the count.
3. People walking side-by-side on wider trails can be counted as a single visitor.
4. Tightly packed groups passing the monitor at the same time can be miscounted.
5. Monitors cannot differentiate human versus animal presence.

Correcting Errors in Monitor Counts

To illustrate our approach to correcting errors in the monitor counts, consider the count data from the Nymph Lake monitor in 2002. The average inflation ratio was calculated by comparing observed visits to monitor counts and was 1.26. This suggests that overall a monitor accurately captured 1/ 1.26 = .794 or about 80% of all the users that passed by any of the locations during year one. To correct the monitor count by a factor of 1.26 at the 95% confidence interval, we used the following formulae:

$$\hat{T} = \left(\frac{N_s}{n}\right) \cdot (\bar{r}) \cdot (\tau) \qquad \text{Equation 1}$$

$$Var(\bar{r}) = [SE(\bar{r})]^2 \qquad \text{Equation 2}$$

$$\text{Var}(\hat{T}) = \left(\frac{N_s}{n}\right)^2 \cdot (\tau)^2 \cdot Var(\bar{r}) \qquad \text{Equation 3}$$

$$B = 2 \cdot \sqrt{Var(\hat{T})} \qquad \text{Equation 4}$$

$$CI = \hat{T} \pm B \qquad \text{Equation 5}$$

Where

$\hat{T}$	= estimated total monitor count	Var	= variance of ratio inflation factor
N_s	= total number of days in the sampling period	SE	= standard error of ratio inflation factor
n	= total number of days monitored	B	= bounds
$\bar{r}$	= average ratio inflation factor	CI	= confidence interval of estimate
τ	= total monitor count		

For the Nymph Lake example we have:

1) $\hat{T} = \left(\frac{N_s}{n}\right) \cdot (\bar{r}) \cdot (\tau) = \left(\frac{134}{134}\right) \cdot (1.26) \cdot (146{,}809) = 184{,}979$

2) $Var(\bar{r}) = [SE(\bar{r})]^2 = (0.0371)^2 = 0.001376$

3) $\text{Var}\left(\hat{T}\right) = \left(\frac{N_s}{n}\right)^2 \cdot (\tau)^2 \cdot Var(\bar{r}) = \left(\frac{134}{134}\right)^2 \cdot (146{,}809)^2 \cdot (0.001376) = 29{,}656{,}766$

4) $B = 2 \cdot \sqrt{Var\left(\hat{T}\right)} = 2 \cdot \sqrt{(26{,}656{,}766)} = 10{,}891$

5) $CI = \hat{T} \pm B = 184{,}979 \pm 10{,}891 = (195{,}870,\ 174{,}088)$

We conclude that the adjusted monitor count for the Nymph Lake location for the 2002 summer season was 184,979. We are 95% confident that the true monitor count is between 174,088 and 195,870.

Estimated Visitor Use

The estimated visitor use was calculated using the same method and same formula that were used to obtain corrected visitor counts with two qualifications. *First*, as suggested above, corrected monitor counts were adjusted for the number of days sampled during the sampling period. The sampling periods were broken into three start dates. The first sampling season started on Memorial Day weekend. The second sampling period began on June 1st and the third began on July 1st. These distinctions were necessary to account for the staggered placement of monitors and access to certain areas in the backcountry. For example, Milner Pass, Chapin Pass and the summit of Longs Peak could not realistically be accessed by average visitors until around the beginning of July. Monitor locations were categorized according to the three sampling seasons to estimate visitor use. For roaming monitor locations from 2002, estimates started at the beginning of the month the monitor was placed. For example if a monitor was installed on August 8th its start date would have been August 1st. Similar to the adjustment for measurement error due to missed counts (ratio inflator), an adjustment for days missed during the sampling season was computed.

$$Sampling\ \ Ratio = \left(\frac{N_s}{n}\right)$$

Where

N_S = the total number of days in the sampling period

n = the total number of days monitored or sampled.

For example, if there were 101 days in a season and we sampled 75, the sampling ratio is 1.35 (i.e., 101 / 75 = 1.35).

Second, the monitors recorded events only (i.e. no direction of travel is indicated). When visitors enter and exit at one and only one location, the monitor will count the visitor twice. Thus, if the corrected monitor count was 200 events in a day, the estimated visitor use was 100 on that day. Estimating the visitor use in an area with multiple ingress / egress points is conceptually similar if all ingress / egress points are monitored (i.e. a closed system where each visitor will count for two events). The estimated total number of visitors for a particular day was based on adding all events at all access points and dividing by 2.

CHAPTER 4 RESULTS

Results by Location and Year

Results for all areas of ROMO are presented by the year the area was sampled with visitor numbers reported first and then the counts used to derive the visitor estimate. Maps are provided to show monitor locations. Other results include mean daily counts by location, monthly counts by location and times visitors were utilizing the Park's trail systems. Final visitor numbers by location are discussed, as is the concept of "rate of decline", a term coined by researchers to describe distances visitors traveled into the backcountry before they turned back.

Monitor Locations for the Bear Lake Area 2002

In 2002, nine areas were sampled in the Bear Lake area of ROMO. These areas comprised the majority of trails that originated out of Bear Lake or were within that area, such as Bierstadt and Glacier Gorge. During sampling researchers noted that the majority of visitors hiking to Bierstadt Lake chose to utilize the trail originating from Bear Lake to access that area making it necessary to move the Bierstadt monitor to the location shown in Figure 3. In addition the ½ mile trail around Bear Lake was not sampled because Park staff and researchers considered it to be a frontcountry area. Future sampling efforts in the Park should try to account for backcountry visitors who use this trail.

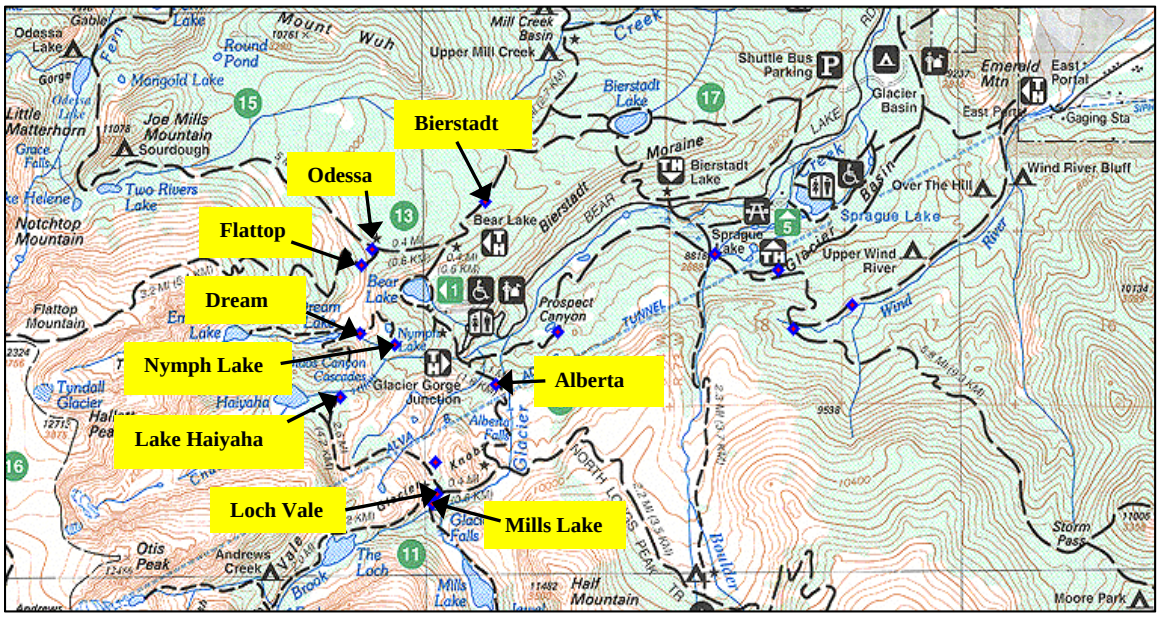

Figure 3. Monitor locations for the Bear Lake area of ROMO 2002.

Bear Lake Area – Estimated Visitor Use (2002)

Table 3 presents estimated visitor use for all monitored Bear Lake locations. Alberta Falls accounted for the highest visitor use with 140,000 visitors during the sampling period. The next two monitored locations having high visitor numbers were at Dream Lake and Nymph Lake with approximately 104,000 and 92,000 visitors respectively. However considering Dream Lake is further into the backcountry than Nymph Lake there is a possibility these visitors bypassed the Nymph Lake monitor by utilizing a service trail near Bear Lake. Unfortunately, this trail was not monitored due to a limited amount of monitors available for the study. The lowest estimated visitor use for the Bear Lake area occurred at Odessa (11,498 visitors).

Table 3. Estimated visitor use for Bear Lake locations (2002).

Monitor Location	Visitor Number	Lower Bound*	Upper Bound
Alberta Falls	140,083	131,835	148,331
Dream Lake	104,696	98,531	107,861
Nymph Lake	92,490	87,044	97,936
Loch Vale	26,113	24,575	27,651
Mills Lake	23,900	22,493	25,307
Lake Haiyaha	21,650	20,375	22,925
Flattop	17,576	16,590	18,562
Bierstadt	13,272	12,490	14,054
Odessa	11,498	10,821	12,175

*Lower and Upper Bounds were calculated with a 95% confidence interval.

Bear Lake Area – Mean Daily Visitor Counts (2002)

Mean daily visitor numbers were based on the visitor numbers for a particular location divided by the number of days sampled (Table 4). The Alberta Falls location had the highest average number of visitors daily with 1,659. The Dream Lake monitor had a higher daily average than Nymph Lake, lending credence to the service trail theory that visitors were bypassing the Nymph Lake monitor.

Table 4. Mean daily visitor counts for trails sampled in the Bear Lake area (2002).

Monitor Location	Count for Location [1]	Percent [2]	Mean Daily Count[3]	Days Sampled
Alberta Falls	222,354	32	1,659.4	134
Dream Lake	166,184	24	1,240.2	134
Nymph Lake	146,809	21	1,095.6	134
Loch Vale	34,195	5	345.4	99
Mills Lake	30,560	4	351.3	87
Lake Haiyaha	28,682	4	270.6	106
Flattop	25,111	4	209.3	120
Bierstadt	20,123	3	157.2	128
Odessa	17,244	3	143.7	120
Total	691,262	100		

[1] Count=the number of events recorded during the sampling period.
[2] Percent is calculated from the monitors in the sampling area for the sampling period.
[3]Mean Daily Counts=the count in each location divided by the days sampled.

Bear Lake Area – Monthly Monitor Counts (2002)

All locations had increasing counts in May and June with a peak in July and a decline in August (Table 5). The exception was Nymph Lake, which peaked in August with a monthly count of 41,039. Alberta Falls had the highest levels of counts throughout the summer months, but was lower in May than Dream Lake.

Table 5. Monthly monitor counts for the Bear Lake area (2002).

	Counts by Month[1]					
Location	May	June	July	Aug.	Sept.	Oct.
Alberta Falls	6,671.7	36,320.76	76,432.86	62,886.60	40,037.76	-
Dream Lake	10,080.00	34,020.00	48,449.52	45,929.52	26,201.70	1,502.18
Nymph Lake	5,724.18	35,404.74	36,984.78	41,039.46	25,830.00	1,832.04
Loch Vale	3,414.60	12,670.56	11,883.06	6,228.18	-	-
Mills Lake	-	2,935.8	12,365.6	11,114.5	4,142.9	-
Lake Haiyaha	-	2,774.04	9,560.88	8,435.70	5,310.90	2,605.68
Flattop	-	4,528.44	9,001.44	7,667.10	3,753.54	162.54

[1] Count=the number of events recorded during the sampling period.

Monitor Locations for the Highway 7 Corridor Area 2002

In 2002, four locations were sampled along the Highway 7 Corridor running from Estes Park towards Allenspark along the Peak to Peak Scenic Byway. These locations consisted of a monitor placement for the Twin Sisters trail near the Lily Lake Visitor Center, with equipment being placed beyond the Forest Service border in the National Park. Other sampling locations included two monitors for Longs Peak, one near the trailhead and one placed in the Home Stretch near the summit. The final location was placed on the Storm Pass cutoff designed to determine the number of visitors venturing to Estes Cone from the Longs Peak trail.

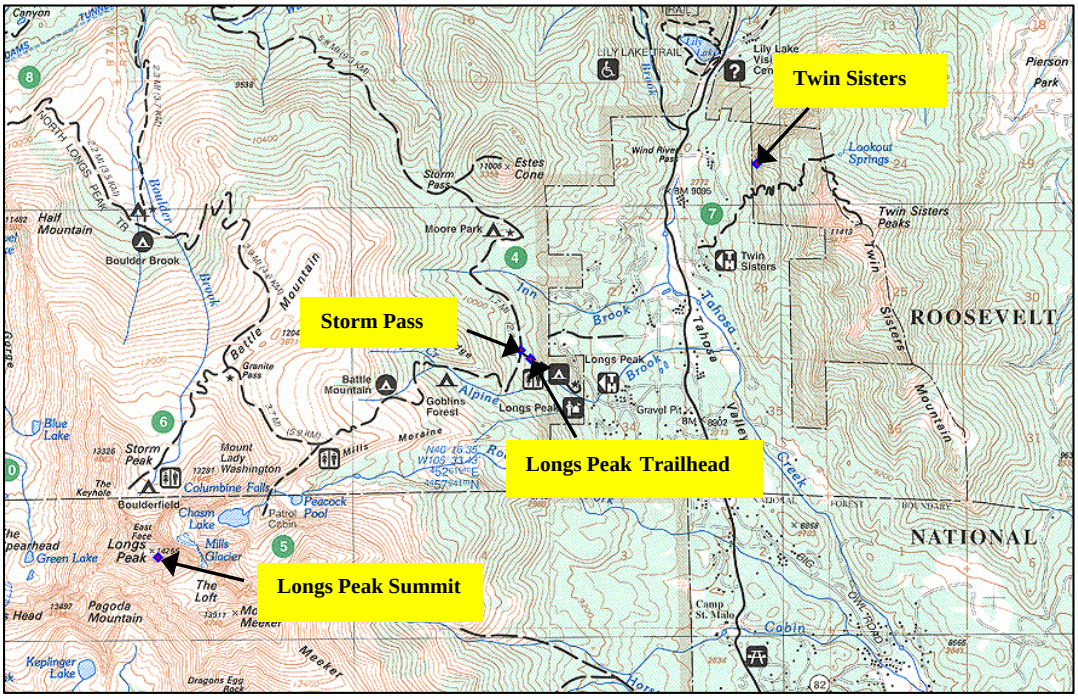

Figure 4. Monitor locations for Highway 7 Corridor area ROMO 2002.

Highway 7 Corridor – Estimated Visitor Use (2002)

The Highway 7 Corridor is the principle access for visitors using the Longs Peak, Twin Sisters and Storm Pass branch trail. The highest recorded visitor numbers occurred at the Longs Peak Trailhead (42,000 visitors) with approximately 11,000 visitors reaching the Longs Peak summit via the Keyhole route. Considering there are two alternative destinations accessed from this trailhead, Estes Cone and Chasm Lake, the 6,820 visitors who went toward Storm Pass can be subtracted from the number of persons who attempted Longs Peak. But due to limitations in placement options for the Chasm Lake the estimate for Longs Peak was not optimal.

Table 6. Estimated visitor use for Highway 7 Corridor locations (2002).

Monitor Location	Visitor Number	Lower Bound*	Upper Bound
Longs Peak Trailhead	41,931	39,462	44,400
Longs Peak Summit	11,186	10,527	11,845
Twin Sisters	9,162	8,622	9,702
Storm Pass	6,820	6,418	7,222

*Lower and Upper Bounds were calculated with a 95% confidence interval.

Highway 7 Corridor Monitor Counts (2002)

This area consisted of locations sampled along Highway 7 (e.g., trails leading to Longs Peak and Twin Sisters). The highest recorded monitor counts for this area were at the Longs Peak Trailhead (64,229), representing approximately two-thirds of the counts for this area (Table 5). This number drops by 60% for those actually reaching the summit of Longs Peak. The Longs Peak Summit monitor was located in the Home Stretch approximately 30 feet below the summit.

Table 7. Monitor counts for the Highway 7 Corridor (2002).

Monitor Location	Count for Location [1]	Percent [2]	Mean Daily Count[1]	Days Sampled
Longs Peak Trailhead	64,230	65	465.4	138
Longs Peak Summit	10,888	11	167.5	65
Twin Sisters	13,975	14	113.6	123
Storm Pass	10,219	10	75.0	135
Total	99,312	100	-	-

[1] Count=the number of events recorded during the sampling period.
[2] Percent is calculated from the monitors in the sampling area for the sampling period.
[3]Mean Daily Counts=the count in each location divided by the days sampled.

Highway 7 Corridor Monthly Monitor Counts (2002)

Table 8 shows the mean monthly counts for the Highway 7 Corridor. The low means for the month of May were caused by the installation of the monitors in the last week of that month. The counts for the Longs Peak Trailhead spiked in August (24,629.22). The Keyhole Route opens for non-technical climbing in the beginning of July, but weather patterns in August could also be a contributing factor. The low count for the summit monitor in the month of July was caused by a faulty placement near the summit necessitating a reinstallation later in the month. The lower count for July (2,102.94) at the Twin Sisters location was due to the proximity of the Big Elk Meadow Fire closing the area for approximately a week. Storm Pass visitation was consistent throughout the summer.

Table 8. Monthly monitor counts for Highway 7 Corridor (2002).

	Counts by Month[1]					
Location	May	June	July	Aug.	Sept.	Oct.
Longs Peak Trailhead	177.66	11,225.34	15,634.08	24,629.22	10,853.64	1,708.56
Twin Sisters	89.46	4,349.52	2,102.94	4,489.38	2,939.58	-
Longs Peak Summit	-	-	182.70	5,987.52	4,570.02	147.42
Storm Pass	-	2,539.38	2,904.30	2,625.84	1,675.80	473.76

[1] Monthly counts= the total counts the location received during the months sampled.

Monitor Locations for the Moraine Park Area 2002

Only two locations were sampled in Moraine Park in 2002, Cub Lake and The Pool. The Cub Lake monitor was placed along that trail approximately ½ mile before the lake. The placement of The Pool monitor was prior to that destination on the Fern Lake trail and can be considered to be an accurate gage of visitors who to that location. However, future visitor use assessments should consider a monitored location past the Pool along the trail to Fern Lake to determine visitor numbers for that lake.

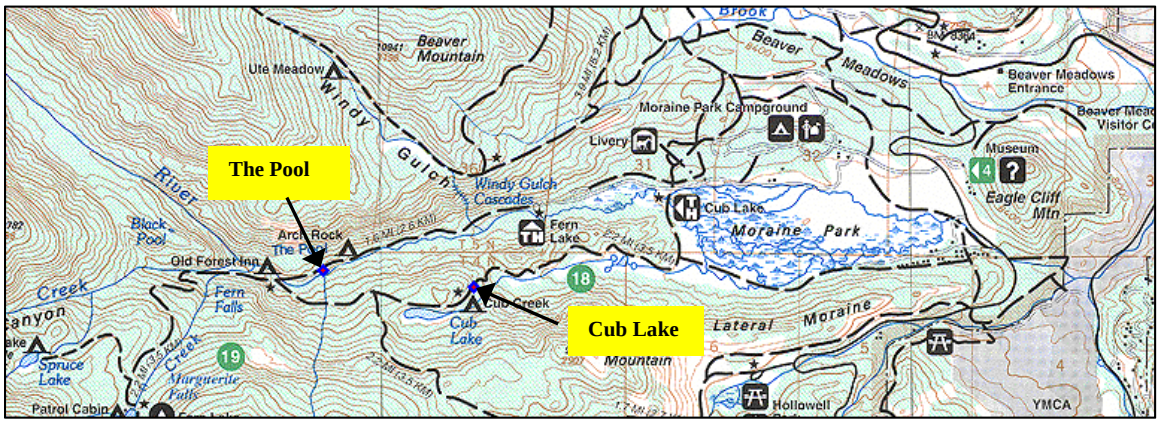

Figure 5. Monitor locations for the Moraine Park area of ROMO 2002.

Moraine Park – Estimated Visitor Use (2002)

Of the two locations in Moraine Park, The Pool had the highest estimated use (34,092), although Cub Lake accounted for 19,756 visitors (Table 9).

Table 9. Estimated visitor use for Moraine Park locations (2002).

Monitor Location	Visitor Number	Lower Bound*	Upper Bound
The Pool	34,092	32,084	36,100
Cub Lake	19,756	18,593	20,919

*Lower and Upper Bounds were calculated with a 95% confidence interval.

Moraine Park Monitor Counts (2002)

The Cub Lake and The Pool trails are the main trails in the Moraine Park area with The Pool receiving more counts (Table 10). Traveling to The Pool is a relatively easy hike along a level trail. Both the Pool and the Cub Lake locations were sampled for 132 days each, with the former accounting for a higher daily average (400 counts).

Table 10. Monitor counts Moraine Park Area (2002).

Monitor Location	Count for Location [1]	Percent [2]	Mean Daily Count[3]	Days Sampled
The Pool	52,912	63	400.8	132
Cub Lake	30,661	37	232.3	132
Total	83,573	100	-	-

[1] Count=the number of events recorded during the sampling period.
[2] Percent is calculated from the monitors in the sampling area for the sampling period.
[3]Mean Daily Counts=the count in each location divided by the days sampled.

Moraine Park Monthly Monitor Counts (2002)

Moraine Park locations were relatively consistent in visitation levels, with counts peaking in July at both sites (Table 11).

Table 11. Monthly monitor counts for Moraine Park (2002).

	Counts by Month[1]					
Location	May	June	July	Aug.	Sept.	Oct.
The Pool	742.14	12,239.64	15,998.22	14,038.92	8,992.62	900.90
Cub Lake	630.00	7,398.70	8,568.00	7,643.20	5,908.10	509.00

[1] Monthly counts=the total counts the location received during the months sampled.

Monitor Locations for Roaming Locations 2002

Roaming monitor locations were areas of interest to the Park, but due to logistical constraints, i.e. lack of equipment or personnel, could not be sampled for the entire sampling period in 2002. Six areas were sampled randomly over the course of 2002 to account for a percentage of visitors utilizing those trail segments. Of the six trail locations sampled, five of these were secondary trails in the Bear Lake area with the final location Stormy Peaks located near CSU's Pingree Park Mountain Campus. One location of particular interest for the Park was a Service trail near Alberta Falls, providing a short cut to Mills Lake and Loch Vale. Mostly used by locals it did prove to have a higher level of use than initially anticipated with results to follow.

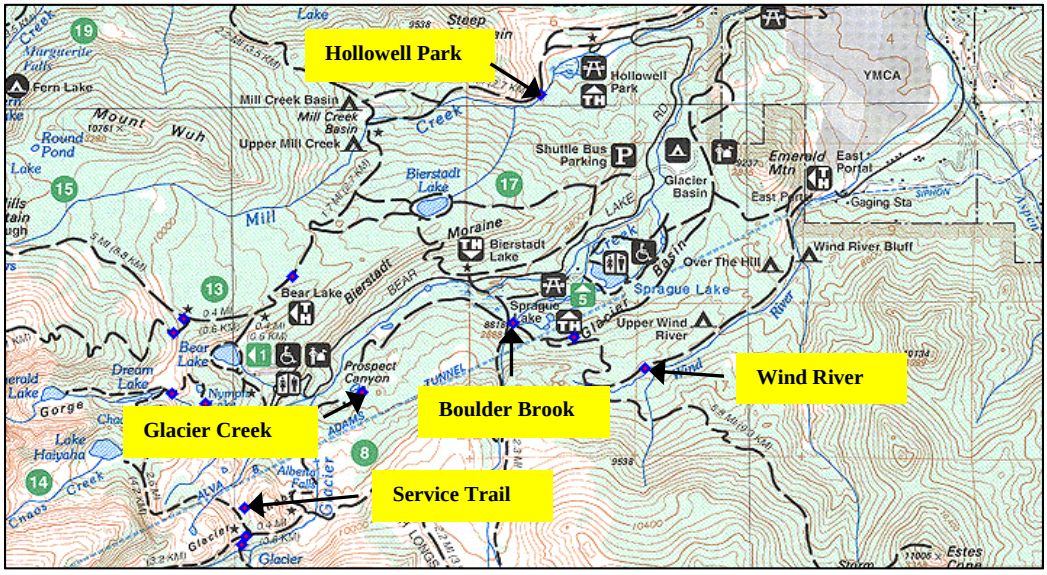

Figure 6. Monitor locations for Roaming Monitors of ROMO 2002.

Roaming Locations – Estimated Visitor Use (2002)

Of these locations, the Service Trail which was located off of the Alberta Falls trail accounted for the highest level of estimated visitor use with 2,407. Hollowell Park had the next highest (≈ 1,600 visitors) for the sampling period beginning in July (Table 12). The visitor

estimate for the northernmost location sampled for the summer (Stormy Peaks, near the Colorado State University's Pingree Park campus) was 288.

Table 12. Estimated visitor use for roaming monitor locations (2002).

Monitor Location	Visitor Number	Lower Bound*	Upper Bound
Service Trail	2,407	2,265	2,549
Hollowell Park	1,596	1,502	1,690
Wind River	927	872	982
Glacier Creek	846	796	896
Stormy Peaks	288	271	305
Boulder Brook	185	174	196

*Lower and Upper Bounds were calculated with a 95% confidence interval.

Roaming Monitor Counts (2002)

Results in Tables 13 and 14 are from monitors labeled as "roaming monitors." These monitors were put in place between 15 – 53 days to approximate the level of use on each trail. The Service Trail monitor had a higher mean daily count (65 counts daily) than the other roaming locations, indicating that this trail does receive considerable use. The NPS should place a "permanent monitor" in conjunction with the other Bear Lake locations to capture the relationship between this trail and other trails in the area.

Table 13. Monitor counts for roaming locations (2002).

Monitor Location	Count for Location[1]	Mean Daily Count[2]	Days Sampled
Service Trail	3,367	64.8	52
Hollowell Park	1,975	42.9	46
Glacier Creek	1,208	22.4	54
Stormy Peaks	444	13.1	34
Wind River	427	47.4	9
Boulder Brook	191	12.7	15
Total	7,612	-	-

[1] Count= the number of events recorded during the sampling period.
[2]Mean Daily Counts=the count for the location divided by the days sampled.

Table 14. Monthly monitor counts for roaming locations (2002).

	Counts by Month[1]				
Location	May	June	July	Aug.	Sept.
Service Trail	-	-	-	2,065.14	1,301.58
Hollowell Park	-	-	-	715.68	1,256.22
Glacier Creek	12.60	744.66	452.34	-	-
Stormy Peaks	-	-	417.06	23.94	-
Wind River	-	-	428.40	-	-
Boulder Brook	-	-	-	190.26	-

[1] Monthly counts=the total counts the location received during the months sampled. These locations were only sampled briefly from 2 weeks to 2 months.

Overall Monthly Monitor Counts for Areas Sampled (2002)

Monthly counts for the Bear Lake, Highway 7, and Moraine Park areas sampled in 2002 ranged from a low of 10,156 in October to a high of 264,279 in July (Table 15). The lower counts in October and May were mainly due to lower visitation levels.

Table 15. Monthly monitor counts for East-Side areas sampled (2002).

Month	Count[1]	Percent
May	24,192	3
June	165,960	19
July	264,279	30
August	261,609	30
September	155,561	18
October	10,156	1
Total	881,756	100

[1] Count= the number of events recorded during the sampling period.

Daily and Hourly Distribution of Trail Counts for the East-Side Areas Sampled (2002)

The active infrared monitors used in this study were time stamped. Considering all sampled locations for 2002, 39% of the use occurred in the morning and 61% occurred in the afternoon (Table 16). Some trails like those leading to Longs Peak or other climbing destinations area were active 24 hours a day. Climbers often start early in the morning to complete a climb by nightfall. These monitors, however, were not calibrated to compensate for the nocturnal use of trails by animals.

Table 16. Hourly monitor counts for trail usage for East Side areas sampled (2002).

Hour	Count[1]	Percent
12:01 AM to 5:00 AM	26,399	3
5:01 AM to 8:00 AM	32,694	4
8:01 AM to 11:00 AM	177,728	20
11:01 AM to 2:00 PM	313,055	36
2:01 PM to 5:00 PM	237,055	27
5:01 PM to 8:00 PM	74,019	8
8:01 PM to Midnight	20,805	2
Total	881,756	100

[1] Count=the number of events recorded during the sampling period.

Monitor Locations for the Wild Basin Area 2003

During 2003, sampling focus changed to the southern areas of the Park, with seven trail locations originating from the Wild Basin Ranger Station. Equipment was placed in an attempt to capture and characterize visitor destinations along the length of this trail up to and including Thunderlake. Researchers also sampled the backcountry campsites trail which provides a nice loop trail for those inclined to follow this trail. In addition to the trails originating from the Wild Basin Ranger Station, four periphery trail locations were sampled to complete the visitor use picture for Wild Basin.

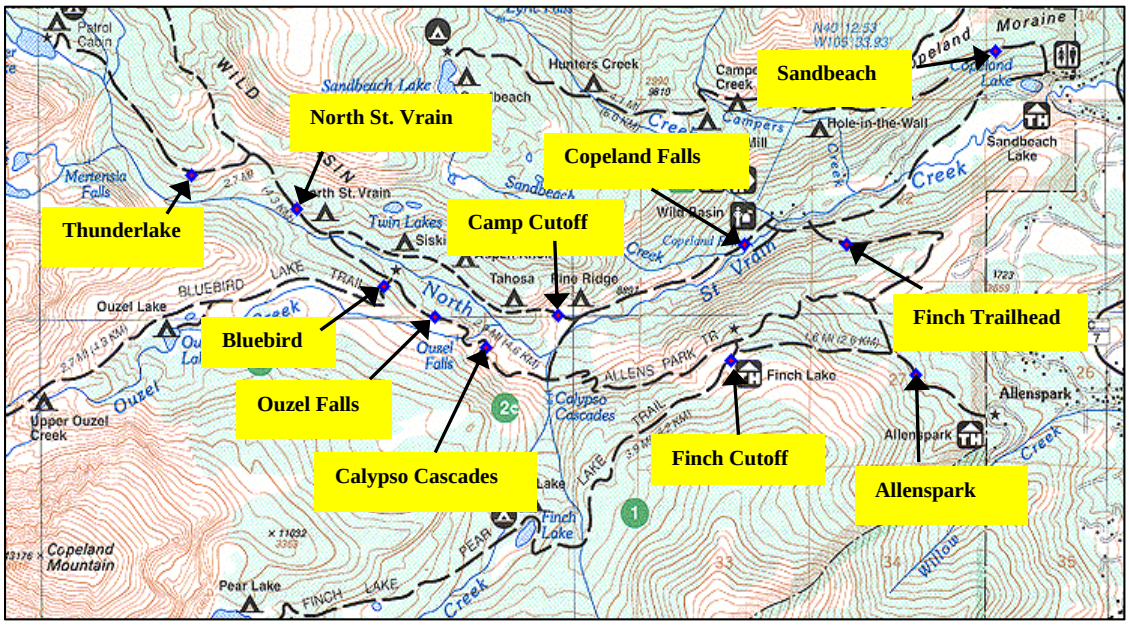

Figure 7. Monitor locations for the Wild Basin area of ROMO 2003.

Estimated Visitor Use (2003)

Wild Basin – Estimated Visitor Use (2003)

Visitor use estimates for the Wild Basin area accessed by the Wild Basin Ranger Station were as follows (Table 17). Copeland Falls had 38,048 visitors for the summer season of 2003.

Calypso Cascades seemed to be more of a destination than Ouzel Falls accounting for 33,800 visitors compared to the 10,234 visitors who continued to Ouzel Falls. Thunderlake received 2,899 visitors for the summer. Some visitors did use the backcountry campsite trail as a loop trail or as a trail to access further into the backcountry (i.e., Lion Lakes or Thunderlake) and this accounted for 2,471 visitors for the season.

Table 17. Estimated visitor use for Wild Basin locations (2003).

Monitor Location	Visitor Number	Lower Bound*	Upper Bound
Copeland Falls	38,048	35,133	40,963
Calypso Cascades	33,800	31,210	36,390
Ouzel Falls	10,234	9,450	11,018
Bluebird	8,483	7,833	9,133
North St. Vrain	4,575	4,224	4,926
Thunderlake	2,899	2,677	3,121
Campground Cutoff	2,471	2,281	2,661

*Lower and Upper Bounds were calculated with a 95% confidence interval.

Wild Basin – Monitor Counts (2003)

Counts for the Wild Basin Area with trails originating from the Wild Basin Ranger Station are shown in Table 18. The highest recorded counts occurred for the Copeland Falls location with 58,213. Researchers noted some visitors were using the backcountry campsite trail as a short cut to locations such as Thunderlake and Lion Lakes. This trail was also used as a loop to return to the main trail and accounted for 3,875 counts during the sampling period.

Overall the Copeland Falls location had the highest mean daily count for the area (380.5), which intuitively makes sense due to the relative ease of reaching this location and the proximity

of the trailhead. Calypso Cascades had the next highest daily average with visitor counts dropping off after Ouzel Falls.

Table 18. Monitor counts for Wild Basin (2003).

Monitor Location	Count for Location[1]	Percent	Mean Daily Count[2]	Days Sampled
Copeland Falls	58,213	38	380.5	153
Calypso Cascades	52,389	34	337.9	155
Ouzel Falls	15,081	10	107.7	140
Bluebird	12,501	8	89.3	140
North St. Vrain	6,741	4	48.2	140
Thunderlake	4,487	3	30.5	147
Campground Cutoff	3,875	3	26.0	149
Total	153,287	100	-	-

[1] Count=the number of events recorded during the sampling period.
[2]Mean Daily Counts=the count for the location divided by the days sampled.

Wild Basin – Monthly Monitor Counts (2003)

Although all months were not recorded in their entirety, a pattern emerges across the locations with monthly counts peaking in the month of July (Table 19). The Copeland Falls location counts declined in August (6667.5), but were higher in September (9600.0). This increase might be attributed to an interest in seeing the changing of Aspen trees in the area.

Table 19. Monthly monitor counts for Wild Basin (2003).

	Counts by Month[1]					
Location	May	June	July	Aug.	Sept.	Oct.
Calypso Cascades	595.0	11983.8	16562.8	12785.0	6785.0	3655.0
Bluebird	-	2402.5	4211.3	3150.0	1828.8	885.0
Camp Cutoff	-	732.5	1211.3	1143.8	515.0	250.0
Copeland Falls	327.5	15157.5	21100.0	6667.5	9600.0	5342.5
Thunderlake	-	647.5	1406.3	1306.3	778.8	325.0
North St. Vrain	-	680.0	2377.5	2248.8	986.3	433.8
Ouzel Falls	-	2632.5	4827.5	3978.8	2406.3	1217.5

[1]Monthly counts=the total counts the location received during the month over the course of the sampling period.

Wild Basin Other Trails Estimated Visitor Use (2003)

Visitors to the periphery of Wild Basin visited Sandbeach more often than the other locations (approximately 4,200 visitors). The Allenspark trail received 3,700 visitors for the season. Visitors attempting to go to Finch Lake could go either from the Finch Lake trailhead located in the Wild Basin area or from the Allenspark trailhead. Given the estimated number of visitors who went to Finch Lake from the trailhead (2,596), and the cutoff from Allenspark (3,030) it seems both options were used.

Table 20. Estimated visitor use for other Wild Basin trail locations (2003).

Monitor Location	Visitor Number	Lower Bound*	Upper Bound
Sandbeach	4,263	3,936	4,590
Allenspark	3,713	3,428	3,998
Finch Cutoff	3,030	2,798	3,262
Finch Trailhead	2,596	2,397	2,795

*Lower and Upper Bounds were calculated with a 95% confidence interval.

Wild Basin Other Trails Monitor Counts (2003)

The other trails that were monitored in Wild Basin Area did not originate from the Wild Basin trailhead (Table 21). The Sandbeach Trail had the highest recorded counts (32% of the observations) for this area. The Finch Cutoff had a higher counts (4,514) than the trailhead monitor (4,153) indicating that more people access the area via the Allenspark trail to get to Finch Lake. Mean daily counts for the trails in the outlying areas of Wild Basin were similar across all locations. The Sandbeach location had the highest daily average with almost 38 counts per day (Table 21). The lowest average was at the Finch Trailhead location with 23 counts per day. The Finch Cutoff had a slightly higher daily average than both the Allenspark and Finch Trailhead locations indicating that people were using both accesses to reach that area.

Table 21. Monitor counts for other trails in Wild Basin (2003).

Monitor Location	Count for Location[1]	Percent	Mean Daily Count	Days Sampled
Sandbeach	6,820	32	37.3	183
Allenspark	5,745	27	32.5	177
Finch Cutoff	4,514	21	33.4	135
Finch Trailhead	4,153	20	22.7	183
Total	21,232	100	-	-

[1] Count= the number of events recorded during the sampling period.

Wild Basin Other Trails Monthly Monitor Counts (2003)

Monthly counts were recorded beginning in May and ending in November for most of the other trail locations in the Wild Basin area (Table 22). Data from the Finch Cutoff were collected from July to November due to a malfunctioning monitor that had to be replaced during the month of June. Highest counts occurred in July and tapered off in the months that followed.

Table 22. Monthly monitor counts for other trails in Wild Basin (2003).

	Counts by Month[1]						
Location	May	June	July	Aug.	Sept.	Oct.	Nov.
Allenspark	8.8	795.0	2110.0	1378.8	897.5	411.3	122.5
Finch TH	65.0	830.0	1380.0	555.0	830.0	401.3	71.3
Finch Cutoff	-	-	1612.5	1498.8	791.3	541.3	55.0
Sandbeach	122.5	1265.0	2150.0	1678.8	702.5	700.0	180.0

[1]Monthly counts=the total counts the location received during the month over the course of the sampling period.

Monitor Locations for Western ROMO 2003

In addition to the trail locations monitored in Wild Basin, eight locations near Grand Lake were sampled in Western ROMO during 2003. Popular destinations originating outside the Park borders and trails originating inside the Park were chosen to provide an understanding of where visitors were traveling to the most. Locations near Grand Lake were once again chosen with regards to destinations. For example, the Green Mountain Trail allowed researchers to determine the number of visitors who chose to hike to Big Meadows along that trail or to continue to Granite Falls.

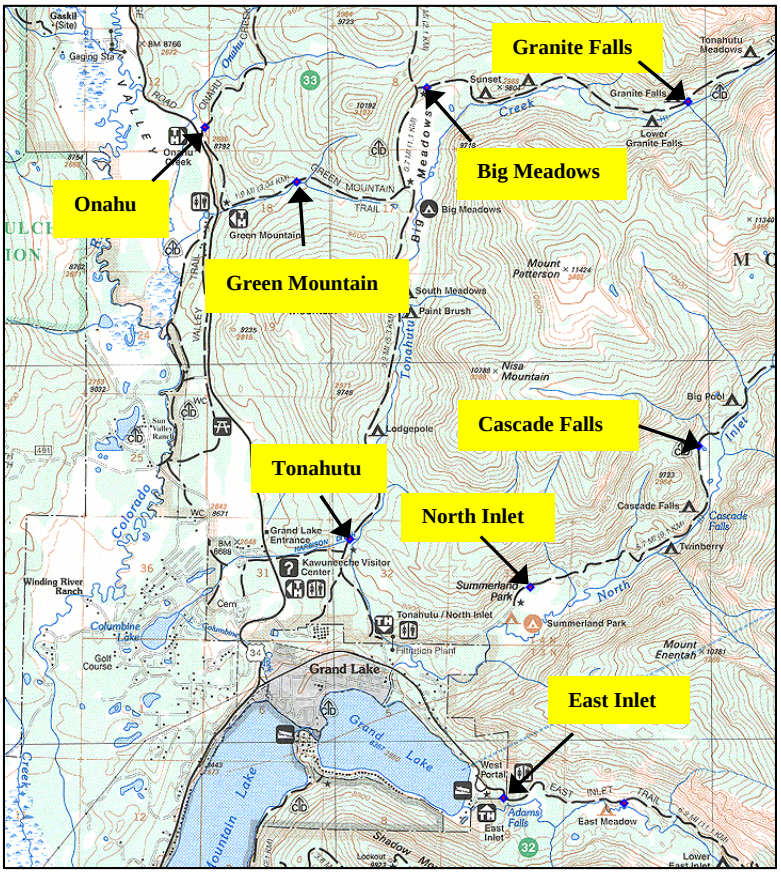

Figure 8. Monitor locations for the Western ROMO area of ROMO 2003.

Western ROMO Estimated Visitor Use (2003)

During the 2003 summer season locations sampled on the western side of ROMO included areas near Grand Lake (Table 23). Overall, the East Inlet trail had the highest visitor estimates, accounting with 38,000 visitors. The next two highest locations were Green Mountain (9,016) and North Inlet Trail (8,395).

Table 23. Estimated visitor use for Western ROMO (2003).

Monitor Location	Visitor Number	Lower Bound*	Upper Bound
East Inlet	38,089	35,171	41,007
Green Mountain	9,016	8,325	9,707
North Inlet	8,395	7,752	9,038
Tonahutu	3,897	3,598	4,196
Onahu	3,583	3,308	3,858
Big Meadows	3,411	3,149	3,673
Cascade Falls	2,771	2,558	2,984
Granite Falls	2,557	2,361	2,753

*Lower and Upper Bounds were calculated with a 95% confidence interval.

Western ROMO Monitor Counts (2003)

In 2003, eight trail locations were sampled on the western side of ROMO (Table 24). Of these trail locations, the two trails nearest to Grand Lake exhibited the highest use. The East Inlet location recorded counts of 55,501 (53% of the sample). The North Inlet only accounted for 12% of the counts for this area. Cascade Falls and Granite Falls were popular destinations for day hikers although visitors tended not to travel much further into the backcountry during day excursions.

On the western side of ROMO the East Inlet trail had the highest level of visitation during the sampling period (555 counts daily). The Green Mountain Trail had a slightly higher daily average (103.7) than the North Inlet Trail (101.7) although the means were similar for both locations.

Table 24. Monitor counts for the Western ROMO (2003).

Monitor Location	Count for Location[1]	Percent	Mean Daily Count	Days Sampled
East Inlet	55,514	53	417.4	133
North Inlet	16,790	12	119.9	140
Green Mountain	12,454	12	103.8	120
Tonahutu	5,978	6	42.7	140
Onahu	5,732	6	39.3	146
Big Meadows	4,711	5	39.2	120
Cascade Falls	3,823	4	32.1	119
Granite Falls	3,358	3	61.1	55
Total	108,360	100	-	-

[1] Count=the number of events recorded during the sampling period.

Western ROMO Monthly Monitor Counts (2003)

Similar to the 2002 findings, the monitor counts for trails sampled on the western side of ROMO in 2003 increased from May to June, peaked in July, and tapered off from August to October (Table 25). The East Inlet area, however, had the highest counts throughout the summer due to the trail's proximity to Grand Lake. This location also showed a decrease in August (5,762), but the counts doubled for September (11,052) indicating fall visitation.

Table 25. Monthly monitor counts for the Western ROMO (2003).

	Counts by Month[1]					
Location	May	June	July	Aug.	Sept.	Oct.
East Inlet	-	13257.5	21810.0	5762.5	11052.5	3618.8
North Inlet	85.0	2758.0	4505.0	3861.3	1630.0	25.0
Granite Falls	-	-	917.5	1895.0	541.3	-
Cascade Falls	-	87.5	1605.0	1422.5	565.0	132.5
Big Meadows	-	531.3	1971.3	1258.8	790.0	141.2
Green Mountain	-	1481.3	4862.5	3340.0	2158.8	600.0
Onahu	122.5	1205.0	1925.0	1413.8	810.0	240.0
Tonahutu	36.3	972.5	1740.0	2452.5	595.0	166.3

[1]Monthly counts=the total counts the location received during the month over the course of the sampling period.

Southern Area of ROMO Monthly Counts (2003)

The southern area of ROMO encompassed both Wild Basin and trails near Grand Lake with sampling occurring from May through November. The highest counts were recorded during July with 35% of the total counts for the sampling period (Table 26). June and August had similar counts.

Table 26. Monthly counts for the Southern area of ROMO (2003).

Month	Count[1]	Percent
May	1,363	1
June	57,420	21
July	98,285	35
August	57,798	21
September	44,264	20
October	19,086	7
November	429	< 1
Total	278,645	100

[1] Count=the number of events recorded during the sampling period.

Overall Hourly Monitor Counts (2003)

In 2003, a majority of counts occurred during the afternoon hours, approximately 64% (Table 27). The highest counts occurred during the hours of 11:01 am to 2:00 pm representing 40% of the sample. The early afternoon and evening hours had the next highest counts representing about 29% for this year.

Table 27. Overall hourly monitor counts (2003).

Hour	Count [1]	Percent
12:01 AM to 5:00 AM	1,016	< 1
5:01 AM to 8:00 AM	4,989	2
8:01 AM to 11:00 AM	57,342	21
11:01 AM to 2:00 PM	111,955	40
2:01 PM to 5:00 PM	80,597	29
5:01 PM to 8:00 PM	20,746	7
8:01 PM to Midnight	2,001	1
Total	278,645	100

[1] Count= the number of events recorded during the sampling period.

Monitor Locations for Northeastern ROMO 2004

Monitor locations for Northeastern ROMO in 2004 sampled areas near Lumpy Ridge, Glen Haven and the Research Ranch (ROMO). During this time the Twin Owls Trailhead on MacGregor Ranch was sampled prior to it being closed for permanent restoration (Patterson, 2014). However the newer Lumpy Ridge Trailhead and parking area, was also sampled providing the overall numbers for Gem Lake.

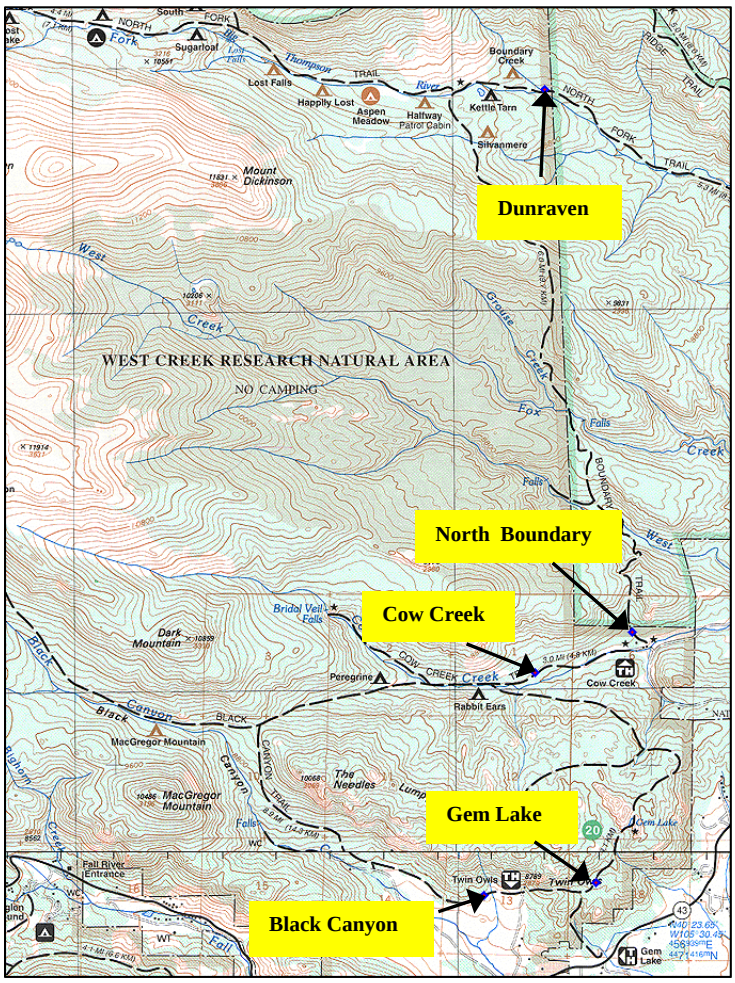

Figure 9. Monitor locations for the Northeastern ROMO area of ROMO 2004.

Estimated Visitor Use (2004)

Northeastern ROMO Estimated Visitor Use (2004)

Visitor estimates for northeastern ROMO included locations sampled from throughout the area (Table 28). Gem Lake had the highest visitor use estimates for the summer season with 24,862 visitors. Black Canyon, which is an access for several climbs in the Lumpy Ridge area, received 8,367 visitors for the season. The lowest visitor estimates for this area occurred at Dunraven. This finding, however, might be attributable to the location of the monitor on the Park border approximately four miles beyond the trailhead.

Table 28. Estimated visitor use for Northeastern ROMO (2004).

Monitor Location	Visitor Number	Lower Bound*	Upper Bound
Gem Lake	24,862	22,310	27,414
Cow Creek	9,862	8,850	10,874
North Boundary	9,245	8,296	10,194
Black Canyon	8,367	7,508	9,226
Dunraven	262	235	289

*Lower and Upper Bounds were calculated with a 95% confidence interval.

Northeastern ROMO Monitor Counts (2004)

Trails included in this sample were from the Lumpy Ridge area, Cow Creek area and the Dunraven trail near Glen Haven (Table 29). Of these locations, Gem Lake had the highest counts (47% of the sample). Cow Creek and the North Boundary area also received high monitor counts, although during the summer sampling period the North Boundary monitoring unit encountered a vegetation problem causing a higher than normal count. An indigenous plant blowing in the wind in front of the transmitting unit caused counts at regular intervals. The Dunraven unit had low representation, probably due to the location of the trailhead and the distance from the trailhead to the Park border. Mean daily counts for northeastern ROMO ranged from 11 to almost 217 daily at the Gem Lake location (Table 29).

Table 29. Monitor counts for Northeastern ROMO (2004).

Monitor Location	Count for Location[1]	Percent	Mean Daily Count[2]	Days Sampled
Gem Lake	35,388	47	217.1	163
Cow Creek	14,103	19	86.0	164
North Boundary	13,221	18	80.6	164
Black Canyon	11,891	16	73.4	162
Dunraven	377	1	10.8	35
Total	74,980	100	-	-

[1] Count=the number of events recorded during the sampling period.
[2]Mean Daily Counts=the count for the location divided by the days sampled.

Northeastern ROMO Monthly Monitor Counts (2004)

Northeastern ROMO park locations were sampled from the beginning of May through October for all locations except the Dunraven location. The Gem Lake location had the highest overall counts for the summer peaking in July with almost 8500 counts (Table 30). All locations peaked in the month of July with two notable exceptions, the Black Canyon location and the North Boundary location. These locations were lower during those months due to lost data from a malfunctioning data collector.

Table 30. Monthly monitor counts for Northeastern ROMO (2004).

	Month					
Location	May	June	July	Aug.	Sept.	Oct.
Gem Lake	6277.2	6815.2	8498.5	6826.3	5358.5	1567.9
Cow Creek	2397.8	2899.5	3077.5	2596.5	2281.0	852.1
Black Canyon	604.7	3265.1	1724.0	2064.2	3130.3	1103.7
North Boundary	321.1	8647.2	493.5	904.9	2681.3	172.4
Dunraven	289.1	84.8	-	-	-	-

[1]Monthly counts=the total counts the location received during the month over the course of the sampling period.

Monitor Locations for the Trail Ridge and Fall River Road Areas of ROMO 2004.

In 2004, four locations were sampled from trails originating along Trail Ridge Road and two locations whose origins were along Fall River Road. These locations encompassed both sides of the Continental Divide and several environmental zones, i.e. Alpine Tundra. Figure 10 presents three of the locations on the Eastern side of ROMO, including Deer Mountain, Lawn Lake and Ute Trail. Given the distance between monitor locations for this year, other locations such as Chapin Pass, Milner Pass and the Poudre River Trail are not included in Figure 10 due to map constraints.

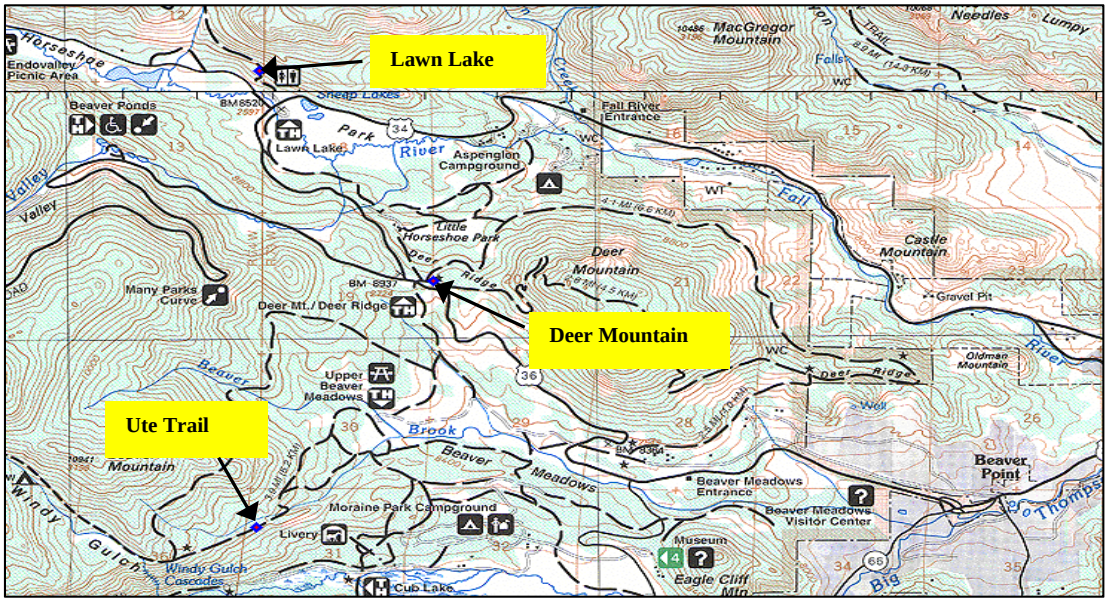

Figure 10. Monitor locations for the Trail Ridge and Fall River Road areas ROMO 2004.

Trail Ridge and Fall River Roads Estimated Visitor Use (2004)

Visitor use estimates for areas sampled along Trail Ridge Road and Fall River Road during the summer of 2004 were lower than expected. The researcher noted higher visitation from automobile traffic with less visitors getting out of their vehicles to explore the backcountry where the monitors were located (Table 31). Lawn Lake had the highest visitor estimates

accounting for 21,767 visitors for the season. Deer Mountain had the next highest level of visitors with 12,323.

Table 31. Estimated visitor use for Trail Ridge and Fall River Road Locations (2004).

Monitor Location	Visitor Number	Lower Bound*	Upper Bound
Lawn Lake	21,767	19,533	24,001
Deer Mountain	12,323	11,058	13,588
Chapin Pass	6,594	5,917	7,271
Ute Trail	4,263	3,825	4,701
Milner Pass	2,121	1,903	2,339
Poudre River Trail	698	626	770

*Lower and Upper Bounds were calculated with a 95% confidence interval.

Trail Ridge Road and Fall River Road Monitor Counts (2004)

These six locations encompassed areas along Trail Ridge Road and Fall River Road, with the exception of the Ute Trail, which was accessed by Upper Beaver Meadows. Lawn Lake exhibited the highest counts (31,319), representing 47% of the sampled locations (Table 32). The Poudre River Trail had the lowest counts (931, 2% of this sample). This location, however, may need to be monitored more frequently to approximate the number of elk creating false positives.

Locations along Trail Ridge Road and Fall River Road had means ranging from 7 to 191 daily counts. The Poudre River Trail exhibited a mean daily count of 6.7 with standard deviation of 13.8, meaning that on a given day visitation could range from almost no visits to approximately 28 visits.

Table 32. Monitor counts for Trail Ridge and Fall River Roads (2004).

Monitor Location	Count for Location[1]	Percent	Mean Daily Count	Days Sampled
Lawn Lake	31,319	47	191.0	164
Deer Mountain	17,730	26	108.1	164
Chapin Pass	8,548	13	93.9	91
Ute Trail	5,919	9	35.7	166
Milner Pass	2,850	4	20.2	141
Poudre River Trail	931	1	6.7	140
Total	67,297	100	-	-

[1] Count=the number of events recorded during the sampling period.
[2]Mean Daily Counts=the count for the location divided by the days sampled.

Trail Ridge and Fall River Roads Monthly Monitor Counts (2004)

Data for the monthly counts for the Trail Ridge and Fall River Road areas (Table 33) were collected from May through the October with two locations sampled into the beginning of November (Chapin Pass and Milner Pass). Similar to other findings, monitor counts peaked in July with the highest counts recorded at Lawn Lake (8,838). Some data were lost due to a malfunctioning data collectors for the Ute Trail in July and the Deer Mountain Trail in July and August. Chapin Pass had an increase in visitor counts for August (4,861). The road to this area opened in July.

Table 33. Monthly monitor counts for Trail Ridge Road and Fall River Road (2004).

	Month						
Location	May	June	July	Aug.	Sept.	Oct.	Nov.
Lawn Lake	2760.5	5418.2	8837.6	7781.2	5158.3	1373.3	-
Deer Mountain	3212.3	3498.6	2349.1	2900.9	4275.6	1494.3	-
Ute Trail	711.68	1050.84	-	1687.5	1804.22	657.5	-
Chapin Pass	-	-	1972.4	4860.8	1691.6	20.9	1.4
Milner Pass	-	-	1160.7	909.1	679.7	80.6	20.9
Poudre River Trail	-	77.8	290.5	314.1	204.3	47.3	-

[1]Monthly counts=the total counts the location received during the month over the course of the sampling period.

Monitor Locations for Western ROMO 2004

Trail locations sampled in the Western part of Rocky Mountain National Park during 2004 included locations along the Colorado River Trail such as the cutoff to Red Mountain, Lulu City, and La Poudre Pass. The Timber Lake trail which is accessed almost directly across Trail Ridge Road from the Colorado River Trailhead was also sampled. The Corral Creek trail is accessed from Highway 14 in the Poudre Canyon directly north of Long Draw Reservoir making it a little more difficult for researchers to reach for regular sampling.

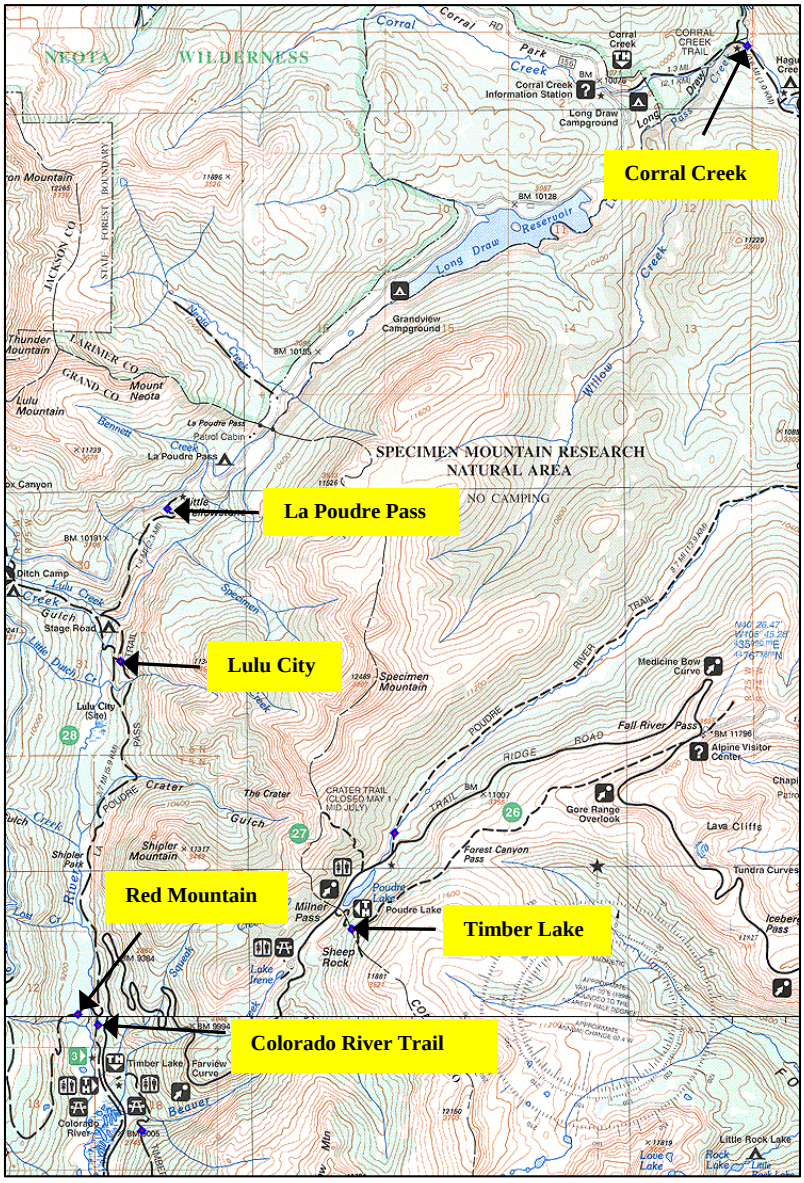

Figure 11. Monitor locations for the Western ROMO area of ROMO 2004.

Western ROMO Estimated Visitor Use (2004)

Locations for 2004 that were sampled in western ROMO included the Colorado River Trail that had 11,761 visitors (Table 34). Locations on the northwest area of ROMO were Corral Creek (1.035 visitors) and La Poudre Pass (564 visitors).

Table 34. Estimated visitor use for Western ROMO (2004).

Monitor Location	Visitor Number	Lower Bound*	Upper Bound
Colorado River Trail	13,270	11,908	14,632
Timber Lake	4,014	3,602	4,426
Red Mountain	3,135	2,813	3,457
Lulu City	3,123	2,802	3,444
Corral Creek	1,489	1,341	1,637
La Poudre Pass	633	568	698

* Lower and Upper Bounds were calculated with a 95% confidence interval.

Western ROMO Monitor Counts (2004)

Similar to 2003, the western area of ROMO was sampled in 2004, although these locations were further into the Park. Two locations (Corral Creek and La Poudre Pass) were near Long Draw Reservoir in the north and accessed through Forest Service land. For these locations, the Colorado River Trail accounted for more of the monitoring events (51%) than the remaining locations. Based on researcher observations, a majority of the visitors were interested in seeing the Colorado River (Table 35), but may not hike very far into the backcountry. For example, the Red Mountain monitor was approximately ¼ mile beyond the trail junction with the Colorado River Trail, but only received about 12% of the visitors who had started on the main trail. The same holds true for the Lulu City location, but distance may be the deciding factor as opposed to difficulty.

Of the six trails sampled in the western part of ROMO in 2004, the Colorado River Trail had the highest mean daily count of almost 91. This might be attributable to the proximity of the trail to Trail Ridge Road and the ease of access. Lulu City had the next highest daily average, suggesting that this location might be a destination for visitors. Informal conversations with

visitors suggested that some were doing a loop via the Grand Ditch Trail to return along the Red Mountain Trail.

Table 35. Monitor counts for Western ROMO (2004).

Monitor Location	Count for Location[1]	Percent	Mean Daily Count	Days Sampled
Colorado River	17,457	51	90.9	192
Timber Lake	5,228	15	27.4	191
Lulu City	4,167	12	36.2	115
Red Mountain	4,104	12	21.4	192
Corral Creek	2,051	6	19.2	107
La Poudre Pass	895	3	7.9	113
Total	33,902	100	-	-

[1] Count=the number of events recorded during the sampling period.
[2]Mean Daily Counts=the count for the location divided by the days sampled.

Western ROMO Monthly Monitor Counts (2004)

Western ROMO for the 2004 sampling year includes all locations sampled on that side of the Park including areas to the north accessed near Long Draw Reservoir. Counts peaked in August and September for Colorado River and Timber Lake locations. It should be noted, however, that some data were lost due to a malfunctioning data collector.

Table 36. Monthly monitor counts for Western ROMO (2004).

	Month						
Location	May	June	July	Aug.	Sept.	Oct.	Nov.
Colorado River	1050.8	3488.9	875.7	4208.9	5387.6	1851.5	592.1
Timber Lake	385.0	1075.9	961.9	900.8	1289.9	462.9	147.3
Lulu City	-	-	1169.0	2144.8	738.1	114.0	1.39
Red Mountain	22.24	533.8	631.1	841.0	1287.1	574.1	209.9
Corral Creek	-	-	959.1	695.1	323.9	69.5	-
La Poudre Pass	-	-	450.4	166.8	223.8	50.0	-

[1]Monthly counts= the total counts the location received during the month over the course of the sampling period.

Northern ROMO Monthly Monitor Counts (2004)

The area sampled for 2004 included several trails along Trail Ridge Road and northern areas of the Park. This year saw lower counts overall but this could be due to accessibility of the some of the areas. Sampling occurred from May through November. The months of June through September had similar levels of use.

Table 37. Overall monthly monitor counts for Northern ROMO (2004).

Month	Count[1]	Percent
May	18,032	10
June	36,856	21
July	33,452	19
August	39,803	23
September	36,515	21
October	10,492	6
November	973	1
Total	176,123	100

[1] Count=the number of events recorded during the sampling period.

Overall Hourly Monitor Counts (2004)

During the 2004 sampling season, a majority of counts occurred in the afternoon hours (64%). The morning hours had a high level of use peaking around the lunch hours and tapering off in the afternoon and early evening hours. The highest level of recorded counts occurred between 11:01 am to 2:00 pm, representing 35% of the counts for the year.

Table 38. Overall hourly monitor counts (2004).

Hour	Count [1]	Percent
12:01 AM to 5:00 AM	2,000	1
5:01 AM to 8:00 AM	5,414	3
8:01 AM to 11:00 AM	36,086	21
11:01 AM to 2:00 PM	62,023	35
2:01 PM to 5:00 PM	51,375	29
5:01 PM to 8:00 PM	16,180	9
8:01 PM to Midnight	3,045	2
Total	176,123	100

[1] Count=the number of events recorded during the sampling period.

Overall Estimated Visitor Use (2002 – 2004)

Table 39 presents the total visitor numbers for the sampled areas over the three summer seasons throughout the Park with a 95% confidence interval. The highest visitor numbers were recorded for the Bear Lake Area (287,125). The second highest area in terms of visitor numbers was Western ROMO in 2003, this area included counts from the East Inlet Trail, which is easily accessed without going through a Park gate. The Highway 7 Corridor accounted for a high level of visitors in 2002, with the majority of these visitors using the Longs Peak area. Visitors were relatively constant across the other sampled areas throughout the three sampling years. The

lowest recorded counts were from the Roaming locations near Bear Lake for the 2002 season. Western ROMO 2004 included areas (Corral Creek and La Poudre Pass) that were visited infrequently due to the difficulty of gaining access from the surrounding forest land to the north.

Table 39. Overall estimated visitor use in sampled areas in ROMO (2002 – 2004).

Park Area	Year	Visitor Numbers	Lower Bound *	Upper Bound *
Bear Lake [1]	2002	287,125	270,267	300,983
Western ROMO [2]	2003	62,980	58,154	67,806
Highway 7 Corridor [3]	2002	51,093	48,084	54,102
Moraine Park [4]	2002	53,848	50,677	57,019
Northeastern ROMO [5]	2004	52,598	47,199	57,997
Wild Basin [6]	2003	48,620	44,894	52,346
Trail Ridge and Fall River Roads [7]	2004	47,766	42,862	52,670
Western ROMO [8]	2004	19,406	17,419	21,393
Roaming Locations [9]	2002	6,249	5,880	6,618

* Lower and Upper Bounds were calculated with a 95% confidence interval.

[1] Bear Lake visitor numbers were calculated from Alberta Falls, Dream Lake, Flattop, Odessa and Bierstadt.

[2] Western ROMO 2003 visitor numbers were calculated from East Inlet, North Inlet, Green Mountain, Tonahutu and Onahu.

[3] Highway 7 Corridor visitor numbers were calculated from Longs Peak Trailhead and Twin Sisters.

[4] Moraine Park visitor numbers were calculated from Cub Lake and The Pool.

[5] Northeastern ROMO visitor numbers were calculated from Gem Lake, Cow Creek, North Boundary, Black Canyon and Dunraven.

[6] Wild Basin visitor numbers were calculated from Copeland Falls, Sandbeach, Allenspark and Finch Trailhead.

[7] Trail Ridge and Fall River visitor numbers were calculated from Lawn Lake, Deer Mountain, Chapin Pass, Ute Trail, Milner Pass and Poudre River Trail.

[8] Western ROMO 2004 visitor numbers were calculated from Colorado River, Timber Lake, Corral Creek and La Poudre Pass.

[9] Roaming visitor numbers were calculated from Service Trail, Hollowell Park, Wind River, Glacier Creek, Stormy Peaks and Boulder Brook.

Visitor Decline for Selected Park Areas (2002 – 2004)

Furthermore some areas of the park provided an opportunity to examine additional theories about the distances visitors travel in the backcountry. Areas such as, Wild Basin, Glacier Gorge, Longs Peak and the Colorado River Trail are trails where there is a relatively linear path of travel (i.e. entrance and exit at the same location). Researchers coined this term as "visitor decline" or the drop off in use the farther one travels from a trailhead. One can ask if ratios for this decline can be established over time for a given trail.

The Wild Basin area, Glacier Gorge area, the Longs Peak area and the Colorado River Trail had monitors within a ¼ to ½ mile from the area trailheads with subsequent monitors prior to or after destination areas enable rudimentary calculations of decline. For example, in Wild Basin a monitor was placed prior to Copeland Falls with additional monitors placed near destination sites or trail cutoffs. These trailhead monitors were used as baseline data to calculate percentage or rate of visitor decline.

Wild Basin

As Table 40 indicates visitor decline did occur for the Wild Basin area. Most visitors went beyond Calypso Cascades to Ouzel Falls. After Ouzel Falls visitation dropped 73%. It is interesting to note that 2,471 visitors used the trail to the backcountry campsites indicating this may be part of a locally used loop or as a shortcut to Thunderlake or the Lion Lakes area. Backcountry Office records may help to determine if these visitors are likely to be overnighters.

Table 40. Visitor decline in Wild Basin trail corridor.

Location	Visitor Numbers	Percent of Visitor Decline[1]
Copeland Falls	38,048	None
Calypso Cascades	33,800	11
Ouzel Falls	10,234	73
Bluebird	8,483	78
North St. Vrain	4,575	88
Thunderlake	2,899	92
Campground Cutoff	2,471	94

[1] Percentages in this column are valid percentages.

Glacier Gorge

The Glacier Gorge area had three monitors to record visitor levels. The Alberta Falls monitor was located approximately ¼ mile from the trailhead with the Loch Vale monitor and the Mills Lake monitor approximately 2 ¼ miles further up the trail each. Both of these monitors had a significant decrease in visitor levels with 81% and 83% respectively (Table 41). This indicates that most of the visitors on that trail are only going to Alberta Falls, but the number of visitors utilizing the service trail needs to be investigated further to determine if visitors are using this as a loop trail to return back to the trailhead.

Table 41. Visitor decline in Glacier Gorge trail corridor.

Location	Visitor Numbers	Percent of Visitor Decline[1]
Alberta Falls	140,083	None
Loch Vale	26,113	81
Mills Lake	23,900	83

[1] Percentages in this column are valid percentages.

Longs Peak

The Longs Peak trail is considered by some to be one of the most challenging trails in the Park. Therefore it should be of no surprise that according to our study that 73% of the visitors attempting to summit Longs Peak fail to do so. However, some of these visitors could be attempting Estes Cone or Eugenia Mine 16%.

Table 42. Visitor decline for Longs Peak trail corridor.

Location	Visitor Numbers	Percent of Visitor Decline
Longs Peak TH	41,931	None
Longs Peak Summit	11,186	73
Storm Pass	6,820	84

[1] Percentages in this column are valid percentages.

Colorado River Trail

For the western side of ROMO, several areas along the Colorado River Trail can be looked at for rate of visitor decline. Using the monitor placed near the trailhead of the Colorado River Trail we can see visitor numbers drop sharply almost immediately. Only 24% of visitors attempt to go to Red Mountain. Also 76% of visitors do not make it to Lulu City and most visitors do not travel beyond Lulu City (95%). Many visitors seemed to use the Red Mountain trail or the Lulu City trail in a loop given that the percentages and visitor numbers for both were virtually identical.

Table 43. Visitor decline in the Colorado River trail corridor.

Location	Visitor Numbers	Percent of Visitor Decline
Colorado River Trail	13,270	None
Red Mountain	3,135	76
Lulu City	3,123	76
La Poudre Pass	633	95

[1] Percentages in this column are valid percentages.

CHAPTER 5 UTILIZATION OF ACTIVE INFRARED MONITORS FOR VISITOR USE ESTIMATES

Visitor use estimation is important for any park or protected area for the management of experience opportunities, allocation of limited resources, such as ranger patrols, trail maintenance, and the scheduling of improvements to infrastructure. However, any use estimation system should have defined objectives with appropriate measurement techniques and reliable equipment, backed by a sound sampling plan, followed by a detailed analysis of collected data (Gregoire & Buhyoff, 1999; Watson et al. 2000; Yuan et al. 1995). In ROMO, entrance station counts provide an overall estimate based on a person per car average for Park visitation and backcountry permits offer data for overnight visitation in the backcountry. Day use of the backcountry areas has always been more difficult to measure as visitors may not always comply with completing information at trail registers and parking lot observations are costly and labor intensive to implement. The use of active infrared monitors to count visitors gives managers an additional tool for improving visitor estimates in specific locations and if used regularly can provide for cumulative estimates of day visitors on most trails.

Active infrared monitors have limitations which include counting errors due to improper installation, site limitations, vandalism, equipment malfunction and weather conditions. In addition to these potential errors the monitor unit can be triggered not only by visitors, but also by wildlife or by branches on windy days (Muhar, Arnberger & Brandenburg, 2002). Another disadvantage of these monitoring units is they usually only record the number of visitors but not their direction of travel. These errors become less important if monitors are used for multiple seasons over multiple years.

Infrared counters are inexpensive and relatively easy to operate (Davenport et. al. 2003). Moreover, some of these aforementioned problems can be mitigated with careful observation and calibrations (Titre, Bates, & Gumina, 2004). To account for the mechanical counter error, each counter needs to be tested at installation and throughout its use to establish a counter error coefficient or multiplier. For ROMO each monitor was calibrated three times during the sampling period to determine the multiplier to adjust these counts. Visitor estimates derived from counters without correction factors and corresponding standard errors should be considered suspect measures of visitation (Pettebone, Newman & Lawson, 2010).

Given that ROMO owns the monitors used in this study, trained park staff or volunteers can install, calibrate, and download the data from the monitors, therefore ensuring estimates becoming more accurate over time. Visitor surveys can complement these visitor estimates by determining visitor characteristics, destinations, number of miles hiked, the types of recreation activities pursued by visitors and their perceptions about the park. Trail registers in key locations such as Longs Peak, Wild Basin and trails on the western side of the Park are still important components to this system by providing another source of data to adjust visitor numbers and can contribute to visitor management.

Visitor use estimates from this study confirmed some of the things that many ROMO managers assumed from their personal experiences. Most backcountry visitation occurs on the eastern side of the Park with the Bear Lake area and Alberta Falls as highly visited locations. Another area on the eastern side of the park that received high visitation was the Highway 7 Corridor consisting of Twin Sisters and Longs Peak. Use at the trailhead of Longs Peak accounted for most of this use, while only a 1/3rd of the visitors who used the Longs Peak Trail reached the summit. Some of the visitors using this trailhead may have been hiking to Estes

Cone or Chasm Lake. This study accounted for the number of visitors hiking toward Estes Cone, but could not account for visitors going to Chasm Lake due to lack of monitor placement options above tree line.

On the West side of the Park, the East Inlet Trail is the most highly visited but as in many places, visitors may not go beyond popular destinations like Adams Falls, Alberta Falls or Dream Lake. Considering the monitors used for this study provided a date and a time for each count researchers were able to ascertain that visitors were most likely to be on the trail between 10:00 AM and 2:00 PM throughout the park. The dates also allowed researchers to determine that visitor numbers for the backcountry peaked each year in July but some selected locations continue to be popular into the fall.

Suggestions about location and techniques for placing monitoring equipment can be made regarding future use estimation using the infrared monitors. Sampling seasons need to be defined more precisely and calibrations should be performed at monitor locations wherever possible. The use of active infrared monitors can be applied to front country locations, where appropriate, to give a more complete picture of overall visitor numbers and allow for a more sophisticated comparison of backcountry versus front country visitation. For this study Bear Lake itself was considered to be a front country area and therefore not monitored, although monitoring this location with this type of equipment could prove to be problematic due to the large number of visitors observed by the research team. Other factors for Bear Lake are very wide trail widths and a relative lack of locations to place monitoring equipment. A solution to this problem could be to compliment monitoring equipment with a sampling plan of observations for Bear Lake.

Some locations during the study were monitored well into the fall season giving researchers a look at use during that timeframe. However, winter use of the backcountry areas of ROMO was not included in this study. The equipment used for this study is capable of functioning in temperatures of 40 degrees below zero (Fahrenheit) which would work well for winter months. But field technicians would have to check equipment more frequently to account for accumulated snowfall and monitors would need to be mounted somewhat higher and shrouded or cleared of snow after storm events. Other things to consider when placing equipment are as follows.

1. Finding naturally narrow areas of trails to funnel people past the monitor single-file.
2. Finding locations with a clear and straight line of sight between the transmitter and receiver to avoid misalignment.
3. Finding sites where equipment blended into the surroundings to avoid detracting from the visitor experience.
4. Avoiding scenic overlooks, crests of steep grades and natural resting areas because visitor behavior in these areas can potentially cause miscounts due to resting or milling about.

If more Park staff and volunteers were involved in all aspects of future use estimation, baseline date will undoubtedly improve. Researchers involved in this study could train staff on appropriate procedures involving use estimation including the details of locating, calibrating, servicing, and downloading the data. Managers need to consider the associated costs of training personnel and field time as part of overall project expenditures. Training to set up counters and collect calibration data requires minimal time needed to accommodate staff training and cover the subject matter. The subsequent amount of time spent in the field by staff to collect calibration data is relative to the level of precision park management desires.

Further, the results from this study show that infrared monitors can provide data to accurately estimate visitor use in parks and protected areas. Monitors used in this study were subject to counting errors and or estimation errors and it is necessary to correct these errors to ensure accurate estimates of visitor use.

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APPENDIX A: CALIBRATION DATA SHEET

DATE ______________ **LOCATION ____________________** **Page ___ of _____**
OBSERVER ____________________
SAMPLE TIME: FROM ________ TO ________ **MONITOR COUNT: START ________ FINISH ______**
TRAVEL DIRECTION: Enter = 1, Exit = 2 **WEATHER CONDITIONS:**

Enter/ Exit	Time	Unit #	Monitor Count	# in Group	Monitor - Group #	Difference in Count	Actual Observation