An Assessment of Indirect Measures for the Social Indicator of Encounters in the Tuolumne Meadows Area of Yosemite National Park

Final Report

Sponsored by the National Park Service and conducted by

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Executive Summary

Tuolumne Meadows is a U-shaped alpine valley located at approximately 9,000 feet in the northeast corner of Yosemite National Park. The area is typified by vast alpine meadows, expansive views of granite peaks, and the meandering waterways of the Tuolumne Wild and Scenic River and its tributaries. The many hiking trails in the area are popular with visitors for both day and overnight use; many of these trails are within designated wilderness. The Wilderness Act of 1964 directs agencies to manage for certain characteristics, one of which is "outstanding opportunities for solitude." To manage for desired conditions, many agencies adopt an indicator and standards based framework. The number of encounters with other groups has long been used as an indicator for the opportunity for solitude provided in an area; typically, a maximum acceptable number of encounters is set and conditions are monitored to assess whether this standard is exceeded. The predominant method of data collection has been direct observation by field employees; however, this can be both time consuming and costly.

This study evaluates the ability of indirect measures (infrared beam counters at trailheads and mechanical traffic counters on Tioga Road) to predict encounter rates on trail segments, thus replacing the need for field observations by staff. Approximately 28 days of encounter observations were made on each of seven trail segments within the Tuolumne Meadows area. Locations were selected to represent a range of visitor use levels and complexity of trail layout, visitor use patterns, and geography. Trained observers collected encounter data over a 4-hour period on each sample day, traveling two miles per hour. Linear regression was used to evaluate the relationship between numbers of people entering and exiting wilderness trails or counts of traffic on Tioga Road and standardized encounter rates on these trails. In addition, visitor reports of encounters were obtained for two of the seven study locations, to permit comparison with observer data.

Results show highly variable relationships between visitor counts at trailheads and standardized encounter rate observations, ranging from no significance to strong in strength (r = .59 to .63), with the study areas of low complexity and greater visitation exhibiting the strongest relationships. Less complex areas show promise for using infrared beam counters as a proxy for encounter monitoring, depending on the level of precision desired by park managers. Traffic counts and encounter rate on trail segments ranged from no significance to strong (r =.53 to .62); though, due to small sample sizes it is recommended that traffic and encounter relationships be explored further.

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Introduction

Yosemite National Park managers have determined, as part of the ongoing Tuolumne Wild and Scenic River planning process, that encounters between groups will be used as an indicator for monitoring the social setting within wilderness management zones. Encounters are a social indicator often associated with solitude that can be utilized in the monitoring and management of federally designated wilderness (Watson, Cronn, & Christensen, 1998). The Wilderness Act of 1964 mandates that designated wilderness areas will be managed for certain characteristics, one of which is “outstanding opportunities for solitude” ("The Wilderness Act," 1964). Researchers and managers have historically considered encounters to be a primary detractor from solitude. Thus, the number of encounters has become an indicator of solitude, for which standards are set within wilderness planning and monitoring (Dawson, 2004; Watson et al., 1998). However, monitoring encounters directly is time consuming and costly. In order to assist with the encounters monitoring effort, this study – conducted at seven trails in Tuolumne Meadows – explored the relationship between direct measures of encounters and two indirect (proxy) measures of encounters, visitor counts at wilderness portals and vehicle traffic on Tioga Road.

Purpose of Study

The number of encounters has been chosen by many wilderness managers as an indicator for the social setting with the assertion that encounters among groups have an effect on solitude and that field measurements are easy to accomplish (Watson et al., 1998). However, when personnel are tasked with collecting encounter data, the spatial and temporal complexity of monitoring becomes evident (Dawson, 2004). Encounters are not the same as the number of visits to a wilderness (visitor use levels), which can be measured at the trailhead by a variety of means (Hollenhorst, Whisman, & Ewert, 1992). Encounters are also distinct from other indicators that have been used to assess

crowding in specific locations, such as “people at one time” or “persons per viewscape,” each of which can be measured by counting persons in a fixed location at a predetermined time (Manning, 2007). Monitoring encounters entails measuring the number of encounters groups have as they travel throughout the wilderness during a specified time span; accomplishing this turns out to be a management challenge due to the limited resources of staff, time, and budgets. The number of encounters a group has with others will vary by the season, time of day, travel pattern, and other factors (Shelby & Heberlein, 1986). This requires extensive effort to generate valid and reliable data. An indirect measure of lower cost and time requirements would be desirable.

There is a shortage of literature on technical methods for gathering and analyzing encounter data (Broom & Hall, 2009; Watson et al., 1998). Much more prevalent is the literature on estimating use; however, these techniques can only be used as an indirect measure of encounters because they establish the numbers of visitors using an area and do not address how these visitors interact while in the area (Arnberger & Hinterberger, 2003; Cessford & Muhar, 2003; Hollenhorst et al., 1992; Watson, Cole, Turner, & Reynolds, 2000). It is possible that use level data could serve as a proxy for encounters, if the correlation were sufficiently strong. In order to determine the relationship between measures of visitor use and encounter rates, this study collected data on direct encounters in conjunction with visitor use data.

This research project will assist park managers by establishing the strength of the relationships between direct measures of encounters on selected trail segments in the Tuolumne Meadows area and the indirect measures of trail visitor counts (via TrailMaster infrared beam units) and traffic flow (via pneumatic tube vehicle counters) on Tioga Road. Describing the strength and precision of these relationships will allow managers to determine whether traffic flow and/or visitor counts can be used as an indirect measure for encounters. Utilizing one of these two indirect measures would result in considerable savings in both personnel time and monitoring budgets when compared to traditional methods for monitoring encounters. These indirect measures,

captured with mechanical counting devices, could also allow managers to more rapidly assess when standards are being approached, allowing for a proactive response. Direct encounter monitoring often takes one or more seasons to accumulate data for assessment, but because mechanical counters collect data continuously, adequate data could be collected in a single season.

Theoretical Foundations

Encounters have historically been viewed as the most pertinent visitor density indicator in relation to opportunities for solitude (Dawson, 2004). However, empirical research has shown a weak relationship between encounters and visitor perceptions of solitude, privacy, and crowding (Graefe, Vaske, & Kuss, 1984; Lee, 1977; Stewart & Cole, 2001). Despite this weak relationship, there remains enough published work to support the use of encounters as an indicator for opportunities of solitude (Graefe et al., 1984; Lee, 1977; Manning, Valliere, Minteer, Wang, & Jacobi, 2000; Stewart & Cole, 2001; Vaske & Donnelly, 2002). Because encounters have been chosen as a social indicator for Yosemite NP, it was not within the scope of this research to assess the relationship between encounters and solitude opportunities or experiences; instead this research concentrated on the relationship between the dependent variable of encounters and the independent variables of visitor counts and traffic.

The hypothesis which guided this research was that there is a positive relationship between direct measures of encounters and indirect measures of encounters, that is, the visitor counts on study trails and traffic counts on Tioga Road. The intuitive logic behind this relationship is apparent. Hikers are delivered to trailheads by cars. The more cars, the more hikers will depart the trailhead and the more encounters will occur amongst parties while hiking in the area. However, encounter rates are affected by many spatial and temporal factors, resulting at times in a weak relationship between encounters and visitor use (Shelby & Heberlein, 1986). For example, hikers arrive at trailheads at different rates during different seasons and days of the week. Wilderness

visitors also arrive at trailheads during different times of the day and travel at different speeds along the trail. Many wilderness trails branch into multiple trail segments with distinct destinations. Moreover, visitors are not limited to hiking only on trails and will at times engage in cross-country travel. Topography and vegetation can affect travel rates, travel choices, and distances at which other visitors can be seen or heard. All of these factors can affect use-encounter relationships.

Despite the challenge of the variability of encounter rates, research has demonstrated some success in correlating indirect measures to encounter rates. For example, Watson et al. (1998) examined the relationship between four indirect predictors of wilderness encounter estimates (mechanical car counters and mechanical trail counters) for both number of encounters reported by visitors and encounters as measured by trained observers. The variation explained by the indirect predictors exceeded 90% in the more heavily used locations; however, there was a decrease in predictive power for areas with the least use. Watson et al. concluded that all four indirect predictors used in the study can be successful in predicting encounter rates in some locations. However, it should be noted that Watson et al. studied a small, contained use area; hence relationships would be expected to be stronger than in other settings with more complexity.

Shelby and Heberlein (1986) discussed the positive linear relationship between boating use levels and river encounters found on the Rogue River (r = . 71) and the Grand Canyon (r = .68). When considering the strength of these relationships it is important to note that travel is confined to the river corridor and occurs in only one direction (i.e., down river). Research on encounter rates in terrestrial systems with more complex travel patterns produces much weaker correlations. In a study of Wisconsin deer hunters, use level and contact with other groups (i.e., encounters) were unrelated (r = -.07). Further, in a managed goose hunt, use levels and group contacts were also unrelated (r = .03). These findings led Shelby and Heberlein to conclude that there are many factors which may affect the relationship between visitor use level and

encounters. The variability reported in such studies highlighted the need empirically to establish the relationship between use levels and encounters for each site in this study independently.

Another issue was defining what precisely is meant by "encounter." There is no consensus from available sources on what is a "group" and when it counts as an encounter. Although at first it appears intuitive, failing to define the details of an encounter can lead to unreliable measurement by technicians. The definition of a group within the realm of encounter monitoring has been described as a party consisting of one or more people (Hall & Shelby, 1994; Shelby & Hall, 1992; U.S. Department of Agriculture Forest Service, 2007; Watson et al., 1998). However, just how this group must function or relate to other visitors to count as one encounter is often not expressly addressed. For example, if a party that arrived together becomes divided during the day into three subgroups, separated by one-half mile, each of which is encountered by the observer, how are they to be counted? Does this constitute one encounter, or three separate encounters? Or, if two different groups happen to be hiking within speaking distance of each other, should they be counted as one group or two groups by the observer? How specifically such issues are resolved may be less important than clearly articulating all relevant decision rules. For example, *The Bob Marshall Wilderness Complex LAC Monitoring Guidebook* (2007, pp. 17-18) gives direction to employees for how to record encounters when faced with the previous two situations posed here:

> *A party is a group of people readily recognized as traveling together. There should be no more than 1/8 mile and/or 15 minutes between the first and last members of the party. If in doubt as to whether parties are associated and traveling together, tally as separate encounters.*

Because the goal of encounter monitoring is to provide a sense of the opportunities for solitude available to visitors, observers should record encounters from the perspective of a visitor. It is not pertinent whether a small group encountered is actually part of a larger group, though this may be of interest for other managerial reasons.

Researchers and managers have at times chosen to monitor the number of individuals encountered, rather than the number of groups, due to difficulties distinguishing individuals' affiliations to others, especially in busy areas (Shelby & Heberlein, 1986). However, where possible, documenting each group encountered as well as the number of people in the group will provide the most flexibility for subsequent analysis.

The proximity a group must have to the observer in order to be counted as an encounter also differs amongst encounter monitoring protocols. Some programs count as an encounter any group that is seen no matter the distance from the observer, while others count only groups that are passed along a trail corridor. The Watson et al. (1998) study on encounter monitoring measures distinguished between cases when the observer passed within speaking distance, about 25 feet, and groups outside of speaking distance as separate categories of encounters. However, it was found that so few groups were observed outside of speaking distance that the category was dropped for analysis. Whether a similar pattern would occur elsewhere seems likely to vary with terrain and vegetation of a specific site. Other studies have addressed this issue by recording encounters on trail and off trail, the latter capturing the groups seen in the distance and allowing for analysis to be performed on aggregate data or for each type independently (Shelby & Hall, 1992).

Repeatedly encountering the same group during the day has been addressed by protocols within wilderness management plans and research. The question is whether encountering the same group multiple times should count as a single encounter, or whether each time the group is seen should be documented as a separate encounter. Two studies have recorded the encounter the first time a group is met as well as each additional time, with a notation that the group had been seen before (Hall & Shelby, 1994; Shelby & Hall, 1992). This technique allows for analysis to examine both unique encounters and total encounters. Other management protocols, such as at Yosemite NP, only count groups the first time they are seen (Yosemite National Park, 2007). Different forms of a "leapfrogging rule" have been developed that address the time or distance

that must elapse before an encounter with a group is counted again. Two research projects specified that 5 to 10 minutes must pass before counting a group again, unless "leapfrogging" with the group. On the other hand, one management plan specifies 20 minutes or one mile must elapse before counting the same group between sightings (Shelby & Hall, 1992; U.S. Department of Agriculture Forest Service, 2007).

The way in which encounters have been addressed by measuring actual or perceived encounters with direct or indirect methods has also been briefly addressed in the literature (see Table 1 for a summary of encounter measures). "Actual encounters" are encounters witnessed by trained observers, who may be park employees, researchers, or volunteers. A direct measure of actual encounters is achieved by following a visitor party and noting the number of encounters they have during the day (Shelby & Heberlein, 1986; Watson et al., 1998). The advantage of this method is the high level of validity of the construct being measured, that is, the actual encounters a visitor group has during a wilderness visit. However, there are three substantial disadvantages of this direct actual encounter measure. First, the inability to control visitor travel, both duration of stay and presence within the area of study, can lead to lost data points and reduce overall sample size (for instance, the shadowed visitors may go outside the study area). Second, there are potential negative impacts on the experience of the group, if they are aware of the presence of the observer. Third, it can be cost prohibitive to devote enough staff days for adequate sampling. Though the direct actual encounter technique has been used as part of research studies, there are no reports of this technique being employed within the normal operations of a wilderness encounter monitoring program.

Table 1. Definitions of Encounter Measures

	Actual Encounters	**Perceived Encounters**
Direct	Trained observers shadow a visitor group and record the encounters the visitor group has with other groups during the observation period.	The number of encounters self-reported by visitors in trip diaries or post visit surveys.
Indirect	Trained observers travel in a manner emulating a typical visitor and record their own encounters with other groups during their observation period.	No indirect measure of perceived encounters is reported in the literature.

Shaded boxes indicate the encounter measures used in this study.

By far the most common measurement of encounters within wilderness management programs is of actual encounters using trained observers as a surrogate for a visitor; observers record their own encounters as they travel in a manner similar to how a visitor would travel. These are actual encounters because they are witnessed by the recorder; however, this has been classified as an indirect technique in one study because the measure captures encounters of the trained observer who is not an actual member of the visiting public (Watson et al., 1998). The advantages of this method are the validity of the measurement of actual encounters, the increased control of travel duration, and the control of travel routes. The disadvantages of this technique are the need to theorize the travel of a typical visitor and staff costs for observations. Staff costs can be reduced by scheduling normal work duties to coincide with encounter observations or by using trained volunteers. This study used park staff, park interns, researchers, and park volunteers as proxies for visitors for the measure of actual encounters. For clarity, this measure will be referred to simply as “actual encounters.”

Perceived encounters reported by visitors have been another widely used measure (Shelby & Heberlein, 1986; Stankey, 1980; Stewart & Cole, 2001; Watson et al., 1998). This measurement of encounters is operationalized by asking visitors to recall how many encounters they had during the course of their trip or by asking them to record their

encounters during their trip. This method is conceptualized as a measure of perceived encounters because it is the encounters a visitor recalls or notices, rather than the observations of a trained observer whose purpose is to record actual encounters. Visitors might not notice some groups or might forget seeing groups, which could lead to inconsistencies between perceived and actual encounters. Post-visit surveys and visitor diaries have both been used to measure perceived encounters (Shelby & Heberlein, 1986; Stewart & Cole, 2001; Watson et al., 1998). In research using both these methods, Watson et al. (1998) found that self-registration diaries at high use locations produced extremely variable results, perhaps due to low compliance. Further, diary reports sometimes produced lower encounter rate estimates than survey self-reports at high use areas. Our study measured perceived encounters using a post-trip survey administered as visitors were leaving the wilderness at two of the seven sites; this measure was referred to as "perceived encounters."

The relationship between actual encounters and perceived encounters has been examined in only a few studies. It is important to remember that these are different constructs and measures of encounters; that is, they are measuring different things. However, establishing a relationship between these two encounter measures could assist management. For example, if actual indirect encounters closely match perceived direct encounters, then managers would not need to survey visitors to understand the visitor's experience. Watson et al. (1998) found that in easy-access high use areas, visitor self-reports of encounters (direct perceived encounters) and wilderness ranger observations of encounters (indirect actual encounters) did not differ significantly. At these same easy-access high use areas, survey self-reported encounters (direct perceived encounters) produced lower *group* encounter estimates than trained observers shadowing visitors (direct actual encounters); however, self-reported estimates for the number of individuals encountered did not differ statistically from those of trained observers shadowing visitor groups. In summary, these findings demonstrate that for the easy-access high use areas in the study, visitor recall of

encounters was accurate for number of individuals encountered, but underestimated the number of other groups encountered.

It should also be noted that there may be a difference between wilderness ranger reports of actual encounters and reports of actual encounters by field staff tasked solely with recording encounter observations. Wilderness ranger job duties may increase the number of group contacts and alter travel routes from those of the "typical visitor" being emulated by the encounter observer who has only encounter monitoring responsibilities. However, these differences remain hypothetical; within the empirical research, wilderness ranger encounter rates have not been directly compared to those of trained observers only measuring encounters. It was not within the scope of this research project to test this hypothesized difference.

The existence of a positive correlation between traffic rates on roads and visitor counts on trails appears intuitive; however, the dispersion of traffic and the motivations of visitors driving their vehicles determine how heavily specific sites are used by visitors (Regnerus, Beunen, & Jaarsma, 2007). Pettebone (2009), in a study modeling visitor counts at attraction sites in Yosemite NP, used traffic counts at the Park entrance stations as an independent variable and found a moderately strong relationship (r= 0.59) between traffic counts and visitor counts at selected attraction sites after building in a three-hour delay. Further, using a negative binomial regression model with time related independent variables, Pettebone obtained an r^2 value of .89 at the 95 percent confidence level, demonstrating that traffic counts are a significant predictor of visitor counts at selected attraction sites in Yosemite NP. Thus we might expect traffic counts to correlate positively with TrailMaster counts of visitors on trails. However, we expect that the correlation between TrailMaster counts for a specific trail and encounters on that trail to exhibit a stronger and more consistent correlation than will be found between the traffic counts and encounter measures.

To summarize the theoretical grounding of this research, encounter monitoring has a long history within wilderness research and management. The operational definition of

an encounter can be informed by this previous work, contributing to validity and reliability of the measures of encounters used by this research. Additionally, indirect measures of encounters have exhibited strong positive correlations to encounter rates in some locations, lending evidence to support the efforts of this research. Thus, we have endeavored to determine the relationship between the indirect measures of visitor counts and traffic counts and the two measures of encounters (actual and perceived).

Research Question

How strongly is the number of encounters on selected trail segments within the Tuolumne Meadows area related to the number of visitors traveling on those trail segments or number of vehicles traveling the Tioga Road on a given day?

Hypotheses

1. The number of encounters on selected trail segments within the Tuolumne Meadows area will be positively related to the number of people counted entering these trail segments during that day.
2. Perceived encounters and actual encounters on selected trail segments during the same day will be positively correlated.
3. The number of encounters on selected trail segments within the Tuolumne Meadows area will be positively related to the number of vehicles traveling the Tioga Road that same day.
4. Encounters will have a stronger correlation with the number of people counted on selected trail segments than with traffic counts

Methods

Study Locations

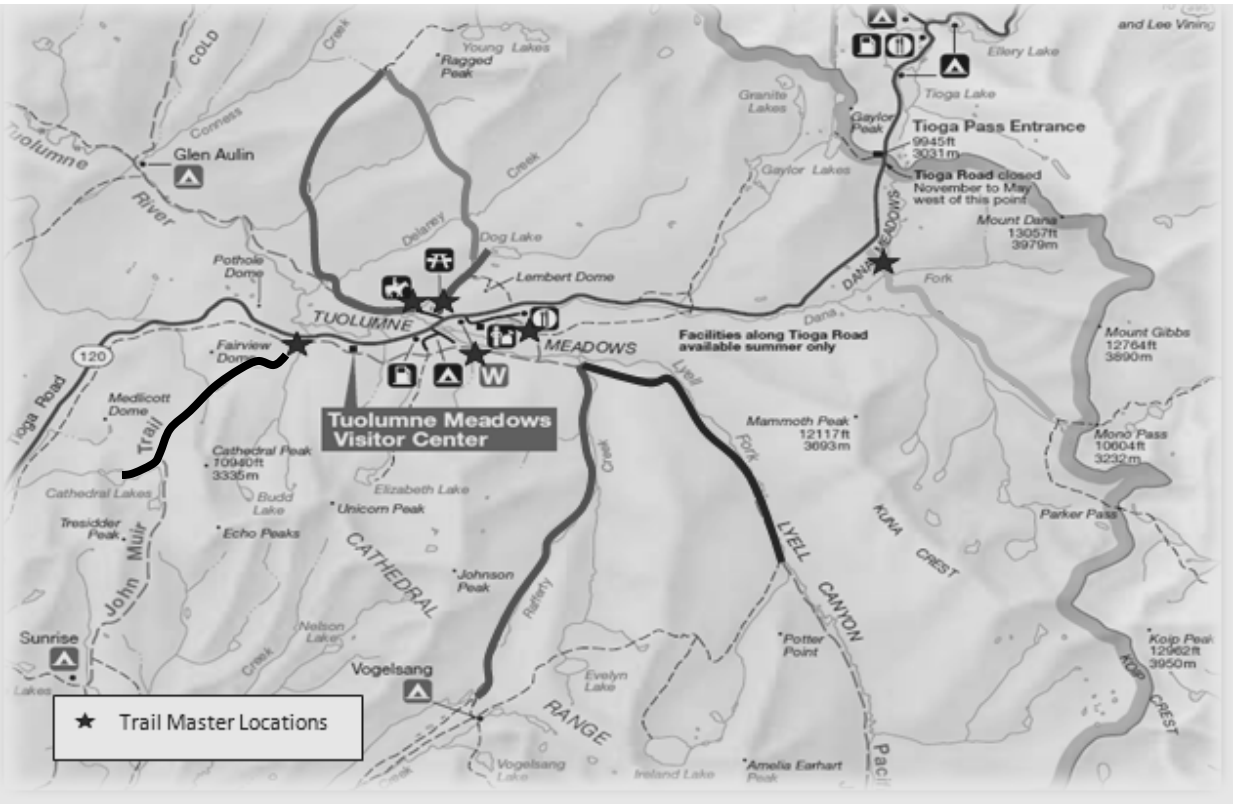

Figure 1. Map of Study Trail Segments and TrailMaster Locations

This study took place on seven trail locations within the Tuolumne Meadows area located in the northeastern section of Yosemite National Park. The many trails in the area are popular with both day hikers and backpackers (Pettebone, Newman, Beaton, Stack, & Gibson, 2008). When choosing the locations for this study, it was desirable to include locations that varied in visitor use level and in complexity of trail layout, visitor use patterns, and day versus overnight use levels (Table 2). By choosing study locations that differ markedly from each other, the range in strength of relationships between indirect and direct measures of encounter rates could be assessed. This will help inform discussions about whether indirect measures of encounters (traffic and visitor counts)

can be used in other locations of the park. The trail segments of this study were located on Cathedral Lakes, Lyell Canyon, Rafferty Creek, Mono Pass, Glen Aulin/Young Lakes, and Dog Lake/Young Lakes trails (Figure 1). In all cases, the TrailMaster was placed at the wilderness boundary, but for two trails (Lyell Canyon and Rafferty Creek) this did not coincide with the beginning of the observed section of the trail. As will be discussed in the results, this introduced confounding factors for those two trails.

Table 2. Study Trail Segments and TrailMaster Locations

Name	Segment	TrailMaster Location	TM Count*	Avg. encounter rate**	Geographic Complexity***
Cathedral Lks	Wilderness boundary to lower Cathedral Lk	Wilderness boundary	19,809	9	Low
Lyell Canyon	Jct Lyell and Rafferty Trs to Jct w/ Ireland Crk Tr	Wilderness boundary near Tioga Lodge	26,843	6	High
Dog Lk	Wilderness boundary near Lembert Dome Day Parking to Dog LK	Wilderness boundary near Lembert Dome Day Parking	18,454	11	Moderate
Rafferty Crk	Jct Raffety and Lyell Trs to 1st tr jct in Tuolumne Pass	Wilderness boundary near Tioga Lodge	26,843	5	High
Mono Pass	Wilderness boundary to Mono Pass and boundary with USFS	Wilderness boundary	5,472	2	Low
Young Lks West	Wilderness boundary near Parsons Lodge to tr jct with Young Lakes East Trail	Wilderness boundary	13,935	3	Moderate
Young Lks East	Tr jct with Dog Lk Tr to tr jct with Young Lks W Tr	Wilderness boundary near Lembert Dome Day Parking	18,454	2	Moderate

* Total corrected TrailMaster count of people for the months of July and August 2009 associated with each trail study segment.
** Grand mean encounters per hour for unique groups within speaking distance for the months of July and August 2009.
*** Determined by management judgment of complexity of trail layout and attraction sites in the trail study segment area

Dependent Variables

Actual encounters are the number of encounters a trained observer had with other parties while traveling within the specified study area. A party was defined as any group

of one or more that was readily recognized as traveling together. If there was doubt as to whether people were associated with each other, each group was counted as a separate party. All parties seen were counted; a notation was made if a group was outside of speaking distance (approximately 25 feet). In the case of encountering the same party during an observation period, it was counted again if more than 20 minutes had passed since the last encounter with that party, along with the notation "seen before." (Otherwise, the second encounter was not recorded. For example, if a groups was in sight continuously for an hour, only one encounter was recorded.) The number of people in a party was also recorded, which allowed for analysis of encounters with parties or encounters with individuals. For the full field data collection protocol, see the data collection section of this document and Appendix A.

Perceived encounters are the number of encounters with other groups self-reported by visitors when surveyed by researchers upon completion of their hike in a study area. A party was again defined as any group of one or more individuals. An encounter was defined as any group that the visitor saw while in the study site. Visitors surveyed were not asked to distinguish between unique encounters and total encounters with other groups; however, they were asked to report both encounters with other groups and encounters with individual people. Perceived encounters were measured at only two trails due to staffing limitations: Cathedral Lakes and Lyell Canyon.

Independent Variables

Traffic counts were collected on Tioga Road from July 1 until August 8 by Yosemite NP. Data after August 8 were lost due to theft of the traffic counters. Traffic can only enter the Tioga Road from the east entrance of Yosemite NP and from the west by the Big Oak Flat Road. Bidirectional tube counters, with the ability to distinguish vehicle class, were installed at the east and west ends of Tioga Road by Yosemite NP staff. Data were recorded with time stamps for each vehicle entry and exit. Calibration and maintenance

of these counters was conducted by Yosemite NP staff. This study received the data in the form of Excel spreadsheets of counts (see Appendix B for an example of the data).

Data on the **number of people traveling on trails** were collected by Yosemite NP using Trailmaster TM 1550 units placed at appropriate locations to correspond with wilderness entry points for the study areas (for four trails, this was at the beginning of the study segment, but for three trails this was approximately one mile away). These units use an infrared beam technology originally designed for wildlife study, but which have been successfully applied to visitor use estimation in numerous locations (Pettebone, 2009). Any time the beam is broken, the unit registers a count, along with a time stamp. These units were installed, maintained and calibrated by Yosemite NP staff. The count data were provided to this study in the form of Excel spreadsheets consisting of summed hourly counts of people passing the monitor, corrected for errors by such things as two individuals walking side by side (see Appendix C for an example of data). The process of calibrating TrailMasters is described by Pettebone (2009; Pettebone et al., 2008). In addition, a unit capable of collecting directional counts of visitors was placed alongside TrailMaster units for extended periods of time; these data were used by Yosemite NP to calculate directional proportion coefficients for each hour of the day for these locations.

In order to determine if ***weather*** influenced the relationship between encounter rates and indirect measures on trails, data were downloaded in electronic format from the Department of Water Resources California Data Exchange Center website for two remote weather stations located in Tuolumne Meadows. The Tuolumne Meadows TUM station is operated by the California Department of Water Resources and is located at 8,600 ft (Lat 37.8730^{o}N Long 119.3500^{o}W). The Tuolumne Meadows TMM station is operated by the National Park Service and is located at 9,200 ft (Lat 37.8680^{o}N Long 119.3190^{o}W). A categorical variable for precipitation was created: “rain” (any occurrence of precipitation by either or both stations) and “no rain” (no occurrence of

precipitation by either station). A continuous variable for Maximum Temperature (F°) was created with the daily maximum temperature from the TMM station.

In addition it was of interest to determine whether visitor behavior on trails differed on ***weekdays versus weekend days / Holidays*** in ways that might affect encounter rates***;*** a categorical variable was thus created (0 = weekday ; 1 = weekend day / holiday). July 3 was recorded as a holiday due to the July 4th holiday falling on a Saturday.

Sampling

A random sampling schedule was used during the months of July and August to select observation days. Randomization eliminates systematic bias and allows for increased confidence in generalizing sample findings to the population (Graziano & Raulin, 2007). In order to calculate the number of sample days necessary to establish the relationship between visitor use and encounter rates on Yosemite NP trail segments with a desired level of confidence and power, the relationship of visitor use and encounter rates was examined using data from a study that took place in wilderness areas in Oregon. That study collected "actual encounters" data using trained observers and visitor use data from mandatory self-issue permits at trailheads. The linear regression models for three different locations show correlation coefficients (*r*) ranging from 0.50 to 0.79. Based on these correlation coefficients, sample size estimates were generated using the Proc Power procedure in SAS (SAS Institute Inc. Cary, NC, USA, version 9.2). Sample size estimates were generated at a power (β) of 0.80 with a confidence level (α) of 0.05; power is conventionally set at 0.80 with an associated .05 alpha level (Mazen, Hemmasi, & Lewis, 1987).

As can be seen in Table 3, for trails with a moderate correlation (i.e., r = 0.50), 28 days of sampling were needed to determine the relationship between encounters and use at a power of 0.80 and an alpha of 0 .05. The assumptions inherent in this analysis were that these Oregon study locations encompass the range of true correlation values found in Yosemite NP. For the sake of caution, the smallest correlation value (r= 0.50)

was chosen to determine the sample size for all locations, which required 28 days of data collection per segment.

Table 3. Power Analysis and Sample Days Needed for Trails with Correlations between Encounters and Visitor Use Ranging from .50 to .80 at Alpha .05 and Power .80

Correlation Coefficient	Confidence	Power	Sample Days Needed
.50	.05	.801	28
.55	.05	.811	23
.60	.05	.818	19
.65	.05	.803	15
.70	.05	.826	13
.75	.05	.839	11
.80	.05	.840	9

Also considered was the length of each observation period needed to reliably reflect daily encounter rates, that is, the duration of time necessary to closely approximate the mean per hour encounter rate for a given day in a given study location. From past data it was known that encounter rates vary throughout the day. If a visitor day is defined as eight hours, then an eight-hour observation period would by definition capture the encounter rate of that day. However, for the practical ability to sample more than one location during a given day with limited personnel, a shorter observation was desired, but it needed to generate data that adequately correspond to the mean hourly encounter rate for that given sample day. Past data from the Obsidian Falls location were examined for this purpose. Figure 2 shows the linear regression for the number of groups encountered per hour for all possible one-hour observations during several 8-hour observation days (x axis), plotted against each day's mean groups per hour (y axis).

To compute this relationship, a day's data were broken into each one-hour block of time, and each hour was plotted against the day's overall average groups per hour. As can be seen, the relationship is moderate (r^2 = 0.50). However, Figure 3 - showing all possible 4-hour observation blocks - increases the strength of the relationship (r^2 = 0.86) substantially. Using all possible 6-hour observation blocks (figure not shown) increases the r^2 value to 0.96, and of course eight hours of observation would explain 100 percent of the daily mean encounter rate for an 8-hour observation day.

The practical implications of these relationships were significant. A 4-hour observation period of hiking in the mountains was more congruent with the fitness level of volunteers. In addition, it was possible for some observers to conduct observations in two locations in one day, maximizing the use of available personnel. Based on Figure 3, it was presumed that 4 hours provided a reasonably accurate picture of the data that would have been collected if 8 hours of observation were made. Encounter observations were made between the hours of 8:00 a.m. to 6:00 p.m. in order to coincide with the primary visitor use period as shown in the visitor use estimation by Pettebone et al. (2008). Start times were varied to capture morning, midday, and afternoon periods.

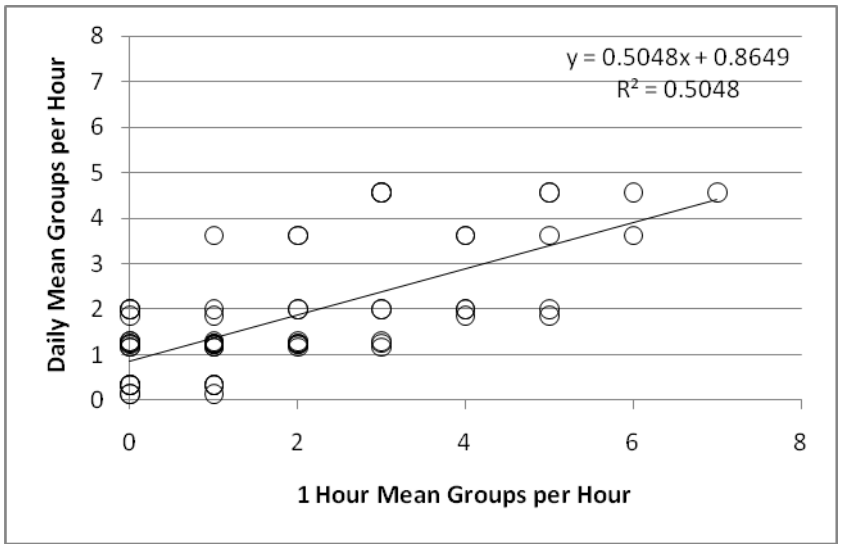

Figure 2**.** Relationship between One-Hour Observation Blocks and Eight-Hour Daily Mean Groups Encountered per Hour at Obsidian Falls

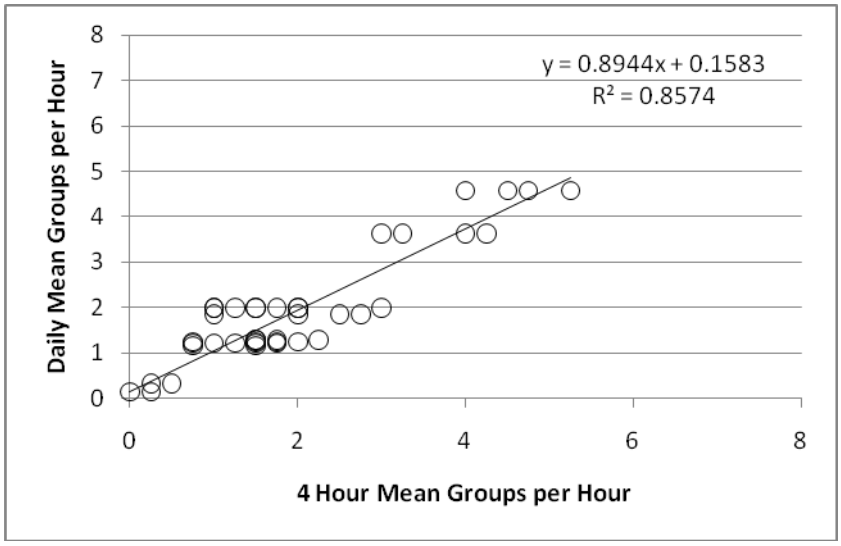

Figure 3. Relationship between Four-Hour Mean Observation Blocks and Eight-Hour Daily Mean Groups per Hour at Obsidian Falls

Data Collection Procedures

We had planned to obtain data on the independent variables of traffic counts and trailhead visitor counts using mechanical counters for the duration of this study. The trail counts were obtained as planned for each trail, but the traffic tube data were only collected until August 8. We considered substituting entrance station data for the traffic data, but there were no entrance station data for Tioga Pass for the month of August. Thus, analyses using traffic counters must be considered with caution. Park staff maintained the mechanical counters, ensuring downloading of data and functionality of the counters. Calibration of the counters was performed by park staff by directly counting visitors and comparing these counts to TrailMaster counts (for an explanation of this procedure see Pettebone, 2009). These data were given to us in Excel spreadsheets with each vehicle count time stamped and the lane of travel noted.

Actual encounter data were collected by trained Yosemite NP staff, Yosemite NP SCA interns, UI researchers, and Yosemite NP volunteers. These observers traveled trail segments within the study area and recorded their encounters with other parties in a

data collection pocket notebook. Observers were instructed to travel at the pace of the average hiker, approximately two miles per hour. Observers began data collection for each trail segment by noting the date, time, and trail segment. Upon completion of the trail segment, the time was recorded. The attributes recorded about each encounter were: reference number, time, number of people, number of stock, direction of travel, day or overnight visitor, whether the group was outside of speaking distance (25 feet), and whether the group had been seen before on that day (see Appendix A for protocols). Observers were assigned four hours to travel upon a trail segment during a sample day. This need not have been a consecutive time, but a total of four hours throughout the day from which the average for the day was calculated. For most locations a single trip out and back accomplished the needed observation time. However, for the Dog Lake location a little more than two trips was needed.

On the randomly sampled days for Cathedral Lakes and Lyell Canyon trails, perceived encounters were collected from visitors by volunteers using a short survey administered at wilderness portals as visitors return from hiking. Due to staffing it was only possible to administer surveys for two locations. Lyell Canyon was chosen due to management interest in the area and its complexity of trail layout, attraction sites, and visitor use patterns. Cathedral Lakes was chosen to contrast with Lyell, having lower levels of complexity of trail layout, different types of attraction sites, and more consistent visitor use patterns, while still having relatively high visitation for surveying purposes. Visitors were asked questions that mirrored the data collected by the trained observers. Information collected by the survey was: survey location, time hike began, end time of hike (recorded by interviewer), route taken (drawn on a map by surveyor or visitor), number of groups encountered on trail study segments, number of individuals encountered on trail study segments, number of persons in the respondent's group, and their length of stay (day or overnight). Survey times coincided with those of actual encounter observers to allow for comparison of the two types of data. Groups were selected using the next to pass method; once the interviewer completed an engagement with a group the next group to pass was asked to participate (Veal, 2006). Refusals were

noted on the interviewer log form along with user type (day or overnight), group size, and reason for refusal if given. (see Appendix D for Protocols).

A pilot test of procedures was conducted for actual encounters the week prior to commencement of the research project. Researchers assessed the measurement constructs utilized in this research and whether they where appropriate for the Tuolumne Meadows study area. All encounter constructs were found to be measurable under the study protocols (see Appendix E for pilot assessment protocols). Perceived encounter measures were evaluated during the initial survey period and determined to function appropriately.

Instrumentation effects were addressed by clear field protocols for both actual and perceived encounters (Creswell, 2009; Graziano & Raulin, 2007). Observers were trained and data were checked for compliance with procedures. Observer trainings consisted of an in-person presentation and discussion of the research project and field procedures for collecting encounter data. In addition, observers received a packet of materials consisting of encounter monitoring protocols, maps showing trail study segments, encounter data collection notebooks, and contact information for researchers. Researchers made periodic reviews of data to ensure that procedures were followed correctly. Observers who did not follow procedures correctly received further training.

Data Management

The data for actual encounters and perceived encounters were collected and entered into a Microsoft Access database by UI staff. The electronic data of traffic counts, trailhead visitor counts, and weather were imported into the Access database. Initial summaries of variables were performed in Access then exported to Excel. Additional summary of variables was then conducted in Excel before the final dataset was exported to SPSS Statistics 17.0 for analysis.

Analysis

Actual encounter rates were computed for the seven study trail segments for each random sample day. In encounter monitoring, it is necessary to standardize the unit of measurement for comparison of observations, because the time span in which encounters are measured can vary. This study standardized the actual encounter rate by dividing the total number of actual encounters for the observation day by the elapsed hours of observation on the trail study segment during that day. This provides the average hourly actual encounter rate for a sample day.

To more fully explore the encounter experience on each trail study segment, three variants of the actual encounter variable were computed for both groups and people (Table 4).

1. *Unique encounters within 25 feet* included each group/person that passed within speaking distance of the observer (approximately 25 feet), counted only during the initial encounter. This variant represents the definition of an encounter described in the Yosemite NP draft encounter monitoring protocols.

2. *All unique encounters* included groups/people encountered both within and outside of speaking distance counted only during the initial encounter. This variant therefore adds groups/people seen in the distance and may result in a higher encounter rate for an area.

3. *Total encounters* included all groups/people within and outside of speaking distance and individual groups each time they were encountered if more than 20 minutes had elapsed between sightings. This variant results in the largest number of encounters.

Table 4. Actual Encounter Variable Variants

Actual Encounters	Proximity		Sighting	
	< 25 feet	> 25 feet	First only	All
Unique < 25 ft	X		X	
All Unique	X	X	X	
Total	X	X		X

In addition to the three variants of the actual encounter measure, the percentage of day and overnight users, visitors traveling in or out of the wilderness, and encounters within or outside of speaking distance was calculated for each study location to further describe the actual encounter experience.

Perceived encounters rates were computed for the Cathedral Lakes and Lyell Canyon locations. To compare these visitor reports of encounters to actual encounters, the reports of encounters with groups and people were divided by the elapsed hiking time for each survey, resulting in the mean perceived encounter rate per hour for both groups and people. At this point all surveys were examined for extreme cases; one survey for the Lyell location (8/10/09 survey number 5) was determined to be improbable and was therefore removed. All other outliers for both Cathedral and Lyell were retained for analysis. Then, for each sample day, the mean hourly encounter rate for both groups and people was computed from all the surveys collected each day. This results in the mean hourly perceived encounter rate for each sample day for comparison with actual encounter rates.

Relationships between actual encounters and TrailMaster counts were examined using linear regression models in SPSS, which utilize the ordinary least squares (OLS) method for best fit of the regression line. Models explored the relationship between the three actual encounter variants and two different time units for TrailMaster corrected counts. Counts of the number of people passing the TrailMaster unit were provided by Yosemite NP, summarized by hourly units and corrected for counter error. In addition, six of the seven locations also included counts corrected for direction of travel. These corrected

counts for total, inbound, and outbound use were summed from 8:00 a.m. to 6:00 p.m. to correspond to the time block in which the 4-hour actual encounter observations occurred. Models were also examined for corrected TrailMaster counts summed for the 24-hour day to examine whether an improvement occurred from using the more refined time block. Each model was run in two stages. First the independent TrailMaster variable was regressed against the mean hourly encounter rate variable. Then two categorical variables - weekday or weekend day, rain or no rain - and a continuous variable of maximum daily temperature were entered into the model and each was removed if not a significant contributor to variance explained (Field, 2009). Only models significant at $\alpha = .05$ are reported in the results. The individual prediction interval for average hourly encounter rates was calculated at the 95% confidence limit in SPSS. The individual prediction interval is the upper and lower bound for a single case of the dependent variable as predicted by the independent variable. The confidence interval then expresses the chance that a case will fall within the range. The mean prediction interval was also calculated; which is the upper and lower bound of the mean value of the dependent variable at a given value of the independent variable expressed by a range set by the confidence interval (Field, 2009). Because visitor use patterns may change on holidays compared to non-holiday days, the standardized and studentized deleted residuals for the fourth of July holiday were examined in the diagnostic output for each of the models (Manning, 1999). The holiday was only found to be an outlier for the Young Lakes West location and was removed. All other outliers for other locations were not associated with the holiday and were retained for analysis.

Relationships of perceived encounters to TrailMaster counts and actual encounters were examined in separate linear regression models, using actual encounters and corrected TrailMaster counts as independent variables. Again, the variables for weekday/weekend day, precipitation, and maximum daily temperature were added in a second stage model and removed if not significant at $\alpha = .05$. For the regression of actual on perceived encounters, sample day average encounter rates per hour for both groups and people were examined. TrailMaster counts from 8:00 a.m. to 6:00 p.m. for

total, inbound, and outbound corrected counts were regressed against the daily mean average hourly perceived encounter rate reported by visitors. Only models significant at the 95% confidence level are reported in the results.

Relationships between actual encounters and Tioga Road traffic counters were examined for all seven locations using linear regression models. Due to the theft of traffic counters, data were only available from July 1st to August 5th. This resulted in a small number of sample days for examination. Traffic counts were bidirectional for both Tioga Road east and west counters, resulting in counts for each monitor of east and west bound traffic. Inbound and outbound lanes from the east and west traffic counters were summed to create a daily total (both inbound and outbound), inbound, and outbound traffic count from 7:00 a.m. to 6:00 p.m. These counts were then used as independent variables. Only significant models are reported. Issues of leverage and influential cases exist within the traffic models, due at least in part to small sample size. These issues will be discussed further in the appropriate section of the results.

Results

Cathedral Lakes

Summary Statistics

Twenty-eight days of data were collected for actual encounters at Cathedral Lakes trail (Figure 4). The average number of encounters per hour with unique groups ranged from approximately 6 to nearly 16, while the average number of total encounters per hour (which include multiple sightings of the same group) ranged from approximately 7 to 18 (Table 5). When examining encounters with individuals (vs. groups), the average number of unique encounters per hour ranged from 13 to 43 people, while the average total encounters per hour ranged from 13 to 45 (Table 6). The similarity between the "unique" and "total" encounters shows that, on this trail, observers generally did not encounter the same group more than once, and a comparison of the number of encounters with groups versus individuals reveals that group sizes were generally 2 to 3 people (Table 7).

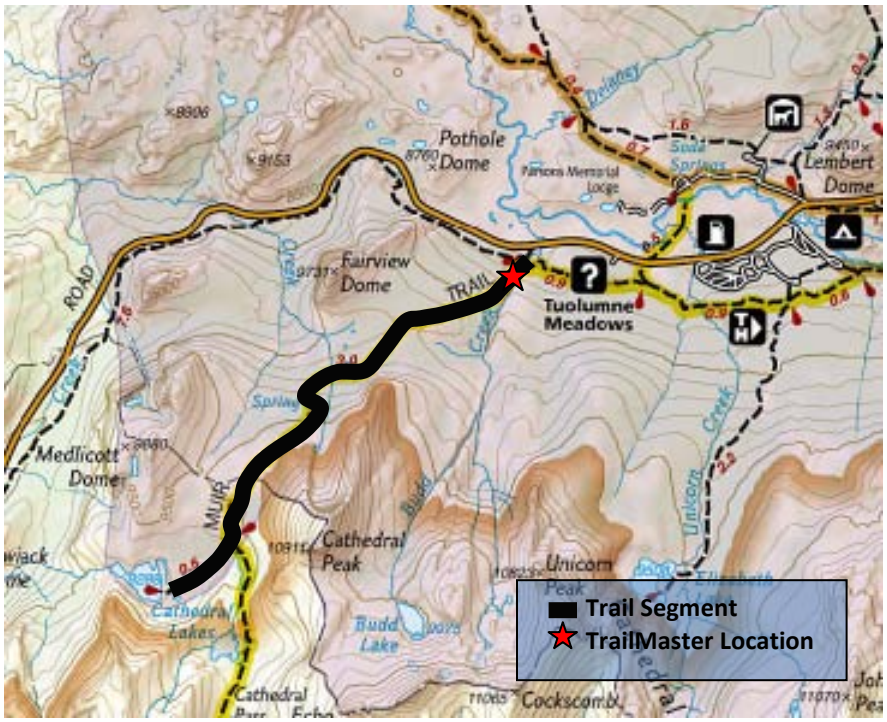

Figure 4. Map of Cathedral Lakes Study Location

Table 5. Cathedral Lakes - Actual Mean Hourly Encounter Rates with Groups, by Day

Date	Weekday	Hours	Unique Groups per Hour (Mean)		Total Groups per Hour* (Mean)
			Enc. < 25'	All Unique Groups	
7/1/2009	Wednesday	4.75	9.26	9.47	10.11
7/2/2009	Thursday	4.13	6.30	6.54	6.78
7/3/2009	Friday	4.08	13.24	14.22	14.46
7/4/2009	Saturday	4.01	14.71	15.46	16.46
7/6/2009	Monday	4.00	8.75	8.75	9.25
7/8/2009	Wednesday	4.00	6.00	6.50	7.00
7/9/2009	Thursday	4.12	8.98	9.95	10.44
7/11/2009	Saturday	4.09	6.11	7.09	7.58
7/15/2009	Wednesday	4.08	10.05	10.78	10.78
7/18/2009	Saturday	3.97	12.34	13.10	16.62
7/28/2009	Tuesday	4.00	10.00	12.75	14.00
7/31/2009	Friday	3.97	9.07	12.09	12.09
8/4/2009	Tuesday	4.00	9.75	12.00	12.75
8/8/2009	Saturday	4.04	13.86	14.60	18.07
8/10/2009	Monday	4.27	12.88	13.11	14.52
8/12/2009	Wednesday	4.04	10.89	12.62	13.12
8/13/2009	Thursday	4.58	8.73	10.48	10.70
8/14/2009	Friday	5.08	5.91	6.89	8.27
8/18/2009	Tuesday	4.92	7.93	8.13	9.15
8/19/2009	Wednesday	3.48	15.80	15.80	16.95
8/20/2009	Thursday	5.35	8.79	9.16	9.72
8/21/2009	Friday	4.07	10.57	10.57	11.30
8/23/2009	Sunday	3.68	6.25	6.25	7.07
8/25/2009	Tuesday	4.01	10.72	10.72	11.72
8/26/2009	Wednesday	4.05	5.93	6.42	7.16
8/28/2009	Friday	4.00	10.00	10.75	11.00
8/29/2009	Saturday	4.00	8.25	9.50	10.50
8/30/2009	Sunday	3.38	4.73	6.51	6.80

* “Total” groups includes groups seen more than once.

Table 6. Cathedral Lakes - Actual Mean Hourly Encounter Rates with People, by Day

Date	Weekday	Hours	Unique People per Hour (Mean)		Total People per Hour* (Mean)
			< 25' Enc.	All Unique People	
7/1/2009	Wednesday	4.75	21.05	21.26	23.37
7/2/2009	Thursday	4.13	13.08	13.32	13.32
7/3/2009	Friday	4.08	30.64	34.31	34.80
7/4/2009	Saturday	4.01	41.40	43.14	45.14
7/6/2009	Monday	4.00	18.75	18.75	19.25
7/8/2009	Wednesday	4.00	16.50	18.00	19.50
7/9/2009	Thursday	4.12	22.82	24.76	25.73
7/11/2009	Saturday	4.09	16.38	19.07	20.78
7/15/2009	Wednesday	4.08	20.34	22.06	22.06
7/18/2009	Saturday	3.97	28.72	33.50	44.08
7/28/2009	Tuesday	4.00	20.00	25.25	27.00
7/31/2009	Friday	3.97	22.92	31.99	31.99
8/4/2009	Tuesday	4.00	23.00	28.50	30.25
8/8/2009	Saturday	4.04	32.43	33.66	42.57
8/10/2009	Monday	4.27	36.53	37.00	42.15
8/12/2009	Wednesday	4.04	25.99	30.94	31.93
8/13/2009	Thursday	4.58	23.58	27.07	27.51
8/14/2009	Friday	5.08	15.35	17.72	20.87
8/18/2009	Tuesday	4.92	18.70	19.11	22.15
8/19/2009	Wednesday	3.48	38.22	38.22	42.24
8/20/2009	Thursday	5.35	18.88	22.06	23.74
8/21/2009	Friday	4.07	25.80	25.80	39.80
8/23/2009	Sunday	3.68	15.49	15.49	17.93
8/25/2009	Tuesday	4.01	20.95	20.95	22.19
8/26/2009	Wednesday	4.05	13.33	17.04	18.52
8/28/2009	Friday	4.00	30.00	31.75	32.25
8/29/2009	Saturday	4.00	20.75	24.25	26.50
8/30/2009	Sunday	3.38	13.02	17.46	18.05

* “Total” includes people encountered more than once.

Table 7. Cathedral Lakes - Summary of Actual Daily Average Hourly Encounter Rates for Groups and People

	Mean Groups Encountered per Hour			Mean People Encountered per Hour		
	Unique < 25'	All Unique	Total*	Unique < 25'	All Unique	Total*
Mean	9.49	10.37	11.23	23.02	24.44	28.06
St. Dev.	2.88	2.92	3.33	7.64	7.77	9.26
Min	4.73	6.25	6.78	13.02	13.32	13.32
Max	15.80	15.80	18.07	41.40	43.14	45.14
Grand Means – All Observations						
	9.44	10.31	11.17	22.88	25.29	27.89

* Total includes multiple sightings of the same group/people.

Of groups encountered on the Cathedral Lakes Trail, just over two-thirds were on day trips (Table 8), while just over half were determined to be entering the wilderness (Table 9). Given the nature of the terrain and forest, almost all of the groups were encountered within speaking distance of the observer (Table 10). Those who were farther away tended to be groups observed off the trail corridor taking a break or seen across lower Cathedral Lake. The direction of travel for such groups was often unknown.

Table 8. Cathedral Lakes -Day and Overnight Visitors Encountered

Duration of Stay	Groups	People
	----------Percent----------	
Day	66	64
Overnight	32	32
Unknown	2	4

Table 9. Cathedral Lake - Direction Traveled by Visitors Encountered

Direction of Travel	Groups	People
	----------Percent----------	
In	53	54
Out	34	30
Unknown	14	16

Table 10. Cathedral Lake - Proximity of Visitors Encountered

Proximity	Groups	People
	----------Percent----------	
< 25'	90	88
> 25'	9	11

Cathedral Lakes Trail was one of the two locations where visitor surveys were conducted to assess perceived encounters. The survey data were averaged for each day to generate data that could be compared to the actual encounters recorded by observers on the same dates. A total of 301 surveys (204 on our study segment) were conducted at the Cathedral location, with a response rate of 87%. It is important to note that, although some days generated more than 10 surveys for our study trail segment, there were many days with only a small number. These surveys showed that, across 26 days, the average number of perceived encounters with groups ranged from approximately 3 to 9 per hour (Table 11), which amounted to between 6 and 23 people per hour (Table 12). The overall averages, based on the daily means, were approximately 6 groups and 15 people per hour (Table 13). It is interesting to note that the mean trip length was approximately 4-5 hours, which corresponded well to the length of time used for monitoring actual encounters with trained observers.

Table 11. Cathedral Lakes – Mean Number of Perceived Encounters per Hour with Groups, by Day

Date	Weekday	N Surveys	Time (hours)		Encounters (groups per hour)			
			Mean	SD	Mean	SD	Min.	Max.
7/1/2009	Wednesday	17	4.77	1.01	4.53	1.76	1.71	7.54
7/2/2009	Thursday	6	2.83	1.52	2.64	0.93	1.53	3.76
7/3/2009	Friday	10	4.50	1.80	8.19	6.99	2.98	22.22
7/4/2009	Saturday	5	3.53	1.19	8.79	5.35	2.41	17.14
7/6/2009	Monday	6	2.99	1.83	4.05	2.26	1.35	7.51
7/8/2009	Wednesday	5	4.17	1.34	3.56	0.49	2.80	4.09
7/9/2009	Thursday	7	3.42	1.20	7.27	7.27	3.28	23.62
7/11/2009	Saturday	3	1.73	1.39	4.31	1.61	2.79	6.00
7/15/2009	Wednesday	7	3.53	1.12	4.45	2.39	1.83	7.78
7/18/2009	Saturday	13	5.04	1.78	5.31	2.67	2.05	9.66
7/28/2009	Tuesday	6	2.57	1.57	4.77	3.39	0.96	11.04
7/31/2009	Friday	7	3.69	1.61	4.50	1.31	1.88	6.02
8/4/2009	Tuesday	13	4.67	0.86	4.35	1.45	2.21	7.29
8/8/2009	Saturday	12	4.50	2.11	6.35	2.78	3.37	10.87
8/10/2009	Monday	9	4.92	1.50	5.86	1.76	3.30	8.21
8/12/2009	Wednesday	9	3.87	1.57	4.99	2.87	0.77	10.81
8/13/2009	Thursday	12	4.89	0.85	6.14	2.29	3.20	12.00
8/14/2009	Friday	6	4.88	1.39	6.03	4.87	2.06	15.15
8/18/2009	Tuesday	6	4.26	1.33	5.70	3.33	2.61	11.85
8/19/2009	Wednesday	8	4.16	1.59	5.48	2.76	1.57	9.16
8/20/2009	Thursday	6	3.27	1.65	8.91	4.59	3.74	14.97
8/21/2009	Friday	12	4.77	1.95	5.27	2.48	1.61	9.62
8/25/2009	Tuesday	5	3.58	1.40	8.62	3.38	4.44	13.61
8/26/2009	Wednesday	11	4.24	1.73	3.82	2.04	1.97	7.39
8/28/2009	Friday	13	4.12	1.72	4.99	2.86	1.71	12.35
8/30/2009	Sunday	10	4.36	0.69	5.20	1.70	3.06	8.04

Table 12. Cathedral Lakes - Mean Number of Perceived Encounters per Hour with People, by Day

Date	Weekday	N Surveys	Time (hours)		Encounters (people per hour)			
			Mean	SD	Mean	SD	Min.	Max.
7/1/2009	Wednesday	17	4.77	1.01	13.05	4.94	6.57	24.86
7/2/2009	Thursday	6	2.83	1.52	6.16	3.40	3.05	12.40
7/3/2009	Friday	10	4.50	1.80	22.31	17.54	7.95	58.14
7/4/2009	Saturday	5	3.53	1.19	24.78	12.96	5.03	40.00
7/6/2009	Monday	6	2.99	1.83	8.73	5.84	3.03	18.02
7/8/2009	Wednesday	5	4.17	1.34	9.51	2.97	6.93	13.64
7/9/2009	Thursday	7	3.42	1.20	20.12	26.01	5.02	78.74
7/11/2009	Saturday	3	1.73	1.39	17.48	4.97	11.76	20.69
7/15/2009	Wednesday	7	3.53	1.12	12.74	5.68	5.49	23.95
7/18/2009	Saturday	13	5.04	1.78	14.30	7.55	4.37	29.24
7/28/2009	Tuesday	6	2.57	1.57	10.73	7.56	1.44	23.66
7/31/2009	Friday	7	3.69	1.61	10.98	4.55	3.75	16.87
8/4/2009	Tuesday	13	4.67	0.86	10.17	3.47	6.22	17.49
8/8/2009	Saturday	12	4.50	2.11	16.98	7.14	7.41	28.27
8/10/2009	Monday	9	4.92	1.50	20.42	12.91	7.69	51.33
8/12/2009	Wednesday	9	3.87	1.57	15.76	14.93	4.81	54.05
8/13/2009	Thursday	12	4.89	0.85	14.39	5.38	6.40	24.00
8/14/2009	Friday	6	4.88	1.39	13.60	9.68	3.43	30.30
8/18/2009	Tuesday	6	4.26	1.33	17.23	15.29	5.22	47.39
8/19/2009	Wednesday	8	4.16	1.59	18.12	10.55	7.43	38.24
8/20/2009	Thursday	6	3.27	1.65	23.48	7.99	11.81	32.35
8/21/2009	Friday	12	4.77	1.95	16.07	9.11	5.36	38.46
8/25/2009	Tuesday	5	3.58	1.40	17.53	7.27	6.80	27.21
8/26/2009	Wednesday	11	4.24	1.73	9.11	4.33	3.32	14.78
8/28/2009	Friday	13	4.12	1.72	12.86	6.97	4.28	30.86
8/30/2009	Sunday	10	4.36	0.69	12.01	4.40	6.98	18.77

Table 13. Cathedral Lakes - Summary of Daily Perceived Encounters per Hour

	Groups	People
Mean	5.54	14.95
St. Dev.	1.65	4.79
Min	2.64	6.16
Max	8.91	24.78

Cathedral Lakes - Relationships between Actual Encounters and TrailMaster Counts

Several subsets of the corrected TrailMaster count data were explored for correlations with encounters; in all analyses, the relationships were statistically significant. Twenty-four-hour (in and outbound) TrailMaster count relationships with encounter variables (Table 14) were slightly weaker than TrailMaster Counts from 8:00 a.m. to 6:00 p.m. (Table 15); however, the 24-hour counts generally performed slightly better than either inbound (Table 16) or outbound (Table 17) TrailMaster counts. TrailMaster counts from 8:00 a.m. to 6:00 p.m. explained 36% of the variance in average hourly encounters with unique groups within speaking distance (the encounter dimension that matches the standard for Yosemite NP), with a one person (count) increase in TrailMaster count predicting a 0.02 (± .01) increase in average hourly encounter rates, (Table 15). Figure 5 shows this relationship graphically with the best fit line and both mean and individual 95% confidence intervals shown with data points from sample days.

The TrailMaster data predicted encounters with people better than encounters with groups. For instance, the adjusted r^2 for total people per hour was .61, compared to .44 for total groups per hour (Table 15). Among all the dependent variables, average encounters with total people per hour exhibited the strongest relationship with corrected TrailMaster counts from 8:00 a.m. to 6:00 p.m., with 61% of the variance

explained (Table 15). Weekday/end, precipitation, and maximum temperature were not significant at the 95% confidence level within the models and therefore were not included in the final models.

Table 14. Cathedral Lakes Regression Models: Actual Encounters and TrailMaster 24-hour Corrected Total Count

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.45	.43	1,26	21.50	.001	Intercept	2.47	4.00	.217
						TrailMaster	0.03	0.01	.001
Average Unique Groups < 25' Encountered per Hour	.39	.36	1,26	16.29	.001	Intercept	2.50	3.68	.175
						TrailMaster	0.02	0.01	.001
Average Hourly Unique Groups Encountered	.40	.38	1,26	17.65	.001	Intercept	3.08	3.67	.096
						TrailMaster	0.02	0.01	.001
Average Hourly Total People Encountered	.60	.58	1,26	38.21	.001	Intercept	0.08	9.59	.987
						TrailMaster	0.09	0.03	.001
Average Hourly Unique People Encountered	.52	.50	1,26	28.33	.001	Intercept	3.48	8.75	.422
						TrailMaster	0.07	0.03	.001

Table 15. Cathedral Lakes Regression Models: Actual Encounters and TrailMaster 8:00 a.m. to 6:00 p.m. Corrected Total Count

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.46	.44	1,26	22.13	.001	Intercept	2.29	4.03	.254
						TrailMaster	0.03	0.01	.001
Average Unique Groups < 25' Encountered per Hour	.40	.38	1,26	17.84	.001	Intercept	2.21	3.65	.225
						TrailMaster	0.03	0.01	.001
Average Hourly Unique Groups Encountered	.43	.40	1,26	19.27	.001	Intercept	2.80	3.65	.127
						TrailMaster	0.03	0.01	.001
Average Hourly Total People Encountered	.62	.61	1,26	42.86	.001	Intercept	-0.92	9.37	.842
						TrailMaster	0.10	0.03	.001
Average Hourly Unique People Encountered	.56	.54	1,26	32.92	.001	Intercept	2.41	8.50	.564
						TrailMaster	0.08	0.03	.001

Table 16. Cathedral Lakes Regression Models: Actual Encounters and TrailMaster 8:00 a.m. to 6:00 p.m. Corrected Inbound Counts

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.41	.39	1,26	18.31	.001	Intercept	2.79	4.18	.181
						TrailMaster	0.06	0.03	.001
Average Unique Groups < 25' Encountered per Hour	.36	.34	1,26	14.91	.001	Intercept	2.63	3.76	.162
						TrailMaster	0.05	0.03	.001
Average Hourly Unique Groups Encountered	.36	.33	1,26	14.39	.001	Intercept	3.48	3.85	.074
						TrailMaster	0.05	0.03	.001
Average Hourly Total People Encountered	.58	.56	1,26	35.57	.001	Intercept	0.28	9.87	.954
						TrailMaster	0.19	0.07	.001
Average Hourly Unique People Encountered	.44	.42	1,26	20.52	.001	Intercept	5.08	9.52	.283
						TrailMaster	0.14	0.06	.001

Table 17. Cathedral Lakes Regression Models: Actual Encounters and TrailMaster 8:00 a.m. to 6:00 p.m. Corrected Outbound Counts

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.43	.41	1,26	19.72	.001	Intercept	3.21	3.84	.098
						TrailMaster	0.05	0.02	.001
Average Unique Groups < 25' Encountered per Hour	.38	.34	1,26	16.12	.001	Intercept	2.95	3.47	.092
						TrailMaster	0.04	0.02	.001
Average Hourly Unique Groups Encountered	.42	.40	1,26	19.15	.001	Intercept	3.37	3.40	.052
						TrailMaster	0.05	0.02	.001
Average Hourly Total People Encountered	.57	.55	1,26	34.07	.001	Intercept	2.44	9.34	.596
						TrailMaster	0.17	0.06	.001
Average Hourly Unique People Encountered	.58	.57	1,26	36.43	.001	Intercept	3.65	7.68	.338
						TrailMaster	0.15	0.05	.001

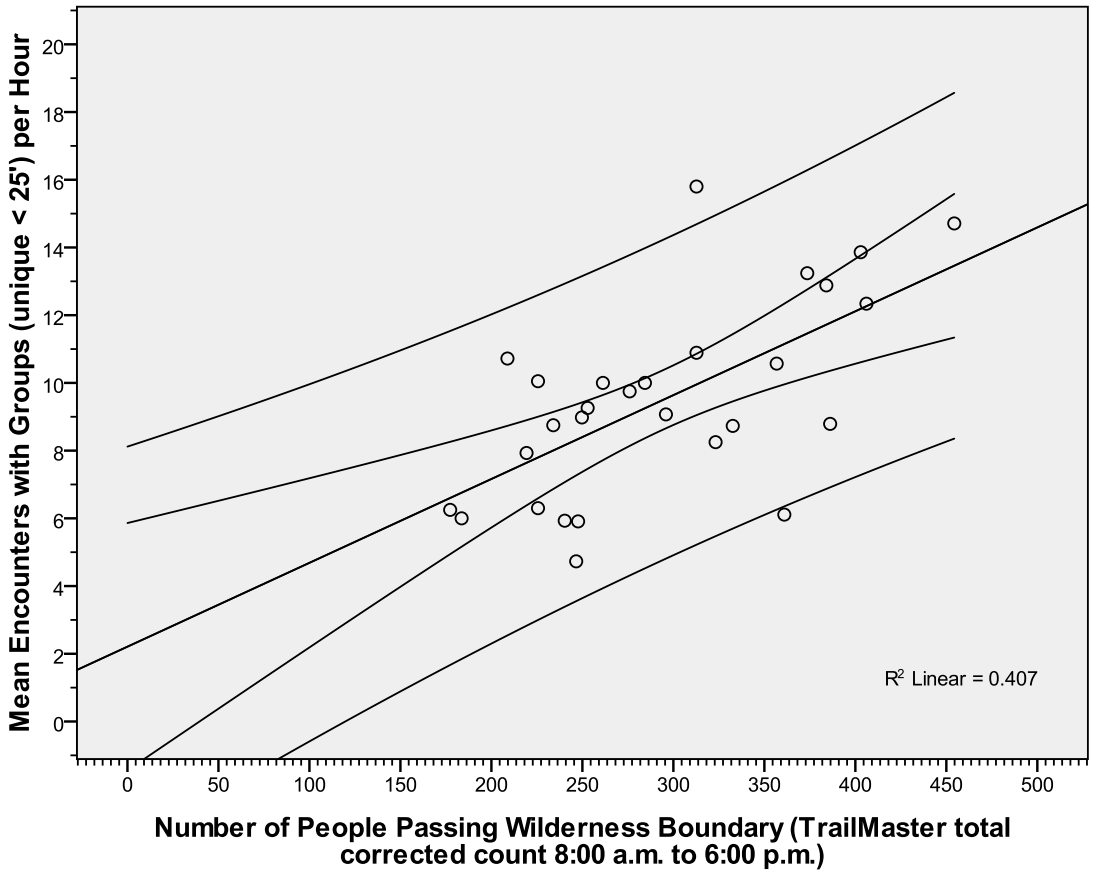

Figure 5. Cathedral Lakes -- regression of corrected TrailMaster counts (8:00 a.m. to 6:00 p.m.) on encounters with unique group within 25 feet per hour. Fit line is shown with mean and individual 95% confidence intervals.

Cathedral Lakes - Relationships between Perceived and Actual Encounters

Visitors' reports of perceived encounters (daily mean encounters per hour) were significantly related to observers' encounter reports. If using perceived encounters as an indirect measure for actual encounters 18% of the variance in average encounters per hour with unique groups within speaking distance is explained, with an increase of one perceived encounter per hour predicting a 0.82 (± 0.66) per hour increase in encounters (Table 18). If instead this relationship was characterized in the more logical order (using actual encounters to estimate perceived encounters), the average hourly actual encounters with groups within speaking distance explains 18% of the variance in perceived encounters, with a one group increase predicting 0.27 increase in average

reported encounters per hour, the reverse of the previous relationship. There were slightly stronger relationships using the data for people encountered than with the group-level data (Table 18). Weekday/end, precipitation and maximum temperature were not significant at the 95% confidence level within the models and therefore were not included in the final models. Using a paired t-test, there is a significant difference between daily average perceived encounters per hour with groups (M = 5.54, SD = 2.20) and daily average actual unique encounters within speaking distance (M = 9.67, SD = 1.65, t_{25} = 8.12, p = .001) with a large effect size (d = 2.12). (Unique encounters within speaking distance are used in this analysis because they correspond to Yosemite's management standards.) This may be due to the under-reporting of groups encountered per hour by visitors compared to actual encounters recorded by observers. This is not surprising given prior research has found that visitors under-report encounter rates when they number greater than 4 to 6 (Shelby & Heberlein, 1986). It may also be the case that visitors on average overestimate the time spent on their hike, which would reduce their average group encounter rate.

Table 18. Cathedral Lakes – Relationship between Actual and Perceived Encounters

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.17	.13	1,24	4.86	.037	Intercept	6.80	4.50	.005
						Perceived E	0.83	0.78	.037
Average Unique Groups < 25' Encountered per Hour	.22	.18	1,24	6.64	.017	Intercept	5.12	3.79	.010
						Perceived E	0.82	0.66	.017
Average Hourly Unique Groups Encountered	.18	.15	1,24	5.30	.030	Intercept	6.39	3.89	.002
						Perceived E	0.75	0.67	.030
Average Hourly Total People Encountered	.28	.25	1,24	9.38	.005	Intercept	12.98	10.97	.022
						Perceived E	1.04	0.70	.005
Average Hourly Unique People Encountered	.31	.28	1,24	10.59	.003	Intercept	12.4	8.96	.009
						Perceived E	0.90	0.57	.003

Perceived encounter rates groups were regressed on actual group encounter rates while perceived encounter rates for people were regressed on actual encounter rates for people.

Cathedral Lakes - Relationships between Perceived Encounters and TrailMaster Counts

Perceived encounters and TrailMaster counts were significantly related. Total TrailMaster counts from 8:00 a.m. to 6:00 p.m. were significant for perceived encounters with both groups and people, explaining 20% and 42% of the variance respectively (Table 19). However, it is noteworthy that these relationships are not as strong as between TrailMaster counts and actual encounters reported by trained observers. For perceived encounters, a one unit increase in TrailMaster counts predicts

a 0.01 (± 0.01) increase in perceived encounters per hour with groups. Using inbound TrailMaster counts does not alter the variance explained (Table 20). Outbound TrailMaster counts were more weakly related than total and inbound counts (data not shown).

Table 19. Cathedral Lakes – Relationship between Perceived Encounters and Total TrailMaster Counts from 8:00 a.m. to 6:00 p.m.

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients	B	95% CI	*p*
Average Groups Encountered per Hour	.23	.20	1,24	7.26	.013	Intercept	2.31	2.55	.073
						TrailMaster	0.01	0.01	.013
Average Hourly People Encountered	.44	.42	1,24	18.89	.001	Intercept	2.01	6.32	.519
						TrailMaster	0.04	0.02	.001

Table 20. Cathedral Lakes – Relationship between Perceived Encounters and Inbound TrailMaster Counts from 8:00 a.m. to 6:00 p.m.

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients	B	95% CI	*p*
Average Groups Encountered per Hour	.26	.23	1,24	8.45	.008	Intercept	2.20	2.44	.076
						TrailMaster	0.02	0.02	.007
Average Hourly People Encountered	.43	.41	1,24	18.06	.001	Intercept	2.47	6.24	.423
						TrailMaster	0.09	0.04	.001

Cathedral Lakes – Relationships between Tioga Road Traffic Counts and Actual Encounters

There were only 13 sample days with both Tioga Road traffic counts and actual encounter data. We explored relationships using total, inbound, and outbound traffic counts from 7:00 a.m. to 6:00 p.m. (Tables 21-23). Unique groups within speaking distance were not significantly related to total, inbound, or outbound traffic counts. Total traffic counts, that is inbound and outbound counts summed, were significantly related only to total groups encountered, with 39% of the variance explained. However, July 18 is a point of leverage within the model, and when removed the relationship is no longer significant (p = .11). Both inbound and outbound traffic counts show relationships of similar strength to mean total people encountered per hour with approximately 44% of the variance in encounter rates explained. The July 4 holiday is an outlier within these models, and removing it further improves the relationship (r^2 = .60 for inbound traffic), Figure 6 shows the relationship graphically. No data points were removed for the reported results. Weekday/end, precipitation, and maximum temperature were not significant at the 95% confidence level and therefore were not included in the final models.

Table 21. Cathedral Lakes - Regression of Tioga Road Inbound and Outbound Traffic Counts from 7:00 a.m. to 6:00 p.m. on Actual Encounters

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.39	.34	1,11	7.04	.002	Intercept	-6.010	14.544	.383
						Traff. Inbound and Outbound	0.003	0.003	.022

Table 22. Cathedral Lakes - Regression of Tioga Road Inbound Traffic Counts from 7:00 a.m. to 6:00 p.m. on Actual Encounters

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.37	.32	1,11	6.57	.026	Intercept	-5.820	14.87	.407
						Traff. Inbound	0.006	0.006	.026
Average Hourly Total People Encountered	.43	.37	1,11	8.18	.016	Intercept	-25.047	40.684	.203
						Traff. Inbound	0.019	0.015	.016
Average Hourly Unique People Encountered	.34	.28	1,11	5.73	.036	Intercept	-15.169	37.823	.396
						Traff. Inbound	0.015	0.014	.036

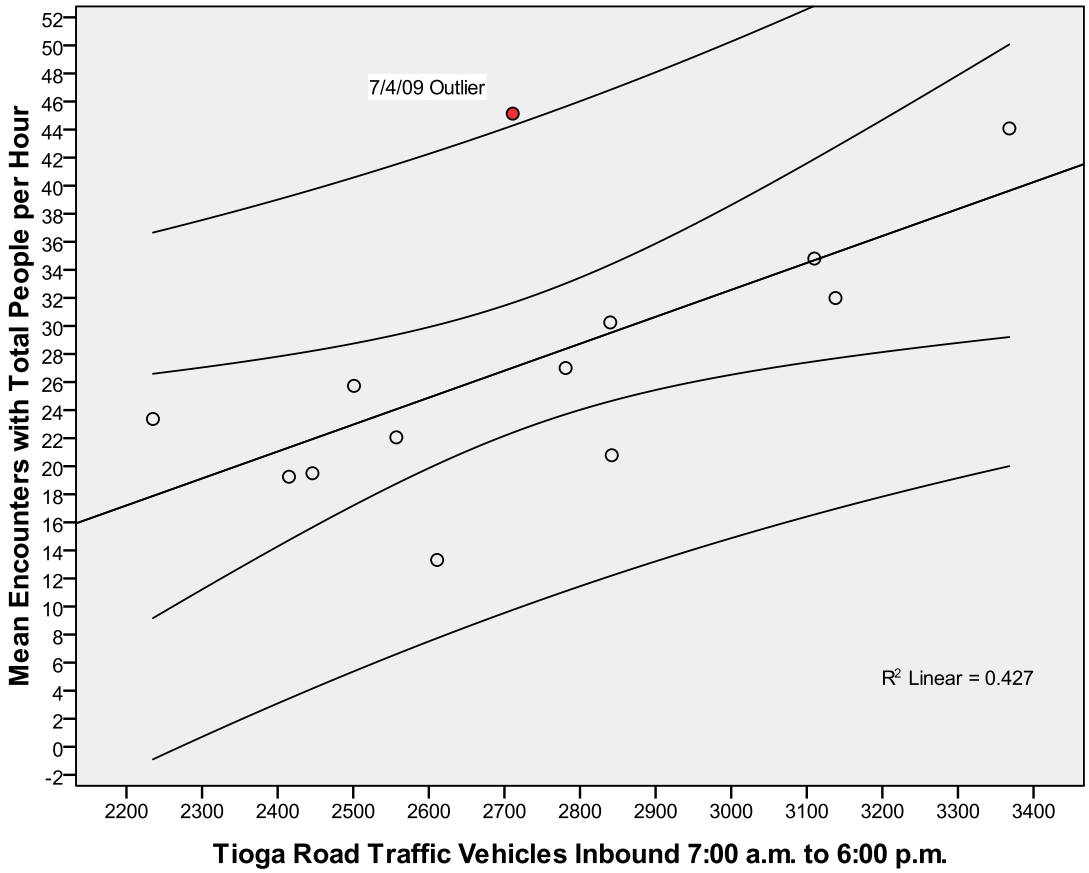

Figure 6. Cathedral Lakes – regression of Tioga Road traffic counts (7:00 a.m. to 6:00 p.m.) on daily mean encounters with total people per hour. Fit line shown with mean and individual 95% confidence intervals.

Table 23. Cathedral Lakes - Regression of Tioga Road Outbound Traffic Counts from 7:00 a.m. to 6:00 p.m. on Actual Encounters

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.40	.35	1,11	7.39	.020	Intercept	-5.997	14.194	.372
						Traff. Outbound	0.006	0.006	.020
Average Hourly Unique Groups Encountered	.33	.27	1,11	5.47	.039	Intercept	-3.161	13.102	.606
						Traff. Outbound	0.005	0.005	.039
Average Hourly Total People Encountered	.45	.40	1,11	9.07	.012	Intercept	-25.260	38.811	.180
						Traff. Outbound	0.019	0.014	.005
Average Hourly Unique People Encountered	.37	.31	1,11	6.44	.028	Intercept	-15.709	36.141	.359
						Traff. Outbound	0.015	0.013	.208

Lyell Canyon

Summary Statistics

Twenty-eight days of data were collected for actual encounters on the Lyell Canyon trail segment (Figure 7). The average number of encounters per hour with unique groups ranged from 4 to nearly 11 (Table 24). The average number of total encounters per hour (which include multiple sightings of the same group) was nearly identical in range to that of unique groups. When examining encounters with individuals (vs. groups), the average number of unique encounters per hour ranged from 9 to 25, while the average total encounters per hour ranged from 9 to 28 (Table 25). The similarity between the "unique" and "total" encounters shows that, on this trail, observers generally did not encounter the same group more than once, and a comparison of the number of encounters with groups versus individuals reveals that group sizes were generally 2 to 3 people (Table 26).

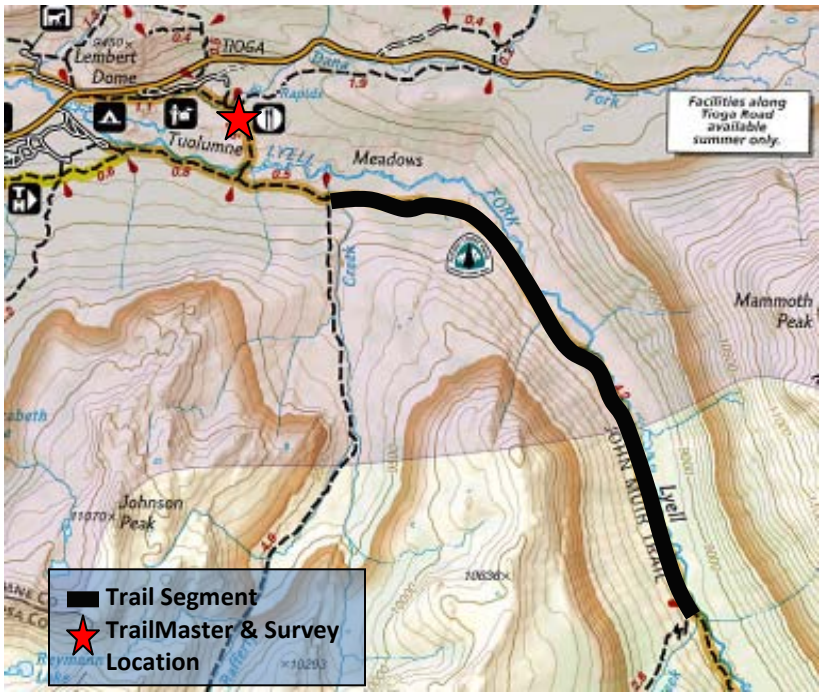

Figure 7. Map of Lyell study location

Table 24. Lyell Canyon - Actual Mean Hourly Encounter Rates with Groups, by Day

Date	Weekday	Hours	Unique Groups per Hour (Mean)		Total Groups per Hour* (Mean)
			Enc. < 25'	All Unique	
7/1/09	Wednesday	3.36	6.85	7.74	8.63
7/3/09	Friday	4.01	7.73	8.73	9.48
7/4/09	Saturday	4.07	7.37	9.34	9.83
7/5/09	Sunday	4.33	9.24	10.85	11.09
7/6/09	Monday	4.11	3.16	4.87	5.60
7/8/09	Wednesday	4.83	7.66	8.90	9.11
7/9/09	Thursday	3.73	5.09	5.36	5.36
7/10/09	Friday	3.72	4.57	5.65	5.65
7/13/09	Monday	4.06	4.19	6.40	7.64
7/15/09	Wednesday	4.03	7.44	7.44	7.44
7/16/09	Thursday	4.00	7.25	8.75	8.75
7/17/09	Friday	4.12	5.10	6.55	6.55
7/21/09	Tuesday	4.05	3.70	6.42	8.15
7/22/09	Wednesday	4.03	3.23	4.22	4.47
7/24/09	Friday	4.01	5.49	6.98	7.73
7/26/09	Sunday	4.10	6.59	7.80	7.80
8/2/09	Sunday	4.10	7.56	9.02	9.51
8/3/09	Monday	4.07	4.18	4.67	5.16
8/6/09	Thursday	4.19	6.92	8.35	9.55
8/7/09	Friday	3.89	7.46	7.71	8.48
8/10/09	Monday	4.00	7.50	8.25	10.00
8/11/09	Tuesday	4.01	7.73	9.23	10.22
8/18/09	Tuesday	5.25	6.10	7.43	7.81
8/19/09	Wednesday	4.78	7.11	7.95	7.95
8/22/09	Saturday	3.45	5.80	6.67	6.96
8/28/09	Friday	3.72	3.23	4.03	4.03
8/30/09	Sunday	4.17	8.63	9.83	11.03
8/31/09	Monday	4.06	5.42	5.91	5.91

* “Total” groups includes groups seen more than once.

Table 25. Lyell Canyon - Actual Mean Hourly Encounter Rates with People, by Day

Date	Weekday	Hours	Unique People per Hour (Mean)		Total People per Hour* (Mean)
			< 25' Enc.	All Unique	
7/1/09	Wednesday	3.36	10.71	12.20	13.99
7/3/09	Friday	4.01	15.71	16.96	18.20
7/4/09	Saturday	4.07	15.97	19.16	20.15
7/5/09	Sunday	4.33	19.63	23.79	25.40
7/6/09	Monday	4.11	5.11	9.00	10.46
7/8/09	Wednesday	4.83	14.70	22.15	22.36
7/9/09	Thursday	3.73	8.85	9.38	9.38
7/10/09	Friday	3.72	10.48	12.10	12.10
7/13/09	Monday	4.06	12.32	17.73	20.94
7/15/09	Wednesday	4.03	22.08	22.08	22.08
7/16/09	Thursday	4.00	13.00	16.50	16.50
7/17/09	Friday	4.12	10.92	14.56	14.56
7/21/09	Tuesday	4.05	10.12	19.75	23.70
7/22/09	Wednesday	4.03	8.93	11.91	12.66
7/24/09	Friday	4.01	12.72	15.71	17.21
7/26/09	Sunday	4.10	18.29	20.73	20.73
8/2/09	Sunday	4.10	20.98	25.12	27.07
8/3/09	Monday	4.07	9.58	10.81	11.79
8/6/09	Thursday	4.19	14.56	17.42	19.57
8/7/09	Friday	3.89	16.45	16.97	18.51
8/10/09	Monday	4.00	21.00	23.50	28.25
8/11/09	Tuesday	4.01	16.21	19.20	20.70
8/18/09	Tuesday	5.25	20.00	24.19	27.24
8/19/09	Wednesday	4.78	18.20	19.87	19.87
8/22/09	Saturday	3.45	15.65	18.26	18.84
8/28/09	Friday	3.72	9.68	12.63	12.63
8/30/09	Sunday	4.17	17.75	21.82	24.22
8/31/09	Monday	4.06	11.33	13.30	13.30

* “Total” includes people encountered more than once.

Table 26. Lyell Canyon - Summary of Actual Daily Average Hourly Encounter Rates for Groups and People

	Mean Groups Encountered per Hour			Mean People Encountered per Hour		
	Unique < 25'	All Unique	Total*	Unique < 25'	All Unique	Total*
Mean	6.15	7.32	7.85	14.32	17.39	18.66
St. Dev.	1.73	1.76	1.95	4.43	4.69	5.35
Min	3.16	4.03	4.03	5.11	9.00	9.38
Max	9.24	10.85	11.09	22.08	25.12	28.25
Grand Means — All observations						
	6.19	7.37	7.89	14.47	17.60	18.89

* Total includes multiple sightings of the same group/people.

Of groups encountered on the Lyell Canyon trail segment, over two-thirds were on overnight trips (Table 27), while almost half were determined to be entering the wilderness (Table 28). Given the open meadows along the trail with many open views of Lyell Creek, this location had the largest number of encounters with groups outside of speaking distance, though it was still small when compared the over three-quarters of encounters that occurred within speaking distance (Table 29).

Table 27. Lyell Canyon - Day and Overnight Visitors Encountered

Duration of Stay	Groups	People
	----------Percent----------	
Day	27	25
Overnight	70	71
Unknown	3	4

Table 28. Lyell Canyon - Direction Traveled by Visitors Encountered

Direction of Travel	Groups	People
	----------Percent----------	
In	45	47
Out	35	32
Unknown	19	21

Table 29. Lyell Canyon - Proximity of Visitors Encountered

Proximity	Groups	People
	----------Percent----------	
< 25'	83	81
> 25'	16	19

The Lyell Canyon trail segment was the other location where visitor surveys were conducted to assess perceived encounters. 440 surveys (148 on the study trail segment) were conducted at this location with a response rate of 92%. These surveys showed that, across 27 days, the average number of perceived encounters with groups ranged from about 1 to 5 per hour (Table 30), with an overall average of approximately 3 groups or 10 people per hour (Tables 31 and 32). It is important to note that only one day generated more than 10 surveys, and most days only had around 5 surveys. The survey data were averaged for each day to generate data that could be compared to the actual encounters recorded by observers on the same dates. There was a significant difference in a paired t-test between daily average perceived encounters per hour with groups (M = 3.23, SD = 1.19) and daily average actual unique encounters within speaking distance (M = 6.13, SD = 1.77, t_{25} = 3.18 p = <.0005, d = 1.92). As with the Cathedral Lakes location, visitors on average under-reported their encounter rate compared to those recorded by observers.

Table 30. Lyell Canyon – Mean Number of Perceived Encounter per Hour with Groups, by Day

Date	Weekday	N Surveys	Time (Hours)		Encounters (groups per hour)			
			Mean	SD	Mean	SD	Min.	Max.
7/1/09	Wednesday	6	4.98	1.81	4.10	2.38	0.94	6.48
7/3/09	Friday	5	3.76	0.81	3.72	1.19	2.26	5.52
7/4/09	Saturday	2	2.08	1.10	4.07	0.78	3.51	4.62
7/5/09	Sunday	6	3.36	1.28	2.96	2.93	0.71	8.24
7/6/09	Monday	5	5.16	2.64	1.35	0.28	0.93	1.65
7/8/09	Wednesday	6	4.02	1.25	2.92	1.25	2.13	5.43
7/9/09	Thursday	4	3.28	0.31	1.90	2.01	0.62	4.86
7/10/09	Friday	6	5.47	1.34	1.75	0.73	1.05	2.78
7/13/09	Monday	5	4.15	1.60	3.72	1.58	1.96	5.91
7/15/09	Wednesday	2	5.10	1.09	1.78	1.07	1.02	2.54
7/16/09	Thursday	2	4.51	0.11	2.22	0.06	2.18	2.26
7/17/09	Friday	7	5.30	0.60	4.08	3.67	0.68	11.29
7/21/09	Tuesday	4	4.46	1.95	2.03	1.12	0.62	3.37
7/22/09	Wednesday	3	4.32	1.40	2.13	0.98	1.10	3.04
7/24/09	Friday	6	5.20	1.68	2.80	2.07	0.85	6.49
7/26/09	Sunday	10	3.50	1.69	3.66	2.08	0.75	6.51
8/2/09	Sunday	4	4.01	1.31	3.96	3.43	1.20	8.93
8/3/09	Monday	1	3.12	0.00	1.28	0.00	1.28	1.28
8/6/09	Thursday	8	3.81	1.27	4.08	2.59	1.20	7.41
8/7/09	Friday	8	5.14	1.30	5.28	2.31	3.17	10.16
8/10/09*	Monday	2	2.93	1.97	29.62	32.07	6.94	52.29
8/11/09	Tuesday	4	3.82	1.42	4.51	1.90	2.79	6.91
8/18/09	Tuesday	10	4.21	1.17	3.97	3.31	0.61	10.36
8/19/09	Wednesday	7	3.73	1.75	3.98	2.58	1.10	7.60
8/22/09	Saturday	12	3.74	1.26	2.03	1.06	0.62	3.70
8/28/09	Friday	4	2.97	0.63	5.22	2.94	0.85	7.25
8/30/09	Sunday	8	3.50	0.99	4.49	1.38	2.35	6.00

* 8/10/09 was removed from analysis as an outlier

Table 31. Lyell Canyon – Mean Number of Perceived Encounter per Hour with People, by Day

Date	Weekday	N Surveys	Time (Hours)		Encounters (people per hour)			
			Mean	SD	Mean	SD	Min.	Max.
7/1/09	Wednesday	6	4.98	1.81	11.01	8.30	2.59	21.82
7/3/09	Friday	5	3.76	0.81	10.54	3.73	4.51	14.81
7/4/09	Saturday	2	2.08	1.10	7.78	2.06	6.32	9.23
7/5/09	Sunday	6	3.36	1.28	7.92	8.65	1.88	24.73
7/6/09	Monday	5	5.16	2.64	3.93	1.33	2.33	5.56
7/8/09	Wednesday	6	4.02	1.25	9.74	8.69	4.92	27.17
7/9/09	Thursday	4	3.28	0.31	4.33	3.06	1.40	8.57
7/10/09	Friday	6	5.47	1.34	5.02	3.38	2.63	10.71
7/13/09	Monday	5	4.15	1.60	10.01	2.92	7.25	14.78
7/15/09	Wednesday	2	5.10	1.09	6.16	4.36	3.07	9.24
7/16/09	Thursday	2	4.51	0.11	5.35	2.01	3.93	6.77
7/17/09	Friday	7	5.30	0.60	12.56	14.92	1.74	45.15
7/21/09	Tuesday	4	4.46	1.95	8.54	4.86	3.10	13.79
7/22/09	Wednesday	3	4.32	1.40	4.47	1.05	3.68	5.66
7/24/09	Friday	6	5.20	1.68	7.67	5.43	1.69	16.23
7/26/09	Sunday	10	3.50	1.69	9.75	4.40	2.26	15.62
8/2/09	Sunday	4	4.01	1.31	16.71	14.94	4.82	38.27
8/3/09	Monday	1	3.12	0.00	5.45	0.00	5.45	5.45
8/6/09	Thursday	8	3.81	1.27	8.84	4.63	3.20	14.81
8/7/09	Friday	8	5.14	1.30	15.69	11.04	7.05	40.65
8/10/09	Monday	2	2.93	1.97	76.94	76.06	23.15	130.72
8/11/09	Tuesday	4	3.82	1.42	28.29	28.46	5.59	69.12
8/18/09	Tuesday	10	4.21	1.17	9.96	8.21	1.06	29.59
8/19/09	Wednesday	7	3.73	1.75	12.78	8.53	2.65	28.52
8/22/09	Saturday	12	3.74	1.26	8.06	4.63	2.48	18.00
8/28/09	Friday	4	2.97	0.63	14.08	8.58	3.40	24.15
8/30/09	Sunday	8	3.50	0.99	18.30	7.59	9.17	32.84

Table 32. Lyell Canyon – Summary of Daily Perceived Encounters per Hour

	Groups	People
Mean	3.23	10.11
St. Dev.	1.19	5.35
Min	1.28	3.93
Max	5.28	28.29

Lyell Canyon - Actual Encounters and TrailMaster Relationships

There were no significant relationships between encounter variables and TrailMaster count variables at the 95 % confidence level for the Lyell Canyon trail segment. It should be remembered that the TrailMaster was located at the wilderness boundary and was nearly one mile from the study trail segment. Between the TrailMaster and the study segment, there were several trail junctions leading to and from other entry points and wilderness destinations. Also in this area were many attraction sights of interest to day hikers, such as Twin Bridges and the meadows along the Lyell Fork. Many visitors were counted by the TrailMaster, but did not reach the study segment. Of the 440 surveys collected at the Lyell Canyon wilderness boundary, only 34% (148 surveys) of visitors had been hiking on the study trail segment; the others were on various other hiking routes in the area. In contrast, at the Cathedral Lakes location, 68% of 301 (204 surveys) visitors surveyed had hiked on the study trail segment. This large number of alternative routes in the Lyell area may explain the inability to establish a relationship between TrailMaster counts and actual encounters at the Lyell location.

Lyell Canyon - Perceived and Actual Encounter Relationships

The relationships between perceived encounters and actual encounters were significant (Table 33). The variance explained in encounters with unique groups within speaking distance by perceived encounters is low at 12%; however, this is consistent with the results from the Cathedral Lakes location. The model indicates for every group a visitor

reports encountering per hour, an increase of 0.59 (± 0.56) groups per hour is predicted for actual encounter rates. As with the Cathedral location, the potential for perceived encounters to be used as an indirect measure for actual encounter rates on trails was evaluated. If considering the visitor experience it would be more appropriate to describe the relationship of actual encounters as an independent variable for a dependent variable of visitor perceptions of encounters, both relationships can be seen in Figure 8. Weekday/end, precipitation and maximum temperature were not significant at the 95% confidence level and were not included in the models.

Table 33. Lyell Canyon - Relationship between Actual and Perceived Encounters*

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*P*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.18	.14	1,24	5.17	.032	Intercept	5.63	2.14	<.0005
						Perceived E	.69	0.62	.032
Average Unique Groups < 25' Encountered per Hour	.16	.12	1,24	4.49	.054	Intercept	4.23	1.97	<.0005
						Perceived E	0.59	0.57	.045
Average Hourly Unique Groups Encountered	.16	.13	1,24	4.67	.041	Intercept	5.37	2.00	<.0005
						Perceived E	0.61	0.58	.041
Average Hourly Total People Encountered	.16	.13	1,24	4.64	.042	Intercept	14.62	4.19	<.0005
						Perceived E	0.38	0.37	.042
Average Hourly Unique People Encountered	.15	.12	1,24	4.32	.049	Intercept	13.88	3.83	<.0005
						Perceived E	0.34	0.34	.049

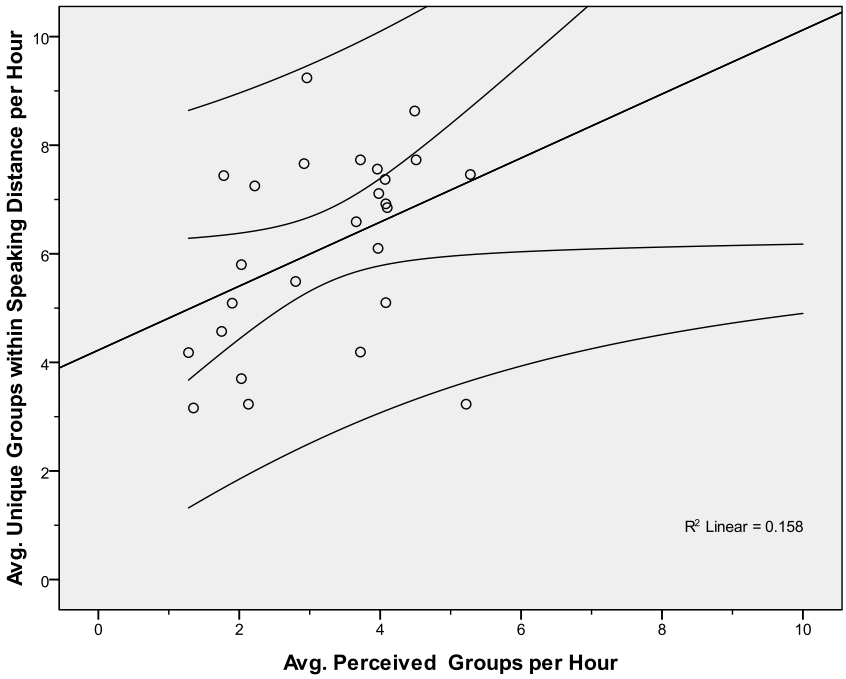

Figure 8. Lyell Canyon -- regression of average perceived groups per hour on unique groups less than 25 feet mean encounters per hour. Fit line is shown with mean and individual 95% confidence limits.

Lyell Canyon - Relationships between Perceived and TrailMaster Counts

There were no significant relationships between average perceived encounters per hour and TrailMaster counts for the Lyell and Tuolumne Campground locations at the 95% confidence level. The separation between the survey location (at the wilderness boundary) and the study trail segment a mile away presented similar issues with establishing relationships with perceived encounters and TrailMaster counts as with actual encounters. Visitors were asked to recall the encounters they had only on the Lyell trail study segment after they passed through an area of relatively high use. This may have presented more difficulty with memory.

Lyell Canyon - Tioga Road Traffic Counters and Actual Encounter Relationships

There were no significant relationships between actual encounter rates and Tioga Road traffic counts from 7:00 a.m. to 6:00 p.m. for total, inbound, or outbound traffic at the 95% confidence level.

Rafferty Creek

Summary Statistics

Twenty-eight days of data were collected for actual encounters on the Rafferty Creek trail segment (Figure 9). The average number of encounters per hour with unique groups ranged from approximately 3 to almost 10, while the average number of total encounters per hour (which include multiple sightings of the same group) ranged from approximately 3 to 12 (Table 34). When examining encounters with individuals (vs. groups), the average number of unique encounters per hour ranged from 7 to 32, while the average total encounters per hour ranged from 8 to 39 (Table 35). Comparing the encounter rates for unique and total groups it can be seen that very few groups were encountered repeatedly; this occurred most commonly by passing or being passed on the steep Rafferty trail and later encountering the same group again while they or the observer were taking a break

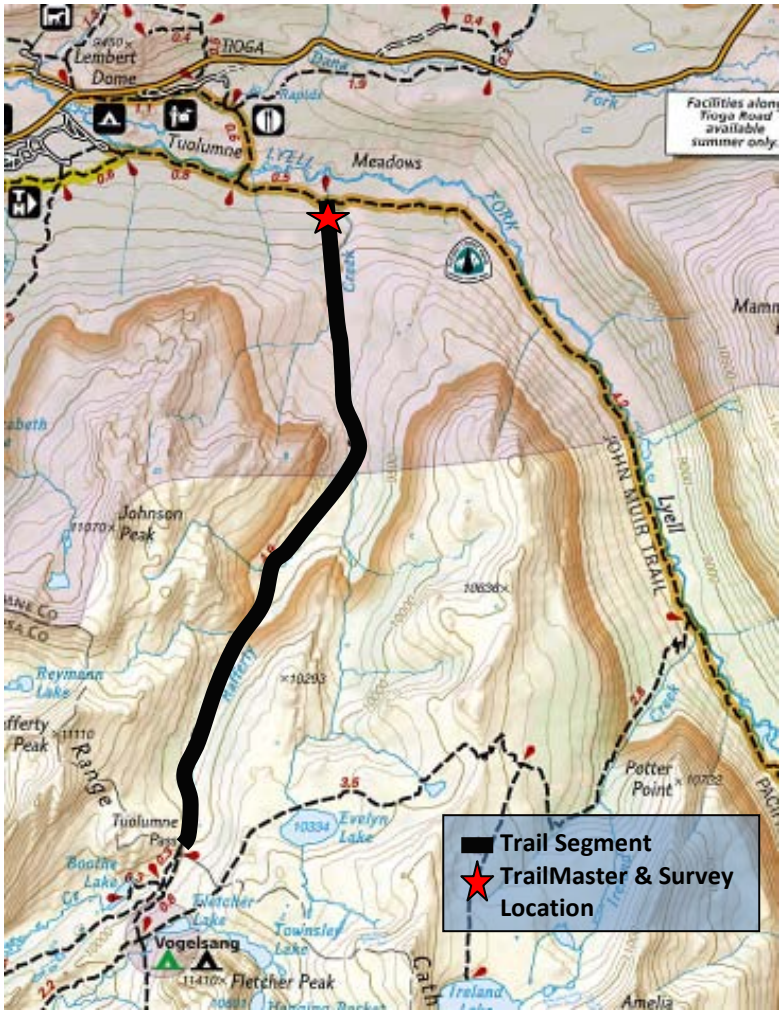

Figure 9. Map of Rafferty Study Location

beside the trail. A comparison of the number of encounters with groups versus individuals reveals that groups generally had 3 people (Table 36).

Table 34. Rafferty Creek - Actual Mean Hourly Encounter Rates with Groups, by Day

Date	Weekday	Hours	Unique Groups per Hour (Mean)		Total Groups per Hour* (Mean)
			Enc. < 25'	All Unique	
7/3/09	Friday	4.98	5.62	5.82	5.82
7/4/09	Saturday	5.01	4.79	4.99	5.39
7/8/09	Wednesday	4.06	3.20	3.20	3.45
7/9/09	Thursday	4.02	4.23	4.48	6.22
7/10/09	Friday	4.36	5.96	5.96	5.96
7/11/09	Saturday	4.88	6.15	6.35	6.56
7/13/09	Monday	5.33	5.25	5.44	5.63
7/18/09	Saturday	4.55	3.52	4.18	5.71
7/21/09	Tuesday	4.45	6.07	6.97	9.89
7/23/09	Thursday	4.59	3.27	3.49	4.36
7/24/09	Friday	5.04	5.75	5.95	6.35
7/25/09	Saturday	5.10	3.33	3.92	4.12
7/27/09	Monday	5.33	1.88	2.63	3.19
7/28/09	Tuesday	4.17	2.64	2.88	3.60
8/2/09	Sunday	4.00	6.00	6.50	7.50
8/4/09	Tuesday	4.17	5.52	5.76	5.76
8/6/09	Thursday	4.05	6.17	6.17	6.67
8/7/09	Friday	3.60	8.89	9.44	11.67
8/9/09	Sunday	4.38	4.79	5.02	5.02
8/21/09	Friday	5.29	8.13	8.13	8.13
8/22/09	Saturday	4.41	8.62	8.84	10.20
8/23/09	Sunday	5.37	8.01	8.38	8.94
8/24/09	Monday	5.36	6.53	6.72	7.65
8/25/09	Tuesday	5.23	4.02	4.02	4.78
8/28/09	Friday	5.37	4.66	5.03	5.59
8/30/09	Sunday	5.03	4.17	4.17	5.57

* “Total” groups includes groups seen more than once.

Table 35. Rafferty Creek - Actual Mean Hourly Encounter Rate with People, by Day

Date	Weekday	Hours	Unique Groups per Hour (Mean)		Total Groups per Hour* (Mean)
			Enc. < 25'	All Unique	
7/3/09	Friday	4.98	11.65	12.25	12.25
7/4/09	Saturday	5.01	10.18	10.78	11.98
7/9/09	Thursday	4.02	7.71	8.21	11.44
7/10/09	Friday	4.36	15.60	15.60	15.60
7/11/09	Saturday	4.88	15.98	16.19	17.21
7/13/09	Monday	5.33	14.07	14.26	14.63
7/18/09	Saturday	4.55	7.91	9.01	12.53
7/21/09	Tuesday	4.45	11.01	12.81	19.78
7/23/09	Thursday	4.59	8.71	9.37	11.11
7/24/09	Friday	5.04	16.07	16.87	20.24
7/25/09	Saturday	5.10	7.84	9.02	10.59
7/27/09	Monday	5.33	4.88	7.32	9.19
7/28/09	Tuesday	4.17	6.00	6.71	8.15
8/2/09	Sunday	4.00	16.25	17.25	20.75
8/4/09	Tuesday	4.17	17.27	18.23	18.23
8/6/09	Thursday	4.05	14.07	14.07	14.81
8/7/09	Friday	3.60	30.56	31.94	39.17
8/9/09	Sunday	4.38	12.33	12.79	12.79
8/21/09	Friday	5.29	19.66	19.66	19.66
8/22/09	Saturday	4.41	17.01	17.23	19.95
8/23/09	Sunday	5.37	17.88	18.44	19.55
8/24/09	Monday	5.36	12.31	13.06	14.93
8/25/09	Tuesday	5.23	8.22	8.22	9.75
8/28/09	Friday	5.37	12.29	12.66	16.39
8/30/09	Sunday	5.03	13.12	13.12	15.51

* “Total” includes People encountered more than once.

Table 36. Rafferty Creek – Summary of Actual Daily Average Hourly Encounter Rates for Groups and People

	Mean Groups Encountered per Hour			Mean People Encountered per Hour		
	Unique < 25'	All Unique	Total*	Unique < 25'	All Unique	Total*
Average	5.20	5.49	6.22	12.94	13.68	15.72
St. Dev.	1.78	1.77	2.06	5.14	5.12	5.97
Min	1.88	2.63	3.19	4.88	6.71	8.15
Max	8.89	9.44	11.67	30.56	31.94	39.17
Grand Means – All Observations						
	5.17	5.46	6.15	12.80	13.52	15.50

* Total includes multiple sightings of the same group/people.

Of groups encountered on the Rafferty Creek trail segment, over three-quarters were on overnight trips (Table 37), while approximately half were determined to be entering the wilderness (Table 38). Even with the open alpine meadows in the upper parts of this trail, almost all encounters occurred within speaking distance (Table 39); this is due to most visitors staying close to the trail corridor even when taking breaks and a lack of attraction sites off the trail corridor. The small number of visitors that were outside of speaking distance tended to be those who did remove themselves a distance from the trail when taking a break or those seen in the distance on the trail but, due to differences in hiking speed, were never passed.

Table 37. Rafferty Creek - Day and Overnight Visitors Encountered

Duration of Stay	Groups	People
	----------Percent----------	
Day	15	12
Overnight	81	84
Unknown	4	4

Table 38. Rafferty Creek - Direction Traveled by Visitors Encountered

Direction of Travel	Groups	People
	----------Percent----------	
In	47	50
Out	44	39
Unknown	10	12

Table 39. Rafferty Creek - Proximity of Visitors Encountered

Proximity	Groups	People
	----------Percent----------	
< 25'	94	95
> 25'	6	5

Rafferty Creek - Encounters and TrailMaster Relationships

There were no significant relationships between encounter variables and TrailMaster variables at the 95% confidence level for the Rafferty Creek trail segment. The TrailMaster for the Rafferty Creek trail segment was the same as that for the Lyell Canyon segment – located at the wilderness boundary – and the beginning of the Rafferty segment was also approximately one mile from that location. Thus, the same issues of trail and visitor use complexity complicated the relationship between TrailMaster data and actual encounters.

Rafferty Creek - Tioga Road Traffic Counters and Actual Encounter Relationships

There were no significant relationships between encounter variables and TrailMaster variables at the 95% confidence level for the Rafferty Creek trail segment.

Dog Lake

Summary Statistics

Twenty-eight days of data were collected for actual encounters on the Dog Lake trail segment (Figure 10). The average number of encounters per hour with unique groups ranged from approximately 7 to 20, while the average number of total encounters per hour (which include multiple sightings of the same group) ranged from approximately 7 to 22 (Table 40). When examining encounters with individuals (vs. groups), the average number of unique encounters per hour ranged from 19 to 59, while the average total encounters per hour ranged from 20 to 82 (Table 41). The similarity between the "unique" and "total" encounters shows that, on this trail, observers only encounter a small number of the same groups more than once. However it is important to note that data for Dog Lake were often collected by two different people at different times of the day (because collecting 4 hours of data required two trips in and back). A comparison of the number of encounters with groups versus individuals reveals that group sizes were generally 3 to 4 people (Table 42).

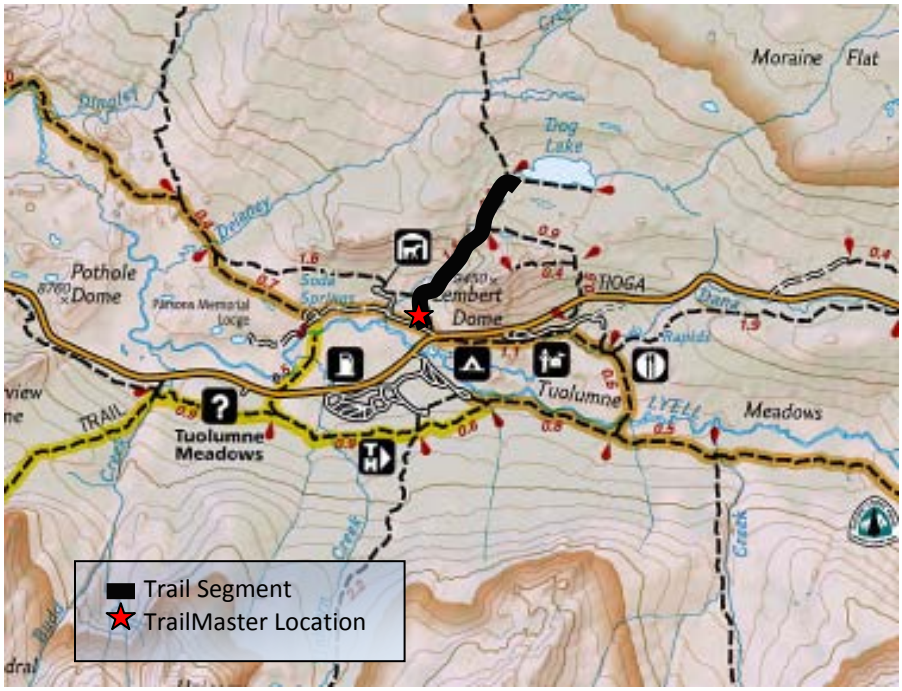

Figure 10. Map of Dog Lake Study Location

Table 40. Dog Lake - Actual Mean Hourly Encounter Rates with Groups, by Day

Date	Weekday	Hours	Unique Groups per Hour (Mean)		Total Groups per Hour* (Mean)
			Enc. < 25'	All Unique Groups	
7/1/09	Wednesday	3.57	6.72	6.72	6.72
7/4/09	Saturday	4.60	18.70	20.22	20.87
7/9/09	Thursday	5.38	12.45	13.20	13.20
7/10/09	Friday	4.11	14.36	14.84	16.30
7/12/09	Sunday	3.33	17.42	18.92	19.82
7/13/09	Monday	4.74	7.17	8.23	8.65
7/14/09	Tuesday	4.05	8.64	9.88	10.62
7/17/09	Friday	4.00	8.50	9.25	9.75
7/19/09	Sunday	4.11	13.14	14.36	15.09
7/20/09	Monday	4.17	8.39	9.11	11.75
7/21/09	Tuesday	4.73	13.11	13.32	21.99
7/22/09	Wednesday	4.14	8.70	8.70	12.56
7/23/09	Thursday	4.01	11.47	14.21	14.71
7/24/09	Friday	3.72	6.45	12.37	16.13
7/28/09	Tuesday	3.98	5.28	7.54	9.30
8/4/09	Tuesday	4.12	7.77	14.56	22.33
8/12/09	Wednesday	3.23	16.10	16.41	19.20
8/15/09	Saturday	4.21	18.76	19.00	21.14
8/16/09	Sunday	4.00	14.25	14.50	17.25
8/17/09	Monday	4.47	13.87	14.99	14.99
8/19/09	Wednesday	3.99	14.54	17.79	20.05
8/21/09	Friday	3.65	14.25	15.34	16.71
8/22/09	Saturday	3.34	11.68	11.98	14.07
8/23/09	Sunday	4.09	9.05	9.29	9.78
8/26/09	Wednesday	4.54	13.44	14.32	14.54
8/27/09	Thursday	4.01	9.73	12.47	12.72
8/29/09	Saturday	3.88	6.19	6.70	6.96
8/31/09	Monday	3.98	8.54	9.80	10.05

* “Total” groups includes groups seen more than once.

Table 41. Dog Lake - Actual Mean Hourly Encounter Rates with People, by Day

Date	Weekday	Hours	Unique People per Hour (Mean)		Total People per Hour* (Mean)
			< 25' Enc.	All Unique People	
07/01/09	Wednesday	3.57	19.61	19.61	19.61
07/04/09	Saturday	4.60	49.78	53.04	55.43
07/09/09	Thursday	5.38	32.90	34.94	34.94
07/10/09	Friday	4.11	45.01	46.72	50.12
07/12/09	Sunday	3.33	41.44	46.25	48.05
07/13/09	Monday	4.74	17.72	20.04	21.31
07/14/09	Tuesday	4.05	16.54	18.77	20.25
07/17/09	Friday	4.00	27.50	29.25	30.50
07/19/09	Sunday	4.11	37.96	42.34	43.55
07/20/09	Monday	4.17	25.90	27.82	38.85
07/21/09	Tuesday	4.73	44.82	45.24	81.82
07/22/09	Wednesday	4.14	25.36	25.36	38.16
07/23/09	Thursday	4.01	33.92	41.40	42.64
07/24/09	Friday	3.72	18.55	35.75	47.31
07/28/09	Tuesday	3.98	19.85	25.38	31.16
08/04/09	Tuesday	4.12	21.36	47.09	76.21
08/12/09	Wednesday	3.23	56.97	58.82	71.52
08/15/09	Saturday	4.21	53.21	53.68	60.81
08/16/09	Sunday	4.00	37.25	38.25	49.75
08/17/09	Monday	4.47	43.62	48.55	48.55
08/19/09	Wednesday	3.99	47.37	56.89	65.66
08/21/09	Friday	3.65	41.64	45.21	50.14
08/22/09	Saturday	3.34	37.72	38.32	45.21
08/23/09	Sunday	4.09	22.74	23.23	23.72
08/26/09	Wednesday	4.54	38.55	40.09	41.63
08/27/09	Thursday	4.01	29.18	35.41	37.91
08/29/09	Saturday	3.88	22.94	25.52	26.80
08/31/09	Monday	3.98	20.10	23.37	24.37

* “Total” includes people encountered more than once.

Table 42. Dog Lake - Summary of Actual Daily Average Hourly Encounter Rates for Groups and People

	Mean Groups Encountered per Hour			Mean People Encountered per Hour		
	Unique < 25'	All Unique	Total*	Unique < 25'	All Unique	Total*
Average	11.38	12.79	14.54	33.20	37.37	43.78
St. Dev.	3.89	3.82	4.62	11.92	11.97	16.74
Min	5.28	6.70	6.72	16.54	18.77	19.61
Max	18.76	20.22	22.33	56.97	58.82	81.82
Average hourly encounter rate for all observations						
	11.40	14.55	12.79	33.17	37.28	43.74

* Total includes multiple sightings of the same group/people

Of groups encountered on the Dog Lake trail segment, nearly all were on day trips (Table 43), while nearly two-thirds were determined to be entering the wilderness (Table 44). Given the nature of the terrain and forest, most groups were encountered within speaking distance of the observer (Table 45). Those who were farther away tended to be groups observed across Dog Lake or climbing on Lembert Dome.

Table 43. Dog Lake - Day and Overnight Visitors Encountered

Duration of Stay	Groups	People
	----------Percent----------	
Day	94	94
Overnight	6	5
Unknown	0	0

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Table 44. Dog Lake - Direction Traveled by Visitors Encountered

Direction of Travel	Groups	People
	----------Percent----------	
In	60	60
Out	30	28
Unknown	10	11

Table 45. Dog Lake - Proximity of Visitors Encountered

Proximity	Groups	People
	----------Percent----------	
< 25'	88	87
> 25'	12	13

Dog Lake - Actual Encounters and TrailMaster Relationships

Actual Encounters and TrailMaster counts were significantly related for both 24-hour total corrected counts and the counts from 8:00 a.m. to 6:00 p.m. (Tables 46 and 47). No directional counts were available for analysis at this location. Total corrected TrailMaster counts from 8:00 a.m. to 6:00 p.m. explained 43% of the variance in average hourly encounters with unique groups within speaking distance; this is a slight, though not significant, improvement over 24-hour counts. Using the 10-hour daytime period, a TrailMaster count of one additional person predicts an increase in average group encounters of 0.04 (± 0.02) unique groups per hour within speaking distance (Table 47).

As with the Cathedral Lakes trail, average hourly encounters with people had the strongest relationship with TrailMaster counts. For example, the most variance explained (60%) was from the relationship of unique people and 8:00 a.m. to 6:00 p.m. TrailMaster counts (Table 47). Figure 11 depicts the relationship between TrailMaster

counts from 8:00 a.m. to 6:00 p.m. and encounters with unique groups within speaking distance. Weekday/end, precipitation, and maximum temperature were not significant within the models at the 95% confidence level and therefore were not included.

Table 46. Dog Lake Regression Models: Actual Encounters and TrailMaster 24-hours Corrected Total Count

Dependent Variables	R^2	**Adj. R^2**	***df***	***F***	***p***	**Coefficients**		**95% CI**	***p***
Average Hourly Total Groups Encountered	.53	.51	1,26	29.19	.001	Intercept	-2.72	3.97	.410
						TrailMaster	0.06	0.02	.001
Average Unique Groups < 25' Encountered per Hour	.42	.40	1,26	18.93	.001	Intercept	-1.60	6.21	.604
						TrailMaster	0.04	0.02	.001
Average Hourly Unique Groups Encountered	.50	.48	1,26	26.15	.001	Intercept	-1.11	5.69	.692
						TrailMaster	0.05	0.02	.001
Average Hourly Total People Encountered	.50	.48	1,26	26.07	.001	Intercept	-17.05	24.94	.172
						TrailMaster	0.20	0.08	.001
Average Hourly Unique People Encountered	.58	.57	1,26	36.228	.001	Intercept	-9.54	16.31	.240
						TrailMaster	0.15	0.15	.001

Table 47. Dog Lake Regression Models: Actual Encounters and TrailMaster 8:00 a.m. to 6:00 p.m. Corrected Total Count

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.55	.53	1,26	31.48	.001	Intercept	-2.23	6.28	.463
						TrailMaster	0.06	0.02	.001
Average Unique Groups < 25' Encountered per Hour	.45	.43	1,26	21.59	.001	Intercept	-1.51	5.81	.598
						TrailMaster	0.04	0.02	.001
Average Hourly Unique Groups Encountered	.53	.51	1,26	28.89	.001	Intercept	-0.84	5.32	.747
						TrailMaster	0.05	0.02	.001
Average Hourly Total People Encountered	.52	.50	1,26	28.28	.001	Intercept	-15.63	23.42	.182
						TrailMaster	0.20	0.08	.001
Average Hourly Unique People Encountered	.61	.60	1,26	40.98	.001	Intercept	-8.70	15.07	.248
						TrailMaster	0.14	0.05	.001

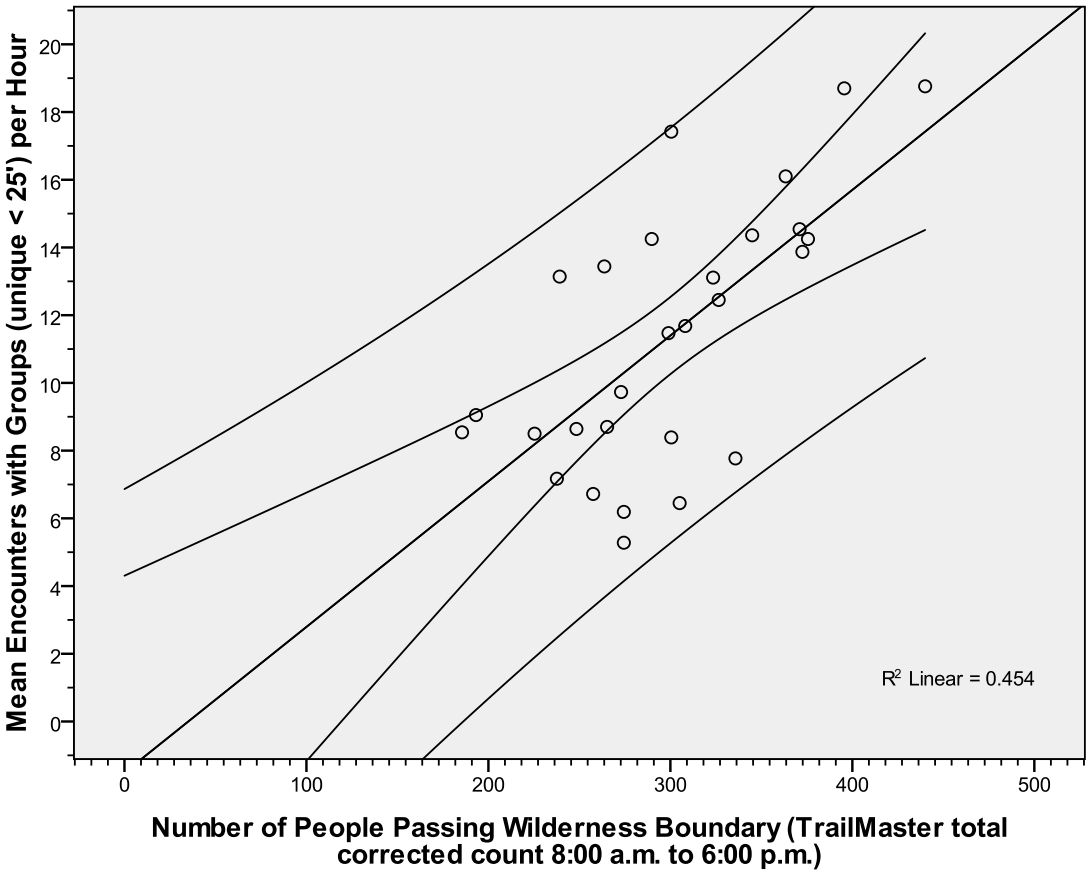

Figure 11. Dog Lake -- regression of corrected TrailMaster counts (8:00 a.m. to 6:00 p.m.) on unique group within 25 feet encounters per hour. Fit line is shown with mean and individual 95% confidence intervals.

Dog Lake - Tioga Road Traffic Counters and Actual Encounter Relationships

There were no significant relationships between encounter variables and Tioga Road traffic counter variables at the 95% confidence level.

Young Lakes East

Summary Statistics

Twenty-eight days of data were collected for actual encounters for the Young Lakes East trail segment (Figure 12). The average number of encounters per hour with both unique groups and total groups was low, ranging from approximately 1 to 7 (Table 48). When examining encounters with individuals (vs. groups), the average number of unique encounters per hour ranged from 1 to 15, while the average total encounters per hour ranged from 1 to 16 (Table 49). The virtually identical range between the "unique" and "total" encounters shows that, on this trail, observers almost never encountered the same group more than once. The comparison of the number of encounters with groups versus individuals reveals that group sizes were generally 1 to 2 people (Table 50).

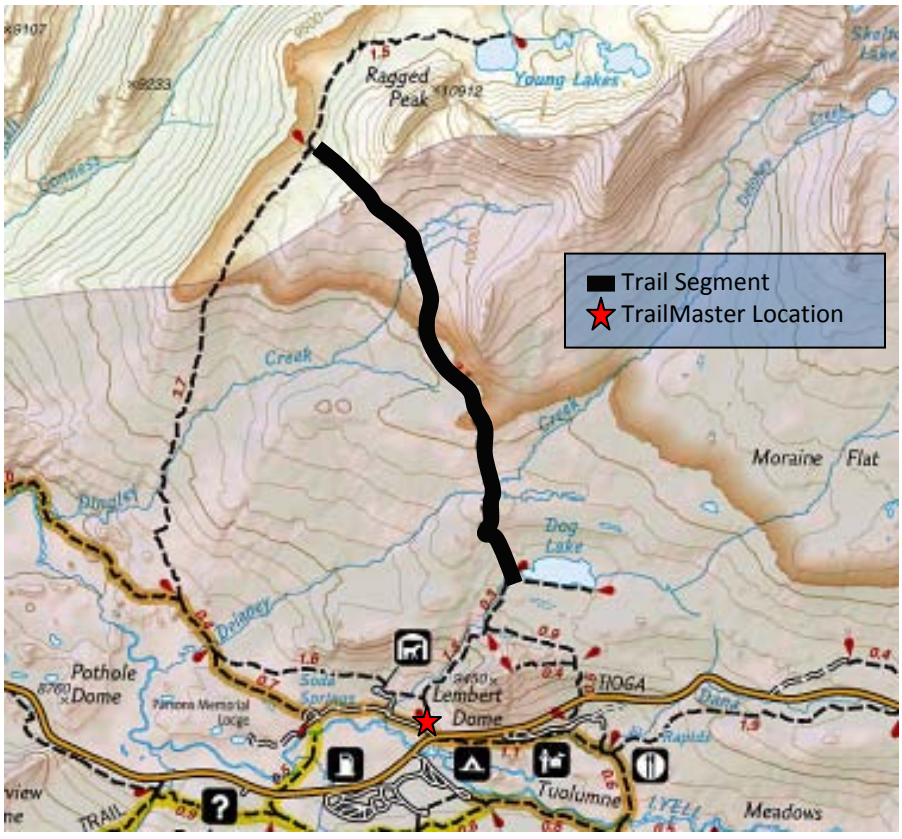

Figure 12. Map of Young Lakes East Study Location

Table 48. Young Lakes East – Actual Mean Average Hourly Encounter Rates with Groups, by Day

Date	Weekday	Hours	Unique Groups per Hour (Mean)		Total Groups per Hour* (Mean)
			Enc. < 25'	All Unique Groups	
7/4/09	Saturday	4.20	2.14	2.62	3.33
7/5/09	Sunday	3.76	2.66	2.93	3.19
7/6/09	Monday	4.00	1.25	1.50	1.50
7/7/09	Tuesday	3.43	1.46	1.46	1.46
7/9/09	Thursday	4.21	1.43	1.66	1.66
7/13/09	Monday	3.15	1.27	1.27	1.27
7/19/09	Sunday	4.14	4.11	4.59	4.59
7/22/09	Wednesday	3.77	2.65	3.45	3.45
7/27/09	Monday	3.84	1.04	1.04	1.04
7/29/09	Wednesday	3.92	1.53	1.53	1.53
7/30/09	Thursday	4.42	1.36	1.81	2.26
8/1/09	Saturday	3.68	3.26	3.26	3.26
8/2/09	Sunday	3.75	1.60	1.60	1.60
8/4/09	Tuesday	4.00	0.75	1.50	1.50
8/7/09	Friday	4.35	1.38	1.38	1.38
8/9/09	Sunday	4.66	7.08	7.08	7.08
8/10/09	Monday	3.73	2.41	2.41	2.41
8/13/09	Thursday	3.87	2.58	2.58	2.58
8/15/09	Saturday	4.49	5.12	5.12	5.79
8/16/09	Sunday	3.58	2.79	3.35	3.91
8/17/09	Monday	6.35	2.20	2.20	2.20
8/18/09	Tuesday	2.12	3.77	3.77	3.77
8/25/09	Tuesday	4.00	2.00	2.00	2.00
8/26/09	Wednesday	3.48	0.86	1.15	1.15
8/27/09	Thursday	3.97	1.51	1.51	1.51
8/29/09	Saturday	3.75	1.07	1.33	1.33
8/31/09	Monday	3.48	1.44	1.44	1.44

* “Total” groups includes groups seen more than once.

Table 49. Young Lakes East - Actual Mean Hourly Encounter Rates with People, by Day

Date	Weekday	Hours	Unique People per Hour (Mean)		Total People per Hour* (Mean)
			< 25' Enc.	All Unique People	
7/4/09	Saturday	4.20	3.57	4.76	6.19
7/5/09	Sunday	3.76	5.85	6.38	7.98
7/6/09	Monday	4.00	2.50	3.00	3.00
7/7/09	Tuesday	3.43	2.04	2.04	2.04
7/9/09	Thursday	4.21	2.85	3.09	3.09
7/13/09	Monday	3.15	2.54	2.54	2.54
7/19/09	Sunday	4.14	10.39	11.35	11.35
7/22/09	Wednesday	3.77	6.10	7.69	7.69
7/27/09	Monday	3.84	1.30	1.30	1.30
7/29/09	Wednesday	3.92	4.08	4.08	4.08
7/30/09	Thursday	4.42	2.26	3.17	4.07
8/1/09	Saturday	3.68	9.78	9.78	9.78
8/2/09	Sunday	3.75	3.73	3.73	3.73
8/4/09	Tuesday	4.00	1.25	2.25	2.25
8/7/09	Friday	4.35	4.37	4.37	4.37
8/9/09	Sunday	4.66	15.02	15.02	15.02
8/10/09	Monday	3.73	5.63	5.63	5.63
8/13/09	Thursday	3.87	8.01	8.01	8.01
8/15/09	Saturday	4.49	14.92	14.92	16.26
8/16/09	Sunday	3.58	5.87	6.98	7.82
8/17/09	Monday	6.35	6.93	6.93	6.93
8/18/09	Tuesday	2.12	11.32	11.32	11.32
8/25/09	Tuesday	4.00	3.50	3.50	3.50
8/26/09	Wednesday	3.48	1.72	2.30	2.30
8/27/09	Thursday	3.97	2.52	2.52	2.52
8/29/09	Saturday	3.75	1.60	2.40	2.40
8/31/09	Monday	3.48	3.45	3.45	3.45

* “Total” includes people encountered more than once.

Table 50. Young Lakes East - Summary of Actual Daily Average Hourly Encounter Rates for Groups and People

	Mean Groups Encountered per Hour			Mean People Encountered per Hour		
	Unique < 25'	All Unique	Total*	Unique < 25'	All Unique	Total*
Mean	2.25	2.43	2.53	5.30	5.65	5.88
St. Dev.	1.43	1.42	1.50	3.94	3.88	4.02
Min	0.75	1.04	1.04	1.25	1.30	1.30
Max	7.08	7.08	7.08	15.02	15.02	16.26
Grand Means – All Observations						
	2.28	2.46	2.56	5.38	5.73	5.97

* Total includes multiple sightings of the same group/people.

Of groups encountered on the Young Lakes East trail segment, slightly more than two-thirds were on day trips (Table 51), while nearly the same number were entering and exiting the wilderness (Table 52). There are many open alpine meadows interspersed with forested sections; however, even with these many open views nearly all encounters occurred within speaking distance of the observer (Table 53). As with the other locations, this suggests that people generally stay on the trail.

Table 51. Young Lakes East - Day and Overnight Visitors Encountered

Duration of Stay	Groups	People
	----------Percent----------	
Day	33	29
Overnight	66	71
Unknown	0	0

Table 52. Young Lakes East - Direction Traveled by Visitors Encountered

Direction of Travel	Groups	People
	----------Percent----------	
In	44	42
Out	44	44
Unknown	12	13

Table 53. Young Lakes East - Proximity of Visitors Encountered

Proximity	Groups	People
	----------Percent----------	
< 25'	93	94
> 25'	7	6

Young Lakes East- Encounters and TrailMaster Relationships

There was a significant relationship between average hourly total people encountered and total corrected TrailMaster counts. Using either the 24-hour or 8:00 a.m. to 6:00 p.m. TrailMaster counts explained the same amount of variance, 12% and 13% respectively (Tables 54 and 55). A one-person increase in TrailMaster count predicts an increase of 0.03 (± 0.03) encounters with people per hour; Figure 13 shows the relationship graphically with mean and individual 95% confidence intervals. It should be noted that the TrailMaster location was at the wilderness boundary on the Dog Lake Trail and that approximately 1.5 miles of high use trail separated the trail segment from this location. This would be the most likely explanation of the low amount of variance explained by the TrailMaster counts and why all other encounter variable and TrailMaster variable relationships were not significant at the 95% confidence level.

Weekday/end, precipitation, and maximum temperature were not significant in the models and there for were not included.

Table 54. Young Lakes East Regression Model: TrailMaster 24-hour Corrected Total Count

Dependent Variables	**R^2**	**Adj. R^2**	***df***	**F**	***p***	**Coefficients**	**B**	**95% CI**	***p***
Average Hourly Total People Encountered	.18	.12	1,26	4.84	.037	Intercept	-3.05	8.28	.456
						TrailMaster	0.03	0.03	.037

Table 55. Young Lakes East Regression Model: TrailMaster 8:00 a.m. to 6:00 p.m. Corrected Total Count

Dependent Variables	***R^2***	**Adj. *R^2***	***df***	***F***	***p***	**Coefficients**		**95% CI**	***p***
Average Hourly Total People Encountered	.16	.13	1,26	5.08	.033	Intercept	-2.78	7.85	.473
						TrailMaster	0.03	0.03	.033

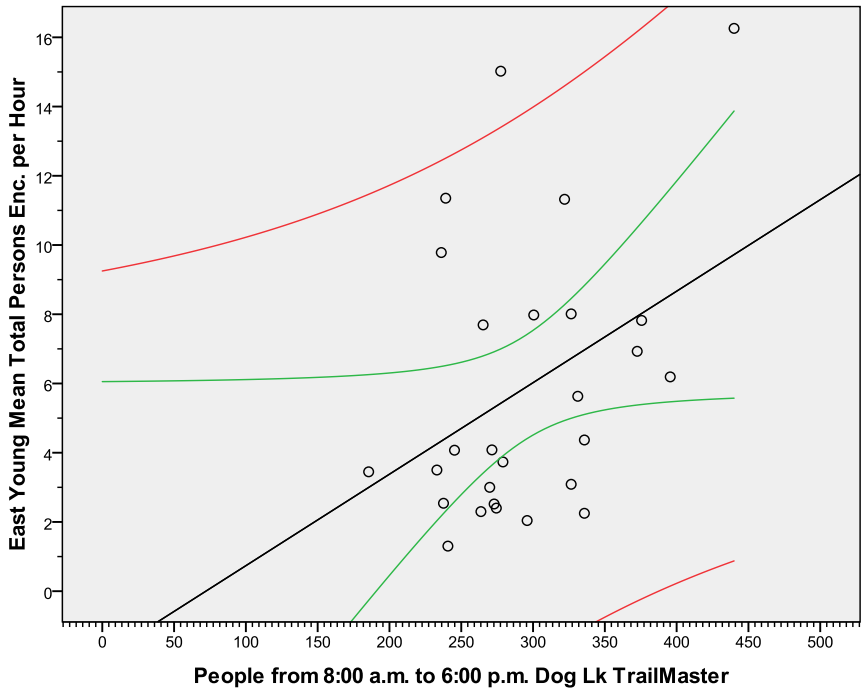

Figure 13. Young Lakes East – regression of corrected TrailMaster counts (8:00 a.m. to 6:00 p.m.) on total people encountered per hour. Fit line is shown with mean and individual 95% confidence interval.

Young Lakes East - Tioga Road Traffic Counters and Actual Encounter Relationships

Using 15 days of data, there were significant relationships between actual encounter rates and Tioga Road traffic counts for the Young Lakes East location. Total traffic counts were only related to unique groups within speaking distance and both total and unique people encounter rates (Table 56). Inbound traffic counts were only significantly related to total and unique people encounter rates, while outbound counts were related to both people encounter rates and also unique groups within speaking distance (Tables 57 and 58). The variance in encounter rates explained by traffic counts was similar for total, inbound, and outbound counts, ranging from 24% to 27%. For total Tioga Road traffic counts (inbound plus outbound), an increase of one vehicle predicts an additional 0.001 mean unique group within speaking distance per hour (Table 56 and Figure 14).

Table 56. Young Lakes East - Regression of Tioga Road Inbound and Outbound Traffic Counts from 7:00 a.m. to 6:00 p.m. on Actual Encounters

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Unique Groups < 25' Encountered per Hour	.29	.23	1,12	4.83	.048	Intercept	-1.68	3.58	.325
						Traff. Inbound & Outbound	0.001	0.000	.048
Average Hourly Total People Encountered	.32	.27	1,12	5.70	.034	Intercept	-7.57	11.52	.178
						Traff. Inbound & Outbound	0.002	0.002	.034
Average Hourly Unique People Encountered	.32	.26	1,12	5.51	.037	Intercept	-7.34	11.24	.180
						Traff. Inbound & Outbound	0.002	0.002	.037

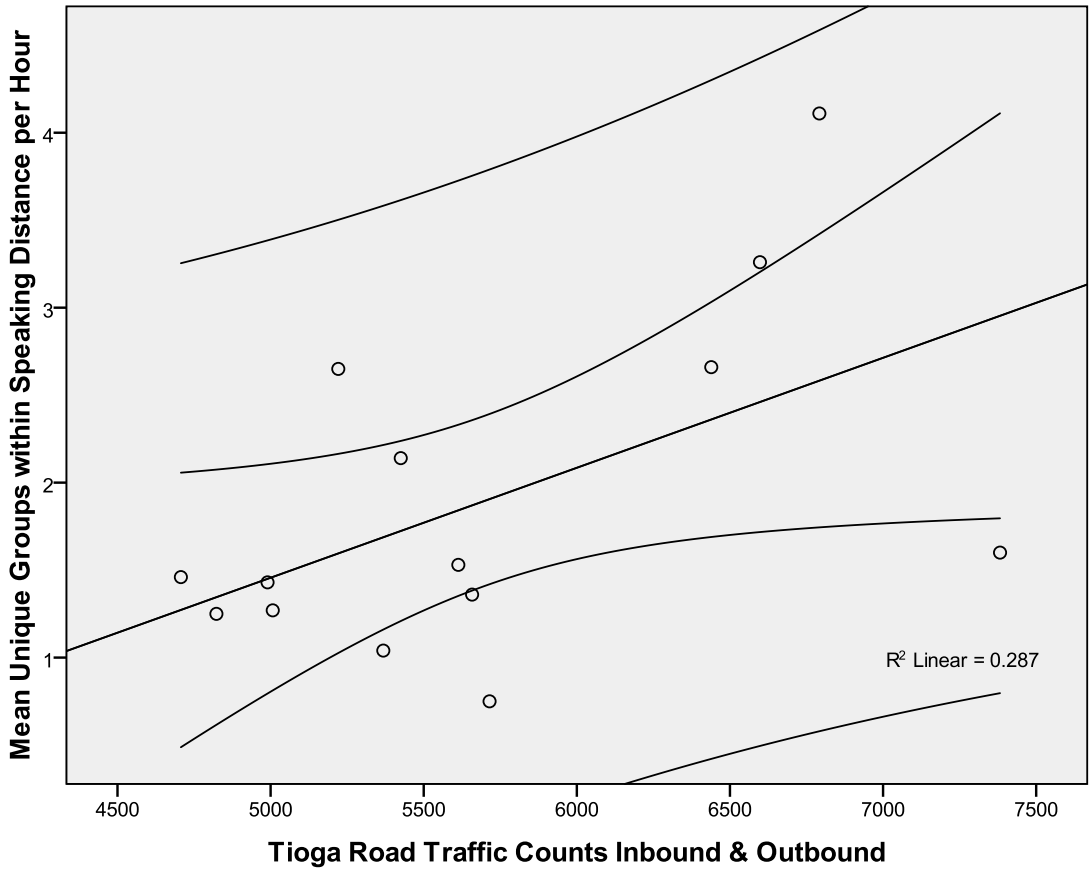

Figure 14. Young Lakes East - regression of Tioga Road total (inbound plus outbound) traffic counts (7:00 a.m. to 6:00 p.m.) on daily mean encounters with unique groups within speaking distance per hour. Fit line shown with mean and individual 95% CI.

Table 57. Young Lakes East - Regression of Tioga Road Inbound Traffic Counts from 7:00 a.m. to 6:00 p.m. on Actual Encounters

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total People Encountered	.31	.26	1,12	5.48	.037	Intercept	-8.17	12.30	.174
						Traff. Inbound	0.005	0.004	.037
Average Hourly Unique People Encountered	.31	.25	1,12	5.37	.039	Intercept	-7.98	11.98	.172
						Traff. Inbound	0.004	0.004	.039

Table 58. Young Lakes East - Regression of Tioga Road Inbound and Outbound Traffic Counts from 7:00 a.m. to 6:00 p.m. on Actual Encounters

Dependent Variables	R^2	**Adj. R^2**	***df***	***F***	***p***	**Coefficients**		**95% CI**	***p***
Average Unique Groups < 25' Encountered per Hour	.30	.24	1,12	5.11	.043	Intercept	-1.00	3.34	.336
						Traff. Outbound	0.001	0.001	.043
Average Hourly Total People Encountered	.33	.27	1,12	5.81	.033	Intercept	-6.89	10.80	.190
						Traff. Outbound	0.004	0.004	.033
Average Hourly Unique People Encountered	.32	.26	1,12	5.54	.036	Intercept	-6.64	10.5	.169
						Traff. Outbound	0.004	0.004	.036

Young Lakes West

Summary Statistics

Twenty-eight days of data were collected for actual encounters at the Young Lakes West trail segment (Figure 15). The average number of encounters per hour with unique and total groups both ranged from approximately 2 to 5, indicating groups were generally not encountered more than once on this trail segment (Table 59). When examining encounters with individuals (vs. groups), the average number of encounters per hour ranged from 3 to 18 (Table 60). A comparison of the number of encounters with groups versus individuals reveals that group sizes were generally 2 to 4 people (Table 61).

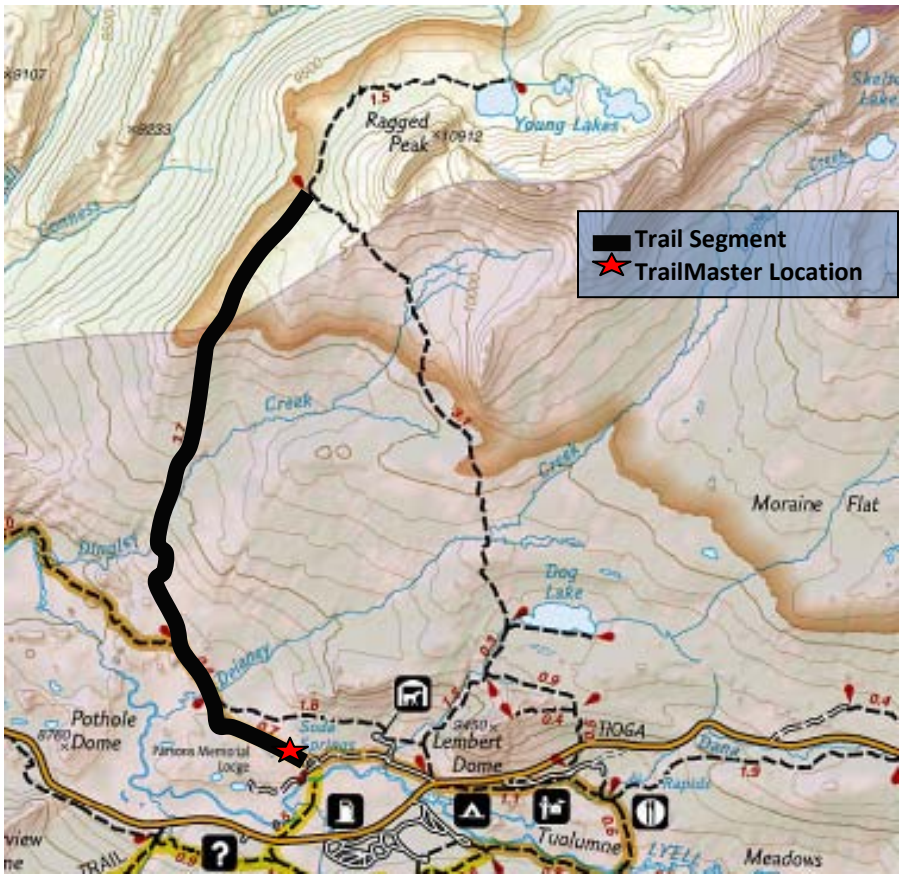

Figure 15. Map of Young Lakes West Study Location

Table 59. Young Lakes West - Actual Mean Hourly Encounter Rates with Groups, by Day

Date	Weekday	Hours	Unique Groups per Hour (Mean)		Total Groups per Hour* (Mean)
			Enc. < 25'	All Unique Groups	
7/4/09	Saturday	4.21	1.19	2.38	2.61
7/5/09	Sunday	4.39	3.19	3.64	4.10
7/6/09	Monday	4.63	1.73	1.73	1.73
7/7/09	Tuesday	4.26	3.05	3.29	3.29
7/8/09	Wednesday	4.70	2.34	2.34	2.34
7/9/09	Thursday	4.05	3.21	3.21	3.21
7/13/09	Monday	4.94	2.63	2.63	2.63
7/19/09	Sunday	4.50	4.67	4.89	4.89
7/22/09	Wednesday	5.01	1.60	2.20	2.20
7/27/09	Monday	3.98	1.76	1.76	1.76
7/29/09	Wednesday	4.24	4.25	4.25	4.48
7/30/09	Thursday	3.61	1.94	2.22	2.22
8/1/09	Saturday	4.50	2.22	2.44	2.44
8/2/09	Sunday	4.20	4.76	4.76	4.76
8/4/09	Tuesday	3.46	2.89	3.76	3.76
8/7/09	Friday	3.95	3.54	3.54	3.54
8/9/09	Sunday	3.16	5.06	5.06	5.06
8/10/09	Monday	4.21	3.80	4.28	4.28
8/13/09	Thursday	3.83	2.35	2.35	2.35
8/15/09	Saturday	3.82	3.93	3.93	3.93
8/16/09	Sunday	4.50	2.67	2.67	2.67
8/17/09	Monday	3.84	2.08	2.08	2.08
8/18/09	Tuesday	4.81	3.12	3.12	3.12
8/25/09	Tuesday	4.93	1.62	1.83	1.83
8/26/09	Wednesday	4.20	1.67	1.67	1.67
8/27/09	Thursday	4.41	1.81	2.04	2.04
8/29/09	Saturday	4.02	2.99	3.23	3.23
8/31/09	Monday	4.45	1.80	1.80	1.80

* “Total” groups includes groups seen more than once.

Table 60. Young Lakes West - Actual Mean Hourly Encounter Rates with People, by Day

Date	Weekday	Hours	Unique People per Hour (Mean)		Total People per Hour* (Mean)
			< 25' Enc.	All Unique People	
7/4/09	Saturday	4.21	7.60	17.81	18.05
7/5/09	Sunday	4.39	7.97	8.88	9.79
7/6/09	Monday	4.63	4.54	4.54	4.54
7/7/09	Tuesday	4.26	11.97	12.44	12.44
7/8/09	Wednesday	4.70	10.00	10.00	10.00
7/9/09	Thursday	4.05	5.93	5.93	5.93
7/13/09	Monday	4.94	10.32	10.32	10.32
7/19/09	Sunday	4.50	9.11	9.78	9.78
7/22/09	Wednesday	5.01	3.59	4.59	4.59
7/27/09	Monday	3.98	7.54	7.54	7.54
7/29/09	Wednesday	4.24	12.03	12.03	13.92
7/30/09	Thursday	3.61	6.65	7.48	7.48
8/1/09	Saturday	4.50	8.00	9.33	9.33
8/2/09	Sunday	4.20	12.86	12.86	12.86
8/4/09	Tuesday	3.46	10.69	13.87	13.87
8/7/09	Friday	3.95	10.13	10.13	10.13
8/9/09	Sunday	3.16	13.92	13.92	13.92
8/10/09	Monday	4.21	11.40	12.83	12.83
8/13/09	Thursday	3.83	6.01	6.01	6.01
8/15/09	Saturday	3.82	11.78	11.78	11.78
8/16/09	Sunday	4.50	6.89	6.89	6.89
8/17/09	Monday	3.84	7.29	7.29	7.29
8/18/09	Tuesday	4.81	8.73	8.73	8.73
8/25/09	Tuesday	4.93	2.84	3.25	3.25
8/26/09	Wednesday	4.20	4.76	4.76	4.76
8/27/09	Thursday	4.41	5.22	6.58	6.58
8/29/09	Saturday	4.02	7.96	8.21	8.21
8/31/09	Monday	4.45	4.94	4.94	4.94

* “Total” includes people encountered more than once.

Table 61. Young Lakes West - Summary of Actual Daily Average Hourly Encounter Rates for Groups and People

	Mean Groups Encountered per Hour			Mean People Encountered per Hour		
	Unique < 25'	All Unique	Total*	Unique < 25'	All Unique	Total*
Mean	2.78	2.97	3.00	8.24	9.03	9.13
St. Dev.	1.07	1.04	1.06	2.95	3.51	3.61
Min	1.19	1.67	1.67	2.84	3.25	3.25
Max	5.06	5.06	5.06	13.92	17.81	18.05
Grand Means – All Observations						
	2.74	2.93	2.96	8.11	8.89	9.00

* Total includes multiple sightings of the same group/people.

Of groups encountered on the Young Lakes West trail segment, just under half were on day trips (Table 62), while just nearly half were determined to be entering the wilderness (Table 63). Given the nature of the terrain and forest, almost all of the groups were encountered within speaking distance of the observer (Table 64).

Table 62. Young Lakes West - Day and Overnight Visitors Encountered

Duration of Stay	Groups	People
	----------Percent----------	
Day	42	44
Overnight	57	50
Unknown	1	6

Table 63. Young Lakes West - Direction Traveled by Visitors Encountered

Direction of Travel	Groups	People
	----------Percent----------	
In	46	46
Out	41	41
Unknown	12	14

Table 64. Young Lakes West - Proximity of Visitors Encountered

Proximity	Groups	People
	----------Percent----------	
< 25'	94	91
> 25'	6	9

Young Lakes West - Actual Encounters and TrailMaster Relationships

Mean encounter rates per hour were significantly related to 24-hour and 8:00 a.m. to 6:00 p.m. total corrected TrailMaster counts (Table 65 and 66); inbound and outbound TrailMaster counts did not perform as well (Table 67 and 68). The strongest relationship was between average hourly unique groups within speaking distance encountered and total corrected TrailMaster counts from 8:00 a.m. to 6:00 p.m., with 23% of the variance explained (Table 66 and Figure 16). Weekday/end, precipitation, and maximum temperature were not significant in the models and therefore were not included.

Table 65. Young Lakes West Regression Models: Actual Encounters and TrailMaster 24-hours Corrected Total Count

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.20	.17	1,25	6.44	.018	Intercept	0.24	2.29	.833
						TrailMaster	0.01	0.01	.018
Average Unique Groups < 25' Encountered per Hour	.23	.19	1,25	7.25	.012	Intercept	0.02	2.19	.985
						TrailMaster	0.01	0.01	.012
Average Hourly Unique Groups Encountered	.18	.15	1,25	5.59	.026	Intercept	0.43	2.26	.700
						TrailMaster	0.01	0.01	.026
Average Hourly Total People Encountered	.20	.17	1,25	6.26	.019	Intercept	0.58	6.87	.893
						TrailMaster	0.04	0.03	.019
Average Hourly Unique People Encountered	.18	.14	1,25	5.30	.030	Intercept	1.26	6.75	.703
						TrailMaster	0.03	0.03	.030

Table 66. Young Lakes West Regression Models: Actual Encounters and TrailMaster 8:00 a.m. to 6:00 p.m. Corrected Total Count

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.24	.21	1,25	7.85	.010	Intercept	-0.04	2.27	.975
						TrailMaster	0.01	0.01	.010
Average Unique Groups < 25' Encountered per Hour	.26	.23	1,25	8.80	.007	Intercept	-0.24	2.17	.819
						TrailMaster	0.02	0.01	.007
Average Hourly Unique Groups Encountered	.22	.19	1,25	6.94	.014	Intercept	0.15	2.25	.891
						TrailMaster	0.01	0.01	.014
Average Hourly Total People Encountered	.23	.20	1,25	7.46	.011	Intercept	-0.15	6.84	.965
						TrailMaster	0.04	0.03	.011
Average Hourly Unique People Encountered	.20	.17	1,25	6.32	.019	Intercept	0.58	6.74	.860
						TrailMaster	0.04	0.03	.019

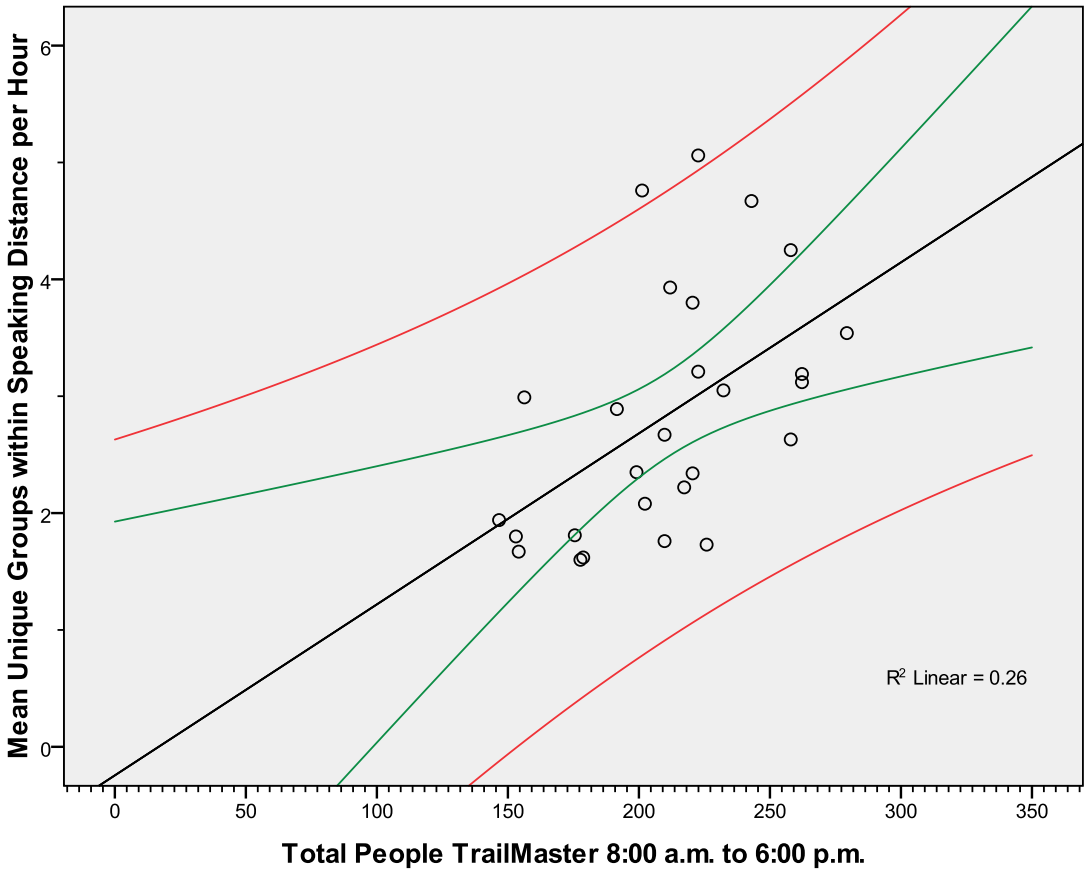

Figure 16. Young Lakes West – regression of corrected TrailMaster counts (8:00 a.m. to 6:00 p.m.) on encounters with unique groups within 25 feet per hour. Fit line is shown with mean and individual 95% confidence intervals.

Table 67. Young Lakes West Regression Models: Actual Encounters and TrailMaster 8:00 a.m. to 6:00 p.m. Corrected Inbound Count

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total People Encountered	.19	.16	1,25	5.94	.022	Intercept	2.49	5.47	.358
						TrailMaster	0.07	0.06	.022
Average Hourly Unique People Encountered	.18	.15	1,25	5.52	.027	Intercept	2.76	5.33	.296
						TrailMaster	0.07	0.06	.027

Table 68. Young Lakes West Regression Models: Actual Encounters and TrailMaster 8:00 a.m. to 6:00 p.m. Corrected Outbound Count

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.22	.19	1,25	6.97	.014	Intercept	0.49	2.01	.622
						TrailMaster	0.02	0.02	.014
Average Unique Groups < 25' Encountered per Hour	.25	.22	1,25	8.23	.008	Intercept	0.23	1.91	.805
						TrailMaster	0.02	0.02	.008
Average Hourly Unique Groups Encountered	.19	.16	1,25	5.98	.022	Intercept	0.67	1.99	.496
						TrailMaster	0.02	0.02	.022

Young Lakes West Tioga Road Traffic Counters and Actual Encounter Relationships

Actual encounters with groups were significantly related to Tioga Road traffic counts at the Young Lakes West location. Total (inbound plus outbound), inbound, and outbound traffic counts from 7:00 a.m. to 6:00 p.m. all exhibited similar relationships to group encounter rate variables; however , traffic was not significantly related to actual

encounter rates with people (Table 69 - 71). Traffic counts explained between 28 to 40% of the variance in daily mean group encounter rates per hour. For total (inbound plus outbound) traffic counts on Tioga Road between 7:00 a.m. and 6:00 p.m. an additional vehicle predicts an increase of 0.001 in the daily mean encounter rate with unique groups within speaking distance per hour (Table 69 & Figure 17).

Table 69. Young Lakes West - Regression of Tioga Road Inbound and Outbound Traffic Counts from 7:00 a.m. to 6:00 p.m. on Actual Encounters

Dependent Variables	R^2	**Adj. R^2**	***df***	***F***	***p***	**Coefficients**		**95% CI**	***p***
Average Hourly Total Groups Encountered	.41	.36	1,13	8.83	.011	Intercept	-1.66	1.83	.323
						Traff. Inbound & Outbound	0.001	0.001	.011
Average Unique Groups < 25' Encountered per Hour	.33	.28	1,13	6.38	.025	Intercept	-1.69	3.85	.359
						Traff. Inbound & Outbound	0.001	.001	.025
Average Hourly Unique Groups Encountered	.40	.35	1,13	8.67	.011	Intercept	-1.53	3.38	.346
						Traff. Inbound & Outbound	0.001	0.001	.001

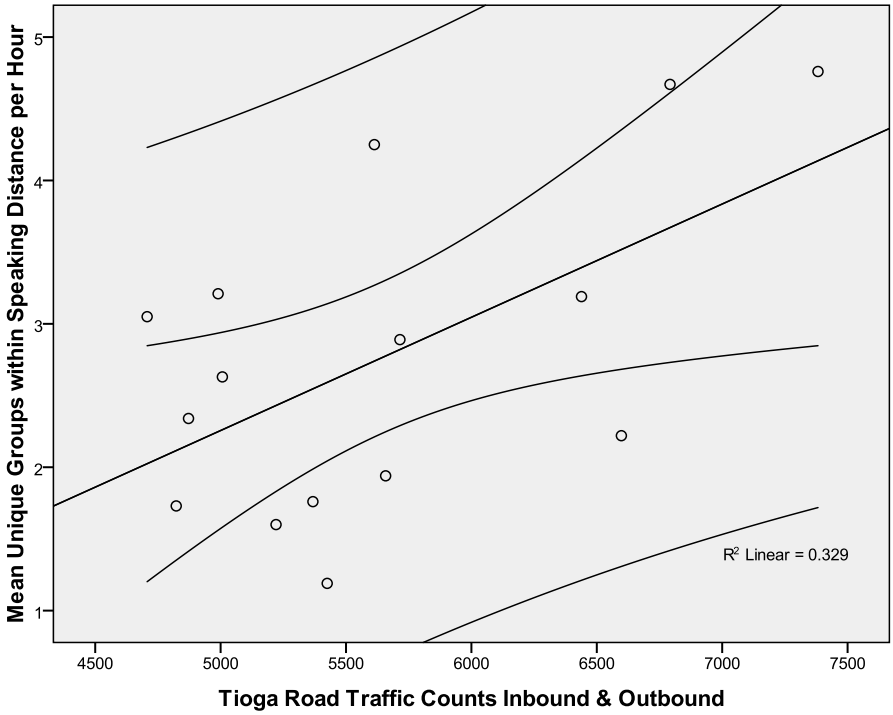

Figure 17. Young Lakes West – regression of Tioga Road total traffic counts (inbound and outbound from 7:00 a.m. to 6:00 p.m.) on mean encounters with unique groups within speaking distance per hour. Fit line shown with mean and individual 95% confidence intervals.

Table 70. Young Lakes West - Regression of Tioga Road Inbound Traffic Counts from 7:00 a.m. to 6:00 p.m. on Actual Encounters

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.36	.31	1,13	7.38	.018	Intercept	-1.67	3.82	.362
						Traff. Inbound	0.002	0.001	.018
Average Unique Groups < 25' Encountered per Hour	.29	.23	1,13	5.27	.039	Intercept	-1.66	4.20	.409
						Traff. Inbound	0.002	0.002	.039
Average Hourly Unique Groups Encountered	.36	.31	1,13	7.33	.018	Intercept	-1.56	3.70	.378
						Traff. Inbound	0.002	0.002	.018

Table 71. Young Lakes West - Regression of Tioga Road Outbound Traffic Counts from 7:00 a.m. to 6:00 p.m. on Actual Encounters

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients		95% CI	*p*
Average Hourly Total Groups Encountered	.44	.40	1,13	10.18	.007	Intercept	-1.57	3.19	.307
						Traff. Outbound	0.002	0.001	.007
Average Unique Groups < 25' Encountered per Hour	.36	.32	1,13	7.42	.017	Intercept	-1.65	1.89	.332
						Traff. Outbound	0.002	0.002	.017
Average Hourly Unique Groups Encountered	.43	.39	1,13	9.88	.008	Intercept	-1.44	3.10	.336
						Traff. Outbound	0.002	0.002	.008

Mono Pass

Summary Statistics

Twenty-six days of data were collected for actual encounters on the Mono Pass trail segment (Figure 18). The average number of encounters per hour for both unique and total groups ranged from approximately 2 to nearly 6, indicating that groups were rarely encountered more than once (Table 72). When examining encounters with individuals (vs. groups), the average number of unique encounters per hour ranged from 3 to 14, while the average total encounters per hour ranged from 3 to 15 (Table 73). A comparison of the number of encounters with groups versus individuals reveals that group sizes were generally 1 to 2 people (Table 74).

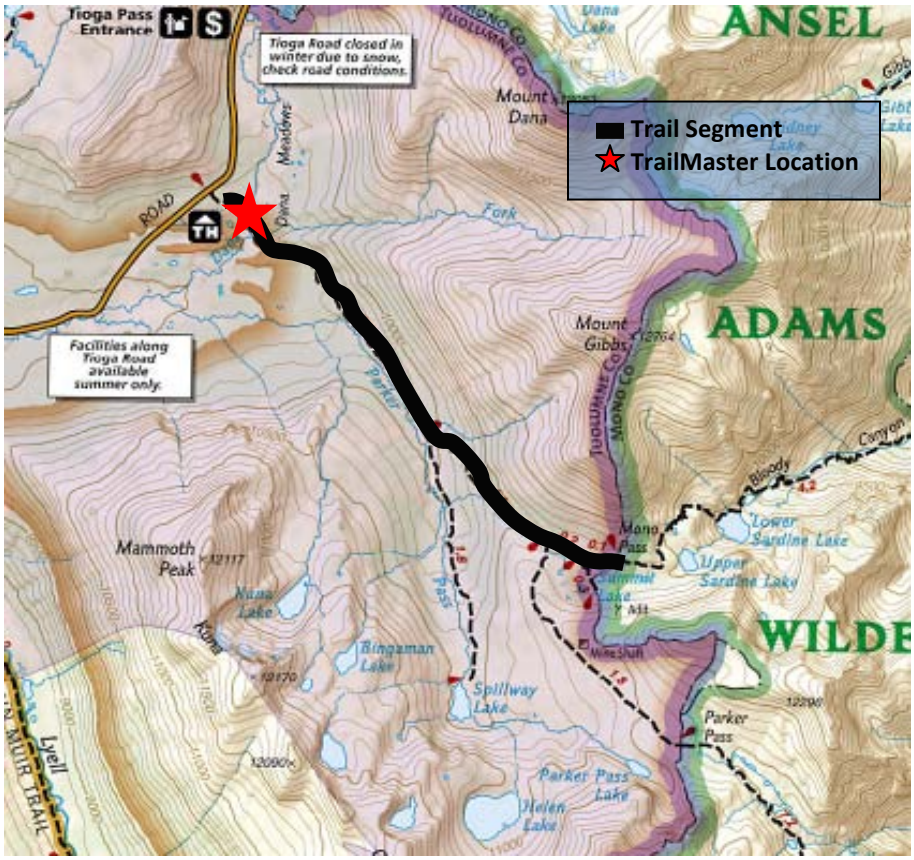

Figure 18. Map of Mono Pass Study Location

Table 72. Mono Pass - Actual Mean Hourly Encounter Rates with Groups, by Day

Date	Weekday	Hours	Unique Groups per Hour (Mean)		Total Groups per Hour* (Mean)
			Enc. < 25'	All Unique Groups	
7/3/09	Friday	3.67	0.27	2.45	2.45
7/7/09	Tuesday	3.75	1.87	2.40	2.40
7/10/09	Friday	4.12	2.43	2.67	2.67
7/14/09	Tuesday	4.11	1.70	1.95	1.95
7/16/09	Thursday	3.95	1.27	1.52	1.52
7/17/09	Friday	4.00	5.00	5.50	5.75
7/21/09	Tuesday	3.63	4.68	5.51	5.79
7/22/09	Wednesday	4.03	4.22	4.22	4.22
7/24/09	Friday	3.99	2.76	3.01	3.26
7/25/09	Saturday	3.99	0.75	3.01	4.51
7/26/09	Sunday	4.21	2.14	2.38	2.85
7/27/09	Monday	3.30	4.55	4.55	4.55
8/3/09	Monday	4.11	2.43	2.68	2.68
8/4/09	Tuesday	4.00	2.75	2.75	3.00
8/6/09	Thursday	4.17	1.44	1.92	2.16
8/7/09	Friday	4.00	2.00	2.00	2.00
8/9/09	Sunday	4.01	4.24	4.24	4.49
8/14/09	Friday	4.00	5.00	5.00	5.25
8/15/09	Saturday	4.25	4.47	4.47	4.94
8/16/09	Sunday	4.33	3.23	3.93	4.39
8/17/09	Monday	3.68	2.99	3.26	4.35
8/19/09	Wednesday	3.94	3.05	4.06	4.06
8/21/09	Friday	3.95	3.29	3.80	4.30
8/23/09	Sunday	3.83	3.66	3.66	3.66
8/26/09	Wednesday	4.33	2.54	2.54	2.54
8/29/09	Saturday	4.02	3.48	3.73	3.73

* “Total” groups includes groups seen more than once.

Table 73. Mono Pass - Actual Mean Hourly Encounter Rates with People, by Day

Date	Weekday	Hours	Unique People per Hour (Mean)		Total People per Hour* (Mean)
			< 25' Enc.	All Unique People	
7/3/09	Friday	3.67	0.27	4.63	4.63
7/7/09	Tuesday	3.75	4.00	5.07	5.07
7/10/09	Friday	4.12	5.34	5.83	5.83
7/14/09	Tuesday	4.11	4.14	4.87	4.87
7/16/09	Thursday	3.95	2.03	2.53	2.53
7/17/09	Friday	4.00	9.00	9.75	10.00
7/21/09	Tuesday	3.63	9.37	10.74	11.02
7/22/09	Wednesday	4.03	7.44	7.44	7.44
7/24/09	Friday	3.99	4.26	5.51	6.27
7/25/09	Saturday	3.99	1.75	7.77	11.03
7/26/09	Sunday	4.21	4.04	4.51	4.99
7/27/09	Monday	3.30	13.64	13.64	13.64
8/3/09	Monday	4.11	6.33	7.06	7.06
8/4/09	Tuesday	4.00	6.50	6.50	7.25
8/6/09	Thursday	4.17	3.12	4.32	5.04
8/7/09	Friday	4.00	4.00	4.00	4.00
8/9/09	Sunday	4.01	11.22	11.22	11.47
8/14/09	Friday	4.00	12.50	12.50	13.00
8/15/09	Saturday	4.25	11.76	11.76	14.59
8/16/09	Sunday	4.33	6.93	9.70	11.09
8/17/09	Monday	3.68	9.51	10.05	13.32
8/19/09	Wednesday	3.94	9.64	12.44	12.44
8/21/09	Friday	3.95	5.57	6.84	7.85
8/23/09	Sunday	3.83	7.31	7.31	7.31
8/26/09	Wednesday	4.33	4.62	4.62	4.62
8/29/09	Saturday	4.02	5.72	6.97	6.97

* “Total” includes people encountered more than once.

Table 74. Mono Pass - Summary of Actual Daily Average Hourly Encounter Rates for Groups and People

	Mean Groups Encountered per Hour			Mean People Encountered per Hour		
	Unique < 25'	All Unique	Total*	Unique < 25'	All Unique	Total*
Average	2.93	3.35	3.59	6.54	7.60	8.20
St. Dev.	1.31	1.12	1.22	3.47	3.10	3.50
Min	0.27	1.52	1.52	0.27	2.53	2.53
Max	5.00	5.51	5.79	13.64	13.64	14.59
Grand Means – All Observations						
	2.29	3.34	3.58	6.49	7.55	8.16

* Total includes multiple sightings of the same group/people.

Of groups encountered on the Mono Pass trail segment, nearly three-quarters were on day trips (Table 75), while just over half were determined to be entering the wilderness (Table 76). Given the open alpine meadow near Mono Pass and branching of the trails in that area, it is not surprising that this study site had one of the highest proportions of groups encountered outside of speaking distance, though it was still small at only 13% of groups encountered (Table 77). Those who were farther away tended to be seen across the pass hiking on adjacent trails or wandering off trail in the meadows.

Table 75. Mono Pass - Day and Overnight Visitors Encountered

Duration of Stay	Groups	People
	----------Percent----------	
Day	73	70
Overnight	26	28
Unknown	1	2

Table 76. Mono Pass - Direction Traveled by Visitors Encountered

Direction of Travel	Groups	People
	----------Percent----------	
In	55	58
Out	37	31
Unknown	8	11

Table 77. Mono Pass – Proximity of Visitors Encountered

Proximity	Groups	People
	----------Percent----------	
< 25'	87	84
> 25'	13	16

Mono Pass - Actual Encounters and TrailMaster Relationships

Significant relationships between encounter variables and TrailMaster variables were found for Mono Pass. The 24-hour and 8:00 a.m. to 6:00 p.m. total corrected TrailMaster counts were, for practical purposes, equal in strength (Table 78 and 79). Using inbound TrailMaster counts caused a slight improvement. For example, for average hourly unique group encounters within speaking distance, 33% of the variance was explained by inbound TrailMaster counts, compared to 27% explained with the other two TrailMaster counts (Table 79 - 81). Each inbound person counted by the TrailMaster predicts a 0.05 (± 0.03) increase in average unique groups encountered within speaking distance per hour (Figure 19). Outbound TrailMaster counts had the weakest relationships (Table 81). Weekday/end, precipitation, and maximum temperature were not significant within the models at the 95% confidence level and therefore were not included.

Table 78. Mono Pass Regression Models: Actual Encounters and TrailMaster 24-hours Corrected Total Count

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients	B	95% CI	*p*
Average Hourly Total Groups Encountered	.33	.30	1,24	11.55	.002	Intercept	1.76	1.19	.006
						TrailMaster	0.02	0.01	.002
Average Unique Groups < 25' Encountered per Hour	.30	.27	1,24	10.21	.004	Intercept	1.04	1.30	.113
						TrailMaster	0.02	0.01	.004
Average Hourly Unique Groups Encountered	.28	.24	1,24	9.09	.006	Intercept	1.79	1.14	.003
						TrailMaster	0.02	0.01	.006
Average Hourly Total People Encountered	.52	.50	1,24	25.09	.001	Intercept	1.57	2.92	.279
						TrailMaster	0.08	0.03	.001
Average Hourly Unique People Encountered	.41	.38	1,24	16.52	.001	Intercept	2.36	2.84	.099
						TrailMaster	0.06	0.03	.001

Table 79. Mono Pass Regression Models: Actual Encounters and TrailMaster 8:00 a.m. to 6:00 p.m. Corrected Total Count

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients	B	95% CI	*p*
Average Hourly Total Groups Encountered	.32	.29	1,24	11.30	.003	Intercept	1.82	1.17	.004
						TrailMaster	0.02	0.04	.003
Average Unique Groups < 25' Encountered per Hour	.30	.27	1,24	10.22	.004	Intercept	1.09	1.27	.088
						TrailMaster	0.02	0.01	.004
Average Hourly Unique Groups Encountered	.27	.24	1,24	9.06	.006	Intercept	1.84	1.11	.729
						TrailMaster	0.02	0.01	.006
Average Hourly Total People Encountered	.53	.50	1,24	26.76	.001	Intercept	1.66	2.80	.233
						TrailMaster	0.08	0.03	.001
Average Hourly Unique People Encountered	.43	.40	1,24	17.87	.001	Intercept	2.39	2.72	.082
						TrailMaster	0.06	0.03	.001

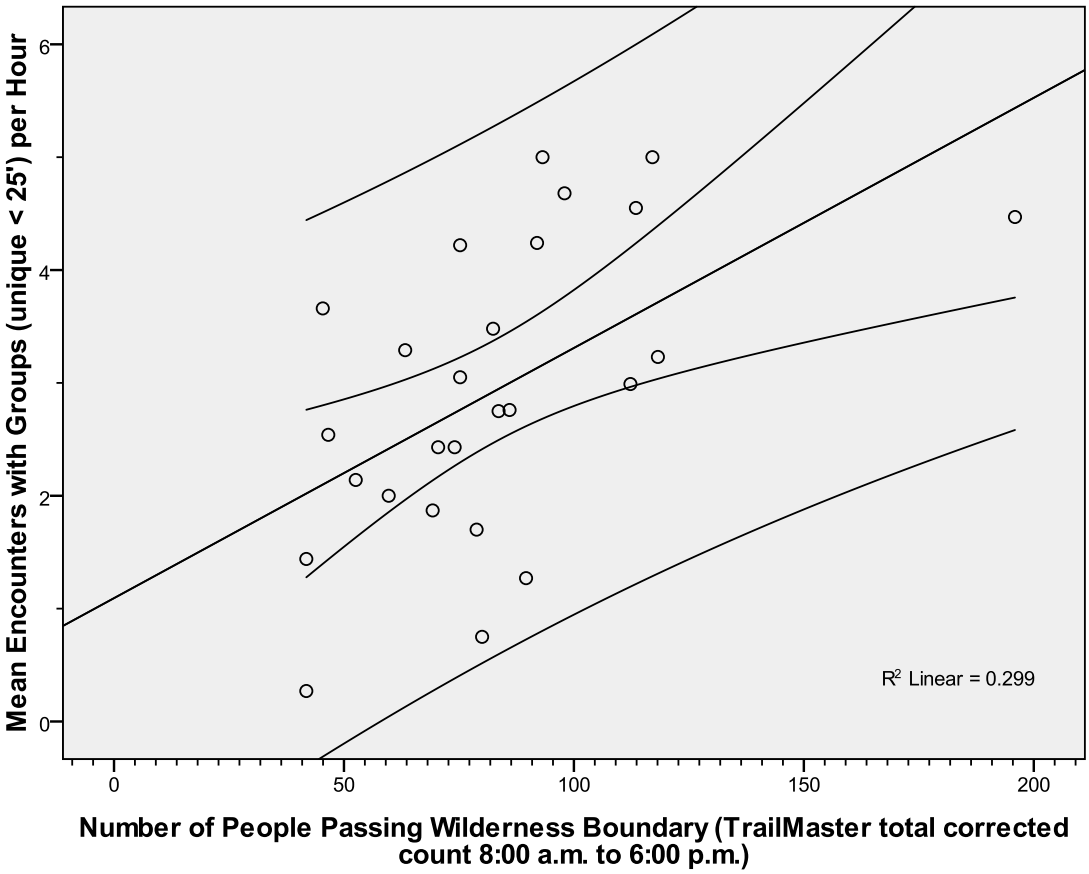

Figure 19. Mono Pass - regression of corrected TrailMaster counts (8:00 a.m. to 6:00 p.m.) on unique group encounters per hour. Fit line is shown with mean and individual 95% confidence intervals.

Table 80. Mono Pass Regression Models: Actual Encounters and TrailMaster 8:00 a.m. to 6:00 p.m. Corrected Inbound Count

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients	B	95% CI	*p*
Average Hourly Total Groups Encountered	.35	.33	1,24	13.09	.001	Intercept	1.58	1.22	.013
						TrailMaster	0.05	0.03	.001
Average Unique Groups < 25' Encountered per Hour	.35	.33	1,24	13.16	.001	Intercept	0.76	1.31	.241
						TrailMaster	0.05	0.03	.001
Average Hourly Unique Groups Encountered	.31	.28	1,24	10.74	.003	Intercept	1.61	1.16	.009
						TrailMaster	0.04	0.02	.003
Average Hourly Total People Encountered	.54	.52	1,24	28.54	.001	Intercept	1.01	2.95	.488
						TrailMaster	0.16	0.06	.001
Average Hourly Unique People Encountered	.45	.43	1,24	19.65	.001	Intercept	1.81	2.86	.205
						TrailMaster	0.13	0.06	.001

Table 81. . Mono Pass Regression Models: Actual Encounters and TrailMaster 8:00 a.m. to 6: p.m. Corrected Outbound Count

Dependent Variables	R^2	Adj. R^2	*df*	*F*	*p*	Coefficients	Beta	95% CI	*p*
Average Hourly Total Groups Encountered	.26	.23	1,24	8.39	.008	Intercept	2.21	1.08	.001
						TrailMaster	0.04	0.03	.008
Average Unique Groups < 25' Encountered per Hour	.22	.19	1,24	6.88	.015	Intercept	1.55	1.19	.013
						TrailMaster	0.04	0.06	.015
Average Hourly Unique Groups Encountered	.22	.18	1,24	6.82	.017	Intercept	2.18	1.02	.001
						TrailMaster	0.03	0.02	.017
Average Hourly Total People Encountered	.46	.43	1,24	20.80	.001	Intercept	2.90	2.66	.033
						TrailMaster	0.14	0.06	.001
Average Hourly Unique People Encountered	.36	.34	1,24	13.57	.001	Intercept	3.43	2.55	.010
						TrailMaster	0.11	0.06	.001

Mono Pass - Tioga Road Traffic Counters and Actual Encounter Relationships

There were no significant relationships between encounter variables and Tioga Road traffic count variables at the 95 % confidence level.

Discussion

The purpose of this study was to describe the relationship between visitor use measured by mechanical counters and encounter rates on trails to assess the feasibility of using these devices to indirectly measure encounter rates and determine whether management standards are being met. The hypotheses were that encounters on trails would be positively related to TrailMaster counts at wilderness portals; that encounters would have a positive relationship to traffic counts on Tioga road, but that this would be weaker than the relationship with TrailMaster counts; and that perceived and actual encounters would be positively related. This discussion section starts by describing the variation across study locations in encounter rates and attributes; it then discusses the relationship between perceived and actual encounters. Next TrailMaster relationships with actual and perceived encounters are examined. Finally, the relationship between actual encounters and traffic counts are examined. Management implications are presented within each section.

Variation in Encounters across Study Locations

In general, use levels and actual encounter rates differed among the study areas, as was expected from previous research and information received from park managers. This is consistent with previous findings that recreational use is not distributed evenly across the landscape (Manning, 1999; Watson et al., 1998) For example, mean encounter rates with unique groups within speaking distance differed significantly, with Dog Lake and Cathedral Lakes being different than all locations; Lyell and Rafferty similar to each other, but different than all other locations; and Mono Pass, Young Lakes East, and Young Lakes West similar to each other, but different than all other locations (Figure 20). The magnitude of difference is quite substantial, from a low of approximately 2 to a high of approximately 11 groups encountered per hour. For a person on a 5-hour hike, this would translate to only 10 total groups encountered on the lowest use trails to a

high of approximately 55 at Dog Lake. Further, across locations the proportion encounters with day users versus overnight users varied greatly, from a low of 15% day use on the on the Rafferty trail segment to a high of 94% on the Dog Lake trail segment.

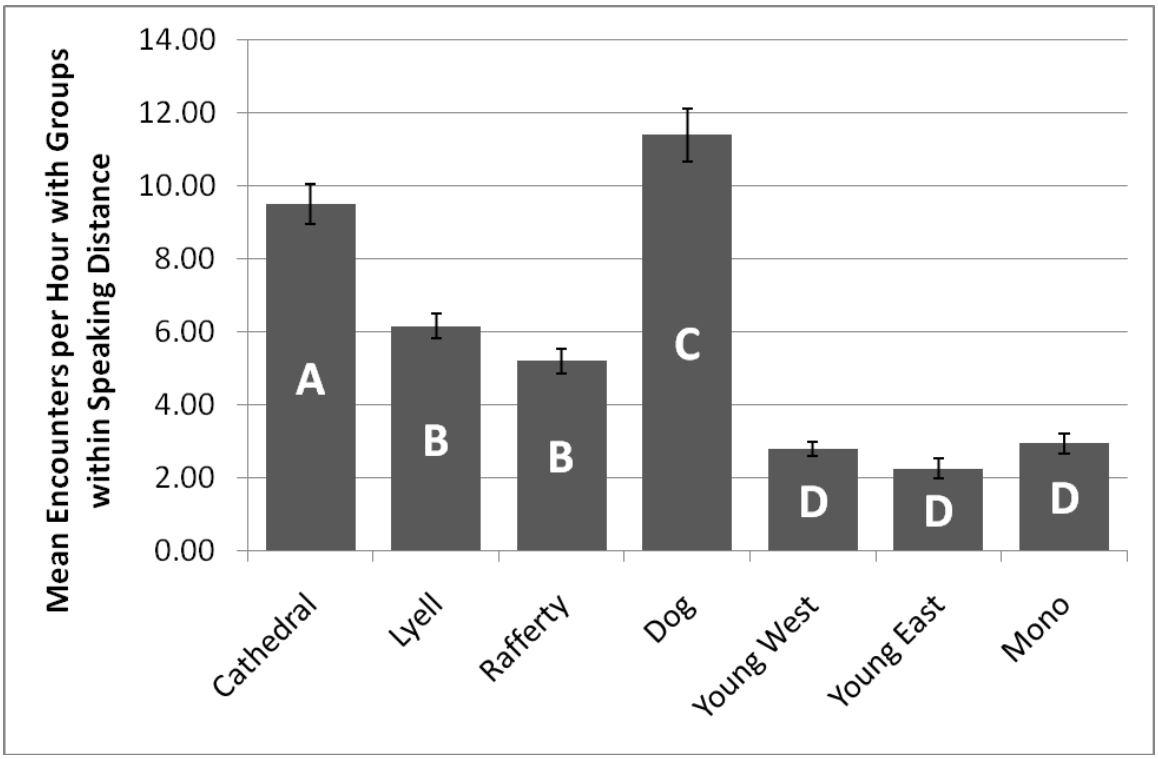

Figure 20. Comparison of Mean Encounter Rates with Groups within Speaking Distance per Hour (± SE) across Study Locations. One-Way ANOVA with Turkey post-hoc test at α = .05 (A, B, C, and D denote significant difference).

The confirmation that encounter rates and attributes are dissimilar across study areas points to the need to develop monitoring and analysis that can account for these differences. For example, concentrating monitoring efforts in either low or high use areas could lead to biased conclusions about the opportunities for solitude available throughout the wilderness area. Similarly, averaging encounter rates across high and low use areas would produce means that are likely to not reflect the actual experience available to visitors on any trail. Also, these trails were mostly day use zones, and encounter patterns might be different in areas with overnight camping.

The data show that – even on a single trail – encounters can be quite different (e.g., between the Young Lakes West trailhead and the Glen Aulin junction versus past the junction). This reaffirms the need to understand use patterns and conduct encounter monitoring within specific use zones independently.

Despite the large differences in encounter rates and types of visitors encountered, there were similarities across study locations in some elements of encounter. For all study locations, the difference between mean encounter rates using only unique groups and using total groups (where each time a group was seen was considered another encounter) was small, indicating that repeatedly encountering the same groups more than once does not occur often on the trails we studied. This finding could support such actions as not requiring observers to track multiple sightings of groups, thereby reducing the time required of employees to monitor encounters while performing other job duties. Also similar across study sites was the low percentage of encounters that occurred with groups outside of speaking distance of the observer; Lyell Canyon was the highest at 16%. Lyell Canyon differed from the other trails in that there are large meadows and streamside resting spots that are used by hikers and anglers. Most of these are more than 25 feet from the trail, and they appear to receive a generous amount of use. Nevertheless, sightings of people at these off-trail locations was only a small percentage of overall encounters. This finding could also be useful in supporting the encounter monitoring protocol of only requiring observers to monitor encounters within speaking distance, further reducing the burden of performing this task. However, before making such a determination, it is worth considering whether there are unique wilderness locations where there might be larger numbers of off-trail encounters. For instance, in Tuolumne Meadows itself, dozens of people can typically be seen from close proximity to hundreds of yards away.

Perceived and Actual Encounters

At both locations where perceived encounters were measured -- Cathedral Lakes and Lyell Canyon -- the mean perceived encounter rate was lower than the actual mean encounter rate with unique groups within speaking distance recorded by observers. It should be remembered that this is the variant of the actual encounter measure that records the fewest encounters, in that it does not include groups outside of speaking distance or groups seen more than once. These finding further reinforce the point that perceived encounters and actual encounters are not the same and is consistent with previous research showing that visitors report fewer encounters than trained observers. This should be considered when developing standards that are based in part of visitor reports of acceptable encounter rates.

Due to staffing constraints, perceived encounters were only measured at two locations. The relationship between perceived and actual encounters was significant and positive for both the Cathedral Lakes and Dog Lake locations; however, only 18% and 12% of the variance in perceived encounters was explained by actual encounters. With precision set at the 95% confidence limit and using a day with a mean visitor reported perceived encounter rate of 4 groups per hour, the mean actual encounter rate recorded by observers of unique groups within speaking distance could range from 3 to 10 groups per hour at the Lyell location and 3 to 14 at the Cathedral location. These findings would suggest that about 85% of the variance in perceived encounters cannot be explained by the mean actual encounter rate for that day, but instead is influenced by other factors such as memory of encounters, estimation of visit duration, not noticing other groups, or the true variability of the visitor encounters in comparison to the actual encounter measure (Shelby & Heberlein, 1986). For example, at Cathedral Lakes, there were 10 days when at least 10 surveys were collected. The coefficient of variation (SD/M) ranged from 0.34 to 0.79, indicating a relatively high degree of variation within a single day. We do not know how actual encounters would vary within a day because, actual encounters were measured with a single observation for each day. Although perceived encounters

are not the same as actual encounters, it should be assumed that the variability in perceived encounters would also be found for actual encounters.

The under-reporting of encounter rates by visitors in comparison to those recorded by observers is consistent with prior research. For example, Shelby and Heberlein (1986) found that visitors under-reported encounters when actual encounters exceeded 4 to 6 encounters during the day. Watson et al. (1998) found that visitors under-reported encounter rates for groups when their encounters for the day were recorded by observers watching these visitors.

Caution should be applied in extrapolating the findings from this study's perceived encounters too broadly. Although our sample size was robust (Cathedral n = 225; Lyell n = 148), only two locations were surveyed, with 26 days for the Cathedral location and 27 days for the Lyell location. Additionally, we generally had fewer than 10 surveys per day. However, adding to the strength of our findings for the study locations, our survey was administered immediately post-experience and simply asked how many groups visitors had encountered; it should not have be subject to the more common confounding variables such as testing, sequence, or experimenter effects. Although the question did not specify whether people should include encounters in/outside speaking distance, or how to treat multiple encounters with the same groups, the fact that there was little variation in the actual encounter variants suggests that this might not be a problem.

Relationships between Actual Encounters and TrailMaster Counts of People

Relationships between actual encounter rates and TrailMaster counts of people entering and exiting wilderness portals ranged across study locations from no significance (Lyell and Rafferty) to r^2 = .62 when using mean total people encountered per hour as the measure of actual encounters. In general, trail study segments whose start point was geographically removed from the TrailMaster location at the wilderness boundary, and where the intervening space was characterized by a high encounter rate,

exhibited no to poor relationships with TrailMaster counts. For example, the Lyell and Rafferty trail segments began one mile from the wilderness boundary. The trail between the TrailMaster location, at the wilderness boundary, and the start of the study segment had very high use and complex trail configurations, attraction sites, and visitor use patterns. These two study segments exhibited no relationship between TrailMaster counts of people at the wilderness boundary and encounter rates on study trail segments.

The start of the Young Lakes East trail segment was also more than one mile from the wilderness boundary and the TrailMaster, with the trail segment between the two receiving very high use with hikers headed to Dog Lake. Thus, relationships were similarly poor for this study location between encounter rates and counts of people at the wilderness boundary. Only the encounter variant of mean total people per hour was significantly related to TrailMaster corrected counts, with 13% of the variance explained. However, this model contained an outlier and cases of leverage and influence that, when removed, caused there to be no significant relationships between encounter rate variables and TrailMaster counts. Further, a Kolmogrov-Smirnov test of the standardized residuals of the model was significant, indicating that they are not normally distributed and the model should not be generalized to the population.

The findings for the Lyell, Rafferty, and Young Lakes East locations suggest that actual encounter rates cannot be modeled by TrailMaster counts of people when there is an intervening zone with use higher than that of the area desired to be described. Instead, individual areas of similar use levels will need to be measured and modeled individually. This will require placing TrailMaster units in the wilderness at location where use levels or behavior change significantly.

Study locations with significant relationships between encounter rates and TrailMaster counts of people were the Cathedral Lakes, Dog Lake, Young Lakes West, and Mono Pass trail segments. We used the TrailMaster counts from 8:00 a.m. to 6:00 p.m., rather than 24-hour counts, because the models had slightly better fit. When examining the

performance of linear regression models for these locations in regard to the ability of the TrailMaster counts to predict the encounter rate variant most similar to the Yosemite draft standard (mean unique encounters with groups within speaking distance), the Dog Lake location exhibited the strongest relationship (43% of the variance explained), while Young Lakes West showed the weakest (23% of the variance explained). It should noted that the Young Lakes West location had high use level on the first mile of trail with visitors headed towards Glen Aulin, who did not go to Young Lakes, which may explain the weaker relationship. Further, the relatively strong relationship for the Dog Lake location is encouraging, considering the complexity of its trail layout, with at least three starting locations for the hike and three other trails intersecting the study segment.

In general, encounters with people were more strongly related to TrailMaster counts (Cathedral r^2= .61, Dog Lake r^2 = .50, and Mono Pass r^2 = .50) than encounters with groups. This makes sense, as the TrailMaster units record individuals, not groups. The exception to this was the Young Lakes West location, where essentially the same variance was explained for people as for groups. The stronger relationship between TrailMaster counts and encounter rates with people would indicate that if there is a desire to monitor encounters using automated counters, a standard using people as the unit of measure would add precision to the method.

The correlation coefficients for the trail segments with significant relationships fall within the range of those from the Oregon State study (r = .50 to .79) on which we based our sample size (Dog Lake r = .67, Cathedral Lakes r = .63, Mono Pass r = .54, and Young Lakes West r = .51), though they are on the lower end of the spectrum. The relationships of our study are also slightly weaker than those reported by Shelby and Heberlein (1986) for the Grand Canyon (r = .68) and Rogue River (r = .71) for the relationship between visitor use and encounter rates. However, we saw much stronger relationships than those reported by the same authors between visitor use levels and encounter rates for deer hunting (r = -.07) and goose hunting (r = .03). When comparing

the strength of the relationship between TrailMasters and actual encounter rates of our study with those found in the study by Watson et al. (1998) between encounter rates and mechanical counters, ours are within a similar range, though they are consistently on the lower end of the spectrum. Watson et al. assessed four trail segments and found coefficients of determination ranging from .17 to .92 for the relationship between group encounter rates and mechanical counts; however, three of the four trail segments were stronger (r^2 = .69, r^2 = .92 and r^2 = .85) than the relationships found in our study (r^2 = .26, r^2 = .30, r^2 = .40, and r^2 = .45). From these comparisons with prior research it is clear that, among those areas found to have significant relationships between the TrailMaster counts of people and encounter rates on trails the strength of these relationships are in the range that is to be expected. However, the range of the strength of relationships between indirect measures and encounter rates is extremely broad.

All encounter models examined whether the time of week (weekday vs. weekend/holiday), occurrence of precipitation during the day, or maximum daily temperature contributed significantly to explaining the variance in encounter rates predicted by TrailMaster counts. We did not have specific hypotheses about how such factors might impact relationships, so this analysis was largely exploratory. However, in all cases these variables did not add significantly to the model. Conceptually this is logical, for though time of week, rain, or high temperatures likely affect overall use levels, in order for these variables to influence the relationship between use and encounter rates, they would also have to affect use patterns and behaviors once visitors were on the trail. The evidence suggest that they do not, at least for the trail segments measured in this study. The significance to managers is that when developing relationships between TrailMaster counts of people and encounter rates it may not be necessary to stratify for day of week or weather. However, this study took place during the months of July and August when little precipitation occurred, and use may be more consistent during this season when it is dominated by visitors on vacation. Also, more extreme weather and environmental factors present during early and late season, such

as spring snowpack and fall snow storms, likely would alter visitor use patterns on trails and thus may affect encounter rates.

Assessing the precision of the models for predicting encounters based on TrailMaster counts is an important consideration for the utility for encounter monitoring application. For example, the Dog Lake model predicts a 0.04 increase in daily mean unique groups encountered per hour for every one person counted passing the TrailMaster unit at the wilderness boundary (this is the total count of people passing the unit and not the number of people using the area). The error associated with this prediction can be expressed by the upper and lower bound of the prediction interval (Figure 21). For a day on which, between 8:00 a.m. and 6:00 p.m., 200 people pass the TrailMaster unit (TM corrected count), the regression model predicts a mean encounter rate of 7 unique groups within speaking distance per hour; if the roundtrip took 2 hours this would equate to 14 encounters. However, for any particular day, 95% of the time this encounter rate could range from 2 to 12 groups per hour, or 4 to 24 encounters with other groups during a 2-hour trip. If the confidence limit is lowered, the range becomes smaller. For example at the 60% CL, the range of encounters is 5 to 9 groups per hour; however 30% of the time the actual rate may be over or under this range. Graphs with 60%, 80%, and 95% confidence limits for the prediction interval of unique group encounter rates within speaking distance for the Cathedral Lakes, Mono Pass, and Young Lakes West can be found in Appendix F

Determining which confidence level to use and whether the precision of the model is sufficient need to be determined by management judgment and the unique needs and purpose of the monitoring program, as well as the severity of impacts to the resource and visitor experience and the political climate under which decisions to take action will be made.

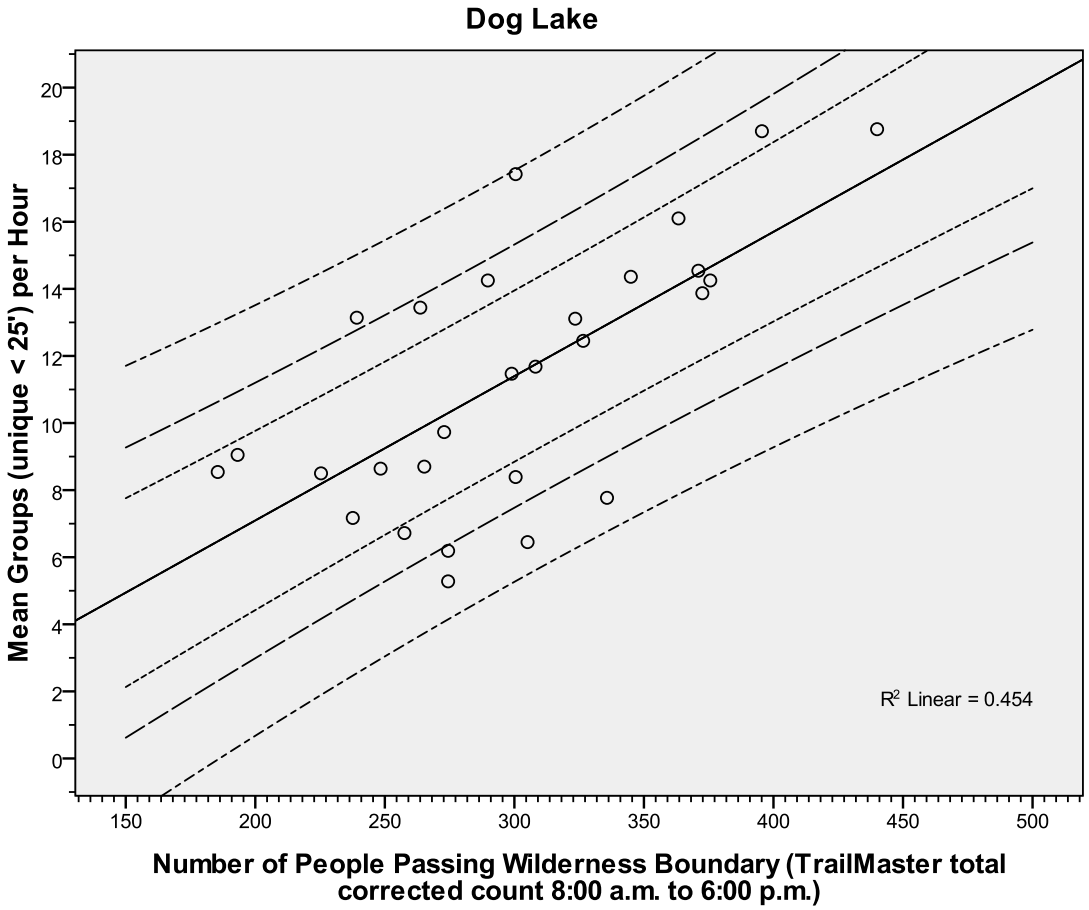

Figure 21. Dog Lake – regression of corrected TrailMaster counts (8:00 a.m. to 6:00 p.m.) on mean unique groups encountered within speaking distance per hour. Prediction line is shown with prediction intervals at the 60%, 80%, and 95% confidence limits.

Relationships between Perceived Encounters and TrailMaster Counts of People

The relationships between perceived encounters and TrailMaster counts of people at the wilderness boundary were similar in nature to their actual encounter counterparts. At the Cathedral location, perceived encounters with groups and people were significantly related to TrailMaster counts of people, with 20% and 42% of the variance explained, respectively. This was a slightly weaker relationship than for actual encounters for both groups; however, it was a stronger relationship than actual and

perceived encounters had to one another. The strengthen of these relationships are within the range reported by Watson et al. (1998) (groups: r^2 = .07 to r^2 = .90, and people: r^2 = .31 to r^2 = .94). Similar to actual encounters, the Lyell location had no significant relationship between perceived encounters and TrailMaster counts; the relationship was likely confounded by the distance and use between the TrailMaster location and the start of the study trail segment. These findings further confirm actual encounters as a stronger measure of the encounter rates being experienced on trails. However, it also supports the conclusion that visitor use levels have an effect on perceived encounters and that perceived and actual encounters are related.

Encounters and Traffic

Sample sizes for relating Tioga Road traffic counts to actual encounter rates were small, due to the theft of the counters the beginning of August, just over half way through the sampling period. Further, for the month of August, the Tioga Pass entry station's traffic counter was off line, and therefore there are no entry gate data to supplement the sample days for comparison. The number of sample days ranges from 18 for Lyell Canyon to 13 for Cathedral Lakes. Three locations exhibited significant relationships between actual encounter rates and traffic on Tioga Road: Cathedral Lakes, Young Lakes East, and Young Lakes West. The remaining locations (Lyell Canyon, Rafferty Creek, Dog Lake, and Mono Pass) had no significant relationship with traffic counts on Tioga Road from 7:00 a.m. to 6:00 p.m. at the 95% confidence level and any of the actual encounter rates variants.

For the locations that exhibited significant relationships between traffic and actual encounters, the relationship is surprisingly strong in comparison to the strength of relationships between TrailMaster counts and actual encounter rates for the same locations. For example, for the Cathedral Lakes location, inbound traffic counts from 7:00 a.m. to 6:00 p.m. explain 32% of the variance in daily mean total groups encountered per hour; this is compared to 44% of the variance explained by total

(inbound and outbound) TrailMaster counts. Similarly at the Young lakes East location, traffic explained 26% of the variance in daily mean encounters per hour with total people, while TrailMaster counts only explained 13% of the variance. At the Young Lakes West location traffic counts explained more of the variance in group encounter rates than did TrailMaster counts: for unique groups within speaking distance 28% for traffic counts, compared to 23% for TrailMaster counts. From the data for these locations it can be seen that encounter rates and traffic are positively related; however, due to the small sample size the variability in encounter rates in relation to traffic levels for the population may not have been captured.

Conclusions

This research has demonstrated that measuring encounter rates on wilderness trail systems utilizing mechanical counters, such as the TrailMaster infrared beam counter, has potential utility in an encounter monitoring program. Yosemite has had difficulty in the past generating adequate sample days of observation during a season to have confidence in conclusions about encounter rates. Whether the models offer the precision needed at the desired confidence to be incorporated into the monitoring program will need to be determined by park administrators. Further, in order to utilize this method more widely, additional trail segments will need to be added over time and a protocol developed for the utilization of the TrailMaster units as part of the encounter monitoring plan. Given the variability in use-encounter relationships among the study trails, it is evident that observational data will need to be collected for each individual trail segment to be monitored, so that the relationships can be empirically established.

It is also apparent from this research that TrailMaster units deployed at wilderness boundaries will not be able to accurately track encounters in more remote areas that have use levels different than those that occur in the area between the TrailMaster unit and the beginning of the trail segment. Instead, trails will need to be segmented according to homogeneous use zones and TrailMasters placed at the beginning of these segments. Then encounter observations, following this study's protocols, will need to be made to populate models. It may be possible to reduce the sample days needed for each location. Sample size for this study was established using a power curve and the weakest relationship between visitor use levels and encounter rates from a previous study in Oregon, using a Pearson's correlation of .50. In the Tuolumne Meadows study area, the two highest use study segments (Dog Lake and Cathedral Lakes) had Pearson's correlations of .66 and .61 respectively. Referring to our power curve table, this would require approximately 15 days of sampling for an area with a relationship as strong as Dog Lake and 19 days for an area similar to Cathedral Lakes. Mono Pass, the lowest use

area in the study with uniform use for the length of the segment had a Pearson's correlation of .51, indicating that an area similar to Mono would require 28 days of sampling.

In future monitoring of encounters, it is recommended that the protocols of this study be reviewed for congruence with the purpose for which they are to be used. These protocols measured the complete set of attributes presented in the past literature and thus are able to describe many elements of the encounter environment. However, if encounter monitoring is to be integrated into daily work activities of staff it may be desirable to streamline data collection to those elements that are most important to management decision making. For example, it may be deemed sufficient to only record unique groups within speaking distance reducing the time necessary to make notations in field notebooks. When developing protocols it is important to be specific about how groups are to be measured, that is, what counts as an encounter and is recorded by the observer. It is also important to record encounters in a manner that they can be compared from one observation to another, a comparable unit of measure that accounts for both space and time. This study accomplished this by requiring observers to record the duration of time they spent on the trail segment (start and end times), specifying the start and end locations of the trail segment, and requiring that they travel at the rate of 2 mph. Further, observers spent approximately four hours recording encounters in a study area in order to determine the daily mean encounter rate; it is clear that spending short amounts of time in an area does not provide an accurate mean encounter rate. Establishing a consistent unit of measure has been accomplished in other ways in other agency monitoring programs, though, surprisingly, it is an often overlooked element. Developing a protocol that best captures encounter rates and their attributes, while utilizing agency resources efficiently, takes careful consideration.

The data from this study can be used to more fully understand the similarities and differences in both encounter rates and the factors that affect encounters. For example, Lyell Canyon and Rafferty Creek have encounter rates that do not differ significantly

from one another and a similar percentage of overnight versus day use; while Dog Lake and Cathedral Lakes, the two locations in this study with the most use, do differ significantly in regards to encounter rates and have a much different proportion of overnight and day use from one another. Rather than attempting to monitor all trails equally, the data provided in this study could be used to assist managers in choosing indicator trails or trail segments for the monitoring of encounter rates. Whether monitoring of encounters is accomplished with models based on TrailMaster counts or through the more traditional means of observation by staff, this would enable a more focused utilization of resources in data collection while monitoring encounter rates and thus provide more confidence in analysis.

Future research assessing indirect measures of encounters could explore other potential independent variables. For example, on trails with a high proportion of overnight visitor use, assessing the strength of the relationship between overnight permits and encounter rates may prove productive. For the Rafferty Creek location, occupancy at the Vogelsang High Sierra Camp could be examined as an indirect measure for encounter rates. Examining the natural variability within daily encounter rates would be resource intensive, but could assist in determining whether stronger relationships between indirect measures and encounter rates can be established.

Monitoring encounters presents managers with the challenge of measuring an attribute that has the complexities of space, time, and multiple perspectives; limiting observations to those that can be performed by a human observer. The ability to estimating encounter rates on trails with models based on mechanical counters at fixed locations can assist management with the monitoring of opportunities for solitude with the indicator of encounters. The benefit of these models is the empirical encounter rate data on which they are based; however, whether the precision of these models at the desired confidence meets management needs will need to be determined.

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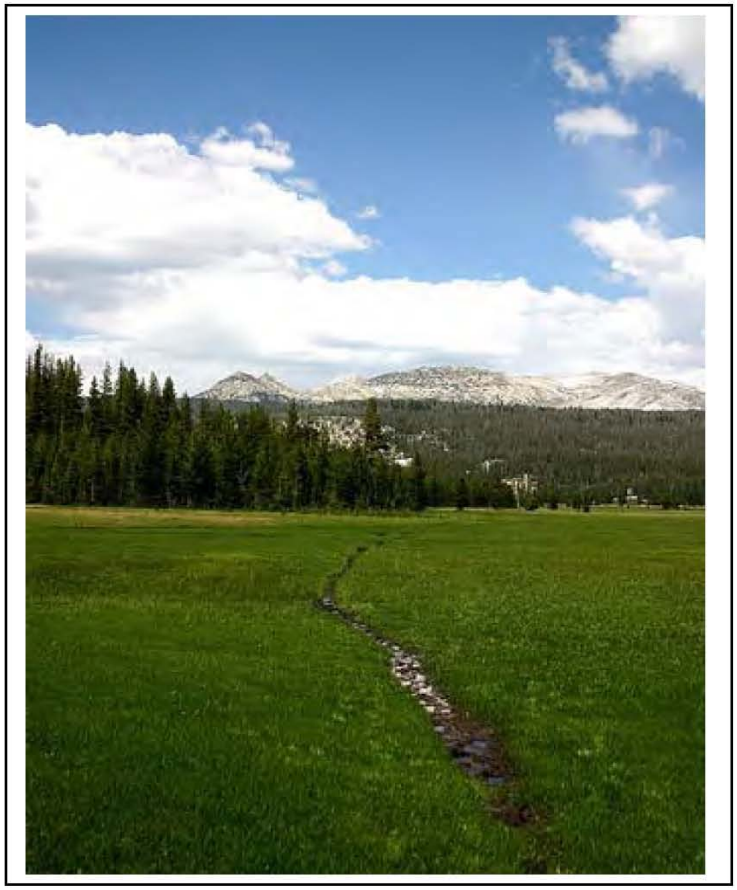
Appendix A: Protocols for Actual Encounter Data Collection

Encounter Monitoring Protocols



Summer 2009
Version 2.0 - 7/10/09

University of Idaho

Notes:

Cover Photo by: http://www.flickr.com/photos/42dreams/1856166847

Contents

Introduction

During July and August of 2009, the University of Idaho will be coordinating a research project to measure encounters rates on wilderness trails in the Tuolumne Meadows area. These measures will help the park assess the opportunities for solitude within designated wilderness areas, as directed by the Wilderness Act of 1964. Collecting encounter data can be staff intensive, because it is usually done by staff who hike through the wilderness, recording their encounters with other groups. For proper analysis, many days of observation are required.

This research project will assess the relationship between encounter rates in the wilderness, visitor counts at the trailhead and traffic flow on Tioga Road in order to determine if visitor trailhead counts and traffic rates can be used as an indirect measure of encounter rates. This would enable park managers to count visitors at trailheads or cars on Tioga Road, a relatively simple task using mechanical counters, and determine what opportunities for solitude are being provided in the wilderness. The potential benefits are cost savings, reduction in employee time devoted to monitoring, and valuable and timely information for wilderness stewardship. In order to understand the relationship between encounters visitor counts at trailheads and traffic, a robust sample of encounter data will be needed.

Instructions for Recording Actual Encounters

"Actual encounters" are encounters witnessed by trained observers, who may be park employees, researchers, or volunteers. These trained observers act as a surrogate for a visitor; observers record their own encounters as they travel in a manner similar to how a visitor would travel. These are actual encounters because they are witnessed by the recorder.

From examination of previous encounter data it has been determined that 4 hours provides a reasonably accurate picture of the data that would be collected during a day (8 hours) of observation were made. **Trail segments must therefore be observed for four hours** while traveling in a manor approximating the "typical visitor". Observers should hike at approximately a 2 mile and hour hiking pace to the end of the trail segment. They should then simulate the visitor behavior, say taking a break enjoying the view while recording their encounters. The observer should then return at a two mile and hour pace while continuing to record their encounters. A trail segment short in length may be hiked several times during the four hour observation period, for example the Dog Lake trail.

Cover "Encounters Monitoring" Notebook:

Fill out the cover with your name, the date you began the book, and the date you completed the book (or turned it in).

Page Header:

Each time you begin an observation period on a trail segment, fill out the page header section with the date, the time you began your observation (hike), the trail segment you are traveling on, and the direction you are headed. When you complete your observation on the trail segment, record the end time in the page header on.

"Date" Enter the month, day, and year

"Time begin" Enter the time you began your observations and hike at the trail segment beginning, don't forget to indicate "am" or "pm."

"Trail Seg" Enter the description of the trail segment on which you are making your observations (Cathedral Lk, Dog Lk, Lyell Frk, Mono Pass, Rafferty Crk, Young Lks W, or Young Lks E). Indicate the direction you are headed with "in" or "out" meaning that you are headed into the wilderness or out of the wilderness.

"Time end" Enter the time that you completed your observation of the trail segment. Enter this on the first page for that segment, not the last.

Encounters table:

Any time you see another group of one or more people make an entry. This includes people seen in the distance, as well as those you meet on the trial.

"En. #" Number each encounter consecutively, starting with 1. Each time you begin a new trail segment or observation period, you should begin again with a new header and start with 1.

"Time" Record the time you encounter the group or person.

"# People" Record the number of people in the group. The intent of the measurement of the trail encounters is to provide a picture of the "sense of solitude" that visitors traveling on a trail are experiencing. Thus, a party is a group of people of one or more readily recognized as traveling together. If in doubt as to whether parties are associated and traveling together, tally as separate encounters. If you are at a destination or attraction site and you are unable to distinguish groups from one another due to the density of people, use the protocol for "crowds at destinations or attraction sites" found bellow.

"# Stock" Enter the number of stock, this includes riding and pack animals.

"Seen Before" Have you seen this group at another time today? Answer "Y" "N" or "UK" (if you cannot determine whether you have seen them before). It is important to record each time you see the same group as a separate encounter if there is **more than 20 minutes** between sightings. This will allow analysis of both unique encounters and total encounters.

"Day or O/N" Enter "D" for day users and "O/N" for overnight users or "UK" if unable to determine.

"Direction of Travel" enter "I" for groups traveling into the wilderness, "O" for groups traveling out of the wilderness, and "UK" for groups whose direction of travel you are unable to determine.

"> 25 feet" Enter "Y" for groups seen outside of speaking distance, greater than approximately 25 feet. Enter "N" for groups within speaking distance (≤ 25 feet). You will mostly entering "N" for a vast majority of encounters are visitors passing by you on the trail. Also, if you see a group in the distance, but you will be passing them in the next 20 minutes record the encounter at the time you pass within 25 feet of them. If more than 20 minutes pass between the time you see them in the distance and when you pass them they should be recorded as two encounters on "Y" (greater than 25 feet) and on "N" (25 feet or less).

Other Notations:

Indicate arrival and departure times at the end of trail segments and departure times from the segment end with direction of travel. For example, when observing encounters on Cathedral Lakes trail fill out the header information and begin recording encounters. When you arrive at the lake take a line and write "11:25 arv @ cathedral lake." Continue recording your encounters while at the lake. When you depart the lake take a line and write "11:45 depart Lk headed out" and then record your encounters on the trip out. When you arrive at the wilderness boundary sign note "1:35 arv @ wilderness boundary." This would also be your end time for the page

header. Indicating your arrival and departure times, as well as your direction of travel will allow us to analyze your data correctly and in detail.

Taking breaks from monitoring encounters. If you need to stop recording encounters, say you leave the trail study segment to attend to personal or work needs, take a line and write "10:42 Break – stopped E monitoring". When you have finished with your business and resume encounter monitoring take the next line and note "11:15 resume encounter monitoring." This will allow us to remove this time from your total time in order to figure your average encounter rate correctly.

Crowds at destinations or attraction sites

If you are at a destination or attraction site and you are unable to distinguish groups from one another due to the density of people, use the protocol for "crowds at destinations or attraction sites" found bellow. Note that this protocol has not yet been necessary; observers thus far have been able to distinguish groups even at crowded lake shores.

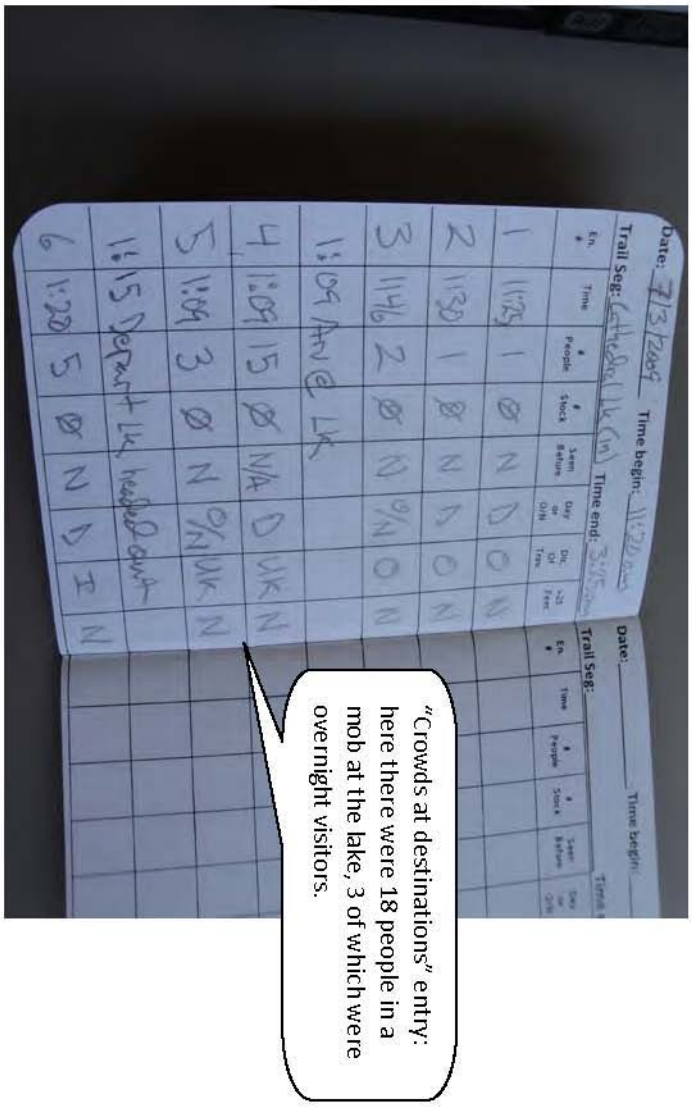
Use an entire entry row to note the common name of the destination or attraction site and write "total # people." There is then the potential to distinguish between day and overnight visitors and people greater than 25 feet or less than 25 feet, thus use four entry rows, one for each.

- **"En #"** number consecutively continuing from where you were before you reached the destination or attraction site.
- **"Time"** the time should be the same for all four entries
- **"# People"** record the total number of people you see.

- **"# Stock"** record the total number of stock you see.
- **"Seen before"** it is likely that you have seen some people and have not seen others before, denote as "N/A" if this is the case.
- **"Day or O/N"** if you can distinguish between the number of day and overnight visitors use a separate row entry for each and put the total number of each in the "# People" box. If you are unable to distinguish between day and overnight visitors enter "UK" and have one line for both.
- **"Dir. of trav."** this should be "UK" since people are grouped at a destination or attraction sight.
- **"> 25 feet"** Use a row for people within approximately 25 feet (noted as "N") and one for people outside of approximately 25 feet (noted as "Y")

Example of Data Entry for Encounter Pocket Notebook

Example of "Crowds at Destinations" Protocol Data Entry Format



Study Locations

There are seven study trail segments. Segment names used here are for the purpose of this study and may not reflect the official name for the trails.

Cathedral Lakes Trail - A section of the John Muir Trail, is a popular hike that leads into the Cathedral Range. The study section is from the wilderness boundary (Marked by the wilderness boundary signs) to Cathedral Lake, approximately 3.5 miles. Surveys will be conducted at the wilderness boundary for perceived encounters.

Elevation gain (in)	1,057’
Time up (in)	2 hrs 5 min
Time down (out)	1 hrs 36 min
Round trip time	3 hrs 41 min

Dog Lakes Trail – Located on the North side of Tioga Road, Dog Lake is a popular day hike location. The study section is the wilderness boundary near the Lembert Dome day parking area to Dog Lake. There are four trail junctions. On the way up follow signs to “Dog Lake.” On the way out follow signs to “Lembert Dome Parking Lot.”

Elevation gain (in)	570’
Time up (in)	52 min
Time down (out)	35 min
Round trip time	1 hr 28 min

Lyell Fork Trail - Part of the Pacific Crest Trail, it follows the Lyell Fork of the Tuolumne River. The Ireland Creek Trail junction is approximately 5.2 miles. The study segment is from the junction with the Rafferty Creek Trail to the junction with the Ireland Creek Trail, approximately 4.7 miles in length. Surveys will be conducted at the wilderness boundary (see map for location).

Elevation gain (in)	242’
Time up (in)	2 hrs 11 min
Time down (out)	2 hrs 3 min
Round trip time	4 hrs 14 min

Rafferty Creek Trail - follows Rafferty creek and climbs to Tuolumne Pass. Vogelsang High Sierra Camp is approximately 6.9 miles (11.1 Km) from the trailhead. The trail study segment is from the trail junction with the Lyell Fork section of the John Muir Trail to Tuolumne Pass at the first signed trail junction, approximately 4.9 miles.

Elevation gain (in)	1,301’
Time up (in)	3 hrs
Time down (out)	2 hrs 22 min
Round trip time	5 hrs 22 min

Mono Pass Trail - Climbs towards Mono and Parker passes and into the Ansel Adams Wilderness. This trail location has been reported by managers to be a lower use area than the other six locations identified for this study. Mono Pass is approximately 3.7 miles. The study segment is from the wilderness Boundary to Mono Pass and the boundary with Ansel Adams Wilderness, approximately 3.86 miles. There are three trail junctions, on the way up follow signs to "Mono Pass." On the way down follow signs to "Tioga Road."

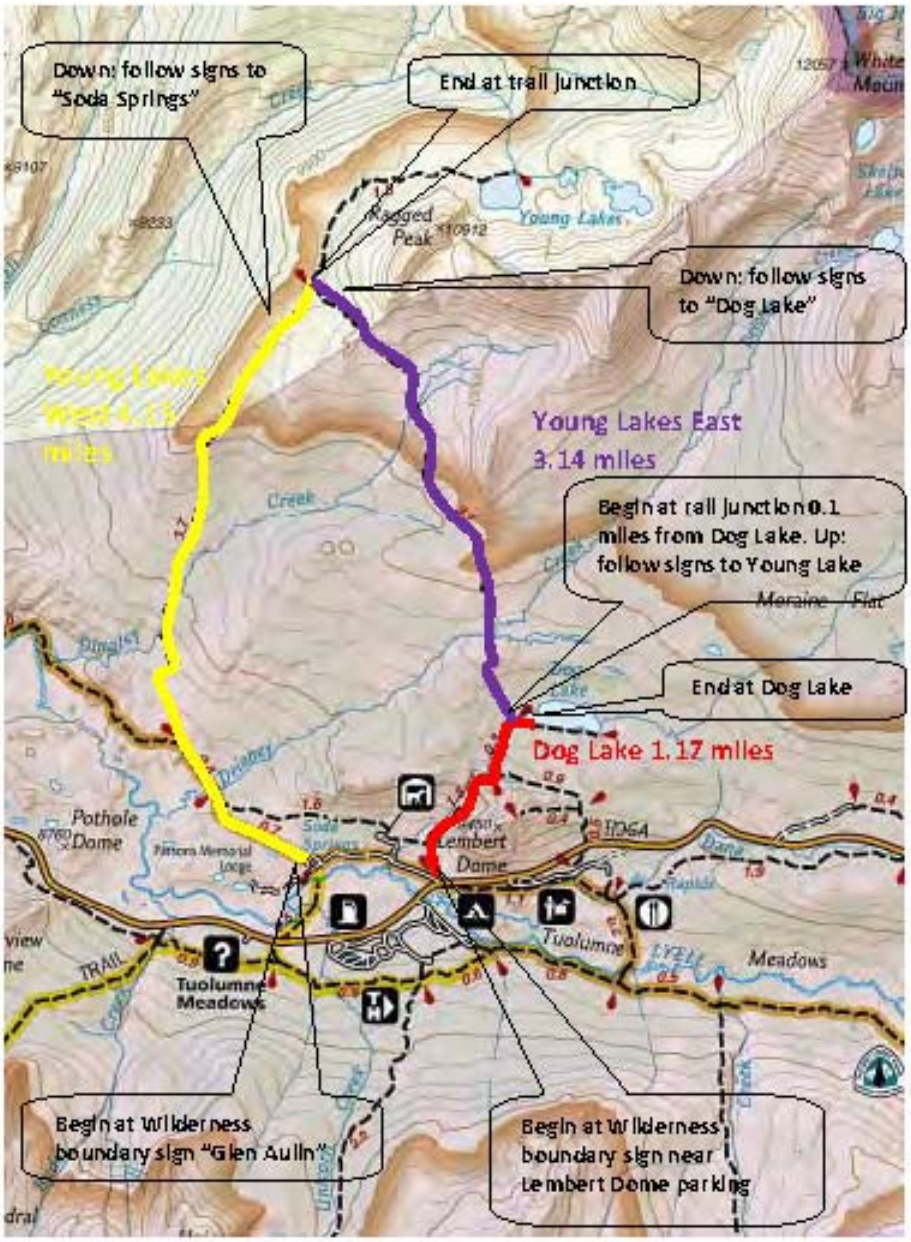
Elevation gain (in)	1,124'
Time up (in)	2 hrs 30 min
Time down (out)	1 hrs 56 min
Round trip time	4 hrs 26 min

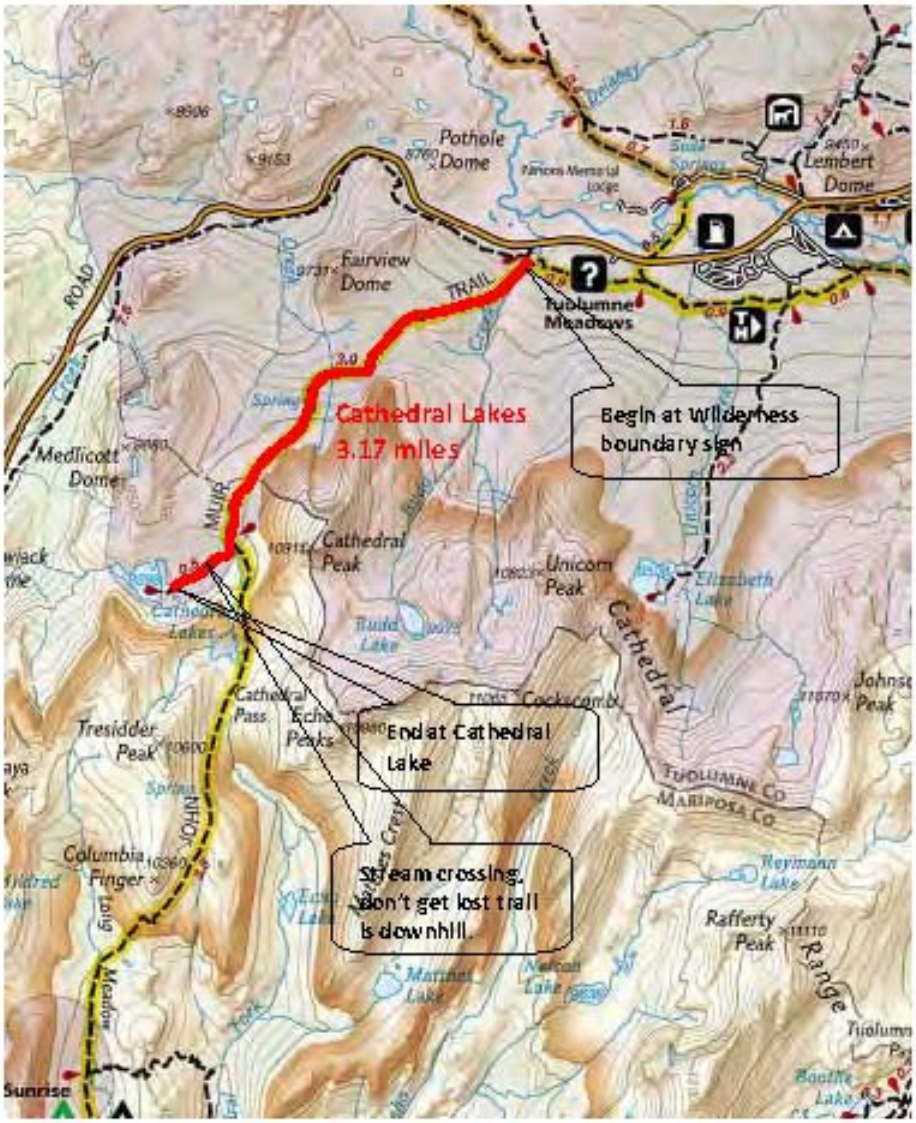
Young Lakes West – This trail study segment begins at the wilderness boundary sign near Parsons Memorial Lodge (the Glen Aulin Trail) and ends 4.15 miles later at the trail junction with the west half of the young Lakes loop. There are two trail junctions on this segment. On the way up follow signs to "Young Lake." On the way down follow signs to "Soda Springs." To Begin the Young Lakes East section from the end of this segment follow signs to "Dog Lake."

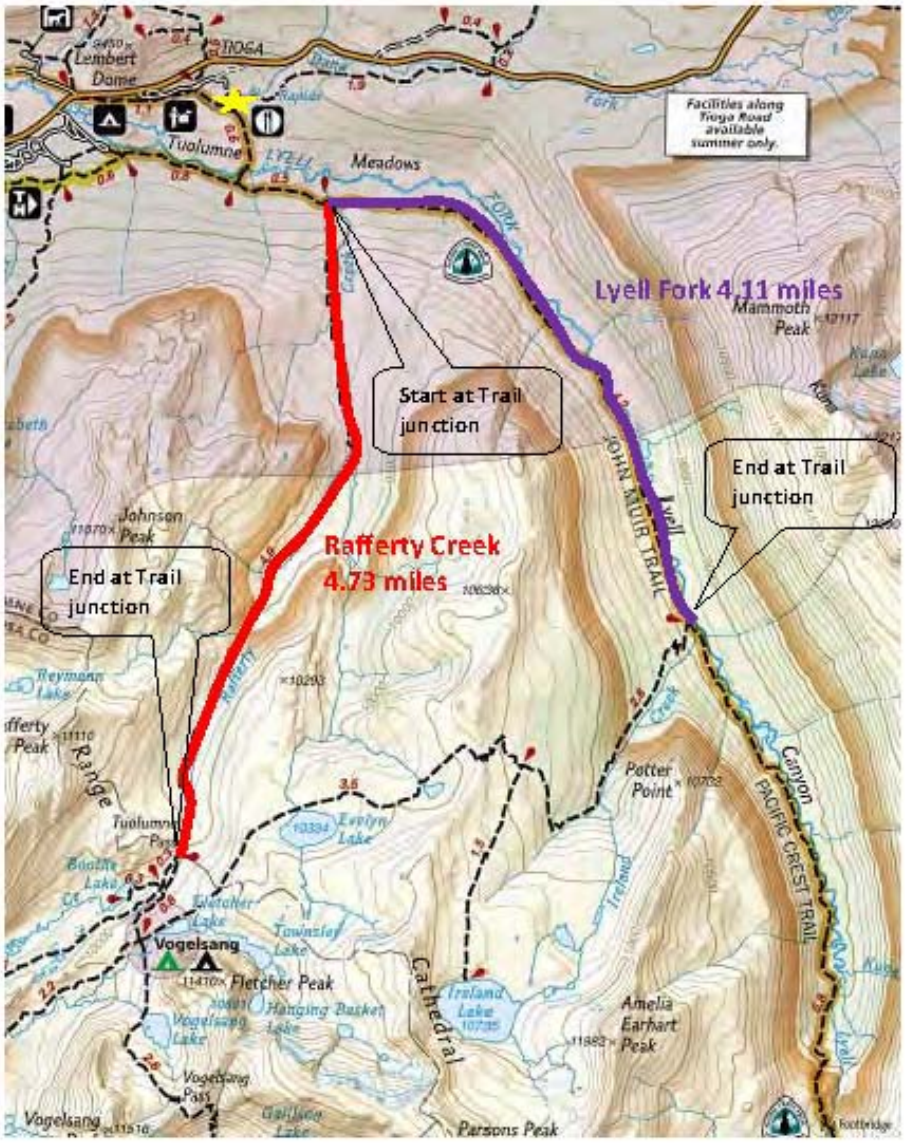
Elevation gain (in)	1,305'
Time up (in)	2 hrs 44 min
Time down (out)	2 hrs 5 min

Yong Lakes East – This trail study segment is from the trail junction of the Young Lakes East trail segment and the Dog Lake spur trail (0.1 miles from Dog Lake) to the trail junction with the west half of the Young Lakes loop, approximately 3.14 miles. Begin encounter observations at the trail junction 0.1 miles from Dog Lake and follow signs to "Young Lake." On the way up follow signs to Young Lake. On the way down follow signs to "Dog Lake." To begin the Young Lakes West section from the end of this tail segment follow signs to "Soda Springs."

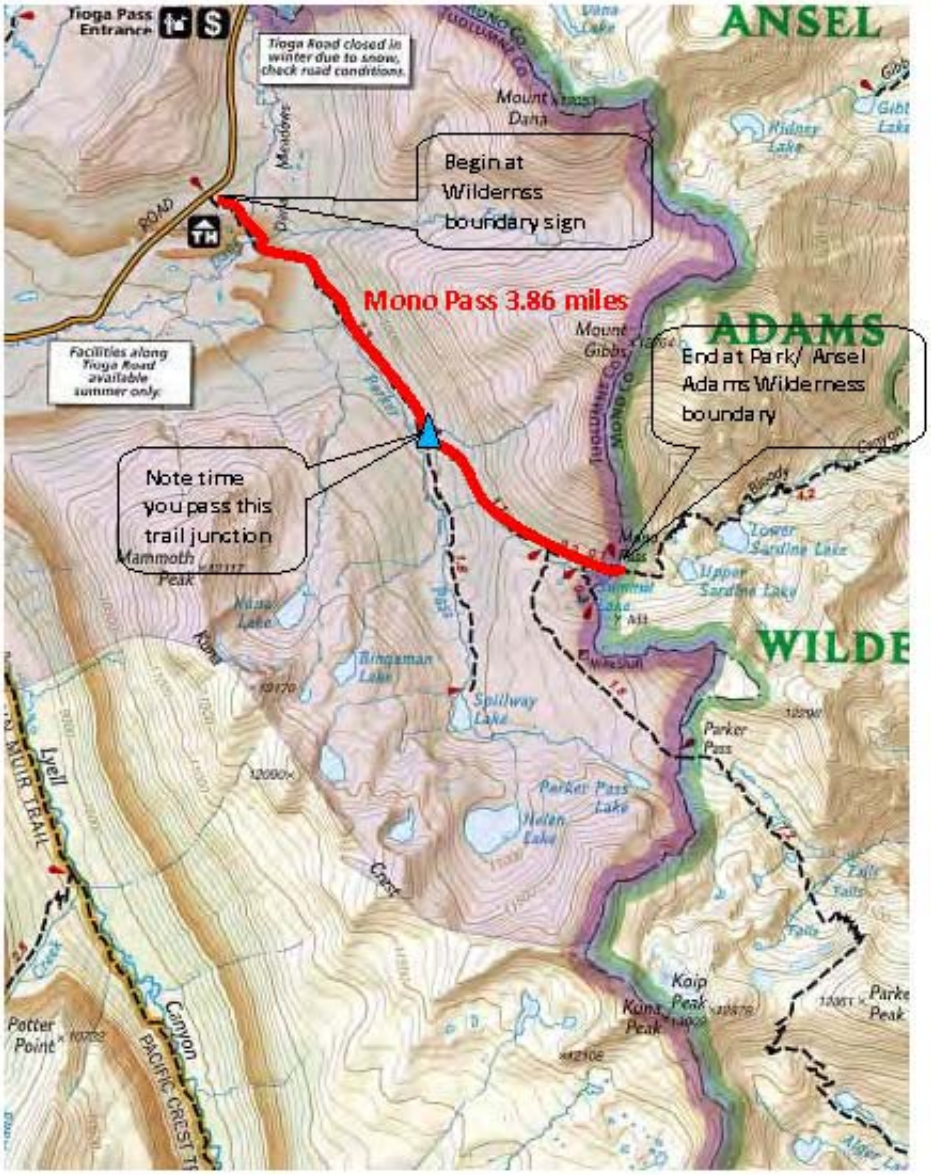
Elevation gain (in)	1,044'
Time up (in)	2 hrs 6 min
Time down (out)	1 hrs 34 min


Down: follow signs to "Soda Springs"
End at trail junction
Down: follow signs to "Dog Lake"
Young Lakes West 4.13 miles
Young Lakes East 3.14 miles
Begin at rail junction 0.1 miles from Dog Lake. Up: follow signs to Young Lake
End at Dog Lake
Dog Lake 1.17 miles
Ragged Peak
Young Lakes
Pothole Dome
Soda Springs
Lembert Dome
Tuolumne Meadows
Begin at Wilderness boundary sign "Glen Aulin"
Begin at Wilderness boundary sign near Lembert Dome parking


Pothole Dome
Lembert Dome
Fairview Dome
TRAIL
ROAD
Tuolumne Meadows
Cathedral Lakes
3.17 miles
Begin at Wilderness boundary sign
Medlicott Dome
MUIR
Cathedral Peak
Unicorn Peak
Cathedral Lakes
Elizabeth Lake
Budd Lake
Cathedral Pass
Echo Peaks
Cockscomb
End at Cathedral Lake
Tresidder Peak
JOHN
Columbia Finger
Long Meadow
Stream crossing. Don't get lost trail is downhill.
Rafferty Peak
Range
Sunrise



★ Survey Location for Lyell Fork Trail segment is at the Lyell Canyon wilderness Boundary sign.



▲ Note time you pass trail junction

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Notes:

Notes:

Appendix B: Example of Traffic Data

N44478

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	File Name: C:\DOCUME~1\DPETTE~1\LOCALS~1\Temp\trx9A4.tmp															
2	Start Date: 7/23/2009															
3	Start Time: 1:58:00 PM															
4	Site Code:															
5	Station ID:															
6	Location 1:															
7	Location 2:															
8	Longitude: 0' 0.000 South															
9	Latidude: 0' 0.000 East															
10	Veh. No.	Date	Time	Hour	Lane	Axles	Spec	Class	Length (In Inches)	Speed (In MPH)	Gap (In Seconds)	Follow (In Inches)	Axle 1-2	Axle 2-3	Axle 3-4	Axle 4-5
11	1	7/23/2009	1:59:25 PM	13	1	0	0	14	0	0	0	0				
12	2	7/23/2009	1:59:27 PM	13	1	0	0	14	0	0	0	0				
13	3	7/23/2009	2:00:14 PM	14	2	2	2	2	105	44	134	9999	105			
14	4	7/23/2009	2:00:20 PM	14	1	2	2	2	98	41	140	9999	98			
15	5	7/23/2009	2:00:22 PM	14	1	0	0	14	0	0	2	0				
16	6	7/23/2009	2:00:33 PM	14	2	0	0	14	0	0	8	0				
17	7	7/23/2009	2:00:44 PM	14	1	0	0	14	0	0	0	0				
18	8	7/23/2009	2:00:52 PM	14	1	0	0	14	0	0	0	0				
19	9	7/23/2009	2:01:42 PM	14	1	2	3	3	121	26	80	9999	121			
20	10	7/23/2009	2:01:50 PM	14	1	2	2	2	100	31	8	4365	100			
21	11	7/23/2009	2:01:53 PM	14	2	2	2	2	99	38	91	9999	99			
22	12	7/23/2009	2:01:56 PM	14	1	2	3	3	141	32	6	3379	141			
23	13	7/23/2009	2:01:57 PM	14	1	2	1	1	33	34	0	0	33			
24	14	7/23/2009	2:01:57 PM	14	1	2	1	1	62	50	0	0	62			
25	15	7/23/2009	2:01:59 PM	14	1	2	2	2	103	35	2	1232	103			
26	16	7/23/2009	2:02:01 PM	14	1	0	0	14	0	0	2	0				
27	17	7/23/2009	2:02:04 PM	14	1	2	2	2	99	31	3	1637	99			
28	18	7/23/2009	2:02:27 PM	14	1	2	2	2	102	33	22	9999	102			

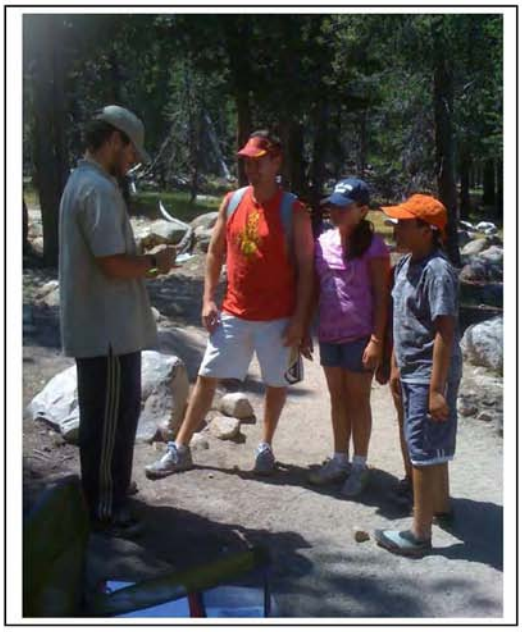
Appendix C: Example of TrailMaster Data

D7 =C7*1.07031

	A	B	C	D	E	F	G	H	I	J	K	L
1	Date	Hour	Total	Total*r	Inbound	Outbound					Inbound Proportion	Outbound Proportion
2	7/1/2009	0	0	0	0	0					0.00	1.00
3	7/1/2009	1	0	0	0	0					1.00	0.00
4	7/1/2009	2	0	0	0	0					0.00	1.00
5	7/1/2009	3	0	0	0	0					1.00	0.00
6	7/1/2009	4	0	0	0	0					1.00	0.00
7	7/1/2009	5	1	1.07031	1.07031	0					1.00	0.00
8	7/1/2009	6	0	0	0	0					0.89	0.11
9	7/1/2009	7	0	0	0	0					0.65	0.35
10	7/1/2009	8	3	3.21093	2.712871	0.498059					0.84	0.16
11	7/1/2009	9	23	24.61713	20.74156	3.875568					0.84	0.16
12	7/1/2009	10	42	44.95302	32.52379	12.42923					0.72	0.28
13	7/1/2009	11	40	42.8124	25.4295	17.3829					0.59	0.41
14	7/1/2009	12	22	23.54682	11.08016	12.46666					0.47	0.53
15	7/1/2009	13	24	25.68744	6.099027	19.58841					0.24	0.76
16	7/1/2009	14	9	9.63279	1.402196	8.230594					0.15	0.85
17	7/1/2009	15	9	9.63279	1.057287	8.575503					0.11	0.89
18	7/1/2009	16	11	11.77341	0.706604	11.06681					0.06	0.94
19	7/1/2009	17	9	9.63279	0.291377	9.341413					0.03	0.97
20	7/1/2009	18	6	6.42186	0.262493	6.159367					0.04	0.96
21	7/1/2009	19	3	3.21093	0.307896	2.903034					0.10	0.90
22	7/1/2009	20	7	7.49217	0.670852	6.821318					0.09	0.91
23	7/1/2009	21	0	0	0	0					0.00	1.00
24	7/1/2009	22	0	0	0	0					0.00	1.00
25	7/1/2009	23	0	0	0	0					0.00	1.00
26	7/2/2009	0	0	0	0	0						
27	7/2/2009	1	0	0	0	0						

Appendix D: Protocols for Perceived Encounter Data Collection

Perceived Encounter Monitoring Protocols



Summer 2009

University of Idaho

Contents

Introduction

During July and August of 2009, the University of Idaho will be coordinating a research project to measure encounters rates on wilderness trails in the Tuolumne Meadows area. These measures will help the park assess the opportunities for solitude within designated wilderness areas, as directed by the Wilderness Act of 1964. Collecting encounter data can be staff intensive, because it is usually done by staff who hike through the wilderness, recording their encounters with other groups. For proper analysis, many days of observation are required.

This research project will assess the relationship between encounter rates in the wilderness, visitor counts at the trailhead and traffic flow on Tioga Road in order to determine if visitor trailhead counts and traffic rates can be used as an indirect measure of encounter rates. This would enable park managers to count visitors at trailheads or cars on Tioga Road, a relatively simple task using mechanical counters, and determine what opportunities for solitude are being provided in the wilderness. The potential benefits are cost savings, reduction in employee time devoted to monitoring, and valuable and timely information for wilderness stewardship. In order to understand the relationship between encounters visitor counts at trailheads and traffic, a robust sample of encounter data will be needed.

Instructions for Visitor Surveys of Perceived Encounters

You will be surveying visitors for their reported number of encounters on study trail segments. This method is conceptualized as a measure of perceived encounters because it is the encounters a visitor recalls or notices, rather than the observations of a trained observer whose purpose is to record actual encounters. While you are surveying visitors, an observer will be hiking in the study locations recording their own encounters. This will allow us to compare actual encounter rates to visitor reported encounter rates. Survey periods will therefore also be four hours in length to corresponded to that of the observer.

Preparation:

- Report to assigned survey location
- Fill out "Visitor Reported Encounters" log form.
    - Location: Where you are stationed for surveying
    - Start Time: When you began your survey period

Survey:

- **Step 1 –** Record date and location on survey
- **Step 2 -** Contact the first group exiting the study location using language form the script.
    - "Hello, I am _____(state name, and position). We are conducting a research project today. Could I ask you a few questions about your hike? It will only take about 5 minutes. The University of Idaho's Human Assurance Committee has approved this project. I will be asking you how many other groups and individuals you saw while you were on your hike. This information will be used to assess opportunities for solitude in the Yosemite Wilderness. Participating will contribute to park stewardship benefiting both you and society. There is no risk to you. This is an anonymous survey; no personally identifying information will be recorded. I would be happy to answer any questions you have about the research now, once we have completed the survey, or provide you with our contact information for later.

You do not have to participate in this survey and there are no consequences for choosing to abstain or choosing to end the survey before you have completed it. If the survey becomes stressful or unpleasant for you we will stop the survey. Is this acceptable to you; would you answer a few questions about your hike today?"

- Visitor answers **"Yes"**, **record time** and administer survey.
  - Go to administering survey step 3
- Visitor answers **"No"**, Thank them and wish them a nice day, then fill out noncompliance information on the daily log sheet.
  - Time, group type (day or overnight), group size, and reason for refusal if given.

Administer Survey

- **Step 3 -** Start with map on survey. Ask the visitor to describe where they went on their hike (for overnight visitors ask them just for that day).
  - Researcher- mark the route on the survey map.
  - Determine if the group hiked in the study location(s)
    - **Yes**, continue with entire survey (step 4)
    - **No**, mark not in survey location and fill out date, time, time party started, number of persons in group, day or overnight group. Thank them for their time.
- **Step 4 –** Fill out survey by asking visitor group the following:
  - **Time** visitor group began their hike that day in the survey area.
  - **Total number of groups encountered and individuals** the survey group encountered during their hike. Ask separately for each trail study segment the group hiked upon.
  - **Number of persons in their group** during their hike for which they are being surveyed.
- **Step 5 –** Fill out visitor character information
  - **Day user or overnight** mark whether they were day users or overnight
- **Step 6 –** Thank them for their time.

- **Step 7 –** Look over the survey to ensure that all data fields are entered. Put the survey away.

- **Step 8 –** take a breath, then begin again at step one.

Breaks

There will be two fifteen minute breaks, one in the morning hours and one in the afternoon hours. There is also a 30 minute lunch period. When taking these breaks, if they occur during the survey period, note the start and end time on the daily log sheet. If the surveyor needs to leave the survey location for any other reason (say a bathroom break), note the start and end time of the absence.

Ending the survey period

When the survey period has ended, note the time on the log sheet that you stopped surveying. Also, note the time the encounter observer returned if applicable. Pack up your stuff and head back to camp. Turn in your surveys and log form from the day to University of Idaho Researcher.

PERCEIVED ENCOUNTERS SURVEY

University of Idaho

Form Reference Number: _____

Survey Location: **Cathedral Lakes**

Date: _____ Time: _____

What Time did they start their hike? _____

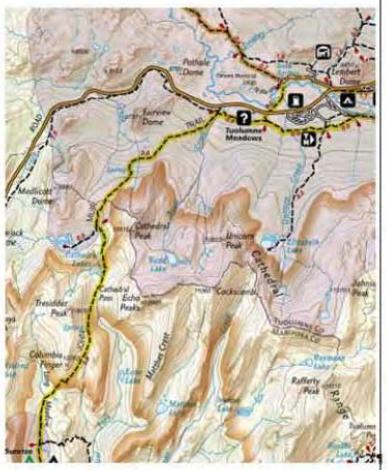
Number of Persons in their group: _____

This group is day or overnight? _____

Trail Segment	# groups	# individuals
Cathedral Lakes		

(See reverse side for map) ..... Section Break (Next Page) .....

Begin with map, draw visitor's route.



Group was in study location (circle one): ···**Yes**·····**No**

PERCEIVED ENCOUNTERS SURVEY

University of Idaho

Form Reference Number:_____

Survey Location: **Lyell Fork**

Date:_____ Time:_____

What Time did they start their hike?:_____

Number of Persons in their group:_____

This group is day or overnight?:_____

Trail Segment	# groups	# individuals
Lyell Fork		

(See reverse side for map) ..... Section Break (Next Page) .....

Begin with map, draw visitor's route.

Group was in study location (circle one): **Yes** **No**

Study Locations

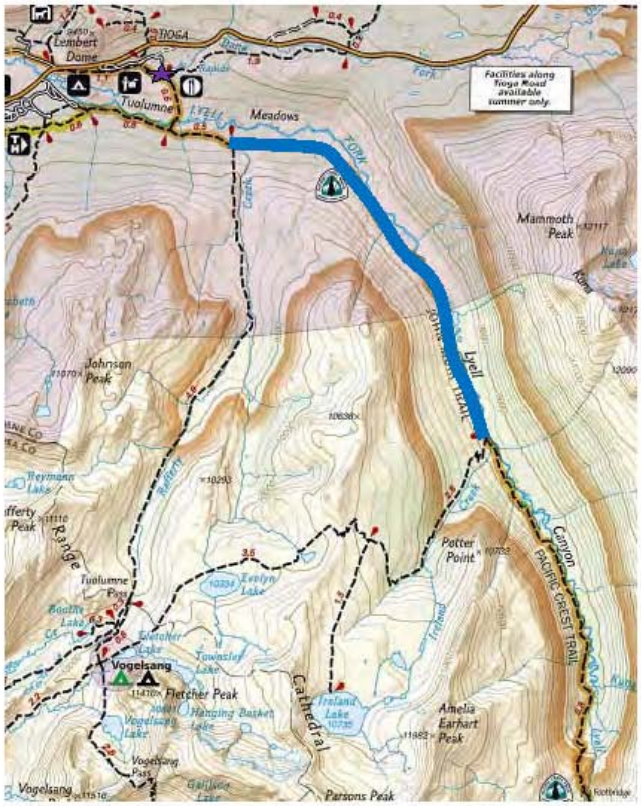
There are two study trail locations for perceived encounters.

Cathedral Lakes Trail - A section of the John Muir Trail, is a popular hike that leads into the Cathedral Range. The study section is from the wilderness boundary to the Cathedral Lake, approximately 3.5 miles. Surveys will be conducted at the wilderness boundary.

Lyell Fork Trail - Part of the Pacific Crest Trail, it follows the Lyell Fork of the Tuolumne River. The Ireland Creek Trail junction is approximately 5.2 miles. The study segment is from the junction with the Rafferty Creek Trail to the popular camping area about a ½ mile past the junction with the Ireland Creek Trail, approximately 4.7 miles in length. Surveys will be conducted at the wilderness boundary.

Cathedral Location

Lyell Location



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Appendix E: Pilot Protocols

Construct Validity Pilot of Actual Encounters

Date:_____

Location:_____

Evaluator:_____

Instructions:

Following the Actual Encounters data collection protocols collect data for a 4 hour observation period in several study locations. Upon completion, fill out the form bellow to assess validity of constructs being measured by this research for the Tuolumne area. Check the box if the construct is measurable according to protocols. Write comments about any issues or concerns for a construct.

- ☐ **"Trail Seg"** Enter the description to the trail segment on which you are making your observations (see table and maps). Order the start and end point to indicate your direction of travel (e.g.," Dog Lake trailhead to Dog Lake" when headed in, or when headed out "Dog Lake to Dog Lake trailhead.")

Researcher comments:

- ☐ **Groups,** any time you see another group of one or more people make an entry. This includes people seen in the distance, as well as those you meet on the trial.

Researcher comments:

- ☐ **"Time"** Record the time you encounter the group or person.

Researcher comments:

- **"# People"** Record the number of people in the group. The intent of the measurement of the trail encounters is to provide a picture of the "sense of solitude" that visitors traveling on a trail are experiencing. Thus, a party is a group of people of one or more readily recognized as traveling together. If in doubt as to whether parties are associated and traveling together, tally as separate encounters. If you are at a destination or attraction site and you are unable to distinguish groups from one another due to the density of people, use the protocol for "crowds at destinations or attraction sites" found bellow.

Researcher comments:

- **"# Stock"** Enter the number of stock, this includes riding and pack animals.

Researcher comments:

- **"Seen Before"** Have you seen this group at another time today? Answer "Y" of "N." It is important to record each time you see the same group as a separate encounter if there is more than 20 minutes between sightings. This will allow analysis of both unique encounters and total encounters.

Researcher comments:

- **"Day or O/N"** Enter "D" for day users and "ON" for overnight users.

Researcher Comments:

- **"Direction of Travel"** enter "I" for groups traveling into the wilderness, "O" for groups traveling out of the wilderness, and "UK" for groups whose direction of travel you are unable to determine.

Researcher Comments:

- **"> 25 feet"** Enter "Y" for groups seen outside of speaking distance, greater than approximately 25 feet. Enter "N" for groups within speaking distance (≤ 25 feet).

Researcher Comments:

Crowds at destinations or attraction sites

- If you are at a destination or attraction site and you are unable to distinguish groups from one another due to the density of people, use the protocol for "crowds at destinations or attraction sites" found bellow. Use an entire entry row to note the common name of the destination or attraction site and write "total # people." There is then the potential to distinguish between day and overnight visitors and people greater than 25 feet or less than 25 feet, thus use four entry rows.
  - **"En #"** number consecutively continuing from where you were before you reached the destination or attraction site.
  - **"Time"** the time should be the same for all four entrys
  - **"# People"** record the total number of people you see.
  - **"# Stock"** record the total number of stock you see.
  - **"Seen before"** it is likely that you have seen some people and have not seen others before, denote as "N/A" if this is the case.
  - **"Day or O/N"** if you can distinguish between the number of day and overnight visitors use a separate row entry for each and put the total number of each here. If you are unable to distinguish between day and overnight visitors enter "UK."
  - **"Dir. of trav."** this should be "UK" since people are grouped at a destination or attraction sight.
  - **"> 25 feet"** Use a row for people within approximately 25 feet (noted as "N") and one for people outside of approximately 25 feet (noted as "Y")

Researcher Comments:

Construct Validity Pilot of Perceived Encounters

Date:_____

Location:_____

Evaluator:_____

Instructions:

Following the perceived encounters data collection protocols collect data for a 4 hour observation period in several study locations. Upon completion, fill out the form bellow to assess validity of constructs being measured by this research for the Tuolumne area. Check the bullet if the construct is measurable according to protocols. Write comments about any issues or concerns for a construct.

- **Step 2** - Contact the first group exiting the study location using language form the script.
- Contact the first group exiting the study location using language form the script.
    - "Hello, I am _____(state name, and position). We are conducting a research project today. Could I ask you a few questions about your hike? It will only take about 5 minutes. The University of Idaho's Human Assurance Committee has approved this project. I will be asking you how many other groups and individuals you saw while you were on your hike. This information will be used to assess opportunities for solitude in the Yosemite Wilderness. Participating will contribute to park stewardship benefiting both you and society. There is no risk to you. This is an anonymous survey, no personally identifying information will be recorded. I would be happy to answer any questions you have about the research now, once we have completed the survey, or provide you with our contact information for later. You do not have to participate in this survey and there are no consequences for choosing to abstain or choosing to end the survey before you have completed it. If the survey becomes stressful or unpleasant for you we will stop the survey. Is this acceptable to you; would you answer a few questions about your hike today?"

Researcher Comments:

- Visitor answers **"Yes"**, **record time** and administer survey. Ask for adult group member with nearest birthday to current day to represent the group.
    - Go to administering survey step 3

Researcher Comments:

- Visitor answers **"No"**, Thank them and wish them a nice day, then fill out noncompliance information on the daily log sheet.
    - Time, group type (day or overnight), and group size

Researcher Comments:

☐ Administer Survey

- **Step 3 -** Start with map on survey. Ask the visitor to describe where they went on their hike (for overnight visitors ask them just for that day).
    - Researcher- mark the route on the survey map.
    - Determine if the group hiked in the study location(s)
        - **Yes**, continue with entire survey (step 4)
        - **No**, mark not in survey location and fill out visitor characteristics section of survey and thank them for their time.

Researcher Comments:

- **Step 4 –** Fill out survey by asking visitor group the following:
    - **Time** visitor group began their hike that day in the survey area.

Researcher Comments:

- **Total number of groups encountered and individuals** the survey group encountered during their hike. Ask separately for each trail study segment the group hiked upon.

Researcher Comments:

- **Number of persons in their group** during their hike for which they are being surveyed.

Researcher Comments:

- **Zip code or Country of origin** ask for their postal zip code or, if not from the U.S., their country of origin.

Researcher Comments:

- **Step 5 –** Fill out visitor character information
  - **Day user or overnight** mark whether they were day users or overnight

Researcher Comments:

Appendix F: Actual Encounters and TrailMaster Count Regression Models with 60%, 80% and 95% Individual Confidence Intervals

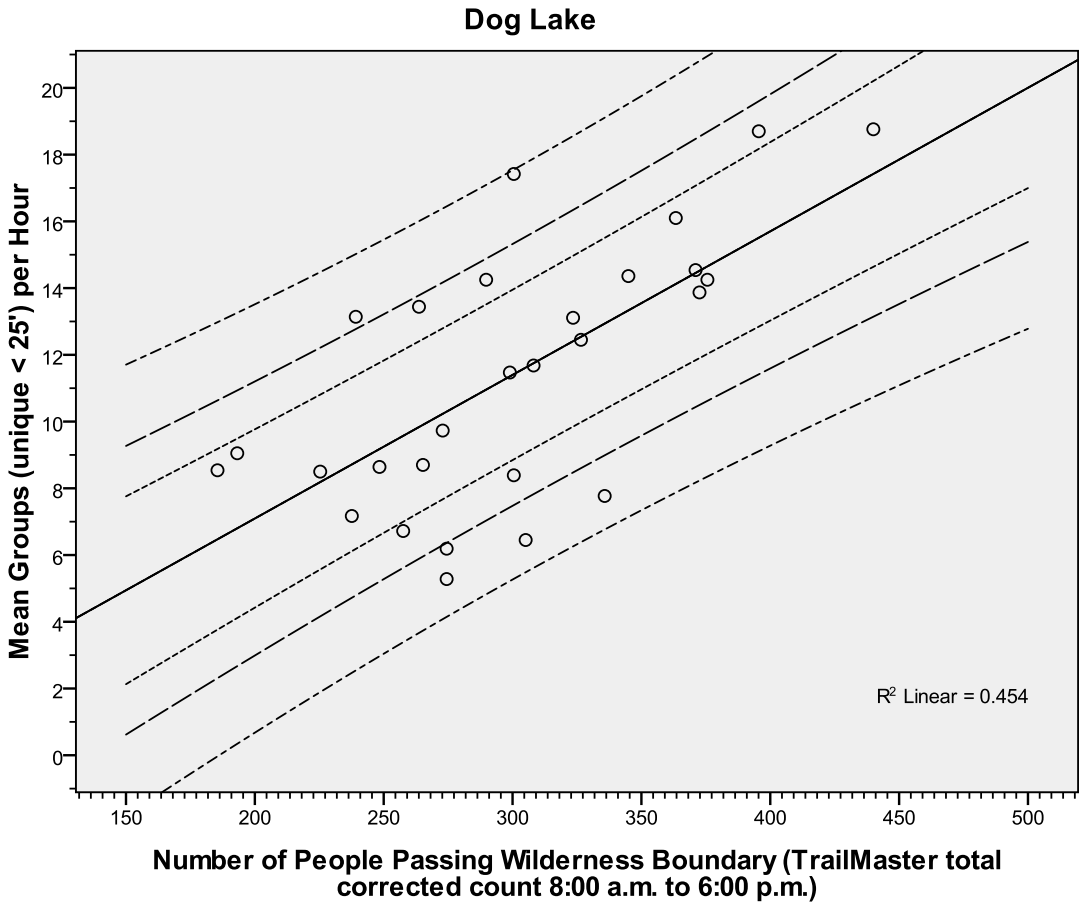

Figure 22. Dog Lake – regression of corrected TrailMaster counts (8:00 a.m. to 6:00 p.m.) on mean unique groups encountered within speaking distance per hour. Prediction line is shown with prediction intervals at the 60%, 80%, and 95% confidence limits.

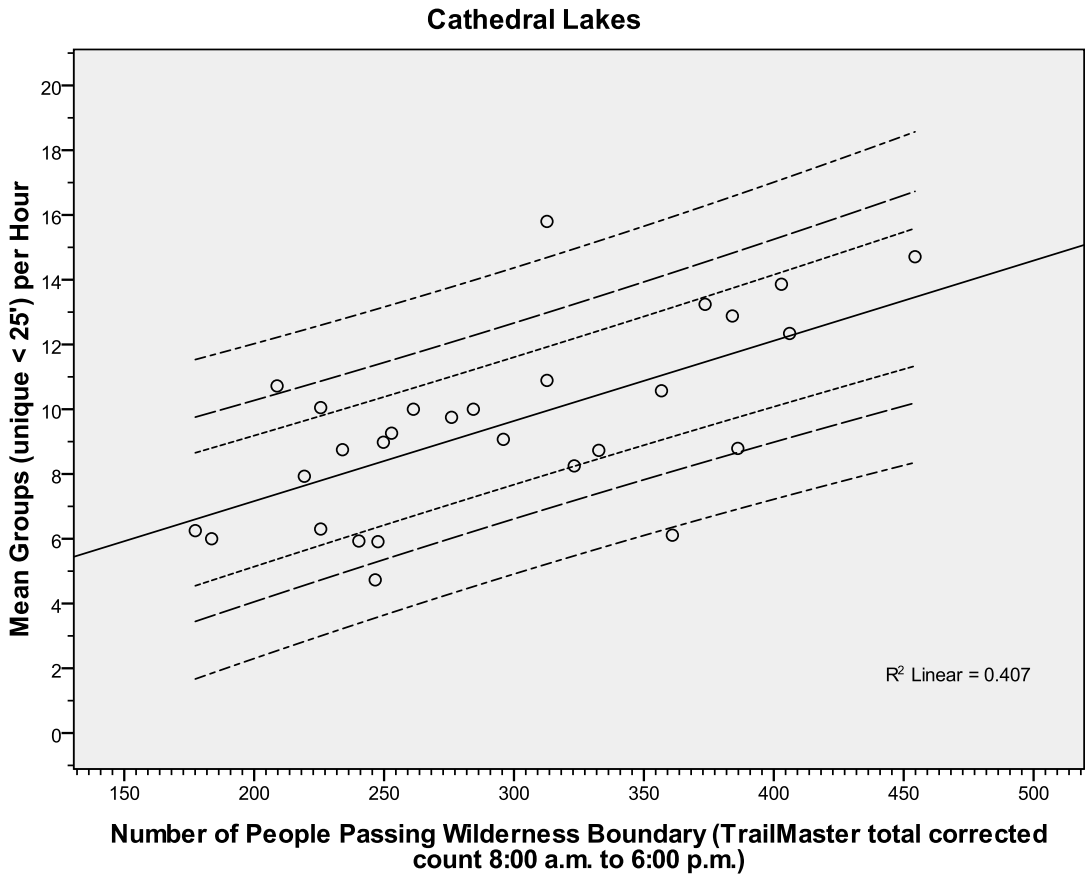

Figure 23. Cathedral Lakes – regression of corrected TrailMaster counts (8:00 a.m. to 6:00 p.m.) on mean unique groups encountered within speaking distance per hour. Prediction line is shown with prediction intervals at the 60%, 80%, and 95% confidence limits.

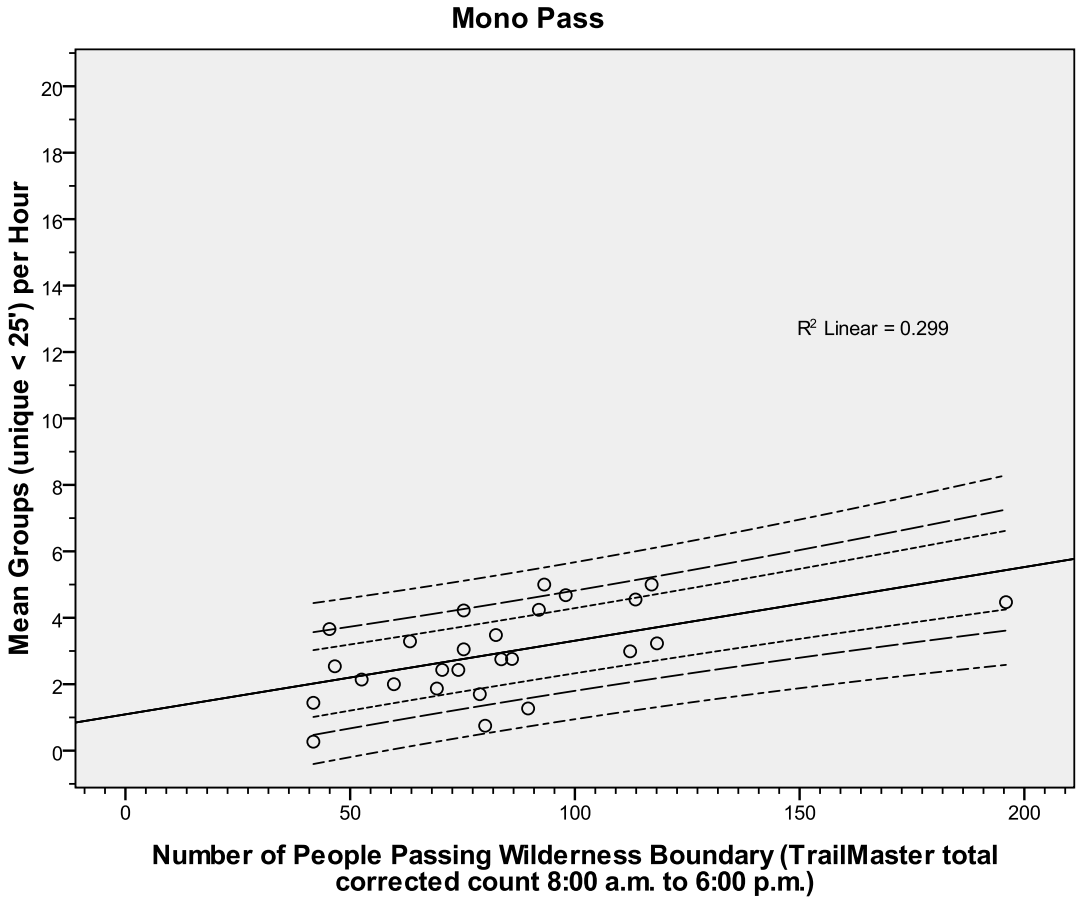

Figure 24. Mono Pass – regression of corrected TrailMaster counts (8:00 a.m. to 6:00 p.m.) on mean unique groups encountered within speaking distance per hour. Prediction line is shown with prediction intervals at the 60%, 80%, and 95% confidence limits.

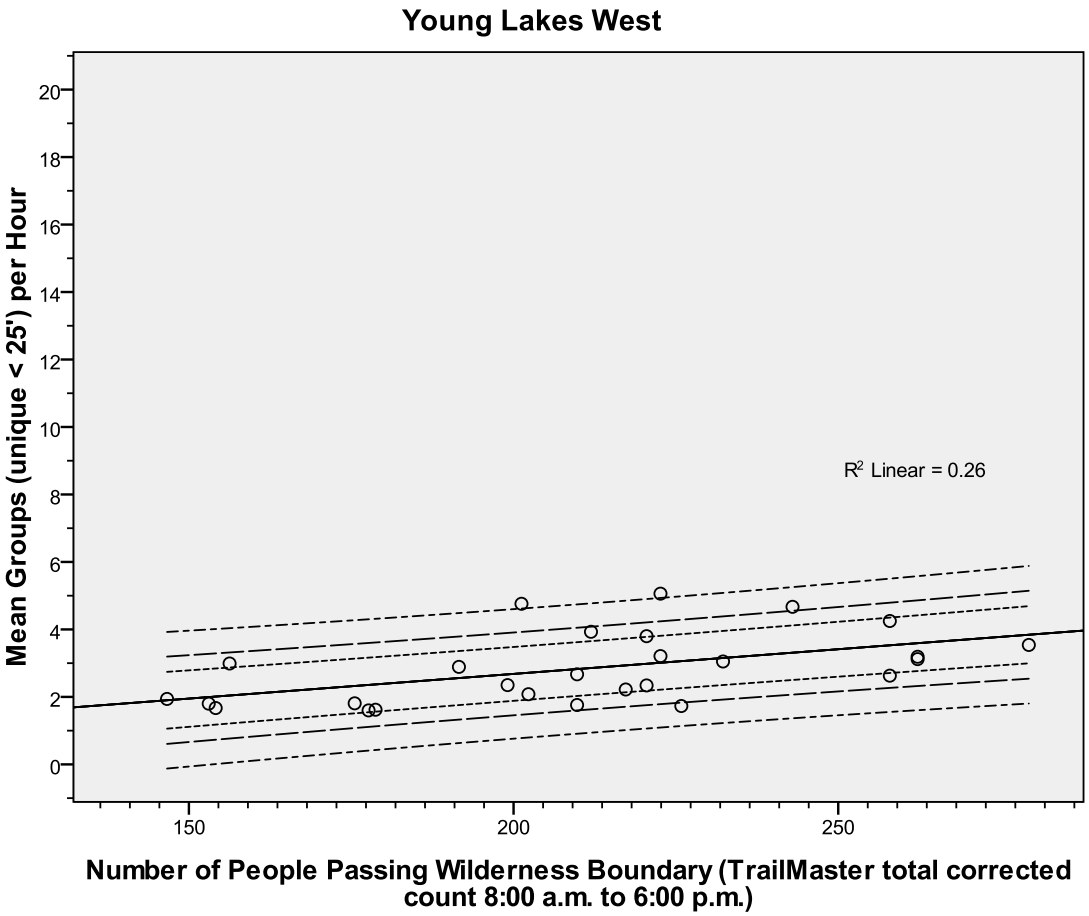

Figure 25. Young Lakes West – regression of corrected TrailMaster counts (8:00 a.m. to 6:00 p.m.) on mean unique groups encountered within speaking distance per hour. Prediction line is shown with prediction intervals at the 60%, 80%, and 95% confidence limits.

Appendix G: Human Assurances Committee Approval

University of Idaho

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Moscow ID 83844-3010

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Cc: Dr. Troy Hall
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From: Casey Inge
Chair, University of Idaho Institutional Review Board
University Research Office
Moscow, Idaho 83844-3010

IRB No.: IRB00000843

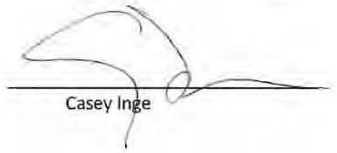
FWA: FWA00005639

Date: June 11, 2009

Project: Approval of "An Assessment of Indirect Measures for the Social Indicator of Encounters in the Tuolumne Meadows Area of Yosemite National Park", Project 08-315

On behalf of the Institutional Review Board at the University of Idaho, I am pleased to inform you that the above-named project is approved as exempt from review by the Committee. Please note, however, that you should make every effort to ensure that your project is conducted in a manner consistent with the three fundamental principles identified in the Belmont Report: respect for persons; beneficence; and justice.

Should there be significant changes in the protocol for this project, it will be necessary for you to resubmit the protocol for review by the Committee.



Casey Inge