DAY HIKERS IN YOSEMITE WILDERNESS: UNDERSTANDING TRAVEL PATTERNS AND TRAIL CHOICE DECISION MAKING

A Thesis

Presented in Partial Fulfillment of the Requirements for the

Degree of Master of Science

with a

Major in Natural Resources

in the

College of Graduate Studies

University of Idaho

by

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May 2014

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Abstract

Current gaps in the wilderness day use literature are addressed. Two wilderness trip variables were quantified using GPS tracks collected from day hikers in Yosemite Wilderness: distance traveled and time spent hiking. The impact of group size and age of group members on dependent variables was explored; data show that group characteristics examined did not consistently influence distance traveled or time spent in wilderness. Spatial distributions of wilderness users at attraction sites were examined at three use levels, and a new method for documenting the occurrence of micro-level site displacement at attraction sites using GPS and infrared trail counter data is presented. Second, day hiker trail choice decision making was explored using bounded rationality and information search theory. Seven wilderness day hiker types emerged from 80 semi-structured interviews conducted with wilderness day hikers on high and moderate use trails. Theoretical implications are discussed, and recommendations for hiking information provision at Yosemite are made.

Acknowledgements

I want to thank my advisor, Dr. Troy Hall, for pushing me succeed, providing me with room to grow as a researcher and student, and for trusting in my ability to produce good work. Throughout the development of my thesis, Troy supported me in innumerable ways, from asking the tough questions to visiting me onsite at Yosemite to correcting the same grammar mistakes in every draft. Troy tirelessly dedicated her time to my development as a professional, and for that, I am truly grateful.

I would like to thank Yosemite National Park for funding the Graduate Research Assistantship that allowed me to conduct on-site wilderness research in the park. Specifically, I would like to thank Brett Meldrum, Karen Hockett, and Todd Newburger for their assistance with on-site logistics during the summer 2012 and 2013 field seasons. I would especially like to thank Steven Mantani and Nina Berman, the two Student Conservation Association interns that made the GPS data collection possible.

I thank my committee members Dr. Ed Krumpe, Dr. Eva Strand, and Dr. Dave Pettebone for their time and consideration. Each of them contributed in a unique way to the development of this thesis, and I value the perspectives and suggestions they have shared with me.

I thank my brother, Daniel Irizarry, for his Python programming expertise. Without his knowledge and generosity, I would not have been able to process the GPS data so integral to this work. Finally, I want to thank my friends and family for their emotional support through this process. I would not be where I am today without their encouragement and guidance.

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Chapter 1

Wilderness Management: The Question of Day Use

Overview

Two studies reported in this thesis examine aspects of wilderness day use in Yosemite National Park. A discussion of wilderness day use and Yosemite Wilderness sets the context for both studies by discussing the rise of day use in wilderness, reviewing wilderness day use literature, and providing information regarding the state of wilderness management in Yosemite. Existing gaps in the wilderness day use literature will be addressed with a study looking at the spatial distributions of day hikers at popular wilderness attraction sites (Chapter 2) and with a qualitative study seeking to understand how and why wilderness day users select a wilderness trail for hiking (Chapter 3). Chapter 4 provides an executive summary of the findings for Yosemite managers.

Wilderness Day Use

Since the 1970s, wilderness use has been on the rise nationally; moreover, day users comprise a considerable portion of all wilderness users, and the trend is expected to continue in the future (Chavez, 2000; Roggenbuck, Marion, & Manning, 1994). In fact, some claim that day use may define the next generation of wilderness users (Chavez, 2000). Increases in wilderness day use have been attributed to several factors, including population growth, the availability of better and more affordable outdoor gear, decreased vacation time of the American workforce, and the desire for recreation destinations close to home (Chavez, 2000; Nash, 2001; Roggenbuck et al., 1994). Additionally, the increase in day use has led to use concentration in easily accessible areas such as well-marked trails, trails located near parking areas, or destinations within a short distance from a trailhead (Cole, 2001a). The increased concentration of day users near wilderness boundaries presents wilderness managers with the challenge of providing all users (both day and overnight) with the same opportunities for high quality experiences regardless of the user's location in a wilderness area.

Despite documented increases in the number of users taking wilderness day trips, gaps still remain in what is known about this user group. To date, the literature on day users in wilderness broadly focuses on three main areas: managers' perceptions of wilderness day use, contrasting day users with overnight users, and examining impacts of day users in wilderness. Some studies have examined managers' perceptions of wilderness day users and the effectiveness of strategies designed to manage day users. For example, Abbe and Manning (2007) examined the perceptions of National Park Service managers regarding aspects of wilderness day use. Managers perceived an increase in wilderness day use over the previous 20 years, demonstrating recognition of a phenomenon well documented in wilderness literature (Abbe & Manning, 2007). Furthermore, managers believed day users enter wilderness in larger groups, are more racially and ethnically diverse than overnight users, and include more women. Finally, managers estimated the average length of stay in wilderness by day users to be five hours. While Abbe and Manning's study showed that wilderness managers perceived differences in the characteristics of day users and overnight users, it also documented a lack of management initiatives that focus specifically on managing wilderness day users. Furthermore, managers reported a need for increased management actions tailored to wilderness day users.

With the goal of providing information to address the needs of wilderness day users, other studies have examined aspects of the question: are wilderness day users and overnight users inherently different? Cole (2001a) concluded that generally wilderness day users are not different from overnight users; however, a few significant differences exist between the two user groups. In terms of group characteristics, day user groups are more likely to consist of a single individual, more likely to contain women, more likely to contain family members, and less likely to be part of organized groups (Cole, 2001a). Day users are usually slightly more tolerant of crowding and less likely to favor use limits than overnight users. Furthermore, day users tend to have lower expectations for day trips into wilderness and are less likely to have their trip goals compromised by the social conditions present in wilderness. Cole and Hall's (2008) study of wildernesses in Oregon and Washington found slight differences between day and overnight users' trip expectations and achievement; day users had lower trip expectations and also experienced lower achievement of those trip expectations.

Despite these differences in group characteristics, crowding tolerance, and trip expectations, which tend to be small, day users and overnight users have similar amounts of wilderness travel experience, levels of attachment to wilderness, and support for wilderness protection (Cole & Hall, 2008; Cole, 2001b). Furthermore, day users and overnight users have similar levels of support for the idea of wilderness, with comparable knowledge about the meaning of wilderness and similar conceptualizations of wilderness experience (Papenfuse, Roggenbuck, & Hall, 2000; Seekamp, Hall, Harris, & Cole, 2006). The lack of consistent, managerially meaningful differences between day users and overnight users on a variety of measures supports the conclusion that day and overnight users of wilderness do not differ greatly. The primary explanation for the lack of differences between the two user groups is that often day users and overnight users come from the same population – the two groups are not mutually exclusive (Cole, 2001a).

Justification for inquiry seeking to document differences between day and overnight users stems from the thought that a better understanding of wilderness day users is critical to meeting the needs of this growing segment of wilderness users. Contrary to expectations, wilderness day users generally do not differ in terms of visitor characteristics from overnight users, yet the fact remains that an increased portion of wilderness users are deciding to take shorter trips in wilderness. The central difference between the two user groups is not the characteristics, opinions, or evaluations of the user, but the wilderness trip itself. Specific strategies for managing day trips vary across wilderness areas; however, most are united by the common theme that day use management in wilderness is more characteristic of front country management than of backcountry, wilderness management. For example, the majority of management actions reported by National Park Service wilderness managers were focused on promoting visitor safety, facilitating convenience, restoring or closing impacted sites, and enforcing regulations (Roggenbuck et al., 1994). Some of these strategies conflict with aspects of wilderness character such as the untrammeled and undeveloped qualities that are outlined as management objectives in the Wilderness Act of 1964. Additionally, given that day users do not differ in their concept of wilderness, affinity for wilderness, or level of overall experience in wilderness from overnight users, providing a more constrained wilderness experience in areas typically used by day hikers does not align with the shared wilderness values between the groups (Roggenbuck et al., 1994).

Twenty years ago, Roggenbuck et al. (1994) identified an array of gaps in the day use literature in their article, “Day users of the backcountry: the neglected National Park

Service visitor." Since publication, some of the literature gaps have been addressed, as discussed above. However, two areas of research remain relatively undeveloped: (1) the spatial and temporal distribution of day use in parks, and (2) information on why day users enter the backcountry. At a 2011 wilderness workshop, McCool and Dawson (2012) used a modified nominal group technique with workshop participants to generate a list of over forty potential research needs for wilderness. Almost twenty years after Roggenbuck et al. (1994) published a list of wilderness research needs, many of the same topics were identified as existing knowledge gaps by wilderness managers and researchers. Relevant to my thesis, the following four issues were identified by workshop participants as continuing knowledge gaps in the literature: (1) research on capacity issues that get away from simplistic number approaches; (2) what is "appropriate" in wilderness in terms of behavior and crowding when at visitor thresholds; (3) day use and how to manage it, including management tools that might be effective for lowering crowding among day users; and (4) the different roles and effect of different types of information (and timing of information use) on the wilderness experience (McCool & Dawson, 2012). The results of my studies contribute new knowledge to the gaps identified by both Roggenbuck et al. (1994) and McCool and Dawson (2012). Through examining the spatial and temporal characteristics of wilderness day users using objective measures of time and distance traveled derived from personal GPS units, my work contributes new knowledge that can be used by managers to better understand day use of Yosemite Wilderness and that can be used to understand visitor behavior at varying use levels in wilderness. Additionally, the exploration of visitor use at wilderness attraction sites as it varies with use density contributes new knowledge to visitor behavior in response to crowding. Finally, the qualitative exploration of information use and trail choice decision making contributes a greater understanding of the roles and effects of information on wilderness decision making, and therefore day user experience.

Wilderness Management: Yosemite National Park

Both studies presented in this thesis were conducted at Yosemite National Park and were focused on the subpopulation of wilderness day users to high and moderate use trails throughout Yosemite Wilderness. Approximately 95% of Yosemite National Park is federally designated wilderness, with the wilderness designation in Yosemite Valley beginning above the 4200-foot contour (approximately 200 vertical feet from the valley floor) and the wilderness designation in the eastern part of the park beginning approximately 200 feet from the center line of the Tioga Road, the park's central east-west highway. In the remainder of the park, wilderness designation begins 200 feet from public roads and 100 feet from developed areas. The *California Wilderness Act of 1984* established Yosemite's wilderness. The park's existing wilderness management protocols are derived from the 1989 Wilderness Management Plan (Yosemite National Park, 1989). The park is currently working on the initial phases of its first contemporary wilderness stewardship plan; the plan should be available for public review within the next few years.

The Wilderness Act of 1964 states that wilderness areas:

> "Shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, [and] the preservation of their wilderness character" (Sec. 2. (a)).

Managing for wilderness character ensures that wilderness areas remain natural and relatively untouched by human influences and provide recreationists with opportunities for solitude or primitive and unconfined recreation experiences. Each of the four federal agencies that administer wilderness is required to uphold the Wilderness Act through its individual wilderness management programs. Through development and implementation of recreation planning and monitoring frameworks such as the Visitor Experience and Resource Protection (VERP) framework, the National Park Service has made a targeted commitment to address two wilderness related issues: visitor use management and carrying capacity in National Park Service units (Belnap et al., 1997). More recently, National Park Service Director John Jarvis reinvigorated NPS wilderness management by issuing Director's Order #41, which provides "Accountability, consistency, and continuity in the National Park Service wilderness stewardship program," and guides "Service-wide efforts in meeting the letter and spirit of the Wilderness Act" (National Park Service, 2013). This call adds renewed salience and scrutiny to the issue of wilderness management in individual National Park Service units.

Specific to upholding wilderness character in Yosemite National Park, managers have implemented wilderness regulations to help distribute use in a way that preserves the resource and social conditions of its wilderness. Currently, Yosemite manages overnight wilderness trips using a mandatory limited-use permit system structured around zone-based trailhead quotas. Furthermore, Yosemite implemented a mandatory, limited-use permit system for day hikers on the Half Dome Trail System in 2011 (National Park Service, 2012). The permit system was instituted primarily to address safety concerns magnified by the trail's high visitation rates. While addressing issues of public safety and resource protection, this highly controversial day trip regulation stirred concern among the public (Peterson, 2012; Skindrud, 2012). As Yosemite continues to move forward in developing its wilderness stewardship plan, managers will have to address issues of trail crowding and compromised wilderness character in areas that have experienced large increases in the number of day trips. Given the large number of wilderness day users at Yosemite, managers will have to consider the concerns and impacts of this large segment of the wilderness user population in addition to legal mandates originating from the Wilderness Act and National Park Service directives.

Relevance of Thesis Work to Wilderness Day Use Management

As wilderness managers act to comply with legislative and institutional pressures for developing contemporary wilderness stewardship plans that address current and future threats to wilderness character (National Park Service, 2013; *Wilderness Act of* 1964), information regarding the spatial travel patterns and decision making of the growing wilderness day use population will be valuable in justifying new management actions. The goal of the National Wilderness Preservation System to protect large, undeveloped areas from future development for enjoyment of current and future generations has remained unchanged since its inception in 1964. However, over the past 50 years the type of use in wilderness has evolved with shifting societal values (Chavez, 2000; Cordell, Tarrant, & Green, 2003). As wilderness managers work to promote a fixed goal in the midst of continual changes in use and values, being equipped with as much accurate information about the changing user groups as possible will enable managers to enact and defend sound management strategies to uphold the provisions of the Wilderness Act of 1964.

Knowledge of visitor movement and flow on popular wilderness day hiking trails will provide managers with concrete data on visitor use in areas of wilderness easily accessible to the day user population. This knowledge can be used to support targeted management actions in areas where wilderness character has been compromised due to high use. Data on spatial distributions of visitors at wilderness attraction sites is valuable in answering questions about use capacity, providing data on both social impacts to wilderness experience and the location of biophysical site impacts resulting from changes in visitor use. This spatial and temporal knowledge will enable managers to view wilderness areas as networks through which visitors move, allowing for development of management interventions targeted at known problem areas.

Additionally, understanding how wilderness day users choose a wilderness trail is necessary in the creation of new management strategies that target day trips in crowded areas of wilderness. Knowledge of the sources and information used in decision making, the decision-making process itself, and the range of context-dependent factors influencing visitor decisions to take day trips in wilderness will enable managers to target specific aspects of visitor decision making when designing communication campaigns, engaging in site management, and potentially instituting use limits or other regulations.

Contribution to Larger Body of Research

The two studies that follow expand on the research methods and theory used in understanding wilderness day users. Focusing on day user decision making and the spatial and temporal variation in day use not only provides Yosemite managers with knowledge that can be directly used in planning, but it also fills gaps in the wilderness day use literature. The examination of the spatial and temporal characteristics of wilderness day use in Chapter 2 contributes to current literature on the viability of using visitor carried GPS units for recreation user data collection and using spatial statistics to examine use patterns. Furthermore, this work explores methods for quantifying visitor micro-level displacement behavior at wilderness attraction sites. Previous micro-level displacement studies have used invasive and time consuming methods to record visitor behavior; employing GPS technology overcomes these traditional data collection limits. Chapter 2 expands the understanding of visitor micro-level site displacement through contributing a method for determining micro-level site displacement derived from GPS data. Chapter 3 examines day user trail choice decision making, contributing to the decision making and information theory literature by demonstrating a new application of theory to wilderness users and through linking decision making and information theory in a single application. Additionally, it provides Yosemite managers with a snapshot of how wilderness day users are obtaining information about wilderness day hikes and which pieces of information are important in decision making. This information provides a potential avenue for influencing day user decision making through strategic information provision.

Chapter 2

Spatial and Temporal Characteristics of Wilderness Day User Distribution: Descriptive Statistics and Micro-Level Displacement Measures

The study of an individual's use of space and time is an ongoing subject of interest for a variety of fields, including urban planning and design, tourism, transportation, and health (Beeco et al., 2013; Biljecki, Ledoux, & van Oosterom, 2013; Boers & Cottrell, 2007; van der Spek, van Schaick, de Bois, & de Haan, 2009; Vine, Buys, & Aird, 2012). The advent of widely available access to Global Positioning System (GPS) technology has led to the ability to track the movement of people through space and time (van der Spek et al., 2009).

The application of GPS to tracking individuals provides researchers, managers, and planners with discrete, objective data on movement patterns and the amount of time spent in locations. This type of information is especially relevant to planners and policy makers because it provides concrete information about the individual's movements within an environment that can be used in decision making and allocation of funds. A recent application of GPS technology to visitor tracking illustrates the utility of this type of information in a real-world setting. GPS units were used to track visitor movement along the Blue Ridge Parkway in two Virginia counties to determine movement patterns through tourist destinations (Beeco et al., 2013). The GPS units provided researchers with the time spent on primary roads, secondary roads, and at stopping locations; these dependent variables were used in conjunction with survey data to classify participants into one of two visitor types. Researchers found that tourists visiting the counties spent the majority of time stopped at locations rather than traveling on scenic, secondary roads. This type of information was useful to community economic development planners and advertisers for justifying recommendations regarding advertisement placement along highways and other economic development efforts within the tourist attraction areas along the Blue Ridge Parkway.

In the context of Yosemite National Park, wilderness managers have some knowledge of the amount of wilderness day use in the park. For example, they have enough professional knowledge to classify wilderness trails as high, moderate, and low day use trails. However, they have only anecdotal and limited observational evidence of the spatial movements of day users in wilderness. Yosemite managers have little definitive information regarding trip characteristics such as average amount of time spent in wilderness, average distance traveled in wilderness, or visitor behavior at attraction sites. Quantifying these factors would provide managers with a concrete understanding of how day hikers are using wilderness areas and an indication of potentially compromised resource or social conditions due to human use (Hammitt & Cole, 1998). For example, if micro-level site displacement coping behaviors can be linked to levels of use density, managers may be able develop an indicator of social conditions present at an attraction site (Broom, 2010). As such, spatial data may be valuable in developing realistic management strategies to address known problem areas, in justifying changes to existing management strategies, and in defending management actions for public and legal audiences (Hallo et al., 2012; van der Spek et al., 2009).

Visitor Tracking

To generate data characterizing the extent of wilderness day use on high and moderate use trails, visitor-held GPS units were used to collect spatial and temporal data from day users during their trips on select Yosemite wilderness trails from June to

September, 2012. Automated GPS loggers collected a series of X and Y coordinates, accompanied by time stamps, for each hiker sampled, which were used to create a “track” of the travel route taken by the wilderness day hiker (van der Spek et al., 2009). Using GPS as a method of data collection overcomes some of the limits of traditional methods of collecting visitor use tracking information such as travel dairies, way-cards, and researcher observation. GPS tracking expands on previous methods by providing a reliable way to estimate the temporal component of movement (van der Spek et al., 2009). Specifically, GPS provides researchers with exact locations and time stamps for tracks, whereas self-reported or researcher recorded methods of data collection are subject to estimation error and imprecision that can lead to misrepresentations of actual travel patterns (Hallo et al., 2012; van der Spek et al., 2009). Using GPS technology also removes the potential negative impacts to experience caused by more invasive methods of data collection such as physically following the visitor or observing visitor movements (Cole & Hall, 2012). Furthermore, as GPS technology has continued to advance, earlier obstacles to using GPS technology in visitor use studies, such as burden to the visitor and unit cost, have been resolved (Hallo et al., 2012).

The use of GPS units as a means of collecting travel pattern information from individuals is well documented in multiple bodies of literature. GPS units have been successfully used to track pedestrian travel in urban, built environments in the Netherlands (van der Spek et al., 2009) and Australia (Vine et al., 2012), as well as in urban parks in Hong Kong (Lai, Li, Chan, & Kwong, 2007) and Denmark (Harder et al., 2007). Additionally, GPS units have been used to track the movement of hunters in various natural settings (Broseth & Pedersen, 2000; Lyon & Burcham, 1998; Stedman et al., 2004). In recreation studies, GPS units have been used to track vehicle travel patterns in Acadia National Park and vehicle movement along the Blue Ridge Parkway, demonstrating that GPS technology can be used effectively in complex travel networks (Beeco et al., 2013; Hallo, Manning, Valliere, & Budruk, 2005). Specific to Yosemite, GPS technology has been used to understand visitor movement patterns in the Mariposa Grove (Leslie et al., 2012) and on select wilderness trails in Tuolumne Meadows (Newman & Lawson, 2012, *unpublished draft*).

This study contributes to the literature through application of GPS technology to develop two dependent variables (distance traveled and time spent in wilderness) for use in understanding variation in hiking experience between various user groups of interest on trails in Yosemite Wilderness. In addition, this study examined the potential for analysis of attraction site GPS data to create an automated measure of micro-level site displacement at wilderness destinations, such as lakes or vista points. Finally, this study explored the strength of correlations between the developed micro-level site displacement measure and other relevant visitor use data, such as use density derived from trail counters and survey items such as visitor-reported encounters and crowding. Use counts and visitor reports are already used by wilderness managers to quantify social conditions present in wilderness (Broom & Hall, 2010). While GPS technology has the potential for increased accuracy of spatial and temporal information, when used in isolation it does not provide qualitative or contextual data that might be collected using more traditional forms of visitor tracking. Therefore, traditional methods of visitor tracking should not be discounted, but rather researchers should investigate the integration of GPS with other data collection methods to determine the potential ability to understand visitor use from multiple dimensions (Beeco et al., 2013). Identifying whether meaningful relationships exist between any of the social indicators generated as part of this study and micro-level site displacement will be useful to managers interested in meeting site-specific experience standards in wilderness and integrating automated and traditional methods for collecting visitor use data.

Researcher Observation of Visitor Characteristics

Survey research on wilderness day users often reports demographic information about the survey respondents to provide a general idea of the composition of the wilderness user population. In fact, visitor characteristics are often considered a form of baseline data for wilderness managers, helping to answer the question of who visits wilderness (Cole & Wright, 2004). For example, a wilderness visitor use study conducted in Rocky Mountain National Park in 2002 provided detailed breakdowns of both visitor and trip characteristics, including age of wilderness users and group size distributions. This type of descriptive information was included because of managerial requests to know more about wilderness visitors (Wallace, Brooks, & Bates, 2004). In keeping with the trend to report demographic characteristics of wilderness users, group size and estimated age of group members were recorded for all hiking groups participating in the Yosemite GPS study. These two characteristics were included specifically because they could be easily observed by researchers and because they have the potential to impact the two measures of interest: distance traveled in wilderness and time spent in wilderness. Group size has the potential to impact travel due to variability in group members' physical hiking abilities and desired experiences. Similarly, age of group members also has the potential to impact travel, particularly in terms of hiking ability. Children or elderly group members might reduce the distance or duration of wilderness travel. Determining if group size and age of group members impact the average distance traveled and average time spent in wilderness provides a tangible linkage between the user characteristics and their physical use of wilderness. The strength of the linkage between the two data types can provide managers with concrete data about whether group characteristics are useful in predicting the physical use of wilderness. This type of linkage will allow managers to not only better understand the composition of wilderness day users, but also identify managerially relevant user groups. Furthermore, any documented differences originating from these group characteristics will provide further justification for recording and accounting for this sort of demographic data in further spatial research.

Micro-Level Site Displacement

Increased day use in wilderness has resulted in crowding due to high densities of users in some wilderness areas (Cole & Hall, 2008, 2012; Cole, 2001a, 2001b). Crowding can negatively impact a visitor's experience when the level of use exceeds the visitor's expectation for his or her experience (Hall & Shelby, 2000). When experience expectations are not met, visitors use both cognitive and behavioral coping mechanisms to respond to the negative stimulus (Manning & Valliere, 2001). Displacement is a behavioral coping mechanism in which visitors respond to undesirable resource conditions (such a crowding) by changing their recreation-related behavior. Displacement, in a recreation setting, can take three different forms: activity, temporal, and spatial displacement. If a visitor chooses to return to a site, despite undesirable conditions, but copes by changing his or her use activity at the site, activity displacement has occurred (Hall & Shelby, 2000). Temporal displacement occurs when a visitor returns to the same geographic location, but chooses to alter the timing of his or her visit to avoid undesirable conditions (Hall & Shelby, 2000;

Schneider, 2007). Spatial displacement occurs when the visitor reacts to undesirable resource conditions by changing the geographic location of his or her recreation experience. If the visitor decides to visit a new location altogether to avoid the undesirable conditions, inter-site displacement has occurred. If the visitor returns to the same geographic location, but alters his or her placement within the site, micro-level site displacement (intra-site displacement) has occurred (Cole & Hall, 2012; Hall & Shelby, 2000; Schneider, 2007).

Empirical support for the occurrence of displacement in recreation settings is variable, with displacement studies occurring across a wide variety of scales, settings, and populations. Spatial and temporal displacement have been studied among boaters on popular rivers (Shelby, Bregenzer, & Johnson, 1988), visitors to high use reservoirs (Hall & Shelby, 2000), users of natural parks close to urban centers (Arnberger & Brandenburg, 2007; Arnberger & Haider, 2007), residents of gateway communities (Manning & Valliere, 2001), and wilderness users (Cole & Hall, 2012). Multiple data collection methods have been employed to examine displacement, including on-site interviews and questionnaires, mail back questionnaires, and researcher observation. Relevant to this work, a recent study by Cole and Hall (2012) measured four aspects of micro-level displacement using researcher observation methods at wilderness attraction sites:

- Percentage of groups that passed over an occupied preferred site
- Percentage of groups that selected an already occupied site
- Percentage of groups that displaced another group by intruding on their site
- Percentage of groups that were displaced by arrivals of new groups at their site

Examining these micro-level displacement measures in the context of use density, Cole and Hall (2012) found that under high use density social conditions, displacement behaviors were significantly higher than at moderate to low use density social conditions.

Cole and Hall (2012) used researcher observations to document visitor movement and record the number of other people present at the wilderness attraction site during the observation period. Researchers observed selected hiking groups at Snow Lake (Alpine Lakes Wilderness, WA) for 30 minutes, recording the behavior exhibited in selecting a stopping place and any other activities during the observation period. The focus of my study was also micro-level site displacement; however, I used spatial statistics for cluster analysis of GPS track logs of visitor movement at popular wilderness attraction sites in Yosemite National Park to operationalize the occurrence of micro-level site displacement using two forms of sensor data: infrared trail counters and visitor carried GPS units. Rather than using the researcher observation method employed to quantify micro-level site displacement in the Snow Lake study, I used a combination of spatial (GPS tracks) and aspatial (use density) data to study the relationship between visitor location within space and use level within that space. Additionally, instead of looking at the individual activity of each visitor like the Snow Lake study, visitor behaviors at specific use levels were examined in aggregate using Ripley's *K* functions, a descriptive spatial analysis technique that uses the distance between points to determine overall cluster patterns (Mitchell, 2005; Ripley, 1981). Subsequently, nearest neighbor hierarchical cluster analysis, a spatial analysis technique that identifies the occurrence of clusters, was used to further explore trends in cluster patterns.

The Snow Lake study characterized use density by day of the week, with weekend days classified as high use density and weekdays classified as low use density. However, studies have found considerable variation in use within a day. For example, in a study of visitors to popular attraction sites in Uluru National Park, Australia, McIntyre and Boag (1995) found that use density preferences of visitors were exceeded only for certain portions of the day during peak season use. Furthermore, at certain hours of the day very few visitors were present at popular attraction sites, despite sampling the during peak use season (McIntyre & Boag, 1995). Therefore, I used trail counter data to allow for more refined use density classification of GPS tracks based on actual use, rather than merely by day of the week. This accounts for the reality that use on a given day varies and, therefore, the social conditions present likewise vary throughout the day.

My analysis focused on identifying differences in use patterns at specific attraction sites among high, medium, and low use periods. Quantifying the dispersion or clustering of hikers provided information on the geographic locations of visitors in space at the three use levels. Based on Cole and Hall's (2012) findings at Snow Lake, I expected micro-level site displacement to be lower at low use levels and higher at high use levels. In other words, I expected a higher level of dispersion or a greater number of clusters at high use levels, indicating that users may be displaced from the most desirable places within an attraction site. Examining the clustering of track data at low use levels revealed patterns in visitor movement when a smaller number of visitors is present at the site, enabling the identification of movement patterns under desirable social conditions. Looking to see if systematic differences existed in the clustering of users at the three use levels provided a broad picture of micro-level displacement. As an exploratory effort, this portion of the thesis was designed to determine how well two automated data collection methods (GPS and trail counter) could be used to refine the study of micro-level site displacement.

The data collection and analysis methods used in this study overcome limitations of the methods used in the Snow Lake study. First, using GPS units to collect data about visitor location at the attraction site reduces observer error and the intrusion of being watched on a visitor's experience. Additionally, rather than collecting data for only the first 30 minutes a visitor was at an attraction site, the GPS tracks provided spatial data during the entire duration of the visitor's presence at the attraction site. However, a limitation of the use of GPS units for data collection is that visitor interactions with other visitors cannot be documented – GPS units do not interact with each other, and GPS units were not carried simultaneously by all groups present at the attraction site. Furthermore, relying solely on GPS and trail counter data does not provide data on each individual's experience with micro-level site displacement. This limitation was overcome by the availability of exit survey data in which GPS participants reported the number of other groups encountered, the degree of crowding on trails and at attraction sites, and the impact of encounters on four aspects of wilderness experience. The inclusion of the exit survey enabled this work to shed light on the overall trend in the occurrence of micro-level displacement as it relates to trail use in conjunction with an investigation of self-reported crowding and encounter impacts. The Snow Lake study found that weekend visitors, considered to be experiencing high density use social conditions, were more likely than weekday users to report feelings of crowdedness at attraction sites due to high use densities (Cole & Hall, 2012). Therefore, I hypothesized that perceived crowding and negative experience measures would be correlated with high use density and the occurrence of micro-level displacement behavior.

Research Questions

This study sought to answer the following research questions:

1. What is the average distance traveled by wilderness day users?
    a. Is group size a predictor of average distance traveled in wilderness?
    b. Does the average distance traveled vary by the age category of the majority of group members? Does the average distance traveled vary by the age category of the oldest group member?
    c. Does the average distance traveled vary with the presence of children 17 years of age and below? Does the average distance traveled vary with the presence of children under 10 years of age?
2. What is the average amount of time spent in wilderness by day users?
    a. Is group size a significant predictor of the average amount of time spent in wilderness?
    b. Does the average amount of time spent in wilderness vary by the age category of the majority of group members? Does the average time spent vary by the age category of the oldest group member?
    c. Does the average amount of time spent in wilderness vary with the presence of children 17 years of age and below? Does the average distance traveled vary with the presence of children under 10 years of age?
3. What percentage of wilderness day hikers only travel to the most popular wilderness attraction site for a given trail? What percentage of hikers do not make it to the attraction site? What percentage hikes beyond the attraction site?
4. What percentage of wilderness day hikers take one-way trips, connecting two or more wilderness trails into a loop?

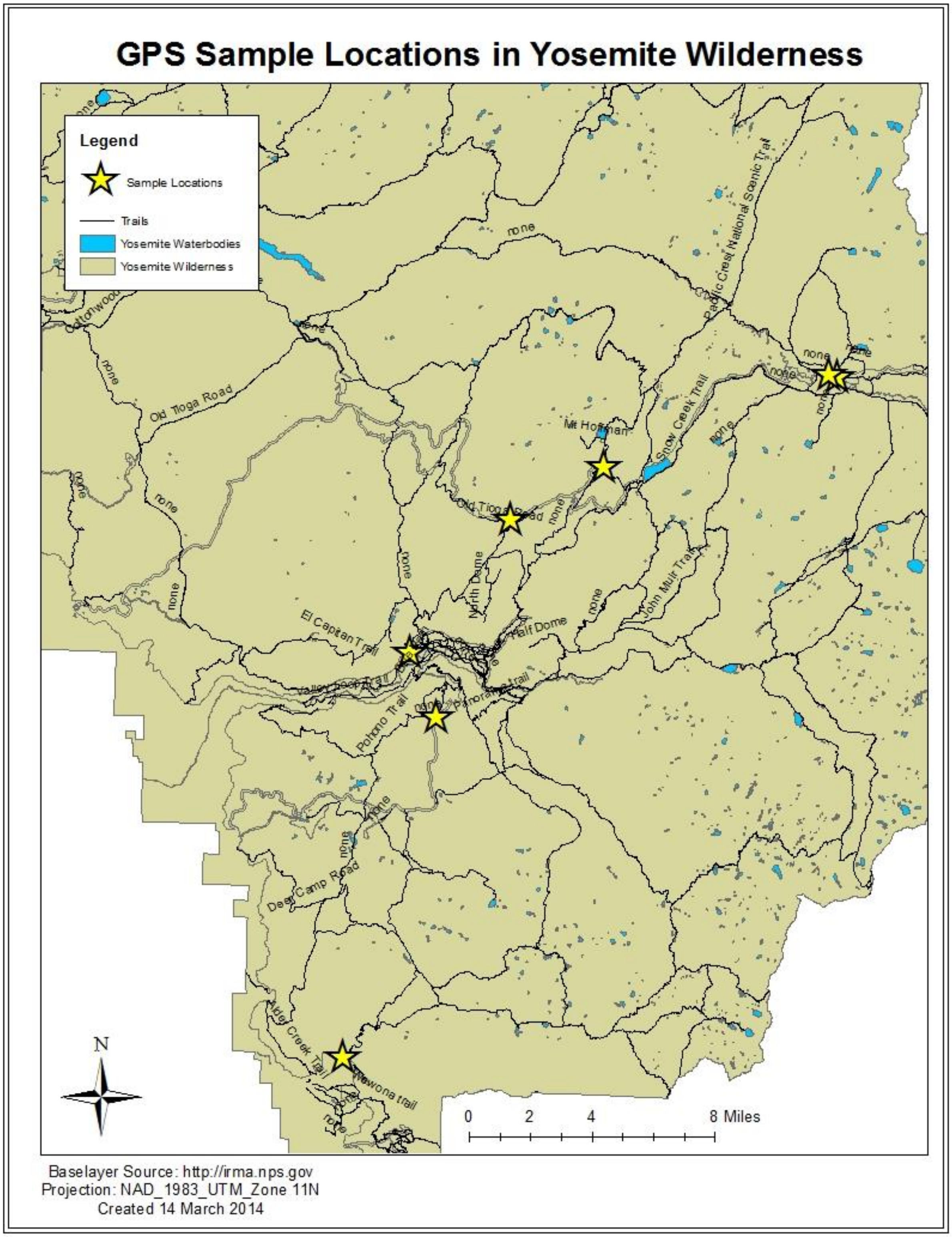
5. What effect does use density have on micro-level site displacement of visitors at wilderness attraction sites?
6. Does the occurrence of micro-level site displacement correlate with the number of self-reported wilderness encounters, crowding on trails and at destinations, and the reported impacts of encounters on wilderness experience?

Data Collection Methods

Data were collected during the summer 2012 field season at seven wilderness trails in Yosemite National Park. Figure 1 depicts the geographic location of the seven sampled trails – sample locations are marked with yellow stars.

Figure 1

Map of GPS Distribution Locations in Yosemite Wilderness



Three primary goals influenced trailhead selection for distribution of GPS units. To gain an understanding of wilderness use park-wide, wilderness trails were selected in three main regions of the park: Wawona, Yosemite Valley, and along Tioga Road. Trails were also selected based on their connectivity to a larger trail network. Connectivity between trails was a factor in selection because managers expressed an interest in determining travel direction of day hikers, namely whether or not the majority of day hikers on these trails through-hike via connected trails or hike to a point and return via the same route. Trails were identified through consideration of their popularity for day use, geographic location, and the number of other trails to which they connected. Trails located along Tioga Road and in Tuolumne Meadows previously sampled with GPS units in Lawson's 2009 Tioga Noise Exposure Modeling project were not considered for resampling. Additionally, only trails classified as receiving high or moderate use by the Visitor Use and Social Science Branch were selected to maximize data generation efforts during a limited field season. Final trail selections were made after consultation with wilderness managers and researchers from the Visitor Use and Social Science Branch of Yosemite's Resource Management and Science Division.

The limits of GPS technology also impacted site selection. Landscape topography can impact the accuracy of the GPS coordinates recorded by a device. Steep canyon walls or dense forest canopy can block the line of sight between the GPS unit and its triangulating satellites. When the GPS unit cannot receive satellite signals it cannot record accurate location coordinates, becoming ineffective as a method of data collection. In the application of GPS units in this study, study administrators tested the reliability of the GPS unit to collect accurate GPS location points on each trail being sampled. Wilderness trails located on the south side of Yosemite Valley Canyon (Four Mile Trail) and in narrower portions of Yosemite Valley Canyon (Mist Trail, John Muir Trail) were not selected for sampling because unit error was too great at these locations. The following seven wilderness trails met the criteria discussed above, serving as the focus of this study: Chilnualna Falls, Upper Yosemite Falls, Porcupine Creek, May Lake, the trail to Glen Aulin at Parson's Lodge, the Dog Lake / Lembert Dome loop, and the Sentinel Dome / Taft Point loop.

Sampling targeted the peak use times documented in the 2008 visitor use study, *Estimating Visitor Use in Yosemite National Park* (Pettebone, Newman, Beaton, Stack, & Gibson, 2008). Consideration of time constraints, gear availability, and the feasibility of on-the-ground field operations led me to decide that targeting peak use dates would be the most appropriate way to generate data. Specifically, because the study was not launched until June 23, 2012, the field season was shortened, and I concluded that focusing the work on peak use times would be more likely to generate adequately large samples than a representative sample of the days remaining in the summer 2012 field season. Moreover, because peak use times differ in different sections of the park, this sampling scheme allowed for data generation at several geographic locations throughout Yosemite's Wilderness, satisfying one of the study's main goals to understand day user travel patterns wilderness-wide. Additionally, I had to consider the limited availability of trail counters, GPS unit drop boxes, and GPS units and the feasibility of deploying equipment at each sampling location. A continuous sampling period at each location was used to accommodate gear availability, reduce user error in gear setup and take-down, and minimize ecological and social impacts of gear deployment.

The Chilnualna Falls and Upper Yosemite Falls trails were sampled earlier in the summer field season (end of June to mid-July) because they contained waterfall viewing areas where use declines as water levels drop. Trails along Tioga Road and in Tuolumne Meadows were sampled in late July and August because use in these areas generally increases as the summer progresses. The Sentinel Dome / Taft Point loop was sampled over Labor Day weekend because use is higher in this area during the holiday weekend (Pettebone, Newman, & Lawson, 2010).

Variability of travel patterns in terms of distance traveled in wilderness and use of multiple connected trails in a single day trip were considered in selecting the number of days for each sample period. More complex trails were sampled for more days than trails determined to be less complex. Trail complexity was evaluated on a number of factors including the length of the trail, physical difficulty of the trail, the number of other trails to which the sampled trail connected, the number of entry points leading to the trail, and the number of attractions along the trail. For example, the Chilnualna Falls Trail was considered to be relatively simple because it only leads to only one trail junction, approximately 5.5 miles into wilderness. Furthermore, managers anecdotally know that most hikers on this trail go to the only wilderness attraction located along the trail, the top of Chilnualna Falls, and return to the starting trailhead. The low level of trail complexity and manager knowledge led to the assumption that spatial variability would be low for the Chilnualna Falls Trail – in other words, the likelihood that the sampled trips would vary greatly from visitor to visitor was determined to be low. This determination led to a shorter sampling period of five days. Conversely, the Upper Yosemite Falls Trail and the Porcupine Creek Trail were each sampled for 11 days due to the potential for high spatial variability in travel patterns of trail users on these trails. The day of the week was not a consideration in sample design because GPS units were handed out according to the same time interval schedule, regardless of the day of the week. Trail counters were deployed during GPS sample periods to provide contextual information regarding the volume of visitors using a trail during sampling. Most sample periods contained a combination of weekdays and weekends. Table 1 lists the seven selected trails and the dates during which they were sampled with GPS units.

Table 1

GPS Distribution Locations and Sample Periods

Trailhead	*Sample Period*
Chilnualna Falls	June 23 - June 28
Upper Yosemite Falls	June 30 - July 10
Porcupine Creek	July 14 - July 24
Dog Lake / Lembert Dome	August 2 - August 12
Parson's Lodge	August 2 - August 12
May Lake	August 17 - August 30
Sentinel Dome/Taft Point	August 31 - Sept. 6

Data collection began with deployment of trail counters at the marked wilderness boundary of the sampled trail to track volume of visitors (both day and overnight) using the trail network during the sample period. The TRAFx counters used were two-way counters, recording a tally each time an individual passed through the infrared beam emitted by the counter scope (TRAFx Research Ltd., 2007). Each counter was programmed to record counts in one-hour time bins. The observer calibration method was used to calibrate all deployed trail counters to account for inherent unit error and determine reliability of the counter (Watson, Cole, Turner, & Reynolds, 2000). To do this, the study administrators recorded the total number of visitors entering and exiting the trail, as well as the corresponding count displayed on the counter screen. Regression analysis was used to determine the numerical relationship between the counts observed by study administrators and the counts recorded by the TRAFx unit, allowing a calibration coefficient to be developed for each TRAFx counter (Pettebone, Newman, & Lawson, 2010). The count data collected by the trail counter were multiplied by the calibration coefficient (Table 2) to produce an estimate of actual use. Calibration data were recorded at fifteen minute time intervals for eight to ten hours per day, resulting in 32-40 calibration observations. Overall, the units were quite accurate.

Table 2

Trail Counter Calibration Coefficients

Location	*Calibration Coefficient*
Chilnualna Falls	0.989
Upper Yosemite Falls	0.976
Porcupine Creek	0.973
Dog Lake	0.965
Lembert Dome	0.983
Parsons Lodge	0.964
May Lake	0.984
Sentinel Dome/Taft Point	0.986

Due to the limited number of GPS units available for the study and the logistics of charging and downloading the units before deployment, distribution of 28 units per day was set as the desired target for each trail system. Beginning at 8:00 a.m. (except at the Sentinel Dome / Taft Point trailhead, where distribution began at 9:00 a.m.), units were distributed at 15-minute, 20-minute, or 30-minute intervals depending on the number of trails being sampled that day. Table 3 lists the trails where GPS units were distributed, the time interval of distribution, and the target number of units per day.

Table 3

GPS Distribution Intervals and Target Units per Day

Trailhead	*Time Interval*	*Target Units Per Day*
Chilnualna Falls	15 minutes	28
Upper Yosemite Falls	15 minutes	28
*Porcupine Creek**	20, 15 minutes	21, 28
Dog Lake / Lembert Dome	30 minutes	14
Parson's Lodge	30 minutes	14
May Lake	15 minutes	28
Sentinel Dome / Taft Point	15 minutes	28

* Distribution of units varied during the 11 day sample period due to the discontinuation of concurrent sampling due to low use at Yosemite Creek. Units intended for Yosemite Creek distribution were reassigned to concurrent distribution at Porcupine Creek, resulting in 15-minute distribution intervals for Porcupine Creek from July 19-24, 2012.

Study administrators approached visitors at the specified time interval; if a day use group did not arrive at the appointed time or refused to participate in the study, the next arriving group was approached. Reasons for refusal to participate were recorded when offered by the visitor. If multiple time stamps were missed due to low trail use, unit distribution continued until the desired number of units (28) was distributed each day.

Overall, the response rate for the GPS study was 94.7%, with 73 groups refusing to carry a GPS unit out of a total of 1,382 groups that were approached to participate in the study. The most common reasons for refusal included language barriers preventing group members from understanding the approach script, and groups stating that they were in a hurry to get back or that they did not want to carry the unit. Interestingly, only three groups refused to participate in the study because a member did not agree with the use of technology by the park to track visitors.

In addition to distributing GPS units, researchers recorded the following publicly observable demographic information for all participating groups: entrance time, exit time, group size, and estimated age of each member in the hiking group. GPS units were not distributed to day use groups with stock. Age was estimated by placing each visitor into one of the following categories: less than 10 years of age, 10-17 years of age, 18-40 years of age, 41-60 years of age, and older than 60 years of age. For children under 10 years of age, gender was not recorded; rather, study administrators recorded whether the child was walking or being carried by another group member (factors that could potentially impact the group's movement in wilderness). Each study administrator was trained by the lead researcher to control for variability in estimating an individual's age. Demographic information was collected to provide the park with an idea of the current day user demographic in Yosemite and determine if average length and duration of the wilderness trip varied with group size and age of group members.

Because of the use of human subjects, Institutional Review Board (IRB) approval was obtained; due to the use of anonymous human subjects, the study received an IRB certification of exemption (Appendix A). Study administrators used a script approved by the IRB and Yosemite National Park to solicit participation in the GPS study (Appendix B). Additionally, because research was conducted in Yosemite National Park, a park research permit was obtained June 6, 2012 (YOSE-2012-SCI-0125; Appendix C).

GPS Participant Exit Survey

As part of a larger data collection effort to understand wilderness day users that took place during the summer 2012 field season, brief exit surveys were administered to GPS study participants at the Dog Lake / Lembert Dome, May Lake, and Sentinel Dome / Taft Point distribution locations. The number of completed exit surveys varied by location and is not equivalent to the number of GPS tracks collected at each location. Only exit surveys that could be matched with a GPS track used for the micro-level displacement study were used for analysis. At Dog Lake, 58 surveys were available for analysis. At May Lake, 127 surveys were available, and at Sentinel Dome 62 surveys were available. Missing surveys were due to refusals or incomplete and/or blank surveys returned.

Three questions on the exit survey were used to explore the potential for triangulating multiple sources of data as part of the micro-level site displacement study. Participants were asked to report the number of other groups encountered while hiking, the degree of crowding on trails and at destinations, and the impact of the number of people encountered on four aspects of wilderness experience (Appendix D). These aspects were enjoyment, sense of being in wilderness, sense of solitude, and sense of freedom, scored on a five-point Likert-type scale ranging from 2 (encounters added greatly) to -2 (encountered detracted greatly). These measures are commonly used by wilderness researchers to understand the user's evaluation of the impacts of use density on his or her wilderness experience (Cole & Williams, 2012). Asking questions about variation in social conditions during different aspects of the wilderness trip (i.e., on trails and at attraction sites) was helpful for understanding the strength of relationships between user evaluations of their experience and use density throughout a wilderness trip. These surveys were coded as originating from users during low, moderate, or high use periods, to examine differences related to use levels at each location.

GPS Data Processing

GPS data were downloaded on site and exported as GPX files; in total, 1,276 GPS tracks were collected from wilderness day hikers. My colleague, Daniel Irizarry, wrote a Python script that converted the GPX files to a CSV file format that was compatible with ArcMap 10.1. I wrote a separate script that produced line feature classes for each GPS track, and calculated the two dependent variables of interest, distance traveled and time spent in wilderness, for each of the feature classes. To ensure that the distance calculation accurately reflected the geographic curvature of Earth, a projected coordinate system was used to project the geographic coordinate system before the distance calculation was completed (NAD 1983 UTM Zone 11N). The distance calculation was completed using a built-in function in ArcMap 10.1 that automatically calculates the length of a line feature class based on the projected coordinate system. This figure was converted into miles, serving as the dependent variable for distance traveled. The time spent in wilderness variable was calculated using the first and last time entries embedded in the GPS data file – the difference between the two time entries was calculated to produce the time spent hiking in hours and minutes.

Approximately 200 GPS units were deposited in GPS drop boxes located at the sampling trailheads or were otherwise not returned to study administrators at the point of distribution. Additional processing was performed on these tracks to accurately represent the time and distance traveled by hikers carrying these GPS units. The GPX files were converted to the CSV format using the same initial script. I wrote a script that produced a point feature class of each CSV file for use in ArcMap 10.1. The drop box files were manually cleaned, deleting the points originating from the location of the drop box, along park roads, and at entrance gates or other buildings where the unit was returned. Figures 2 and 3 show two screen shots of a GPS unit that was returned to a drop box located at the trailhead. This unit continued to collect data until its battery died. The large congregation of points at the end of the trail represent the data points collected while the unit was in the drop box. As the figures show, these large collections of points were easy to identify manually and, therefore, easy to delete with accuracy.

Figure 2

Track from a GPS Unit Deposited in a Drop Box

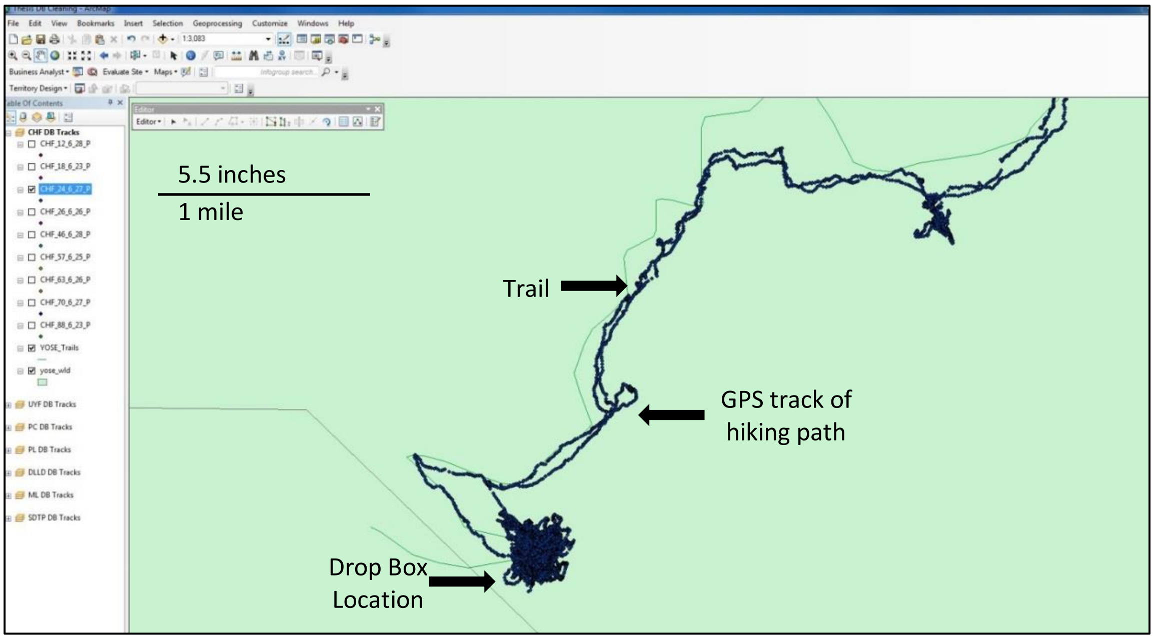
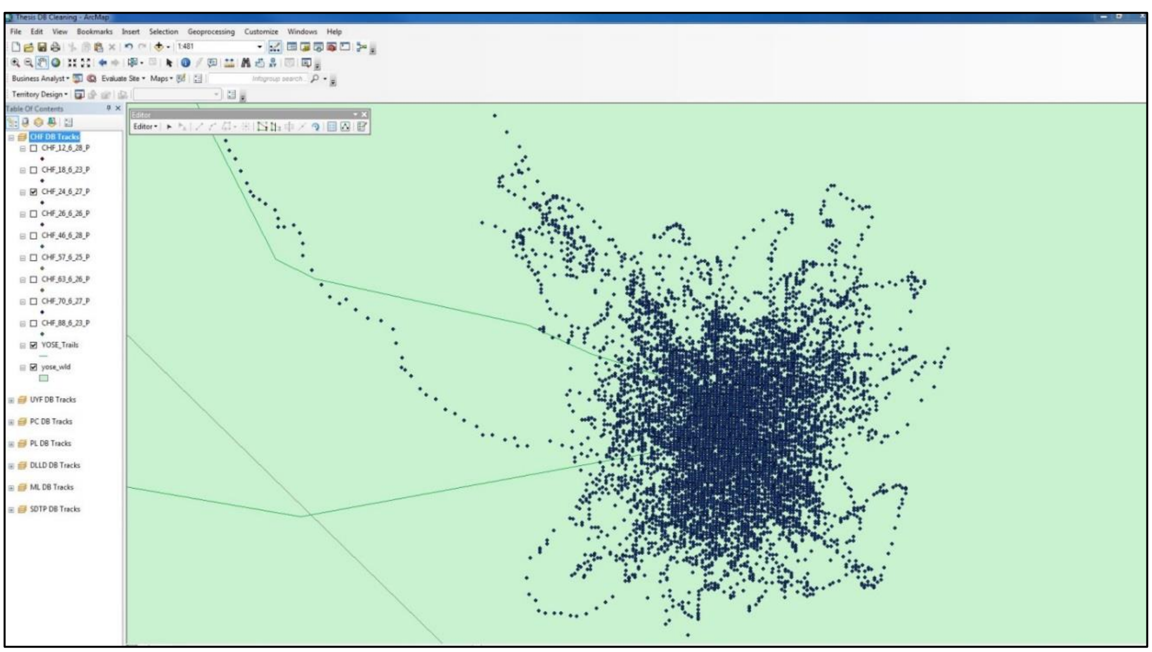


Figure 3

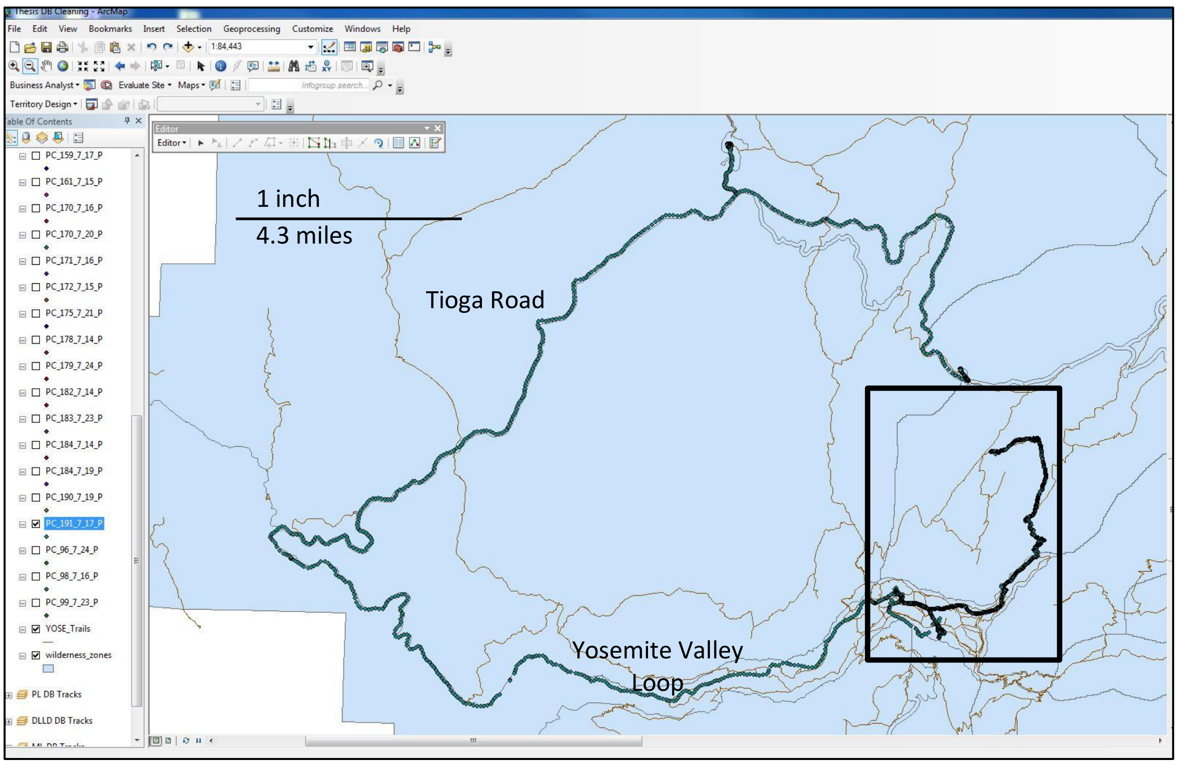
Close-up of Drop Box Points for Deletion



Figures 4 and 5 show two sequential screenshots of the data cleaning process for a unit that was not returned at the trailhead. The unit was distributed at the Porcupine Creek sample location, the hike was recorded, and then the unit left the wilderness and traveled along major park roads. The track finally ends at the Tuolumne Meadows Ranger Station where the unit was returned. The two figures show the results of the data cleaning process.

Figure 4

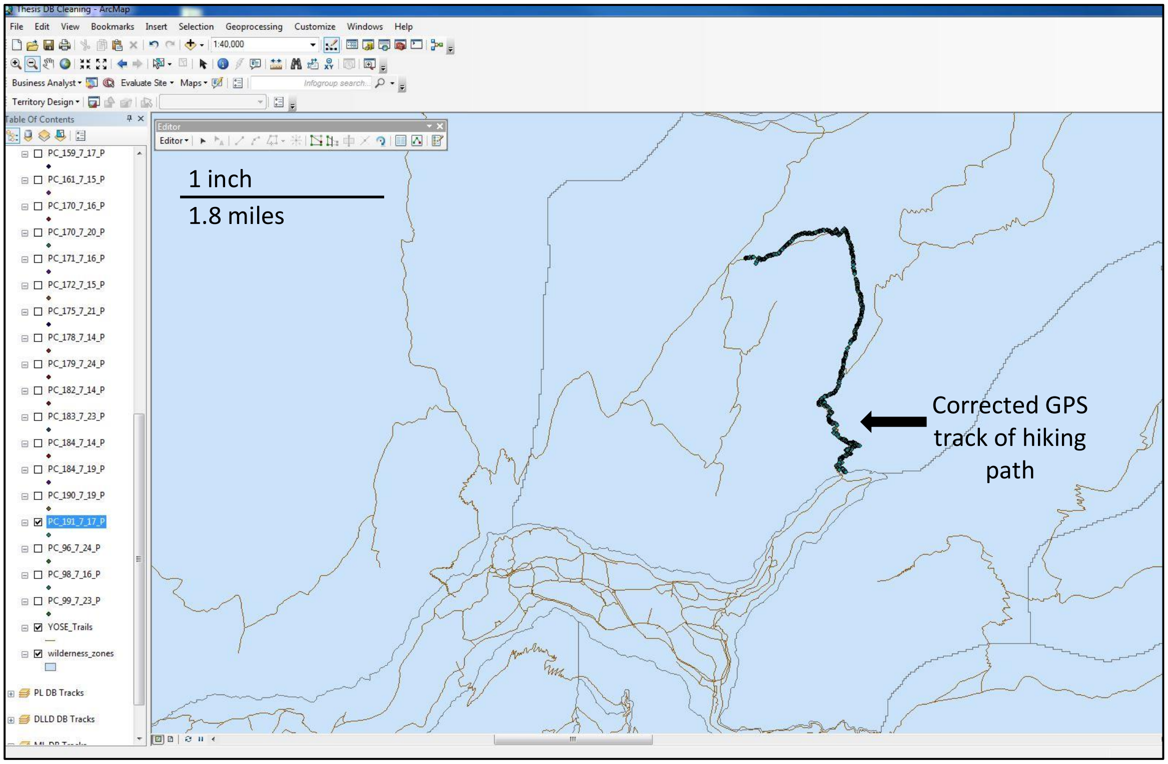
Driving Track before Data Cleaning



This GPS unit was not returned to the study administrator. This track indicates that the unit continued collecting points while the hiker was driving through the park. Only the portion of the track located within the rectangular outline is actually located on a trail. The rest of the track is located on park roads.

Figure 5

Driving Track after Data Cleaning



The cleaning process removed all of the points that were collected outside of wilderness (on the road). The remaining points were saved, converted to a line feature class, and used in analysis.

I undertook precautions to ensure that valid data points were not deleted, such as examining the time stamps and accompanying geographic locations of the points in the attribute table of each track. For example, ArcMap 10.1 allows for the selection of a data point based on any attribute of that data point. In examining whether points were drop box points or valid data points, I looked at the Object ID attribute of the data point. If the Object ID was in the first 100 or so points, I was able to determine that those points were not drop box points (they were points from the beginning of the hike) and exclude them from the selected points to be removed. After the bad points had been removed from each of the point feature classes, I exported the attribute table of each feature class to a CSV file. These files were then run through a similar Python script to create a line feature class, calculating and adding the two dependent variables as attribute fields.

After calculating both dependent variables for each GPS track, I manually associated the dependent variables with the information from the track log. This was possible based on the location, date of collection, and unit number stored in both data sets. This step provided another opportunity for data cleaning, as missing data files and bad GPS tracks were identified during this process. Approximately 8% of the data files (n=102) were identified as missing during this process. Missing files arose for a number of reasons including poor GPS signal preventing the collection of data, dysfunctional GPS units that were not emitting or receiving data, and accidental deletion during the data download process. (Due the limited availability of GPS units for distribution, some of the units were sent out multiple times to collect data for multiple different trips – this sometimes caused confusion in the data download process that could have resulted in track deletion.) Finally, some GPS units were not returned by the visitor. A review of the database indicates that tracks were not systematically missing, and the percent missing for any one site varied from 4.4% to 11.7%.

After adjusting for the missing tracks, 1,174 GPS tracks were available for analysis. From this group, bad tracks were removed. Bad tracks were those in which the distance traveled and/or time spent did not seem possible or the time traveled did not match with a manually calculated time traveled. For example, if a track showed a distance traveled of .03 miles in 20 hours, it was identified as a “bad track.” Two time calculations were also used to determine unit accuracy. All GPS units that were received by administrators had the time of entry and time of exit recorded on the on-site log form. The difference between these two times was calculated and compared to the time traveled variable calculated from the GPS data. If the time calculated from the unit and the time recorded by the administrator differed by more than 30 minutes, then the unit was marked as a bad track. Thirty minutes was determined to be a reasonable margin of error between the two times, allowing for the GPS unit to obtain a fix and also accounting for human error and/or estimation in recording time on the log form. Possible reasons for the existence of bad tracks include disruptions of satellite reception, the GPS unit obtaining a fix from another receiver, the GPS signal reverberating between canyon walls creating noise in the data, or the visitor turning the unit off. In total, 148 tracks (12.6%) were identified as bad tracks and excluded from the final analysis. The final dataset used for analysis was comprised of 1,026 tracks. Table 4 reports the percentage of missing units and bad tracks by sample location.

Table 4

Missing and Bad GPS Tracks by Location

Location	*Initial*	*% Missing*	*Adjusted*	*% Bad Tracks*	*Useable Tracks*
Chilnualna Falls	92	4.4 (n=4)	88	12.5 (n=11)	77
Dog Lake / Lembert Dome	160	11.3 (n=18)	142	22.5 (n=32)	110
May Lake	228	8.8 (n=20)	208	7.7 (n=16)	192
Porcupine Creek	191	5.8 (n=11)	180	13.9 (n=25)	155
Parson's Lodge	135	10.4 (n=14)	121	12.4 (n=15)	106
Sentinel Dome / Taft Point	163	11.7 (n=19)	144	17.4 (n=25)	119
Upper Yosemite Falls	307	5.2 (n=16)	291	8.3 (24)	267
Total	1276	8.0 (n=102)	1174	12.6 (n=148)	1026

Excluding bad data points from the overall data set is consistent with other studies that use personal GPS units to track individuals. In fact, the percentages for this study were smaller than many reported in the literature. For example in their study tracking the movement of urban residents, van der Spek et al. (2009) reported that with an original sample size of 1,300 tracks, only 60% of the GPS data collected were valid. The remaining

40% of the data were determined to be inaccurate due to problems with obtaining a satellite fix, batteries dying, clouds obscuring GPS signal reception, and fragmentation of the tracks.

Analysis: Group Characteristics and Use Variation

IBM SPSS was used to perform all statistical analyses. Due to a non-normal distribution of the full dataset and the physical differences between each of the seven trails sampled, analyses were performed at the trail level rather than aggregated at the park level. The seven trails were chosen to represent a range of wilderness experiences in Yosemite including variation in geographic location, trail difficulty, distance to an attraction site, and use level. Therefore, it is inappropriate to aggregate the data to provide wilderness-wide averages of distance traveled and time spent in wilderness. Consequently, results are reported for each trail individually.

The data were examined for normality using box and whisker plots, population pyramid distributions, and simple scatter plots. Additionally, skewness and kurtosis values were calculated for the two dependent variables at each location (Table 5). Data for two locations were found to have unacceptable skewness and kurtosis values; therefore, non-parametric tests were performed for these two locations to overcome the violated assumptions of normality needed for parametric tests. Non-parametric tests assign ranks to data points, assigning low ranks to low values and high ranks to high values. The analysis is then performed on the ranks, eliminating outliers and peaks occurring in the original dataset that caused the non-normal distribution, violating the normality assumption needed for parametric tests (Field, 2013).

Table 5

Examination of Normality: Skewness and Kurtosis Values for Distance and Time, by Trail

	Distance Traveled in Wilderness		*Time Spent in Wilderness*	
	Skewness	**Kurtosis**	**Skewness**	**Kurtosis**
Chilnualna Falls	-0.76	-0.69	0.35	0.21
*Dog Lake / Lembert Dome**	2.45	5.58	2.23	4.70
*May Lake**	4.00	24.60	1.41	3.82
Porcupine Creek	-0.93	1.83	-0.36	1.33
Parson's Lodge	0.53	0.65	0.59	0.96
Sentinel Dome / Taft Point	0.59	-0.90	0.69	-0.33
Upper Yosemite Falls	0.80	1.26	0.29	-0.39

*Denotes scores unacceptable for the use of parametric statistical tests. Non-parametric tests were used.

Sample means were generated to provide estimates of the average distance traveled in wilderness and the average amount of time spent in wilderness by trail. Linear regression was used to examine the relationship between group size and distance traveled, and between group size and time spent in wilderness. Linear regression was chosen because the two variables of interest for this question were continuous variables.

One-way analysis of variance (ANOVA) tests were used to examine the relationship between age categories of group members and the two dependent variables of interest (time spent in wilderness and distance traveled in wilderness). To determine significance at the 95% confidence level, $\alpha = 0.05$ was used for all tests. Levene's test was performed to determine whether the data upheld the assumption of homogeneity of variance needed for accurate application of the ANOVA test. A significant Levene's test statistic indicates that the assumption of homogeneity of variance has been violated. In these instances, Welch and Browns-Forsythe tests were conducted. For ANOVAs, Tukey's HSD post-hoc comparisons for unequal sample sizes were conducted to determine where significant differences existed between groups. Data from the Dog Lake / Lembert Dome trail and the May Lake trail were heavily right skewed and the distribution around the mean was leptokurtic, with a sharper than normal distribution (Table 5). Therefore, the non-parametric Kruskal-Wallis test was conducted to examine variation according to the age category of group members at these locations.

Two variables were created to examine the relationship between age and the dependent variables: age category of the majority of group members and age category of the oldest group member. Codes were assigned to represent the following categories: 3 was assigned to entries with the majority in the 18-40 category, 2 was assigned to entries with the majority in the 41-60 category, and 1 was assigned to entries with the majority in the 61 + category. The codes were assigned in reverse order because I anticipated that the younger the age category of the group members, the longer and farther would be the trip. Similarly, the age category of the oldest group member was coded using a 1, 2, or 3. If at least one group member was in the 61 + age category, then a 1 was assigned to the group. If the oldest category was the 41-60 category, a 2 was assigned to the entry. All other entries were assigned a 3, because the oldest group member was in the 18-40 age category.

Independent sample *t*-tests were used to examine the relationship between presence of children and the dependent variables to answer research questions 1c and 2c. To determine significance at the 95% confidence level, $\alpha = 0.05$ was used for all tests. Levene's test was conducted for each of the *t*-tests to determine whether the assumption of equal variances was upheld. In cases where this assumption was violated, the test statistic and significance level for the equal variances not assumed were used to determine the statistical significance of potential differences in the two populations. Mann-Whitney non-parametric statistical tests were used to evaluate differences between groups for data from Dog Lake / Lembert Dome and May Lake.

A binary code was assigned to the data (0 = absence of children, 1 = presence of children), creating the two groups for conducting the *t*-tests. Two different variables were created to examine the impact of children on the dependent variables. The first represented any children present in any of the four categories on the original log form: children under the age of ten 10 being carried, children under the age of 10 walking, female children ages 10 – 17, male children ages 10 – 17. To further examine the impact of younger children on trip duration and distance traveled, the second variable represented presence of children under 10. This use of two separate variables for presence of children allowed for the exploration of the specific impact of small children on trip length and duration.

Analysis: Trail Network Use Patterns

To summarize data on wilderness day hiker use patterns, the data were examined in ESRI's ArcMap 10.1 to determine extent and direction of travel. For each location, I calculated the percentage of hikers that traveled only to wilderness attraction sites (and no further), the percentage of hikers that did not make it to the wilderness attraction site, and the percentage of hikers that traveled beyond the wilderness attraction site. Attraction sites for each trail were determined using a combination of previous professional experience and reviewing Yosemite National Park's printed hiking resources distributed to visitors at the park's visitor centers. For example, the "Tuolumne Area Day Hikes" pamphlet available for free from the Tuolumne Meadows Visitor Center includes the following information about the Dog Lake / Lembert Dome trail: "The trail rises steeply for 0.75 miles to a signed junction. Turn left to reach the top of Lembert Dome for a spectacular view of Tuolumne

Meadows and the surrounding peaks. To reach Dog Log, continue straight at the junction." From this description, it is clear that Dog Lake and Lembert Dome are the two hiking destinations present within this small trail network. For sites with multiple attraction sites along the trail, like the Dog Lake / Lembert Dome trail system referenced above, percentages were computed for each attraction site. Finally, the percentage of hikers taking one-way trips that connected two or more trails in a single trip was also calculated to provide information on day hiker use of wilderness trail networks. For this calculation, the percentages reported for Dog Lake / Lembert Dome and Sentinel Dome / Taft Point represent individuals who traveled beyond the two trail networks. These two sampling locations are small, interconnected trail networks with two destinations located a short distance apart. Use of these smaller networks was not considered in calculating the network percentages because the physical location of unit distribution at these sites made it inappropriate to determine how many hikers completed a loop trip; the percentages would have misrepresented the data. Particularly at Dog Lake, two study administrators would have had to be stationed at the Dog Lake trailhead and at the Lembert Dome trailhead to be able to accurately describe the percentage of hikers making a loop trip. Due to personnel and equipment limits, only one study administrator distributed units at the Dog Lake site.

Tracks were categorized in ArcMap 10.1 by overlaying the tracks on a detailed map of Yosemite National Park. The map included three main features: wilderness trails, water features, and a digital elevation model (DEM). The inclusion of wilderness trails allowed for the determination of a one-way trip versus an out-and-back trip. The inclusion of water features and a DEM allowed for the determination of whether the hiker traveled to a wilderness attraction site such as a dome (DEM), lake (water feature), or waterfall (water feature). Table 6 contains a list of the most popular wilderness attraction sites for each of the sample location. Appendix E contains a complete list of the title and source of the data layers used in analysis.

Table 6

Wilderness Attraction Sites for Each Location

Location	*Attraction Site*
Chilnualna Falls	Top of Chilnualna Falls
*Dog Lake / Lembert Dome**	Dog Lake or top of Lembert Dome
May Lake	May Lake
Porcupine Creek	North Dome
Parson's Lodge	Glen Aulin
*Sentinel Dome / Taft Point**	Sentinel Dome or Taft Point
Upper Yosemite Falls	Top of Upper Yosemite Falls

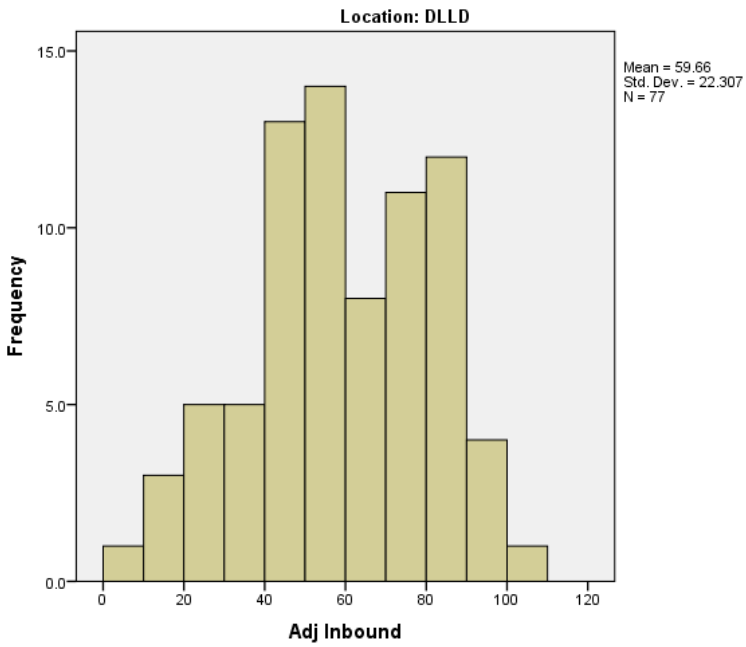
*These two trails are designed as loop trails with two distinct destination points. Units were handed out at the trail junction for both trails.

Analysis: Micro-Level Site Displacement

Each GPS track log was assigned a use level: high, moderate, low. The use level attribute was calculated using calibrated hourly trail counter data that were collected concurrently during the distribution of GPS units at the wilderness trailhead from which the GPS track originated. Calibrated trail counter data from the hour prior to distribution, hour of distribution, and hour after distribution of the GPS unit were summed to produce an estimate of the number of hikers present on the trail, and potentially at the attraction site. The summed total was multiplied by the coefficient for the percentage of inbound hikers on the trail. The calibrated inbound hiker count was used because it most accurately represented the number of other individuals headed toward the same destination point as the hiker carrying the GPS unit. This final use figure represented the estimated number of inbound hikers during the three-hour period during which the GPS unit was distributed. This three-hour block should adequately represent use of the wilderness attraction site because the trails considered for this portion of the study are relatively short in terms of mileage to the destination point. Assuming an average pace of two miles per hour, this three-hour window would accommodate the paces of slow, fast, and average hikers on the trail at a given time, providing a generous window for arrival at the attraction site. The summed totals of trail use for all the GPS units were divided into three categories using natural breaks in the data at each location to minimize within group variation from the mean while maximizing between group variation from the group means. Histograms of the use estimates per track were generated to identify the three natural groups at each of the three locations. Valleys in the histograms represented the natural break points in use within each location. Figure 6 provides the histograms from which the breaks were identified. At Dog Lake, low use was considered to be 40 or fewer inbound individuals, moderate use was considered to be 41 to 70 inbound individuals, and high use was considered to be more than 70 inbound hikers. At May Lake, 35 or fewer inbound individuals represented low use, 36 to 50 represented moderate use, and more than 50 individuals represented high use at the attraction site. Finally, at Sentinel Dome, 70 inbound individuals or less represented low use, 71 to 110 individuals represented moderate use, and more than 110 inbound individuals represented high use.

Figure 6

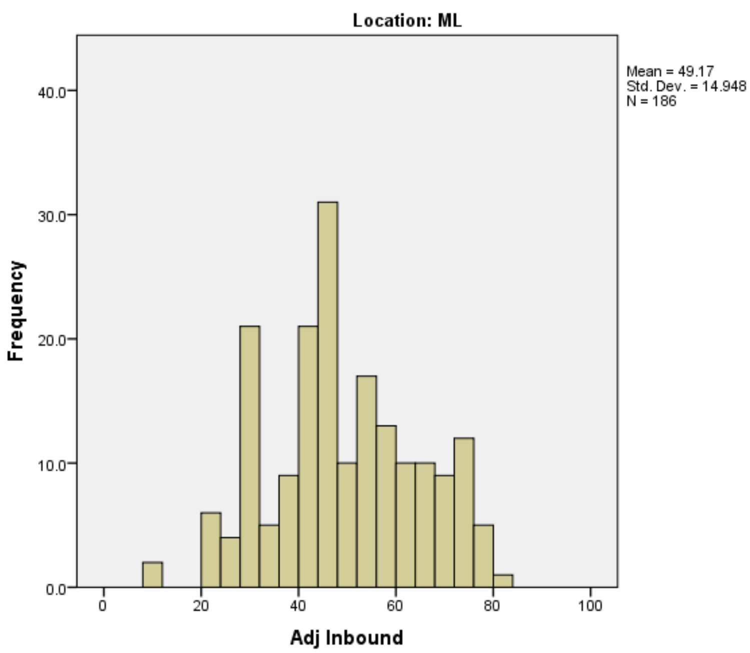
Histograms of Inbound Use



Histograms of the frequency of inbound use estimate for (top to bottom) Dog Lake, May Lake, and Sentinel Dome.

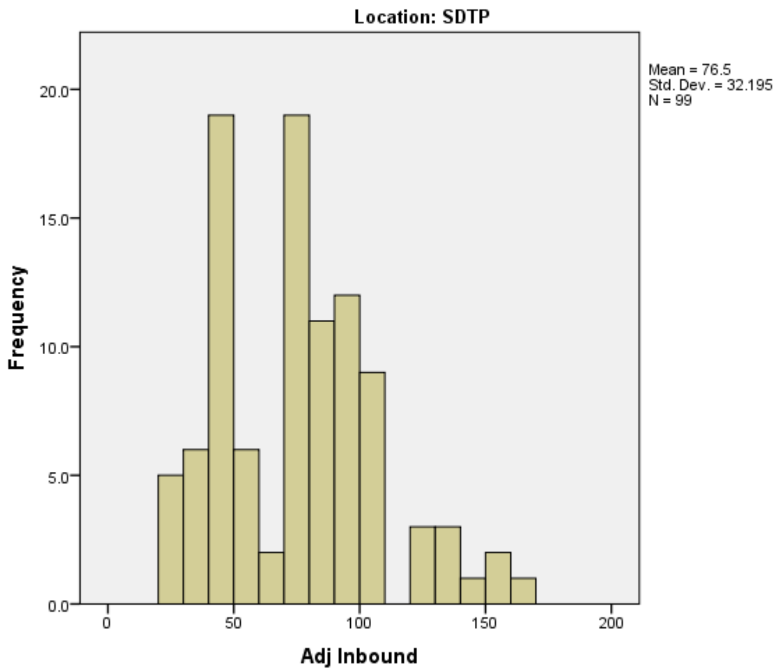
Dog Lake

Dog Lake breaks: low fewer than 40, moderate 41 to 70, high more than 70 inbound hikers.



May Lake

May Lake breaks: low fewer than 35, moderate 36 to 50, high more than 50 inbound hikers.



Sentinel Dome

Sentinel Dome breaks: low fewer than 70, moderate 71 to 110, high more than 110 inbound hikers.

Ripley's *K* function analyses were used to calculate a *K* statistic for each group of tracks at each of the use classification levels at each location using CrimeStat III, an open source spatial analysis and statistics software (Levine, 2010). A *K* function is a spatial statistic used for identifying cluster patterns in spatial data (Mitchell, 2005). This analysis counts the number of neighboring points within a given distance of each feature, summing the number of points. If the number of points found within the distance is greater than the number of points expected from a random distribution, the data are considered to be statistically clustered. CrimeStat III produces a modified Ripley's *K* function, known as an *L* function – a rescaled *K* function that establishes linear and horizontal references for spatial randomness to zero (Levine, 2010). As the distance measure between points increases, *K* values can become extremely large; applying an *L* function transformation is standard practice for making the output easier to read (Mitchell, 2005). In other words, the *L* function simply rescales the results of the *K* function to manageable Y-axis values. Calculating *K* functions using the point data from track logs at each use level not only determines if clustering occurs within a use level at a given distance, but it determines the statistical significance of the cluster pattern, adding rigor to the analysis and strength to the conclusions. Furthermore, *K* functions (or *L* functions) can be compared; *K* functions at high, moderate, and low use levels were compared for differences in clustering behavior within a site. *K* functions between sites were compared for similarities in clustering behavior between the use levels. Determining if the observed patterns can be observed between use levels at more than one location adds further strength to the conclusions drawn from the cluster analysis.

Point feature classes at each of the three sample locations were clipped using a buffered area around the wilderness attraction site at which displacement was explored. For the two lake sites, linear unit distance buffers were created around the lake feature to isolate the points representing use at the attraction site. Visual inspection of the data showed that a 200-foot buffer around Dog Lake adequately captured use around the lake; a 300-foot buffer adequately selected points at May Lake. At Sentinel Dome, points were selected based on their location relative to the trail junction leading to the dome. The last portion of the Sentinel Dome trail begins at the base of Sentinel Dome – points past this trail junction leading to the summit were selected. Points from each track were merged according to the use classification assigned to each track, creating nine point feature classes representing the point data at each location at each use level (Figures 7, 8, and 9). These point feature classes were used for Ripley's *K* function analysis. Both the Dog Lake and May Lake point feature classes contained a few points located in the lake. These points may represent noise in the data, but they also might represent a hiker walking in a shallow part of the lake. It is not anticipated that these points had an impact on either of the spatial analyses performed on the data.

Figure 7

Point Feature Classes Used in Dog Lake Spatial Analysis

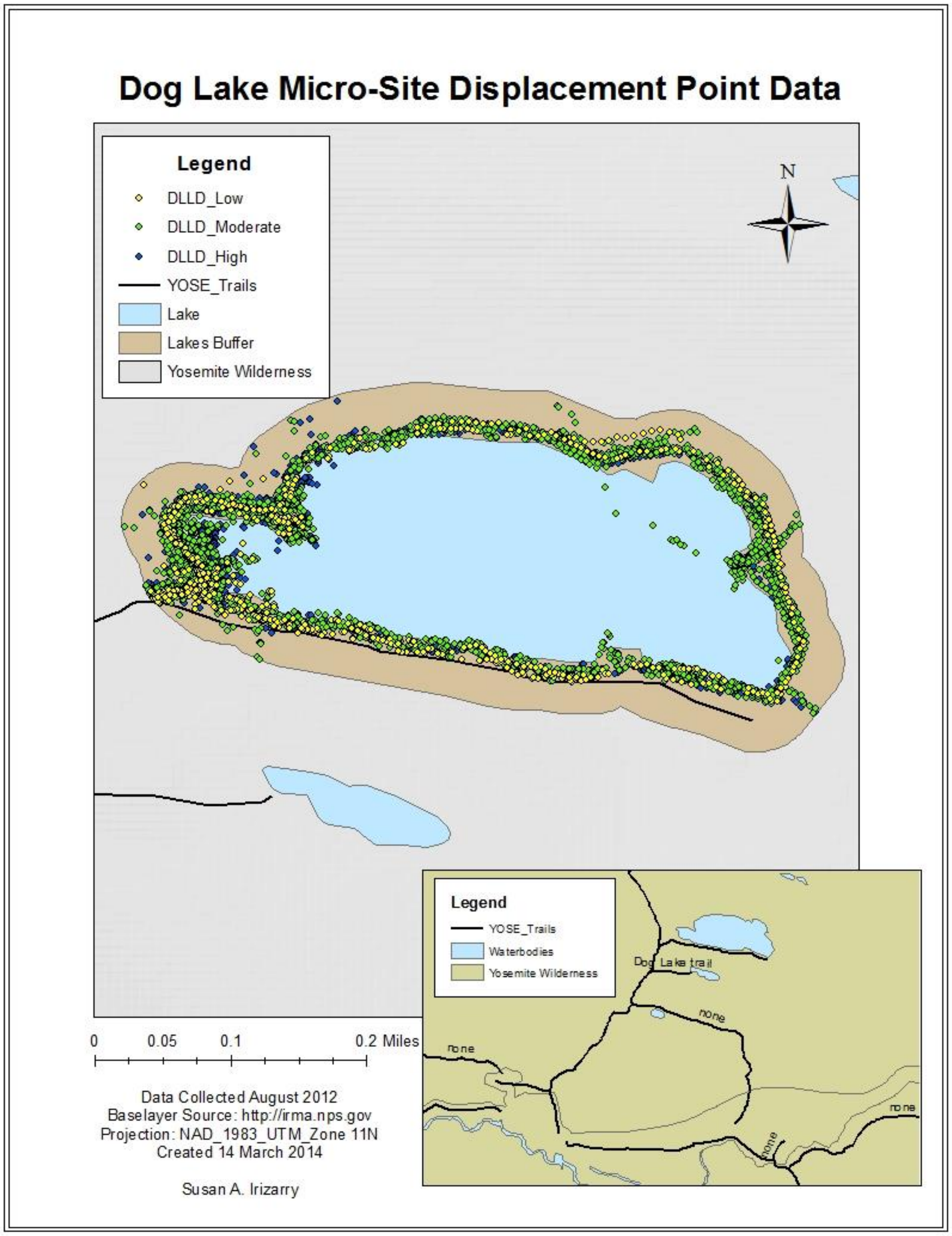


Figure 8

Point Feature Classes Used in May Lake Spatial Analysis

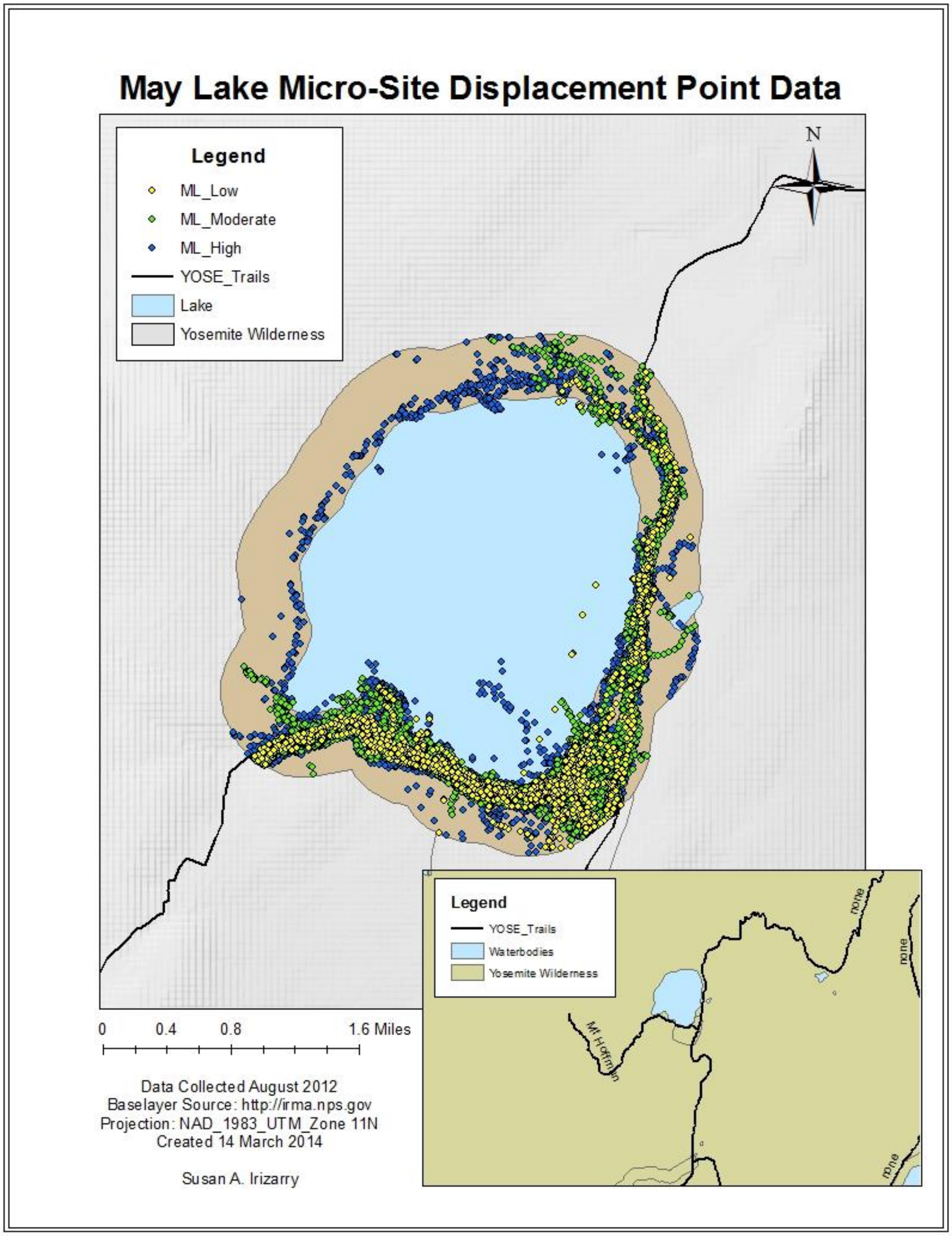
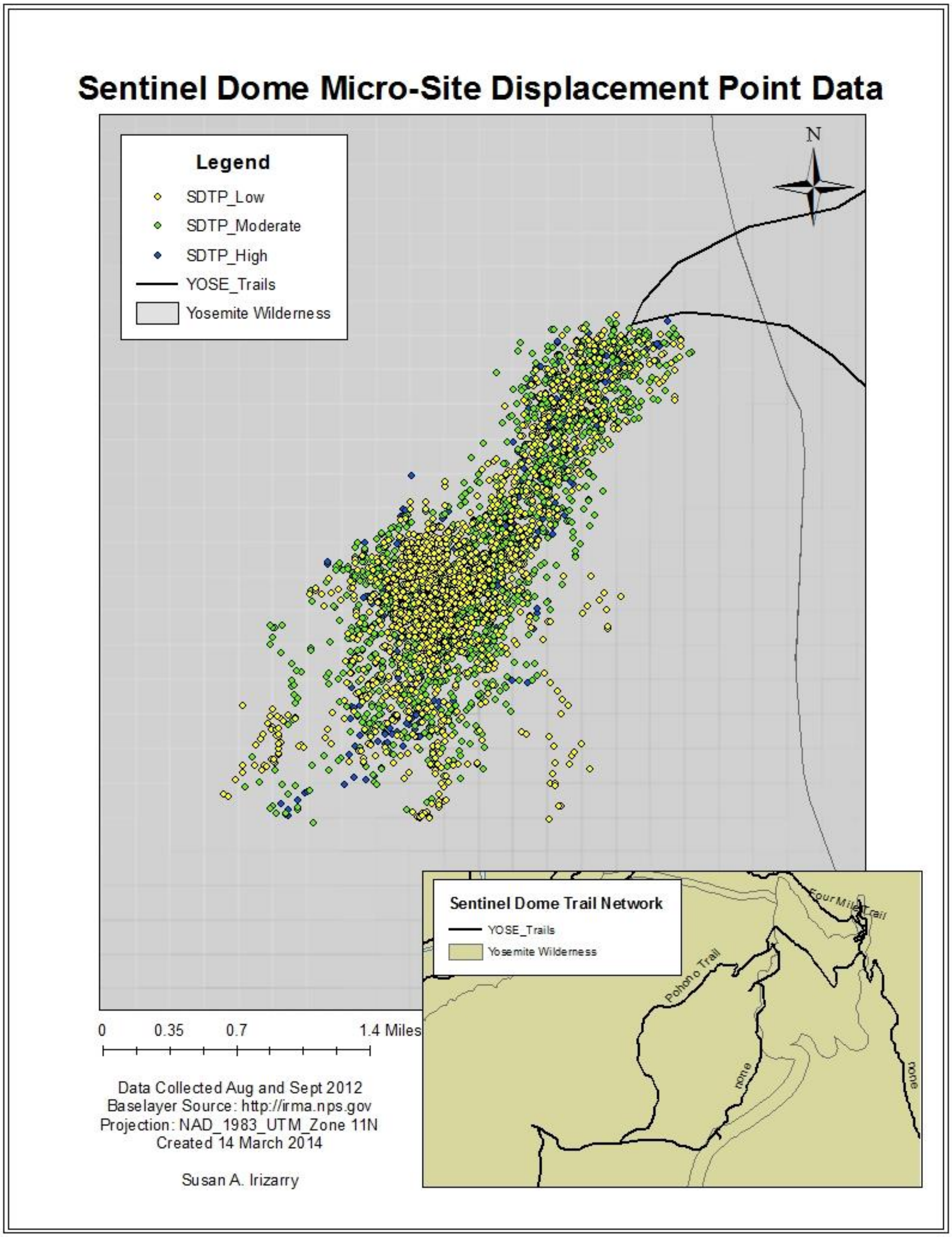


Figure 9

Point Feature Classes Used in Sentinel Dome Spatial Analysis



If differences and patterns in clustering behavior were determined to exist through *K* function comparison, nearest neighbor hierarchical cluster analysis was performed using CrimeStat III to determine where the clusters existed within each use level (Levine, 2010; Mitchell, 2005). This type of spatial analysis identifies clusters of discrete features based on a user-established confidence interval and a threshold distance. A 90% confidence interval was used for analysis; the threshold distance was calculated automatically by CrimeStat III based on the confidence interval provided. After exploring the responsiveness of the data to the minimum points per cluster parameter, the minimum number of points per cluster was set to 25 points for each cluster analysis. Additionally, the area of the spatial extent of each location was entered into the measurement parameter field to provide the software with a reference for the location of cluster activity. The areas for the locations are as follows: Dog Lake 1,317,373.47 ft^2, May Lake 2,098,166.00 ft^2, and Sentinel Dome 293,854.75 ft^2. Areas were calculated in ArcMap 10.1 using the "calculate area" tool for buffers created around each attraction site. For Dog Lake and May Lake, the areas were calculated for the shape encompassed by the 200-foot or 300-foot buffer around the respective lakes. For Sentinel Dome, a 200-foot buffer from the trail was used for the area calculation.

First order clusters (level 1 clusters) were identified through initial iterations of the analysis, and second order clusters (level 2 clusters) were hierarchically identified at larger scales through additional iterations. This type of multi-step analysis allows for the identification of specific clusters and patterns in the clustering. It also tests the likelihood that the clusters were produced due to chance, again adding rigor and confidence to conclusions drawn from the analysis. Clusters were symbolized using convex hulls rather than ellipses because the shape of the convex hull is driven by the actual shape of the cluster, making convex hulls the most accurate representation of point data (Levine, 2010).

Data Collection and Analysis Summary

Table 7 provides a breakdown of the data, analysis technique, and software used to answer each research question. As stated previously, results are reported at the trail level – each analysis was performed for an individual trail rather than trails in aggregate.

Table 7

Summary of Data and Analyses Performed for Each Trail

Research Question	*Data*	*Analysis*	*Program*
What is the average distance traveled by wilderness day users?	All GPS tracks, demographic data	Descriptive summary statistics, linear regression, ANOVA, *t*-test	SPSS
What is the average amount of time spent in wilderness by day users?	All GPS tracks, demographic data	Descriptive summary statistics, linear regression, ANOVA, *t*-test	SPSS
What percentage of users only travel to a wilderness attraction site?	All GPS tracks	Descriptive statistics	ArcMap 10.1
What percentage of users take one-way trips in wilderness?	All GPS Tracks	Descriptive statistics	ArcMap 10.1
What effect does use density have on micro-level displacement behavior?	GPS tracks (Dog Lake, May Lake, Sentinel Dome), trail counter data	Ripley's *K* function, Nearest neighbor hierarchical cluster analysis	CrimeStat III, ArcMap 10.1
Does visitor displacement behavior correlate with self-reported wilderness encounters and reported impacts to experience?	GPS tracks (Dog Lake, May Lake, Sentinel Dome), trail counter data, exit survey	ANOVA	SPSS

Results: Group Characteristics and Use Variation

The mean distance traveled and mean amount of time spent in wilderness varied among the seven sample locations (Table 8). The location with the shortest distance traveled and amount of time spent in wilderness was Dog Lake / Lembert Dome, while the longest distance traveled and time spent in wilderness was Porcupine Creek. Distance traveled and time spent in wilderness were highly variable at Dog Lake / Lembert Dome and Parson's Lodge, as indicated by the relatively large standard deviations for distance and time at each of those locations. The large standard deviations seen at Dog Lake / Lembert Dome are probably the result of a subgroup of visitors traveling well beyond Dog Lake / Lembert Dome to destinations such as Young Lakes. The variation seen at Parson's Lodge can also be explained by subgroups of visitors traveling variable distances along the trail to Glen Aulin that begins at Parson's Lodge. The primary destination for this trail, Glen Aulin, is approximately 5 miles from the trailhead. However, the views and scenery located along the trail are extremely beautiful, and the trail itself is quite flat. Variability in distance and time could have resulted from different hiking goals between sampled groups, given the wide range of experiential options hikers on the trail to Glen Aulin have at their disposal.

Table 8

Sample Means for Distance Traveled and Time Spent in Wilderness by Trail

Location	*Sub-sample Size (n)*	*Mean Distance Traveled (Miles)*	*Mean Time Spent Hiking (Hours)*
Chinualna Falls	77	$\bar{x}$ = 4.46, *SD* = 1.84	$\bar{x}$ = 3.75, *SD* = 1.82
Dog Lake / Lembert Dome	110	$\bar{x}$ = 2.48, *SD* = 3.20	$\bar{x}$ = 2.03, *SD* = 2.08
May Lake	192	$\bar{x}$ = 3.18, *SD* = 2.23	$\bar{x}$ = 3.00, *SD* = 1.75
Porcupine Creek	155	$\bar{x}$ = 6.61, *SD* = 1.81	$\bar{x}$ = 4.50, *SD* = 1.37
Parson's Lodge	106	$\bar{x}$ = 5.75, *SD* = 3.46	$\bar{x}$ = 3.90, *SD* = 2.35
Sentinel Dome / Taft Point	119	$\bar{x}$ = 2.94, *SD* = 1.31	$\bar{x}$ = 2.37, *SD* = 1.05
Upper Yosemite Falls	267	$\bar{x}$ = 4.71, *SD* = 2.90	$\bar{x}$ = 4.35, *SD* = 2.33

Linear regression analysis showed that group size did not significantly predict distance traveled in wilderness or amount time spent in wilderness (Tables 9 and 10). *F*-tests were not statistically significant at $\alpha = 0.05$, indicating that group size was no better than chance at predicting the dependent variables of time and distance.

Table 9

Distance Traveled in Wilderness as a Function of Group Size

Location	*R*	R^2	*F-test Statistic*	*p-value*
Chilnualna Falls	0.18	0.03	2.57	0.11
Dog Lake / Lembert Dome	0.16	0.03	2.78	0.10
May Lake	0.06	0.00	0.78	0.38
Porcupine Creek	0.04	0.00	0.26	0.61
Parson's Lodge	0.17	0.03	3.09	0.08
Sentinel Dome / Taft Point	0.14	0.02	2.37	0.13
Upper Yosemite Falls	0.05	0.00	0.72	0.40

Table 10

Time Spent in Wilderness as a Function of Group Size

Location	R	R^2	F-*test Statistic*	p-*value*
Chilnualna Falls	0.00	0.00	0.00	0.99
Dog Lake / Lembert Dome	0.11	0.01	1.40	0.24
May Lake	0.03	0.00	0.13	0.72
Porcupine Creek	0.08	0.01	0.94	0.34
Parson's Lodge	0.10	0.01	0.94	0.33
Sentinel Dome / Taft Point	0.03	0.00	0.12	0.73
Upper Yosemite Falls	0.01	0.00	0.01	0.91

Few significant differences resulted from ANOVA analyses examining variation in the mean distance traveled and mean amount of time spent in wilderness between the three age categories (Table 11). For the independent variable age category of the majority of group members, the mean distance traveled differed significantly between the three groups at one location, Upper Yosemite Falls ($F = 5.40$, $p = .005$, effect size 0.20). Specifically, groups with the majority of members in the 18-40 category traveled a longer distance than groups with the majority of members in the 41-60 category. The null hypothesis that the mean distance traveled for the three groups is equal can thus be rejected at Upper Yosemite Falls. However, for the other four locations, there was no relationship between the age category of the majority of group members and distance traveled.

Table 11

Mean Distance Traveled in Wilderness (Miles) by Age Category of the Majority of Group Members

Location	Age Category of Majority of Group Members			*F*	*p*
	18-40	41-60	61 +		
Chilnualna Falls	4.84_a (n=30) (1.61)	4.41_a (n=34) (1.85)	3.74_a (n=12) (2.27)	1.32	0.28
Porcupine Creek	6.52_a (n=68) (1.84)	6.70_a (n=60) (1.91)	6.59_a (n=26) (1.57)	0.17	0.84
Parson's Lodge	6.02_a (n=31) (3.82)	5.31_a (n=50) (3.27)	6.13_a (n=24) (3.32)	0.64	0.53
Sentinel Dome / Taft Point	2.65_a (n=32) (1.29)	3.13_a (n=47) (2.98)	3.14_a (n=24) (1.42)	1.49	0.23
Upper Yosemite Falls	5.24_a (n=160) (2.71)	4.08_b (n=85) (3.07)	3.89_{ab} (n=13) (2.43)	5.40	0.01

Standard deviations appear in parentheses below means. Means with differing subscripts within rows are significantly different at $\alpha = 0.05$ based on Tukey's HSD post hoc paired comparisons for groups with unequal sample sizes.

The Kruskal-Wallis non-parametric tests for Dog Lake / Lembert Dome and May Lake, performed because those data were not normally distributed, to test whether distance traveled varied with age category of the majority of group members did not produce significant differences between groups (Table 12).

Table 12

Median Distance Traveled in Wilderness (Miles) by Age Category of the Majority of Group Members for Dog Lake / Lembert Dome and May Lake

	Independent Samples Kruskal-Wallis Test						
		Medians by Age Category					
Location	*N*	18-40	41-60	61+	*H*	*df*	*p*
Dog Lake / Lembert Dome	109	1.40	1.54	1.44	0.25	2	0.89
May Lake	189	2.84	2.30	2.26	5.15	2	0.08

The amount of time spent in wilderness differed significantly by age category of the majority of group members at two locations: Sentinel Dome / Taft Point and Upper Yosemite Falls (Table 13). For the independent variable age of the majority of group members, the mean amount of time spent in wilderness differed significantly at the 95% confidence level between the three groups at Sentinel Dome / Taft Point (F = 3.99, p = 0.02, effect size 0.22) and Upper Yosemite Falls (Welch F = 3.47, p = 0.04; Brown-Forsythe F = 3.65, p = 0.03; effect size 0.17). (The Levene's test statistic for Upper Yosemite Falls was significant, indicating that the data violated the assumption of homogeneity of variance; therefore, Welch and Brown-Forsythe tests were conducted to compute more robust tests of equality of means). Interestingly, in both cases with significant differences, the differences were between the 18-40 and 41-60 groups, according to the Tukey's HSD post hoc comparisons, while the 61+ group was intermediate. For Upper Yosemite Falls, groups with the majority of members in the 18-40 category spent a longer amount of time in wilderness than groups with the majority of members in the 41-60 category. However, at Sentinel

Dome the results were reversed, with groups with the majority of members in the 41-60 category spending a longer amount of time in wilderness.

Table 13

Mean Amount of Time Spent in Wilderness (Hours) by the Age Category of Majority of Group Members

	Age Category of Majority of Group Members				
Location	18-40	41-60	61 +	*F*	*p*
Chilnualna Falls	4.00_a (n=30) (1.67)	3.68_a (n=34) (1.98)	3.57_a (n=12) (1.72)	0.33	0.72
Porcupine Creek	4.38_a (n=68) (1.37)	4.55_a (n=60) (1.47)	4.72_a (n=26) (1.18)	0.56	0.57
Parson's Lodge	4.08_a (n=31) (2.72)	3.58_a (n=50) (2.20)	4.27_a (n=24) (2.22)	0.82	0.44
Sentinel Dome / Taft Point	2.02_a (n=32) (0.87)	2.68_b (n=47) (1.15)	2.40_{ab} (n=24) (0.95)	3.99	0.02
Upper Yosemite Falls	4.70_a (n=160) (2.12)	3.88_b (n=85) (2.58)	3.93_{ab} (n=13) (2.27)	3.47	0.04

Standard deviations appear in parentheses below means. Means with differing subscripts within rows are significantly different at $\alpha = 0.05$ based on Tukey's HSD post hoc paired comparisons for groups with unequal sample sizes.

For Dog Lake / Lembert Dome and May Lake, the Kruskal-Wallis non-parametric tests comparing time spent for the three age categories did not show significant differences between groups at either location (Table 14).

Table 14

Median Amount of Time Spent in Wilderness (Hours) by the Age Category of the Majority of Group Members for Dog Lake / Lembert Dome and May Lake

	Independent Samples Kruskal-Wallis Test						
		Medians by Age Category					
Location	*N*	18-40	41-60	61+	*H*	*df*	*p*
Dog Lake / Lembert Dome	109	1.37	1.48	2.35	1.29	2	0.53
May Lake	189	3.12	2.08	2.45	4.17	2	0.13

When examining differences among groups based on the variable age category of oldest member of the group, the data showed a similar pattern to the previous age variable (age category of the majority of group members; Table 15). The distance traveled varied significantly at the same location, Upper Yosemite Falls (F = 3.17, p = 0.04, effect size 0.16). Again, the Tukey's HSD post-hoc contrast showed a significant contrast between groups with the oldest member in the 41-60 age category and groups with the oldest member in the 18-40 category, with a mean difference of 0.90 miles, standard error of 0.38 miles, and p = 0.05. Distance traveled for the other four locations did not vary with the age category of the majority of group members. These results also show that using a different representation of the age variables (i.e., age category of majority of group members and age category of the oldest group member) did not produce any differences in the ANOVA results for the parametric statistically tests.

Table 15

Mean Distance Traveled in Wilderness (Miles) by Age Category of the Oldest Group Member

Location	Age Category of Oldest Group Member			F	p
	18-40	41-60	61 +		
Chilnualna Falls	4.74_a (n=24) (1.73)	4.41_a (n=36) (1.80)	4.25_a (n=16) (2.17)	0.38	0.69
Porcupine Creek	6.46_a (n=60) (1.90)	6.74_a (n=63) (1.86)	6.61_a (n=31) (1.58)	0.37	0.69
Parson's Lodge	5.97_a (n=26) (4.11)	5.37_a (n=53) (3.23)	6.11_a (n=26) (3.19)	0.51	0.61
Sentinel Dome / Taft Point	2.75_a (n=29) (1.32)	3.09_a (n=47) (1.29)	3.07_a (n=27) (1.39)	0.66	0.52
Upper Yosemite Falls	5.18_a (n=147) (2.62)	4.28_b (n=93) (3.20)	4.24_{ab} (n=18) (2.64)	3.18	0.04

Standard deviations appear in parentheses below means. Means with differing subscripts within rows are significantly different at $\alpha = 0.05$ based on Tukey's HSD post hoc paired comparisons for groups with unequal sample sizes.

Non-parametric Kruskal-Wallis tests explored differences at Dog Lake / Lembert Dome and May Lake (Table 16). Significant differences existed between groups at May Lake — this differs from the results of the Kruskal-Wallis tests using age category of the majority of group members as the independent variable, which were not significant. Mann-Whitney post-hoc contrasts were performed on the May Lake data due to the statistical significance of the Kruskal-Wallis test (Table 17). These tests showed significant differences exist between the 18-40 and 61+ groups and the 40-60 and 61+ groups, unlike the trends in the Tukey's HSD post-hoc comparisons showing differences between the 18-40 and 41-60 groups only.

Table 16

Median Distance Traveled in Wilderness (Miles) by Age Category of the Oldest Group Member for Dog Lake / Lembert Dome and May Lake

	Independent Samples Kruskal-Wallis Test						
		Medians by Age Category					
Location	*N*	18-40	41-60	61+	*H*	*df*	*p*
Dog Lake / Lembert Dome	109	1.55	1.16	1.41	0.19	2	0.91
May Lake	189	2.19	2.33	2.51	8.74	2	0.01

Table 17

Post Hoc Contrasts for Distance Traveled in Wilderness by Age Category of Oldest Group Member at May Lake

	Mann-Whitney Post Hoc Contrasts					
Contrast	N	Medians for Age Categories		*U*	*z*	*p*
18-40 and 41-60	111	1.55	1.16	1,186.00	2.80	0.85
18-40 and 61+	108	1.55	1.41	1,450.50	1.92	0.05
41-60 and 61+	159	1.16	1.41	3.971.00	-0.19	0.01

ANOVA and Kruskal-Wallis tests for differences in the amount of time spent in wilderness across age category of the oldest group member were not significant at any locations (Tables 18 and 19).

Table 18

Mean Amount of Time Spent in Wilderness (Hours) by Age Category of the Oldest Group Member

Location	Age Category of Oldest Group Member			F	p
	18-40	41-60	61 +		
Chilnualna Falls	4.07_a (n=24) (1.82)	3.58_a (n=36) (1.90)	3.85_a (n=16) (1.62)	0.51	0.69
Porcupine Creek	4.32_a (n=60) (1.42)	4.60_a (n=63) (1.42)	4.70_a (n=31) (1.20)	1.01	0.37
Parson's Lodge	3.68_a (n=26) (2.18)	3.80_a (n=53) (2.57)	4.27_a (n=26) (2.13)	0.46	0.63
Sentinel Dome / Taft Point	2.05_a (n=29) (0.90)	2.65_a (n=47) (1.17)	2.38_a (n=27) (0.93)	2.98	0.06
Upper Yosemite Falls	4.68_a (n=147) (2.08)	4.02_a (n=93) (2.57)	4.00_a (n=18) (2.48)	2.50	0.09

Standard deviations appear in parentheses below means. Means with differing subscripts within rows are significantly different at $\alpha = 0.05$ based on Tukey's HSD post hoc paired comparisons for groups with unequal sample sizes.

Table 19

Median Amount of Time Spent in Wilderness (Hours) by Age Category of the Oldest Group for Dog Lake / Lembert Dome and May Lake

Location	Independent Samples Kruskal-Wallis Test						
		Medians by Age Category					
	N	18-40	41-60	61+	H	df	p
Dog Lake / Lembert Dome	109	1.58	1.10	1.32	1.39	2	0.50
May Lake	189	2.45	2.07	3.12	3.79	2	0.15

The presence or absence of children in a group had a slightly larger impact on the distance traveled in wilderness than the age categories of the adult members in the group (Table 20). Four of the seven sampled locations had significantly different distances between groups with children under the age of 18 and groups with no children. For the two locations where *t*-tests were significant, Parson's Lodge and Upper Yosemite Falls, groups without children traveled farther than groups with children, but Pearson's *r* effect sizes were less than 0.3, indicating a small effect of the treatment. For the two locations where Mann-Whitney tests were used (Dog Lake / Lembert Dome and May Lake), the differences were also significant (Table 21).

Table 20

Mean Distance Traveled in Wilderness (Miles) by Groups With and Without Children Under 18 Years of Age

Location	Hiking Group Type: With	Hiking Group Type: Without	*t*	*p*
Chilnualna Falls	4.22 (n=17) (2.05)	4.52 (n=60) (1.80)	0.57	0.57
Porcupine Creek	6.55 (n=30) (1.95)	6.62 (n=125) (1.78)	0.20	0.85
Parson's Lodge	4.16 (n=25) (3.23)	6.24 (n=81) (3.40)	2.71	0.01
Sentinel Dome / Taft Point	2.98 (n=13) (1.35)	2.94 (n=106) (0.13)	-0.67	0.95
Upper Yosemite Falls	4.02 (n=61) (2.75)	4.92 (n=206) (2.88)	2.17	0.03

Standard deviations appear in parentheses below means.

Table 21

Median Distance Traveled in Wilderness (Miles) by Groups With and Without Children Under 18 Years of Age for Dog Lake / Lembert Dome and May Lake

	Independent Samples Mann-Whitney Test					
		Medians for Hiking Group Type				
Location	*N*	With	Without	*U*	*z*	*p*
Dog Lake / Lembert Dome	110	0.93	1.54	1,011.00	-2.24	0.03
May Lake	192	2.17	2.43	2,100.50	-1.99	0.05

The presence or absence of children under 18 years of age in a group had less of an impact on the amount of time spent in wilderness (Table 22). Differences were significant for Parson's Lodge and Upper Yosemite Falls, which also showed significant differences in the distance traveled, but not at Dog Lake / Lembert Dome and May Lake where distance was significantly impacted (Table 23). Groups without children spent upwards of 45 minutes longer in wilderness than groups with children; however, effect sizes (Pearson's *r*) for significant findings were considered to be small (< 0.3).

Table 22

Mean Amount of Time Spent in Wilderness (Hours) by Groups With and Without Children Under 18 Years of Age

Location	Hiking Group Type: With	Hiking Group Type: Without	*t*	*p*
Chilnualna Falls	4.13 (n=17) (2.05)	3.65 (n=60) (1.75)	-0.95	0.35
Porcupine Creek	4.50 (n=30) (1.38)	4.50 (n=125) (1.37)	0.01	0.99
Parson's Lodge	2.83 (n=25) (1.92)	4.23 (n=81) (2.40)	2.66	0.01
Sentinel Dome / Taft Point	2.58 (n=13) (0.92)	2.35 (n=106) (1.07)	-0.75	0.46
Upper Yosemite Falls	3.75 (n=61) (2.07)	4.53 (n=206) (2.38)	2.32	0.02

Standard deviations appear in parentheses below means.

Table 23

Median Amount of Time Spent in Wilderness (Hours) by Groups With and Without Children Under 18 Years of Age for Dog Lake / Lembert Dome and May Lake

	Independent Samples Mann-Whitney Test					
		Medians by Hiking Group Type				
Location	*N*	With	Without	*U*	*z*	*p*
Dog Lake / Lembert Dome	110	1.22	1.43	1,242.00	-0.79	0.43
May Lake	192	2.30	2.63	2,423.00	-0.89	0.37

To further examine the potential impact of young children on hiking distance and time, a dichotomous variable indicating presence or absence of children under 10 years of age was created for each location. However, statistical analyses were not performed for this variable because sample sizes for groups with children under the age of 10 were too small at most locations for reliable statistical analyses (Table 24). The small subsample sizes across the seven locations for this proposed analysis indicates that not many groups take children under 10 years of age on wilderness day hikes on these trails.

Table 24

Subsample Sizes for Groups with Children Less Than 10 Years of Age

Location	*Subsample Groups With Children Under 10*	*Subsample Groups Without Children Under 10*
Chilnualna Falls	*n* = 3	*n* = 74
Dog Lake / Lembert Dome	*n* = 10	*n* = 100
May Lake	*n* = 14	*n* = 178
Porcupine Creek	*n* = 10	*n* = 145
Parson's Lodge	*n* = 6	*n* = 100
Sentinel Dome / Taft Point	*n* = 6	*n* = 113
Upper Yosemite Falls	*n* = 16	*n* = 251

Results: Trail Network Use Patterns

The percentage of wilderness day users hiking only to a wilderness attraction site varied across the sampled locations, as did the percentages of day users that did not reach the attraction site or that hiked past the attraction site (Table 25). Visitors hiking only to attraction sites and no further ranged from as low as 29.3% on the Parson's Lodge trail to 66.5% at May Lake and Porcupine Creek. The percentage of visitors that did not make it to the wilderness attraction site ranged from less than 1% at Sentinel Dome / Taft Point and Dog Lake / Lembert Dome to as high as 64.2% at Parson's Lodge. Given the nature of the

Sentinel Dome / Taft Point and Dog Lake Lembert Dome trail loops, it is not surprising that less than 1% of visitors did not make it to these attraction sites. The main attractions located along both of these trails are located one to two miles from the trailhead. Conversely, the main attraction site at Parson's Lodge is located more than 5 miles from the trailhead; therefore, more attrition occurred at this site. As discussed previously, the mean distance and time calculations for Parson's Lodge showed considerable variability; the high percentage of hiking groups that did not make it to Glen Aulin contributes to this variability. Furthermore, the trail to Glen Aulin from Parson's Lodge is known for its beautiful scenery and for being a relatively flat trail; these factors could have led to more hiking groups having experience expectations satisfied without hiking all the way to Glen Aulin.

Table 25

Day Hiker Travel to Wilderness Attraction Sites by Location

Location	*Did Not Reach Site*	*Reached Site*	*Traveled Beyond*
Chinualna Falls	33.8%	62.3%	3.9%
Dog Lake / Lembert Dome	0.9%	85.5%	13.6%
May Lake	2.6%	66.5%	30.9%
Porcupine Creek	24.5%	66.5%	9.0%
Parson's Lodge	61.2%	29.3%	6.6%
Sentinel Dome / Taft Point	0.8%	93.3%	5.9%
Upper Yosemite Falls	40.5%	49.4%	10.1%

The Dog Lake / Lembert Dome and Sentinel Dome / Taft Point trails each had two attraction sites within the immediate study area; thus, the percentage of hikers reaching a wilderness attraction site was broken down further to characterize behavior by use of the individual attraction sites. At Dog Lake / Lembert Dome, 85.5% (n = 94) users reached at least one wilderness attraction site. Of these users, 14.9% traveled to both attraction sites, 33.0% traveled only to Lembert Dome, and 53.1% traveled only to Dog Lake. The distribution of units at Dog Lake / Lembert Dome occurred approximately 1.5 miles into wilderness, at the junction of the trails to Dog Lake and Lembert Dome. Because of this distribution location, the reported percentages cannot be considered characteristic of the population of visitors to the Dog Lake / Lembert Dome trail network – the percentages reported here are only representative of the sample group contacted at the Dog Lake / Lembert Dome trail junction.

At Sentinel Dome / Taft Point, 111 hikers reached at least one attraction site. Of these, 31.5% of users traveled to both Sentinel Dome and Taft Point, while 51.4% traveled only to Sentinel Dome and 17.1% traveled to Taft Point. The distribution of units occurred at the start of the shared Sentinel Dome and Taft Point trail; hikers were intercepted before the trail split to the separate locations. Therefore, these percentages are representative of the proportions of users that travel to the destinations at these locations.

The percentage of visitors traveling beyond the most popular wilderness attraction site varied across locations. May Lake, Dog Lake / Lembert Dome, and Upper Yosemite Falls had the largest percentages of hikers exploring beyond the wilderness attraction site. At May Lake, 30.9% of the day users hiked beyond May Lake; the most common destinations for these people were Mount Hoffman and the Crystal Caves. At the Dog Lake / Lembert Dome trail, 13.6% of day hikers traveled beyond Dog Lake, with the most common destinations being Young Lakes and Mount Conness. Finally, 10.1% of day hikers on the Upper Yosemite Falls trail hiked beyond the top of Upper Yosemite Falls, with the most common destinations being Yosemite Point, Eagle Peak, and El Capitan. The other four sample locations had less than 10% of visitors hiking beyond the wilderness attraction site. Common alternate destinations included Upper Yosemite Falls or Snow Creek for the

Porcupine Creek trail, Young Lakes for the trail to Glen Aulin at Parson's Lodge, Glacier Point for the Sentinel Dome / Taft Point trail, and simply beyond the top of Chilnualna Falls for the Chilnualna Falls trail.

As noted above, May Lake had the largest percentage of hiking groups traveling beyond May Lake (30.9%). This large percentage is potentially due to the popularity of Mount Hoffman as an alternate wilderness destination and / or the short length of the hike to May Lake. Mount Hoffman is not advertised by Yosemite National Park as an official system trail, but the social trail leading to Mount Hoffman from May Lake is recognizable. Many hiking information sources not affiliated with Yosemite provide detailed descriptions of this hike as well, potentially adding to public knowledge of the social trail. Alternatively, May Lake is located approximately 1.2 miles from the trailhead; the large percentage of hikers traveling beyond May Lake may be a result of groups feeling the need to hike further than 1.2 miles in order to satisfy experience expectations. The May Lake trailhead is not located particularly close to any of the main amenity centers in the park; therefore, groups traveling to May Lake may be more likely to extend their hiking trip to make it worth the drive.

Direction of travel was also examined to provide data on the percentage of day hikers that utilized trail networks in wilderness (Table 26). Tracks were categorized into two categories: hikers who took out-and-back trips and hikers who traveled on two or more trails, starting and ending at different trailheads. Overall, the percentage of multi-trail hikers was small across the seven sample locations. Parson's Lodge had the largest percentage of day hikers classified as taking one-way trips, with 10.4% of hikers using connected trails. The most common trips taken were traveling from Parson's Lodge on the Glen Aulin trail to

Young Lakes and ending at Dog Lake / Lembert Dome. Additionally, one individual hiked to May Lake from the Glen Aulin trail at Parson's Lodge and another hiker traveled to Tenaya Lake via the Glen Aulin trail at Parson's Lodge. Some users at Dog Lake / Lembert Dome traveled the same route to the Young Lakes in reverse, with 5.5% of users hiking on connected trails, and the most common routes being the hike to the Young Lakes from Dog Lake / Lembert Dome to the Glen Aulin trail at Parson's Lodge. At Porcupine Creek, 7.1% percent of day users connected more than one trail, making it the location with the second highest percentage of one-way hikers. The two most common routes for these hikers were the route from Porcupine Creek to the Upper Yosemite Falls trail and the route from Porcupine Creek to the Snow Creek trail. The remaining trails had 1% or less of users hiking on connected trails.

Table 26

Percentage of Groups Taking One-Way Trips by Location

Location	*One-Way Trips*	*Out and Back Trips*
Chinualna Falls	0.0%	100.0%
Dog Lake / Lembert Dome	5.5%	94.5%
May Lake	1.1%	98.9%
Porcupine Creek	7.1%	92.9%
Parson's Lodge	10.4%	89.6%
Sentinel Dome / Taft Point	0.8%	99.2%
Upper Yosemite Falls	0.0%	100.0%

Results: Micro-Level Site Displacement

L functions for each use level at each location showed significant clustering, meaning that the points were more clustered than would be expected with a random distribution of the same number of points. *L*(d) is a function of the transformed *K* values produced by the Ripley's *K* analysis and the distance at which clustering occurs (Mitchell, 2005). Distance refers to the distance from the target point to other points considered to be within the cluster. For example, if the distance value on the X axis is 30 feet, the value indicates that the cluster for 30 feet is comprised of all the points within 30 feet for the target point. For each point in the feature class, the Ripley's *K* analysis computes the number of points within the specified distance radius around the point, and compares that the expected number for a random distribution of points. *K* values are calculated for all points, and the *L*(d) function provides a trend line for the entire point dataset.

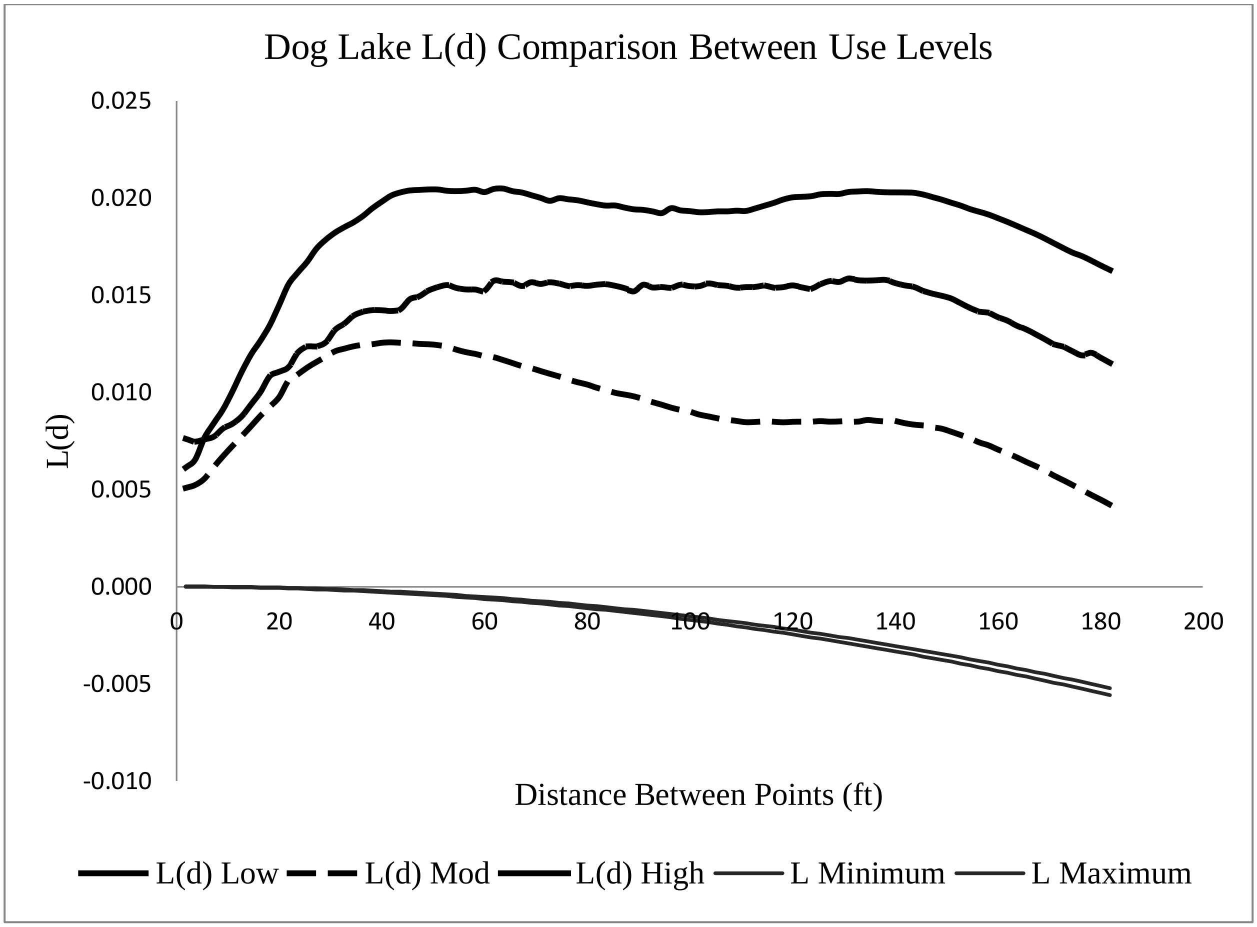
For this application, the distance can be loosely interpreted as the distance between two individuals because each point represents the location of the individual carrying the GPS unit. However, this distance should not be taken too literally because the points were collected at different times and on different days. The point feature classes on which the Ripley's *K* analyses were performed represent a compound view of use throughout the sample period.

The *L* maximum and *L* minimum trend lines represent the upper and lower confidence limits for the Ripley's *K* analyses. An observed *L*(d) that exceeds the confidence limits indicates that clustering is statistically significant for the point feature class. Because the number of points within each feature class is very large, the upper and lower confidence limits produced for the Ripley's *K* analyses are relatively small. For the figures that follow, the *L* maximum and *L* minimum lines are located below the X axis.

At Dog Lake, the high use point feature class showed the overall highest degree of clustering, being significantly more clustered than the moderate use point feature class at all distances, as indicated by the higher *L*(d) values at all distances for the high use point feature class (Figure 10). The high use point feature class was also significantly more clustered than the low use point feature classes at distances greater than approximately 5 feet, as indicated by the high use trend line crossing the low use trend line at approximately 5 feet, and remaining above the low use trend line with higher *L*(d) values at all other distances. The low use point feature class was more clustered than the high and moderate use feature classes at distances less than approximately 5 feet. The moderate use point feature class was the least clustered at all distances, indicating a greater level of dispersion between clusters in this feature class. Each of the three distributions peaked twice; the first peak in each distribution indicates the distance at which the highest level of clustering occurs for that use category. For high use the peak occurs around 45 feet, at low use the peak occurs around 60 feet, and at moderate use the peak occurs around 40 feet. The second peak in each *L* function indicates clustering of the clusters, which is further examined in the discussion of the nearest neighbor hierarchical cluster analysis.

Figure 10

Dog Lake Ripley's K Output

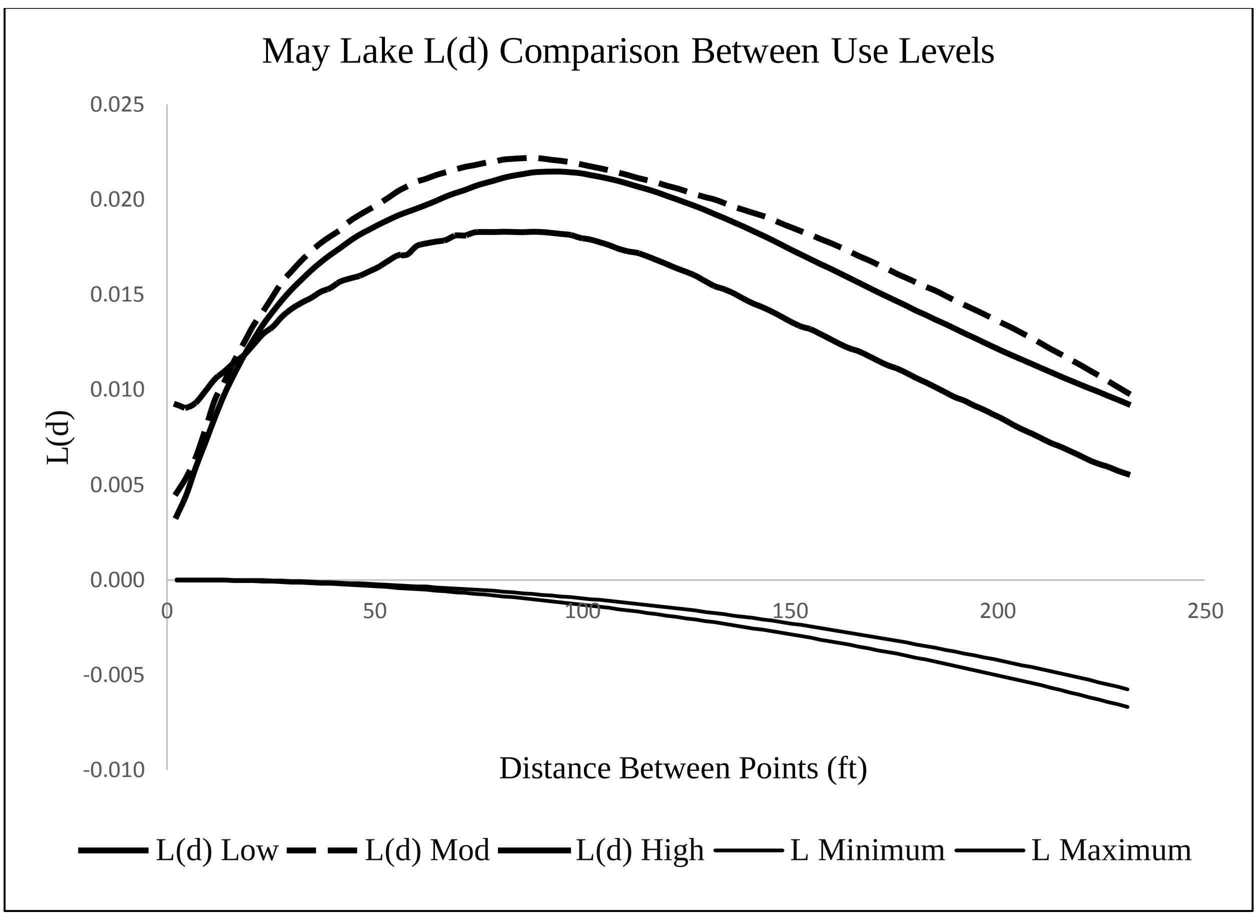


Because of the large number of points at May Lake, the raw data for the May Lake Ripley's *K* analyses were resampled to include every fifth point in the original dataset, resulting in an interval of approximately every 10 seconds rather than every 2 seconds in the original GPS files. This was done to reduce the size of the point feature classes for processing, thereby reducing the processing time from over 24-hours to 4-hours or less per feature class. Reducing the number of points per feature class, even to a fifth of the original dataset, did not alter the size of the *L* maximum and *L* minimum confidence intervals — they did not respond at all to a one-fifth reduction.

At May Lake, the *L* functions originating from the high and moderate use point feature classes show similar patterns of a higher level of clustering at distances greater than 25 feet than the low use point feature class (Figure 11). Conversely, the *L* function from the low use point feature class shows a higher level of clustering at distances less than 25 feet. Like the *L* functions for high and moderate use at Dog Lake, the May Lake high and moderate use *L* functions peak at distances close to each other, around 86 feet and 95 feet respectively. However, unlike the Dog Lake low use *L* function that peaks at a distance greater than both the high and moderate use *L* functions, the May Lake low use *L* function peaks at a distance less than the high and moderate use feature classes, at 70 feet.

Figure 11

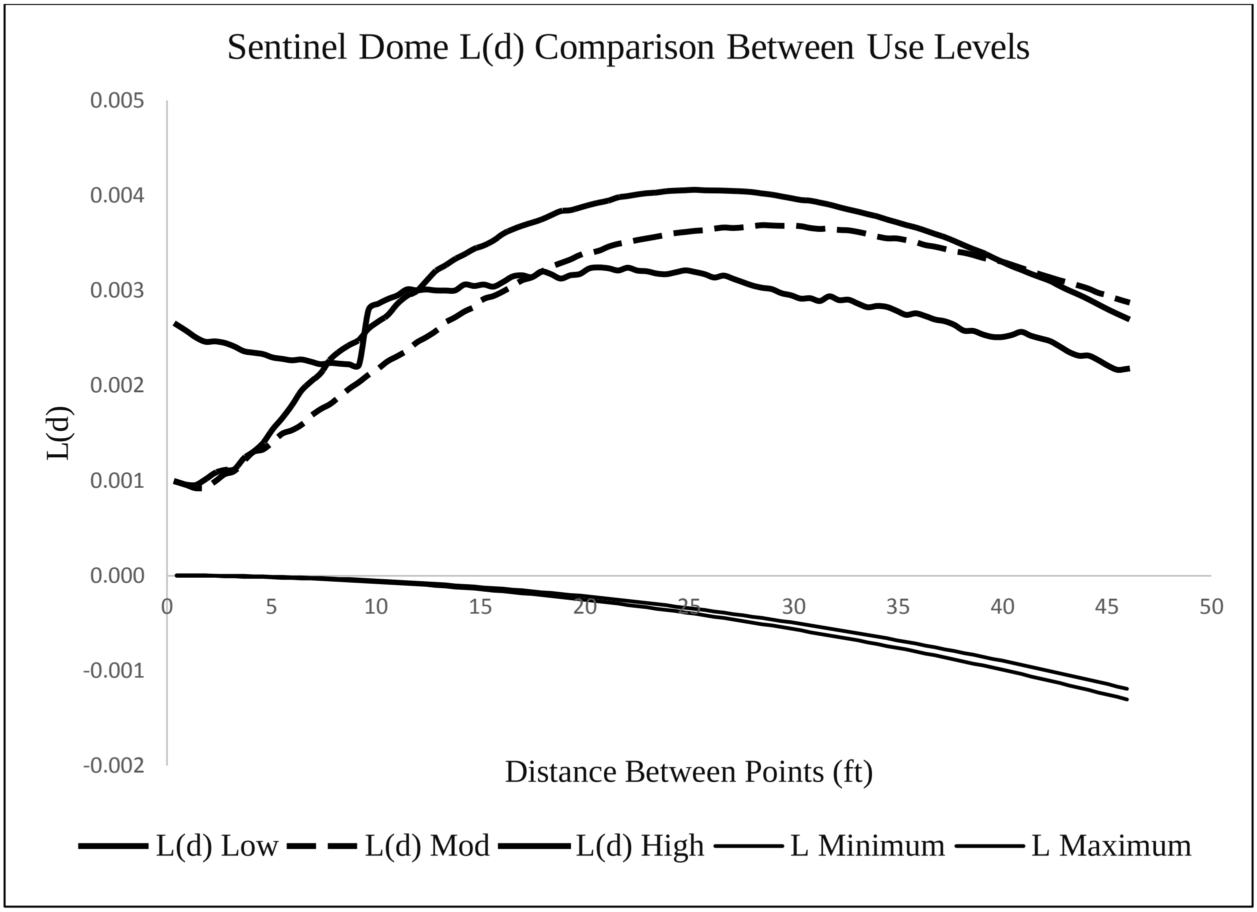
May Lake Ripley's K Output



At Sentinel Dome, the *L* functions showed more variability, with the peaks varying between the three use levels (Figure 12). The *L* functions indicate that the point feature class for high use was more clustered than the point feature class for low use at distances from the target point less than eight feet and again at distances from the target point between approximately 10 and 13 feet. The high use point feature class was also more clustered than the moderate use point feature class at distances from the target feature ≤ 18 feet. The low use point feature class was more clustered than both the high use and moderate use point feature classes at distances between approximately 13 feet and 37 feet. The moderate use point feature class was the most clustered at distances greater than 37 feet. Peaks in each of the three *L* functions occur at different locations, with the low use *L* function peaking around 35 feet, the moderate use *L* function around 30 feet, and the high use *L* function around 20 feet. This indicates that the distance from the target feature at which the greatest number of clusters occurs varied between the three use levels.

Figure 12

Sentinel Dome Ripley's K Output



Collectively, these results show that the clustering in each point feature class at each use level is statistically non-random, meaning that the distribution of points within each wilderness attraction site shows some kind of pattern. For the two lake attraction sites, significant clustering is to be expected due to a limited area available around the lake attraction site and the presence of social trails around each lake. However, the clustering at Sentinel Dome is less expected because visitors have more freedom of movement once on the summit of Sentinel Dome. On the exposed granite dome, social trails do not exist and visitors are not guided toward a specific location.

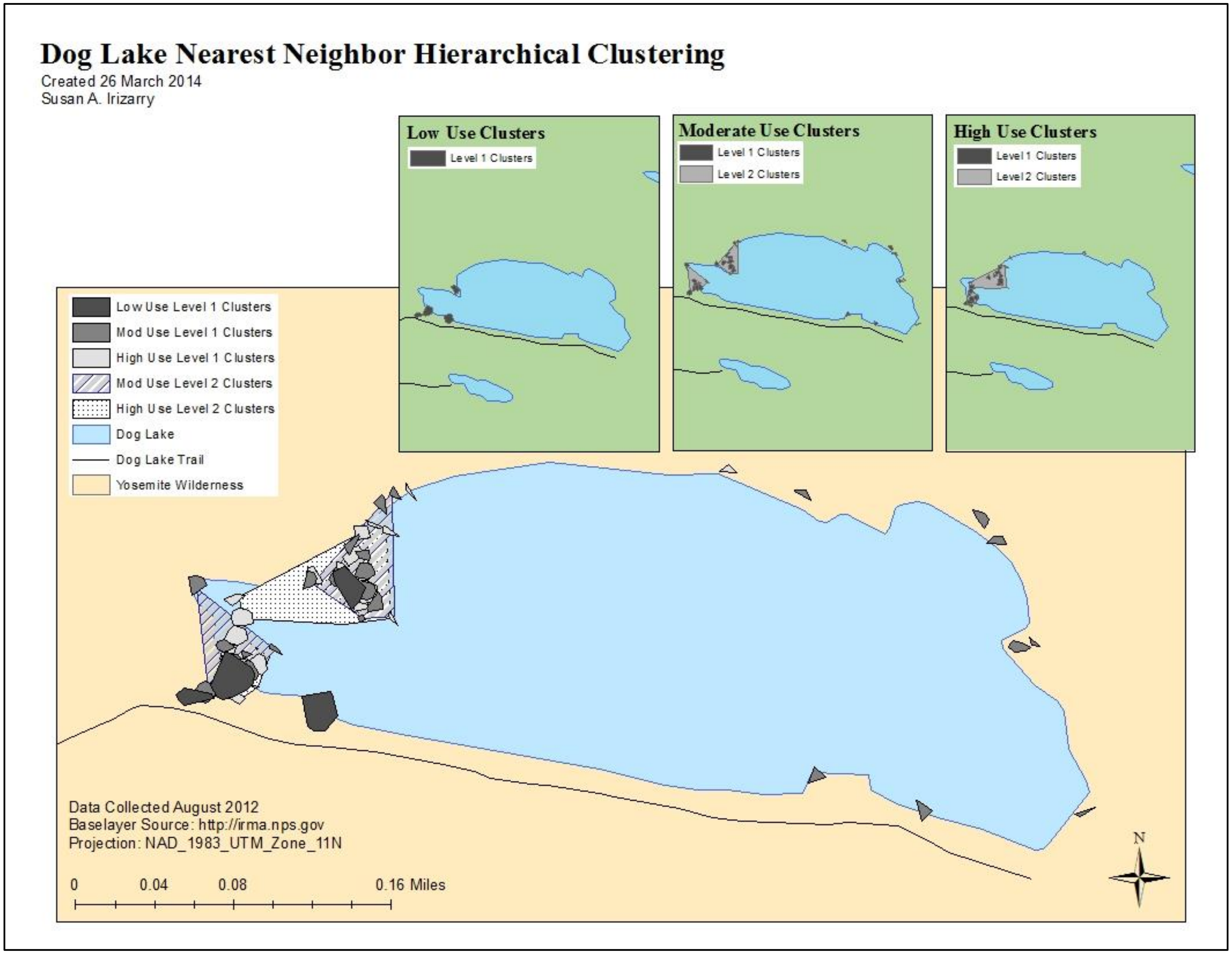
The peaks and cluster distances of each *L* function provide some indication about the behavior of visitors at each use level. However, the knowledge available solely from the Ripley's *K* simulations is limited. Because clustering was significant for each of the point feature classes, nearest neighbor hierarchical cluster analyses were used to identify where clusters existed within each site, and how the clusters change between use levels.

Results: Nearest Neighbor Hierarchical Cluster Analysis

Figure 13 depicts the output of the nearest neighbor hierarchical cluster analysis for Dog Lake, with the main map of Dog Lake containing the clusters for each use level overlayed on top of each other, and the inset maps showing the clusters produced at each use level independently. The low use point feature class produced clusters close to the junction of the Dog Lake trail with the lake. Four larger first order clusters are located close to some of the first viewpoints encountered by a visitor when he or she arrives at the lake. The presence of a few, larger clusters and the absence of any second order clusters indicate that the majority of the points in the low use feature class occurred at these locations. The cluster pattern produced from the moderate use feature class is distinctly different from that of the low use point feature class. The moderate use feature class contains clusters on the far side of Dog Lake. Additionally, the clusters are smaller, indicating more fragmentation and less uniformity in the use of the site by visitors. Two second order clusters were produced, indicating a significant clustering of the clusters in two locations – both located near the Dog Lake trail and in the same locations at the significant clusters from the low use feature class. Finally, the cluster pattern generated from the high use feature class is similar to the pattern generated from the moderate use feature class. The high use feature class contains fewer significant clusters on the far side of Dog Lake, but it does demonstrate the same trend to have a larger number of smaller clusters than the pattern generated from the low use feature class. Moreover, the second order clusters have shifted slightly within the site, with the larger second order cluster located farther from the Dog Lake trail than is observed in the second order cluster pattern generated by the moderate use feature class. Overall, the cluster patterns generated from the moderate and high use feature classes differ from the cluster pattern generated from the low use feature class in terms of the number, size, and distribution of clusters produced by the nearest neighbor hierarchical analysis. A comparison of the three cluster patterns also shows that visitors displace away from the where the trail meets the lake and from the first stopping points encountered upon arrival at the lake.

Figure 13

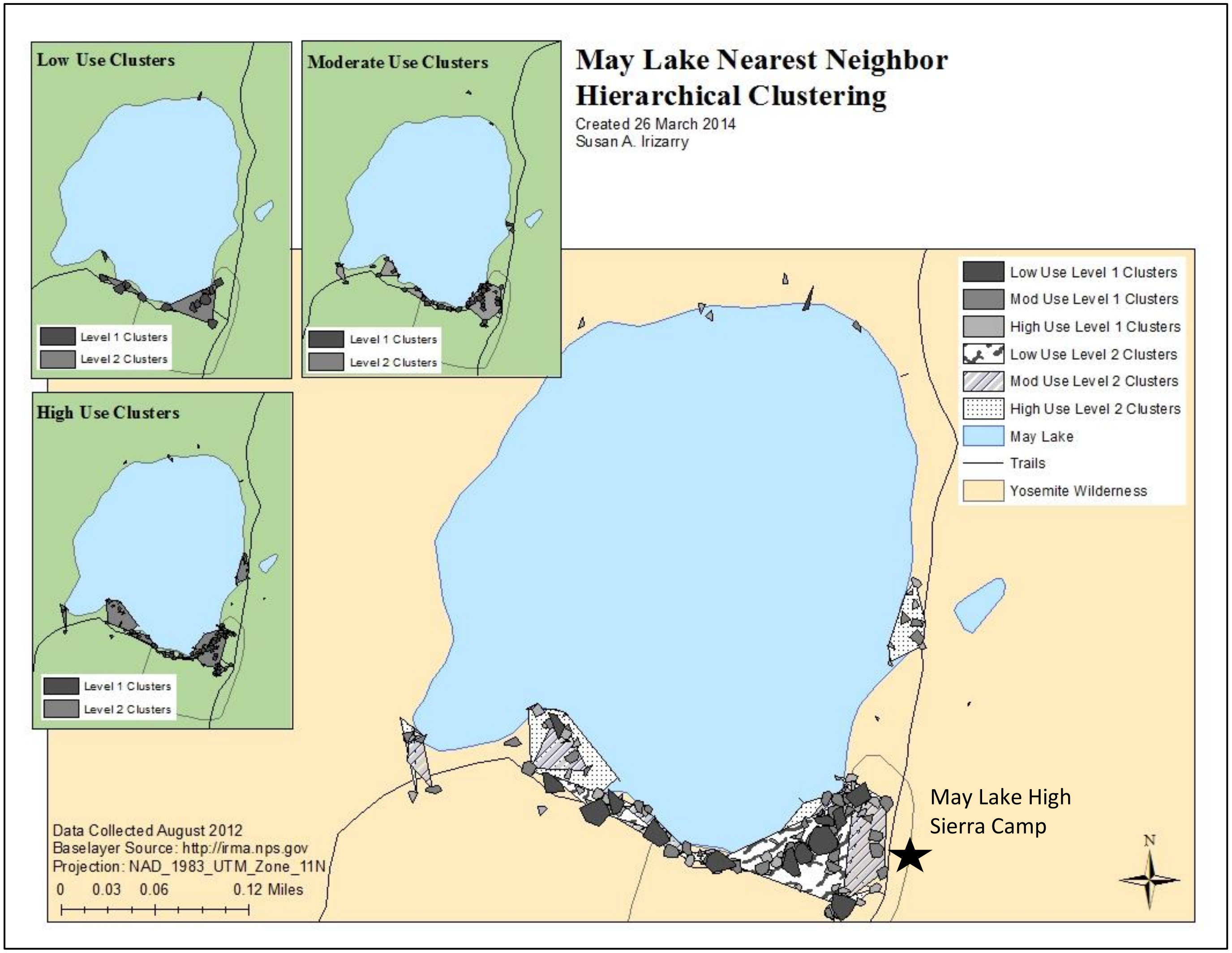
Map of Dog Lake Cluster Patterns



Cluster patterns generated from the three point feature classes at May Lake showed similar trends as those generated from the point feature classes at Dog Lake (Figure 14). However, the trends at May Lake are more distinct, with the number of first and second order clusters increasing as the use level progresses from low to high use. The low use point feature class generated a cluster pattern similar to the low use feature class at Dog Lake — a smaller number of larger clusters near the where the May Lake trail meets the lake and near the first few access points toward the left side of the lake away from the May Lake High Sierra Camp. The cluster pattern produced by the moderate use feature class shows more diversity in cluster location, with clusters being located in new areas around the lake, farther from the trailhead. Additionally, the clusters are smaller in size with a larger proliferation. The number of second order clusters increased as well, with significant second order clusters located beyond the locations of the second order clusters produced using the low use feature class. Finally, the high use feature class cluster pattern shows the highest level of cluster dispersion, with significant first and second order clusters located in numerous locations around the lake, including the largest number of clusters on the far side, across the lake from the trailhead.

Figure 14

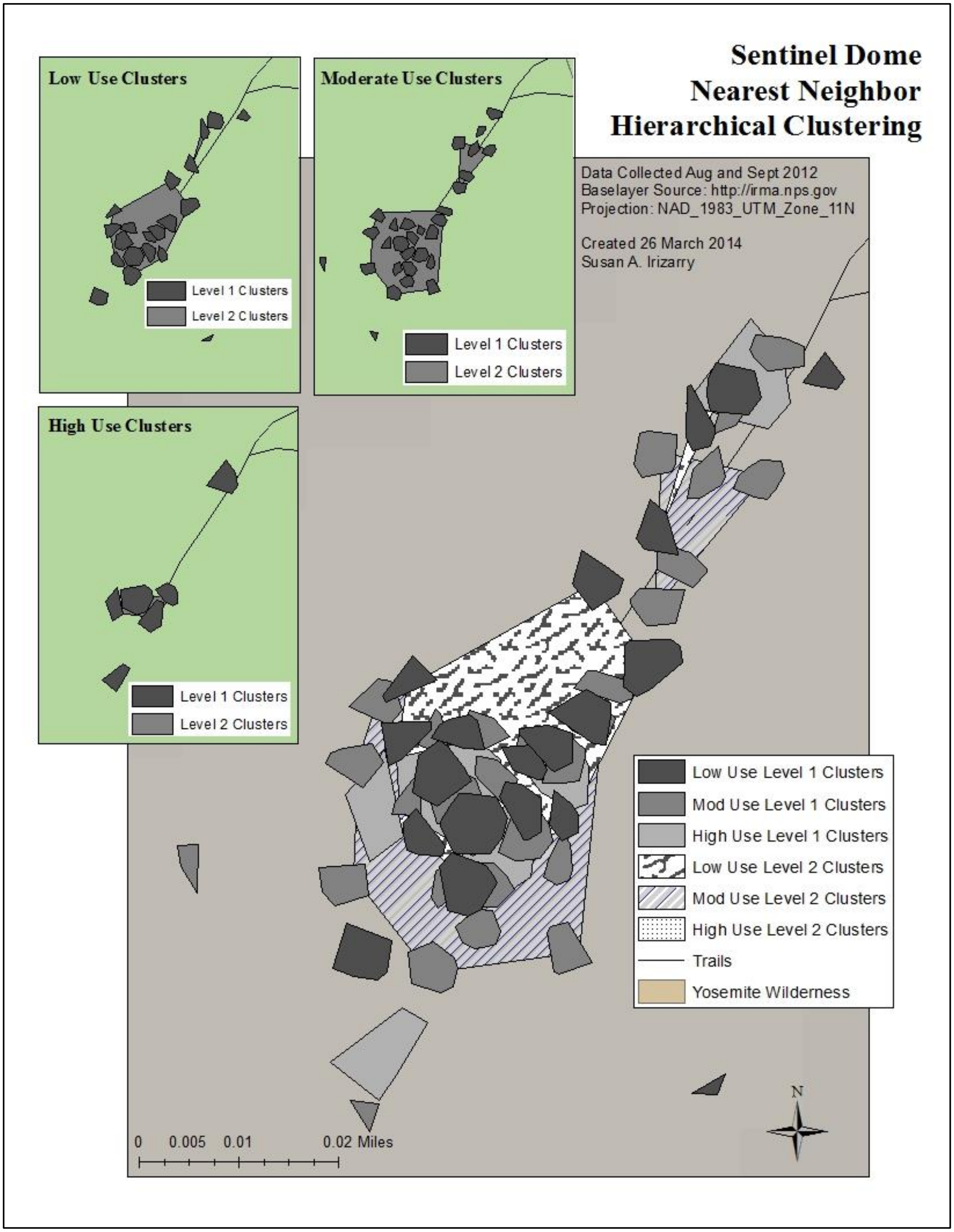
Map of May Lake Cluster Patterns



The cluster patterns generated by the Sentinel Dome feature classes show a different pattern than those produced at the lake attraction sites (Figure 15). The low use cluster pattern is similar to the low use cluster patterns at Dog Lake and May Lake, with a smaller number of larger clusters located near the trail. The moderate use cluster pattern shows less differentiation from the low use cluster pattern than observed in the cluster patterns for moderate use at the other two locations; however, the moderate use cluster pattern does depict slightly smaller clusters and a wider distribution of clusters on the summit (as indicated by the fan-like shape of the moderate use second order cluster). The cluster pattern generated by the high use feature class shows a reversal in the trends seen at the other locations. The high use cluster pattern shows the fewest number of clusters, and these clusters are the largest in size produced at Sentinel Dome.

Figure 15

Map of Sentinel Dome Cluster Patterns



Results: GPS Participant Exit Survey

Because *L* functions and the nearest neighbor hierarchical cluster analysis showed significant results, ANOVA analyses were run on three questions from a short exit survey administered to participants in the GPS study. The questions were chosen for their relevance to factors associated with displacement. GPS study participants were asked to report the number of other groups encountered while hiking, crowdedness on trails and at destination points, and the impact of the number of groups encountered on four wilderness experience variables. Due to high kurtosis values (Dog Lake 6.82, May Lake 6.75, and Sentinel Dome 5.72) for the encounters variable, Kruskal-Wallis non-parametric tests were performed to compare groups.

Although differences were not statistically significant, the mean number of wilderness encounters at each of the three locations was lowest for the low use group and highest for the high use group (Table 27). The increase in the number of groups encountered from the low to high across the three use classes reinforces the validity of the way use was estimated.

Table 27

Number of Groups Encountered by Use Class: Descriptive Statistics

Location	Low Use *M (SD)*	Moderate Use *M (SD)*	High Use *M (SD)*
Dog Lake	8.00 (9.56)	8.96 (5.74)	13.36 (11.83)
May Lake	11.13 (7.27)	11.51 (5.86)	13.62 (7.16)
Sentinel Dome	16.50 (9.65)	17.03 (7.67)	23.60 (7.40)

No significant differences were found between survey respondents classified into the low, moderate, and high use classes at any of the sample locations for the variables of interest (Tables 28-33). Results may have been impacted by low subsample sizes for some of the use classes.

Table 28

Median Number of Groups Encountered by Use Class

	Independent Samples Kruskal-Wallis Test						
		Median Groups Encountered					
Location	*N*	Low	Mod	High	*H*	*df*	*p*
Dog Lake	58	4.50	8.50	9.50	3.71	2	0.16
May Lake	127	10.00	10.00	14.00	5.37	2	0.07
Sentinel Dome	62	14.50	15.00	21.00	5.13	2	0.08

Table 29

Mean Feeling of Crowdedness on Trails by Use Category

	Use Level of GPS Track				
Location	Low	Moderate	High	*F*	*p*
Dog Lake	1.86_a (n=7) (0.690)	1.58_a (n=26) (0.902)	1.96_a (n=23) (0.825)	1.27	0.29
May Lake	1.63_a (n=32) (0.793)	1.68_a (n=41) (0.789)	1.77_a (n=57) (0.907)	0.34	0.72
Sentinel Dome	1.92_a (n=25) (3.82)	1.73_a (n=30) (3.27)	2.50_a (n=6) (3.32)	2.01	0.14

Standard deviations appear in parentheses below means. Means with differing subscripts within rows are significantly different at $\alpha = 0.05$ based on Tukey's HSD post hoc paired comparisons for groups with unequal sample sizes. Scale 1 *(not at all crowded)* to 5 *(extremely crowded)*.

Table 30

Mean Feeling of Crowdedness at Attraction Sites by Use Category

Location	Use Level of GPS Track			F	p
	Low	Moderate	High		
Dog Lake	2.13_a (n=8) (1.13)	2.00_a (n=28) (1.22)	2.09_a (n=22) (1.07)	0.06	0.94
May Lake	2.16_a (n=32) (1.22)	1.76_a (n=42) (0.958)	2.03_a (n=60) (1.03)	1.42	0.25
Sentinel Dome	2.32_a (n=25) (0.945)	2.06_a (n=33) (0.864)	3.00_a (n=6) (1.10)	2.78	0.07

Standard deviations appear in parentheses below means. Means with differing subscripts within rows are significantly different at α = 0.05 based on Tukey's HSD post hoc paired comparisons for groups with unequal sample sizes. Scale 1 *(not at all crowded)* to 5 *(extremely crowded)*.

Table 31

Mean Impact of Number of Encounters on Wilderness Experience Variables at Dog Lake

Variable	Use Level of GPS Track			F	p
	Low (n=8)	Moderate (n=28)	High (n=23)		
Enjoyment	0.50_a (0.93)	0.14_a (1.01)	0.17_a (0.98)	0.42	0.66
Sense of Wilderness	0.25_a (1.28)	-0.54_a (1.17)	-0.35_a (0.98)	1.55	0.22
Solitude	0.13_a (1.46)	-0.61_a (1.13)	-0.74_a (0.86)	1.93	0.15
Freedom	0.13_a (1.12)	-0.18_a (0.91)	-0.09_a (1.00)	0.31	0.74

Standard deviations appear in parentheses next to means. Means with differing subscripts within rows are significantly different at α = 0.05 based on Tukey's HSD post hoc paired comparisons for groups with unequal sample sizes. Scale -2 = *encounters detracted greatly*, +2 = *encounters added greatly*.

Table 32

Mean Impact of Number of Encounters on Wilderness Experience Variables at May Lake

Variable	Use Level of GPS Track: Low (n=33)	Moderate (n=42)	High (n=60)	*F*	*p*
Enjoyment	0.45_a (0.87)	0.38_a (0.99)	0.05_a (0.83)	2.83	0.06
Sense of Wilderness	-0.18_a (0.81)	-0.17_a (1.1)	-0.40_a (0.92)	0.95	0.39
Solitude	-0.24_a (0.87)	-0.36_a (0.98)	-0.48_a (0.91)	0.75	0.47
Freedom	0.09_a (0.68)	0.05_a (0.89)	-0.03_a (0.80)	0.29	0.75

Standard deviations appear in parentheses next to means. Means with differing subscripts within rows are significantly different at $\alpha = 0.05$ based on Tukey's HSD post hoc paired comparisons for groups with unequal sample sizes. Scale -2 = *encounters detracted greatly*, +2 = *encounters added greatly*.

Table 33

Mean Impact of Number of Encounters on Wilderness Experience Variables at Sentinel Dome

Variable	Use Level of GPS Track: Low (n=25)	Moderate (n=33)	High (n=6)	*F*	*p*
Enjoyment	0.04_a (1.10)	0.70_a (1.21)	0.17_a (1.47)	2.80	0.07
Sense of Wilderness	-0.32_a (0.90)	0.00_a (1.02)	-0.50_a (1.38)	1.05	0.36
Solitude	-0.44_a (1.00)	-0.24_a (1.09)	-0.67_a (1.21)	0.52	0.60
Freedom	-0.20_a (0.91)	0.27_a (0.88)	0.00_a (1.10)	1.93	0.15

Standard deviations appear in parentheses next to means. Means with differing subscripts within rows are significantly different at $\alpha = 0.05$ based on Tukey's HSD post hoc paired comparisons for groups with unequal sample sizes. Scale -2 = *encounters detracted greatly*, +2 = *encounters added greatly*.

Conclusions and Implications: Group Characteristics, Use Variation, and Travel Patterns

The mean distance traveled and mean amount of time spent in wilderness varied greatly between the sample locations – indicating that researchers and managers should not try to label wilderness day users with a "one-size-fits-all" distance traveled or amount of time spent in wilderness. The collective variability between locations can be attributed to a number of factors, including the perceived difficulty of the trail or the advertised distance of the trail in hiking books, the *Yosemite Guide* newspaper, or other park and private information sources. The seven trails selected ranged from steep, exposed trails to flat trails through forest; the physical demands of the landscape challenge each hiker differently, impacting the distance and duration of day hikes.

Two trails, with similar characteristics, showed similarities in the amount of variability found in the two dependent variables. Both Chilnualna Falls and Porcupine Creek had less variability in both distance traveled and amount of time spent in wilderness than the other sampled trails. Both trails are classified as moderate use, with destinations between 4 and 5 miles from the trailhead. Additionally, these trails are located a considerable drive from either Yosemite Valley or Tuolumne Meadows, making both hikes the primary destination for hikers traveling to these trailheads. It is unlikely that visitors spontaneously decided to hike these trails, due to the inconvenience of access. The smaller amount of variation seen in the variables for these two locations may be a result of this increased need for planning and/or the amount effort needed to access these trails. In other words, these trails probably attracted hikers who planned to go to the destination.

Surprisingly, group characteristics such as the number and age of group members did not show any substantial relationship to distance or amount of time spent in wilderness. Although a few significant differences were found between groups with members in varying age categories, these differences were rare, small, and exhibited no clear patterns. The greatest impact of age category on either of the dependent variables was seen between groups with children under 18 years of age and groups with no children. Groups without children under 18 traveled farther than groups with children, but effect sizes were small. Group characteristics at Upper Yosemite Falls showed the greatest impact on the dependent variables. Findings at Upper Yosemite Falls tended to be both statistically and practically significant. While the statistical significance of differences may have been due to the large sample at this location, the findings were also supported by practical differences between groups. For example, the mean distance traveled in wilderness by age category of the oldest member of the group was statistically different between the 18-40 and 41-60 groups at Upper Yosemite Falls. Furthermore, the distance traveled by these groups differed by almost a mile. Considering that the Upper Yosemite Falls trail is a 6-mile round-trip hike, the difference of one mile can be considered practically significant for this hike. Groups with the oldest member in the 18-40 category traveled 5.2 miles on average, while groups with the oldest member in the 41-60 category traveled 4.3 on average, indicating that groups with younger members traveled farther on this trail than groups with older members.

Hiker use patterns showed distinct trends in the ways that wilderness day hikers use the overall wilderness trail network available in the park. The majority of day hikers took out-and-back trips, returning to the same trailhead from which they started. Few wilderness day hikers took one-way trips. This may be attributed to the difficulty of coordinating rides to and from the trailheads or a lack of information promoting such activities in wilderness. The majority of the printed NPS materials regarding hiking highlight the attraction sites to be seen along a trail, or simply discuss the trails in such a way that an out-and-back trip is implied as the norm. If Yosemite wilderness managers wanted to change hiking patterns of visitor use on wilderness trails, a change in the focus of the hiking literature provided by the park might precipitate a change in hiking behavior.

The observed hiking patterns serve as a potential gage for where wilderness day use may spread on the sampled trails. For example, 30% of the hiking groups sampled at May Lake traveled beyond May Lake, with many groups traveling either to Mount Hoffman or beyond the ridge to the Crystal Caves. Knowledge of the Mount Hoffman social trail is popularly circulated online and in hiking books. However, other potential destinations beyond May Lake, such as the Crystal Caves, might be less well known to current wilderness day hikers in the park. As use increases, wilderness day hikers seeking solitude or added challenge may be more likely to travel to lesser known destinations to escape crowds. This knowledge of existing use patterns on the May Lake trail can be used by managers in anticipation of future use on this trail, enabling them to be more proactive in their decision-making and planning regarding site restoration, wilderness patrols, or how to deal with the appearance and use of additional social trails in the area.

One of the values of collecting GPS data is the objectivity in calculating variables of interest. The success in generating accurate estimates for both variables in this study demonstrates the utility of using GPS units to collect such information. Furthermore, the knowledge gained from this GPS study contributes a new aspect to the traditional information collected about wilderness users. Information about visitor characteristics is considered baseline data for wilderness managers (Cole & Wright, 2004). Additionally, wilderness researchers and managers have been, and continue to be, interested in answering the questions of who wilderness visitors are, and what they do on their trips (Cole &

Williams, 2012). The collection of GPS data, in conjunction with researcher observation, allows researchers to answer such questions using a more streamlined, objective method of data collection. Burden is removed from the visitor and placed on the study administrators and data analysts, enabling managers and researchers to have a higher level of control over the data collection and analysis process. The visitor's role becomes more passive; rather than relying on a visitor to accurately answer questions about his or her movement in wilderness, the visitor simply has to agree to carry a personal GPS unit. The removal of visitor burden is more in line with the management objective of providing high quality visitor experiences evident in the NPS mission statement, while still allowing researchers and park managers to collect valuable visitor information.

Furthermore, as technology becomes ever more ingrained in modern life, the perceived intrusiveness of being tracked while hiking may continue to decrease. Some wilderness practitioners have cautioned against increased use of technology in wilderness, arguing that technology's presence changes wilderness trip expectations and erodes the element of the "unknown" in a wilderness experience (Borrie, 1998). In the case of my work, some might argue that the use of automated tracking technology is an invasion of privacy or conflicts with wilderness values. Indeed, a few individuals refused to participate in the study, mentioning they were anti-government or against "Big Brother." However, the majority of participants showed no aversion to participating in the study due to the use of technology. Furthermore, while visitor collection of data was passive throughout the wilderness trip, informed consent was still obtained from visitors before GPS units were distributed, ensuring that the use of tracking technology in this study was consistent with the ethics of using human subjects.

Specifically for Yosemite wilderness managers, the availability of objective information about the distance traveled and time spent in wilderness by day hikers provides a snapshot of current wilderness day use prior to any future changes in wilderness management. GPS visitor tracking in wilderness could be incorporated into the park's overall wilderness monitoring protocol to provide more descriptive information of wilderness use over time. Through the selection of indicator trails for sampling, wilderness managers may be able to track how use shifts between and within high and moderate use trails. Furthermore, the park could explore how use differs between destination and non-destination oriented day hiking trails. This study provides baseline information on destination-based hiking on high and moderate use trails; the inclusion of non-destination based trails in GPS sampling could provide additional insight on the variation of day use wilderness experiences offered in the park. As the park continues to develop its Wilderness Stewardship Plan, the availability of such baseline information will be valuable in evaluating future day use trends and the implications of future management actions on two of the most basic components of a wilderness experience: distance and time.

Conclusions: Micro-level Site Displacement

The Ripley's *K* output and cluster patterns generated at each location indicate that micro-level site displacement occurred, to some degree, at each of the sample locations. Because the *L* functions for each of the use classes were located completely outside of the *L*-minimum and *L*-maximum confidence intervals, clustering was significant at all distances tested by analysis (Mitchell, 2005). The significant level of clustering served as a trigger for the nearest neighbor hierarchical cluster analysis to further explore the location of clusters within each attraction site. Moreover, the *L* functions can be used to further interpret clustering behavior within each location, and therefore contribute knowledge to micro-level displacement behavior at a wilderness attraction. Peaks in the *L* functions indicate distances at which the largest numbers of clusters occur. Looking at the distance of “peak clustering” between each of the use levels is useful in providing a metric for understanding on-site cluster distributions. For example, at Dog Lake the *L* function generated from the low use point feature class peaked at a distance of about 60 feet, whereas the moderate use and high use *L* functions peaked around 40 feet and 45 feet, respectively. This indicates that the points comprising the low use clusters are within 60 feet of the target point at the center of the cluster; therefore, the cluster is more spread out than those occurring at moderate or high use densities. This trend from more dispersed clusters to tighter clusters is the type of clustering behavior expected if micro-level site displacement is occurring as use increases at a site. At low use density, individuals have more space to spread out — the hikers may be going to the same relative geographic area, but because fewer people are present they have more freedom of movement within the site. At higher use densities, the distances between points in a cluster decrease as hikers looking for a space near the attraction site that meets expectations are forced to be in closer proximity to each other.

At May Lake, however, the expected trend of the low use feature class peaking at a greater distance than the moderate and high use feature classes was not upheld. The high and moderate use feature classes peaked around 95 feet and 86 feet respectively, while the low use feature class peaked around 70 feet. This could have resulted from the complexity of the May Lake attraction site. May Lake is not only a stunning, easily accessible alpine lake, but amenities such as the May Lake High Sierra Camp, a backpacker’s camp, and a pit toilet exist in close proximity to the lakeshore. The low use cluster distances could have been impacted by the presence of these features, with the dispersion of visitors clustering near these built structures being physically limited by the structures. Conversely, in the high and moderate use cluster patterns we see dispersal away from these built structures, potentially accounting for the increased cluster distances at these use levels.

The Sentinel Dome *L* functions did not follow the expected peaking trends either, with the moderate use feature class peaking at the greatest distance, followed by the low use feature class, and finally the high use feature class. These patterns do reflect what was seen in the nearest neighbor hierarchical cluster analyses for this site, namely the moderate use feature class clusters were the most dispersed and the high use feature class clusters were the least dispersed (most clustered). The variability in the peak cluster trends among the three use levels indicates that Ripley's *K* alone cannot be used to understand micro-level site displacement, and should be followed by nearest neighbor hierarchical cluster analysis to understand site-specific cluster behavior. Nevertheless, the Ripley's *K* analyses were useful in identifying the presence of significant clustering within each use level, and in exploring initial trends in the data.

At all three study locations, the nearest neighbor hierarchical cluster patterns generated from the low use point feature classes shared similar characteristics. Each of the cluster patterns contained a smaller number of clusters than the moderate use feature classes, and at two of the locations (Dog Lake and May Lake) the low use cluster pattern had the fewest total clusters. Additionally, the size of the clusters generated by the low use feature classes tended to be much larger than the size of the clusters produced by the moderate and high use feature classes, indicating that more points comprised the low use clusters than the high and moderate use clusters. The characteristics of the low use cluster patterns indicate that, at low use levels, the distribution of points at the wilderness attraction site is likely to be located near where the trail enters the destination. This is what would be expected if micro-level site displacement is not occurring – the user arrives at the destination point and is able to experience the attraction site from the most convenient viewpoints or locations (Cole & Hall, 2012; Schneider, 2007). The size of the clusters produced by the nearest neighbor analysis is correlated with the number of points in a cluster. The larger size of the low use clusters indicates that more visitors were using the same location, that visitors were spending a longer amount of time at the location of the cluster, or a combination of the two. If displacement is not occurring, this is what would be expected. The user arrives at the attraction site and is able to choose optimal sites close to the trail access point to experience the attraction site because there is a higher likelihood, due to low use on the trail, that these desirable spots are empty. The absence of other users removes potential sources of conflict or impact to trip expectations; therefore, the coping mechanism of micro-level site displacement is not engaged by the visitor (Manning & Valliere, 2001; Schneider, 2000, 2007). Furthermore, if use at the attraction site is low, the user may spend more time there due to the lack of other people impacting his or her experience at the site.

When comparing the cluster patterns created from low use feature classes to those created from moderate use feature classes, it is evident that visitor use of the attraction site is different. At each of the three locations, the cluster patterns generated from moderate use feature classes showed more clusters than the low use feature classes, the clusters were smaller in size than the low use clusters, and the dispersion of clusters at the site was greater than at low use levels. The larger number of smaller clusters indicates that visitors are spreading out, staying at any one geographic location for a shorter amount of time, or a combination of the two. These behaviors are characteristic of micro-level site displacement

— the presence of others led visitors to engage in behavioral coping mechanisms (Schneider, 2000). The user arrives at the site, and due to the presence of other individuals already there, is displaced to different geographic locations within the site to get the experience he or she is seeking. Additionally, if experience expectations are not met at the site due to the presence of other users, the user might decide to spend less time at the attraction site (Schneider, 2000). These types of behaviors would have contributed to the cluster patterns produced at moderate use levels. Particularly evident at moderate use levels is the appearance of new clusters on the periphery of the low use clusters – this trend also contributes evidence for the occurrence of micro-level site displacement. For example, the user arrives at the site and continues past groups already present until he or she locates a spot that is uninhabited by other visitors. This uninhabited spot is likely to be on the outskirts of the most popular spots already inhabited by other users. The uniformity in the behaviors seen in the cluster patterns of the moderate use feature classes relative to the behavior seen in the low use features classes provides concrete evidence that visitors are, in fact, using wilderness attractions sites differently at different use levels. Furthermore, the trends exhibited by the cluster patterns at these two use levels are characteristic of the occurrence of micro-level site displacement.

The trends in the high use cluster patterns differed between sites, providing an interesting contrast for examining the nature of micro-level site displacement. At Dog Lake the high use cluster pattern did not differ greatly from the moderate use cluster pattern. Clusters occurred in generally the same places at both use levels. The lack of a higher level of dispersion between the two use levels could be attributed to a number of factors. First, the geographic layout of the site might not lend itself to further dispersion of clusters. In some areas, the Dog Lake shoreline is not easily accessible, with fallen trees and other natural obstacles blocking the path of visitors seeking to get away from other people at the site. Additionally, depending on the water level, some portions of the lake could have been undesirable to visitors due to dry or swampy conditions, deterring further dispersal. The lack of a noticeable difference between high and moderate clustering could also be attributed to the sensitivity of the use classification at higher use levels. Natural breaks in the use data were used to classify tracks as being collected during low, moderate, or high use times. It is possible that the distinction between high use and moderate use at Dog Lake was not sensitive enough to detect a noticeable change. While the high and moderate use cluster patterns did not differ in a consistent, noticeable way, the difference between the low use cluster pattern and those of the high and moderate use still supports the conclusion that micro-level site displacement occurred at Dog Lake.

The high use cluster pattern at May Lake continued the trend of increased cluster dispersion around May Lake, with the appearance of new first-order and second-order clusters at this use level. The progression of cluster dispersion, decreasing size of clusters, and an increasing number of second-order clusters across the three use levels indicate that micro-level site displacement can evolve along a spectrum of use, rather than simply occurring or not occurring at a site. In other words, the May Lake patterns show degrees of micro-level displacement. Additionally, the presence of such a strong pattern of increasing cluster dispersion between the three use levels discounts possible confounding factors that may have arisen due to the presence of the May Lake High Sierra Camp and the Backpacker’s Camp near May Lake. Both camps are located on either side of the May Lake Trail, and additional users from either of these camps could have been present at the site who were not accounted for in the trail counter use estimation. However, the presence of such a strong trend toward micro-level site displacement between the use levels, regardless of the impacts of users at either camp, adds confidence to the findings at May Lake and the methods used to document displacement.

The high use cluster pattern at Sentinel Dome highlights a potential threshold for micro-level site displacement. The high use cluster pattern did not share the characteristics of those at Dog Lake and May Lake. In fact, this was the most clustered pattern produced at Sentinel Dome. The clusters were large, and clumped into three groups, representing three possible visitor mindsets in this high use situation. First, a large cluster near the base of Sentinel Dome indicates that some users congregated there. This could have occurred for a number of reasons, including delay due to the presence of other users descending from the summit or a decision against hiking to the summit due to the number of visitors already there. The four large clusters located at the end of the Sentinel Dome trail on the summit indicate that users were clustered on the summit, even at high use levels. Because of the limited number of alternative spaces available on the summit of a dome, these users perhaps gave up on the option of finding an unoccupied site and decided that, regardless of use, they were going to get the best view from the center of the summit. Finally, the cluster located beyond the center of the summit may represent users willing to incur some risk in the search for an uninhabited place to relax and enjoy the views. Of the three locations, Sentinel Dome had the highest use, with the high use category assigned to tracks collected with more than 110 inbound users on the Sentinel Dome trail. The behavior exhibited in the Sentinel Dome cluster pattern leads to further areas for micro-level displacement research, including the impact of risk and safety on micro-level site displacement decisions. For example, under high use conditions, how much risk are visitors willing to incur in order to reach a location that satisfies their expectations for the attraction site? At what point does a visitor abandon his or her plan to go to the attraction site due to high use (engaging in another form of geographic displacement)? Does risk play a role in the decision to change plans? As wilderness day use increases and attraction sites become more crowded, these types of considerations may become managerially relevant, particularly on domes and peaks.

Contribution to Micro-Level Site Displacement Literature

The documentation of micro-level site displacement at three wilderness attraction sites in this study adds to the small body of literature looking at micro-level site displacement in urban-proximate wilderness areas. Cole and Hall (2012) found that 49% of weekend (high use) users and 30% of weekday (low use) users passed over an occupied, preferred site at Snow Lake. In a study of urban-proximate recreation conflict, Schneider (2000) also found wilderness users to engage in micro-level site displacement, with approximately 31.9% of wilderness users responding to conflict by leaving the area and moving to a different part of the same area. Furthermore, approximately 31.6% of users of a developed recreation site also engaged in micro-level site displacement in response to some conflict. While this study cannot generalize to the individual wilderness user, it is important to note that micro-level site displacement was documented at each of the three locations at both high and moderate use levels. The combination of findings between these three studies indicates that micro-level site displacement is occurring at varying use levels, and in different recreation settings among a number of wilderness populations including urban-proximate users in the Pacific Northwest, the Southwest, and California. Additionally, these studies were conducted in 2000, 2008, and 2012; the documented occurrence of micro-level site displacement during this 12 year time period indicates that users are likely to continue to engage in micro-level site displacement in the future.

These trends are important for the future of wilderness management in high use wilderness areas. First, managers should be aware that occurrence of micro-level site displacement increases the use of previously lightly-used areas at wilderness attraction sites. This could lead to faster degradation of site conditions than previously expected, and more resources needed to restore site conditions (Schneider, 2007). Particularly for Yosemite managers, river bank and stream restoration is already occurring at a number of popular water features in Yosemite Valley and Tuolumne Meadows. As users continue to seek access to a limited number of water features in Yosemite, managers should be aware that micro-level site displacement is already occurring at two easily accessible wilderness water features (May Lake and Dog Lake). Additionally, micro-level site displacement may lead to other types of displacement in the future. While relationships between the occurrence of micro-level site displacement and other forms of displacement have not been empirically documented in the literature, it is possible that with increased use and micro-level site displacement it is more likely that these patterns might materialize with increased use (Cole & Hall, 2007; Kuentzel & Heberlein, 1992; Schneider, 2000).

Micro-Level Site Displacement and Reported Experience Measures

Interestingly, the visitors' self-reported evaluations of the impact of crowding and the number of other groups encountered on aspects of their wilderness experience did not correlate with the occurrence of micro-level site displacement as had been expected. The cluster patterns at each location showed strong patterns of micro-level site displacement occurring as use increases at a site. In contrast, questions asking visitors to indicate the degree of crowding experienced on trails and at destination points did not reflect the behavioral changes seen in the spatial data. The lack of a strong positive correlation between visitor experience and use density is not uncommon; in fact, this relationship has been studied in a number of settings with varying results (Cole & Williams, 2012). Data on the impact of use density on wilderness experience is often collected using visitor self-reports on the impact of various use density variables on experience. In the case of this study, the spatial data explicitly showed that at varying use levels, the behavior of visitors at attraction sites was different; thus, the impact of use density on experience was concretely demonstrated by the spatial data. However, in asking visitors to report use density impacts on experience, the relationship disappeared.

This discrepancy between visitor reports and actual data on visitor behavior at the attraction site could have arisen from a number of factors. First, the survey was administered to visitors as they exited wilderness at the trailhead; therefore, the time between any negative attraction site experiences and survey administration could have diminished negative evaluations of experience. In general, negative aspects of experience are few compared to the number of positive aspects encountered by a visitor (Cole & Williams, 2012). If negative experiences occurred at the attraction site, the time between the survey administration and that negative experience was probably filled by positive experiences that were fresh in the minds of visitors when responding to survey prompts. Similarly, the user may have answered the question with the entire experience in mind, even though two of the seven questions explicitly asked about the impact of crowding at specific locations (on trails and at attractions). If so, the overall experience may have been evaluated positively. Moreover, visitors may not have viewed the displacement experience negatively. Most recreation users, particularly wilderness day users, have been shown to be fairly adaptable to their surroundings and less sensitive to the presence of other people (Cole & Hall, 2007). Given this adaptability, the ability to find a stopping point meeting trip expectations may have been viewed as a positive aspect of the trip experience.

Finally, micro-level site displacement may not be a conscious activity. Displacement is characterized as a problem-focused behavioral coping mechanism used in response to negative stimuli, suggesting that visitors consciously recognize a negative stimulus and respond with an action (Manning & Valliere, 2001; Schneider, 2007). The data in this study suggest that, upon arrival at an attraction site, a visitor may not even realize that he or she is engaging in a displacement behavior. The ease with which a visitor can continue walking past other groups to find solitude may seem like second nature rather than a conscious decision to choose another location because another group already inhabits a site that looks desirable. This minor adjustment in spatial use of the site would have alleviated any crowding, resulting in the type of survey responses obtained.

The use of GPS tracking allowed for the documentation of movement characteristic of displacement; similarly, Cole and Hall's (2012) Snow Lake study also captured the occurrence of displacement through passive researcher observation. It is possible that micro-level site displacement may only be captured through such methods of data collection that do not prompt a visitor to make a self-evaluation of his or her own behavior. If this is the case, then, the use of GPS tracking in conjunction with use density data to study displacement is particularly relevant to increasing the understanding of micro-level site displacement.

The discrepancy between actual behavior and visitor evaluations leaves managers with an interesting dilemma: should managers care more about experience evaluations or visitor behavior, and which should guide management decisions? Micro-level site displacement is classified as a behavioral coping mechanism; inherently, coping implies a negative aspect that must be overcome or managed in some way by the visitor. The occurrence of micro-level site displacement indicates that, at some level, negative experience aspects exist in wilderness. The presence of these negative experience aspects, in conjunction with environmental and other data relevant to site management, can be used to justify management decisions. Consistent with the existing wilderness literature, Cole and Hall (2012) found that wilderness users were more likely to favor use restrictions for environmental preservation, rather than protection of the social experience. Micro-level site displacement documents the spread of use in response to conditions, thereby documenting the spread of visitor impacts to a resource. The spatial data from this study link the occurrence of potential resource impacts to visitor responses to social conditions. Therefore, using these data managers can understand how changes in visitor use may be expected to influence both resource and social conditions in wilderness. This connection provides an avenue for developing management initiatives that target both resource and social condition preservation, potentially making them more favorable to the public than management initiatives that can only be justified as protecting social conditions.

Methodological Contributions

The success of this study in documenting micro-level site displacement as the use level increased on trails, and therefore at attraction sites, at each of the three study locations confirms the ability of the methods used to explore the movement of visitors as it varies with use level on a trail. This method overcomes some of the limitations of previous methods used to study micro-level site displacement. The use of GPS units to collect information about a visitor's geographic location provides researchers and managers with objective data regarding visitor use on trails and at attraction sites. Namely, estimation by either the researcher or the visitor in reporting time spent hiking and at attraction sites is eliminated. Furthermore, GPS devices do not function without error at all times; however, error can be more easily identified, examined, and ultimately a decision can be made to correct the error or discard the inaccurate tracks through data processing and cleaning. Conversely, human estimation errors are embedded inextricably in the dataset.

In addition to reducing error, using GPS units and trail counters to collect use data reduces the data collection burden for researchers and visitors. Previous methods for collecting data regarding the geographic location of visitors at multiple locations required the visitor to record the time and location of various check points or the researcher to record observations of time and location upon visitor arrival at an attraction site. These methods can be time consuming for both parties involved, resulting in high dropout rates when visitors are asked to record their own locations or low return on time invested for field researchers observing one party at a time (Borrie & Roggenbuck, 2001). Using GPS units to collect this information directly reduces visitor burden — the visitor is only asked to clip a small GPS unit to his or her pack. Similarly, a researcher can distribute multiple GPS units per day, collecting multiple visitor tracks per distribution effort.

Specific to micro-level site displacement studies, using the passive data collection methods employed in the current study eliminates the potential for negatively impacting a visitor's experience at a wilderness attraction site. The micro-level site displacement study conducted at Snow Lake (Cole & Hall, 2012) used researcher observation of the movement of groups at attraction sites to quantify four measures of displacement. While the intention of researchers conducting that study was not to negatively impact visitor experience, the potential for impact remains because researchers had to observe unknowing visitors – consent was not required from visiting groups. Using GPS units to collect data on the spatial use of an attraction site by visitors helps to reduce potential impacts to visitor experience by the research effort, while still collecting valuable use information.

This study also applied robust spatial statistical analysis methods to better understand the spatial data collected, moving beyond reporting basic descriptive statistics or simple map-making of visitor tracks. GPS units output X and Y coordinate points; therefore, the basic structure of a GPS dataset is a point feature class. While point feature classes are the most basic of the spatial data types, specific spatial statistical tests have been developed to explore point patterns. The application of Ripley's *K* and nearest neighbor hierarchical cluster analyses is appropriate for the dataset — both tests compare the spatial distribution of the point data to a random distribution of the same number of points. Using tests that provide a control for comparison produces findings that can be used to defend management decisions, just as other types of statistical analysis are used in science-based decision making. These methods therefore contributed new applications of spatial statistics to the recreation literature, providing practitioners with another avenue for exploring visitor movement through space and time.

Limitations and Future Research

While these methods allowed for the description of a sample group of wilderness day hikers and successfully documented the occurrence of micro-level site displacement across a use gradient at attraction sites, limitations do exist in the methods used for data collection and analysis. First, the learning curve for data processing and analysis was high. Cleaning and processing the large sample of GPS data collected was beyond the capabilities of ESRI's ArcMap software; therefore, future researchers should be prepared to use other software to work with GPS data. For this dataset the most time efficient way to batch process the GPS data was writing scripts in Python, the open-source base language for the ArcMap software. Working in Python allowed for the application of pre-existing ArcMap tools to the GPS data using an iterative process, overcoming the processing limitations of ArcMap's ModelBuilder feature. Additionally, the Python scripts were customized to the format of the output produced by the igotU GPS units used in this study. The production of multiple, customized scripts for data cleaning, database creation and organization, and calculation of independent variables took approximately two months to design and create (after learning how to program in Python). This amount of effort is considerable.

The built-in spatial statistics tools in ArcMap 10.1 could not handle the large amount point data in the feature classes produced by aggregating the data from individual hikers into a single file. The large files repeatedly crashed ArcMap 10.1 without completing. CrimeStat III, an open-source spatial statistics software designed specifically for point data, ended up being a better, more efficient software for spatial analysis. The data processing and analysis for this study was time consuming, with each Ripley's *K* analysis running for a few hours due to the size of the dataset. However, using these techniques satisfied one of the central goals of this work to explore the potential for the use of sensor data and spatial analyses in exploring visitor behavior in wilderness. Researchers and managers interested in using GPS data in future efforts to understand visitor behavior should budget adequate time, resources, and skilled analysts for project completion.

The GPS study conducted during the summer 2012 field season at Yosemite National Park was an exploratory study using multiple methods to understand wilderness day use in the park. Therefore, the results of this study represent a snapshot of wilderness day users on the seven trails sampled during the 2012 field season. The statistical results cannot be generalized across the entire Yosemite Wilderness, nor can they be applied to the overall population of wilderness day users in the park. However, the trends identified by this study may be relevant to similar populations in other high day use wildernesses or on other high and moderate use trails in Yosemite Wilderness. For example, neither group size nor age impacted the distance traveled or amount of time spent in wilderness. For managers of other wilderness areas, this information may be relevant. Additionally, the vast majority of day users took out-and-back trips in wilderness, rather than utilizing the connectivity between trail networks. In similar populations or locations, these factors might be managerially applicable. Regardless, due to the success of this study in providing accurate, descriptive information about wilderness day hikers, future work should move toward using a random, representative sample of wilderness day users park-wide in order to make broader generalizations about overall use.

Future research should explore how the Ripley's *K* analysis may be better applied to study the occurrence of micro-level site displacement. The application of the analysis in this study followed the standards of spatial statistics; however, the results did not provide clear indicators of micro-level site displacement that was found to occur using the nearest neighbor hierarchical cluster analysis. One potential area for exploration is the impact of the size of the point feature class on the confidence intervals. In this application, the confidence intervals for each of the Ripley's K analyses were extremely small, indicating significant clustering at all distances tested. Perhaps adjusting the size of the dataset would adjust the confidence intervals to provide more meaningful information about the significance of difference clustering distances, increasing the sensitivity of the test. Additionally, standardizing the number of points in each point feature class may provide for a more refined comparison of the degree of cluster significance between locations. For example, a point feature class with 1,000 points may show a lesser degree of clustering than a point feature class for the same area with 3,000 points. Because the area for analysis was standardized between the locations, standardizing the number of points between locations may help in making comparisons between locations.

The unit of analysis for the exploration of micro-level site displacement in this study did not allow for the examination of the movements of any one individual hiker at the attraction site, specifically preventing investigation of how time was spatially allocated by each visitor. Time in a single geographic location is reflected in the point data by the presence of a point in the same location at multiple time stamps. The high, moderate, and low use feature classes created at each site were an aggregate of the point data collected at each use level at each site because the required input for the Ripley's *K* analyses and the nearest neighbor cluster analysis is a single point feature class. Aggregating the data eliminates the individual as the unit of analysis, replacing it with the points within a use level as the unit of analysis.

While aggregating the data initially limits the understanding of individual movements at the attraction site, it also provides a gateway for the development of future analyses to explore individual use of the site in a directed way. The nearest neighbor hierarchical cluster analyses identified the locations of statistically significant cluster polygons. In future work, the movement of individual hikers between these polygons can be tracked to determine the amount of time spent in each polygon, and the number of polygons used by each hiker at each use level. Adding these additional measures will provide evidence on the use of the site by individuals, allowing for the comparison of individual behaviors between sites and use levels. Mean amount of time spent in the first polygon visited, mean number of cluster polygons visited, and overall time spent at the attraction site can be derived as dependent variables and compared between use levels. This type of information may provide additional support for the occurrence of micro-level site displacement at wilderness attraction sites, and provides insight on use by individual visitors.

The success of the data collection and analysis techniques used in this study to document the occurrence of micro-level site displacement indicates that researchers and managers can use GPS data and trail counter data to understand visitor use at wilderness attraction sites and how use changes with use density on a given trail. While these exploratory methods were successful in their application at three attraction sites, future research using these methods of data collection and analysis is needed to solidify the methods used in this study as robust, acceptable methods for studying micro-level site displacement.

Chapter 3

Understanding Day Hiker Trail Choice Decision Making in Yosemite National Park

Justification for Examining Day User Trail Choice

As discussed in Chapter 1, wilderness day use has steadily increased in recent decades, making wilderness day users a managerially relevant sub-group of wilderness users. The current wilderness day use literature focuses largely on trying to understand who wilderness day users are and how they differ from overnight users on factors such as demographic characteristics; wilderness experience; and opinions, perceptions, and attitudes toward wilderness management initiatives and resource and social conditions (Cole & Hall, 2008; Cole & Williams, 2012; Cole, 2001a). Many studies employing various research methods and conceptualizations of wilderness experience have attempted to document empirical differences between the two user groups. For example, using a telic approach to wilderness experience — meaning that experience is conceptualized as the outcome of goal attainment through need satisfaction — researchers have quantitatively explored wilderness experience using survey questionnaires and other methods that require the visitor to categorize his or her wilderness experience. Using these quantitative approaches has documented few empirical differences between the wilderness experiences and user characteristics of day and overnight users (Cole & Hall, 2008; Cole, 2001a). Furthermore, where differences exist between the two populations, effect sizes are generally small and patterns across wildernesses have been inconsistent.

Autotelic approaches, or those that conceptualize wilderness experience as an on-going, multiphasic relationship, have also failed to document empirical differences between day and overnight users. Seekamp, Hall, and Cole (2012) used a qualitative approach to understand wilderness experience from the visitor's perspective. Semi-structured interviews were used to explore, among other things, if a visitor considered himself or herself to be having a wilderness experience, conceptualizations of that experience, and factors impacting experience. Approximately half of the interviews originated from day users (46%); however, interviews were ultimately aggregated because noticeable patterns did not exist between use type and other descriptive codes. This study revealed that, even when using more in-depth, autotelic approaches to understand visitor conceptualizations of wilderness experience and qualitative data generation methodologies, differences between day and overnight wilderness users do not surface.

Both telic and autotelic approaches to exploring differences between wilderness day and overnight users have generally focused on wilderness-centric concepts. For example, many studies have focused on quantifying experiential aspects of wilderness character such as solitude (or the lack thereof), challenge and self-reliance, or sense of being away from the modern world (Seekamp, Hall, & Cole, 2012). These approaches to understanding wilderness users stem from language in the Wilderness Act of 1964, and the resulting management objectives that wilderness managers are required to uphold. Furthermore, research into these areas contributes to the development of robust indicators and standards for managing wilderness. However, using these approaches to understand wilderness day users as a distinct population have failed to reveal unique aspects of wilderness day users that differentiate them from overnight users, and therefore, establishes them as a managerially relevant subgroup of users. Furthermore, these approaches ignore contextual factors that may be impacting an individual's decision to take a day trip in wilderness.

Given the existing large body of research on wilderness day user experiences and motivations, I sought to understand a related, but different aspect: wilderness trail choice decision making – that is, how wilderness day users make the decision to hike on a given wilderness trail. I wanted to move away from the general focus of the current wilderness day use literature of differentiating day and overnight users, by focusing specifically on day users and their trail choices, with the goal of providing relevant information about the trail choice process to managers.

Understanding wilderness day user decision making is important because identifying the factors impacting trail choice will allow managers to better communicate with, and perhaps manage, this growing segment of the wilderness user population. This study sought to explore three aspects of wilderness trail choice decision making: the decision making process, the information relevant to trail choice, and the sources of information considered. Information use, as it related to trail choice decision making, was a focus of this study because in other, related fields, information use is studied to provide businesses with data about the sources and amounts of information customers use to make purchasing decisions (Hyde, 2008). Through identifying the information sources used in decision making, tourism business owners, in particular, increase their ability to influence purchase choices, and therefore tourist behavior (Hyde, 2008). Furthermore, by exploring the decision making process, researchers have been able to isolate aspects of tourist decision making that are easily influenced (Moore, Smallman, Wilson, & Simmons, 2012). In a similar way, identifying the sources and relevant pieces of information used by day hikers in trail choice can provide wilderness managers with a better understanding of the viable information outlets available to reach the growing population of wilderness day hikers. More importantly, this type of information can be used in developing indirect wilderness management approaches that target wilderness day users (Dawson & Hendee, 2009; Manning & Lime, 2000; Manning, 2003).

Information provision and visitor education have been shown to influence a variety of wilderness visitor behaviors, including the use patterns of overnight wilderness users (Manning, 2003). In the Boundary Waters Canoe Area, information regarding use levels of popular canoe entry points was distributed to visitors obtaining permits for those entry points. Study participants found information to be useful, and approximately one-third of the participants reported that the information influenced their point of entry, time of trip, or route on subsequent trips (Lime & Lucas, 1977). Similarly, Roggenbuck and Berrier (1982) found that overnight groups at the Shining Rock Wilderness Area (NC) receiving information about the impacts of concentrated camping, either in the form of a brochure or a brochure plus personal ranger contact, were more likely to engage in dispersed camping than participants in a control group that received no information. Krumpe and Brown (1982) showed that trail choice can be influenced by information provision. Trail selector brochures containing information about trail characteristics for low use wilderness trails in Yellowstone National Park were distributed to visitors at ranger stations. Researchers found that visitors receiving the trail selector brochure were more likely to choose one of the trails on the brochure; furthermore, participants receiving the brochure found it to be helpful and were likely to show it to other people. These studies show that targeted information provided to wilderness users can impact the use distributions of overnight wilderness users. In a similar way, managers may be able to use information and education to influence the wilderness trail choices of day hikers in Yosemite.

Information provision and education is not only effective in changing visitor behavior in wilderness, but it is also generally favored by managers and the visiting public over more restrictive management actions (Manning, 2003). This is classified as an indirect management technique, meaning that the manager attempts to influence the decision factors on which visitor behaviors are based through a non-restrictive managerial action (Manning & Lime, 2000). In the case of the studies mentioned above, managers were seeking to influence the distribution of users in wilderness away from high use areas through information provision. In the Boundary Waters Canoe Area, managers were seeking to redistribute trip entry points away from popular entry points (Lime & Lucas, 1977). Similarly, at Yellowstone, the trail selector brochure was designed to highlight low use trails in an attempt to redistribute use from more popular wilderness trails (Krumpe & Brown, 1982). In addition to the demonstrated success of indirect management techniques in redistributing use within wilderness, use of these techniques is generally less expensive, provides for more freedom in recreation decision making, and follows the intent of the Wilderness Act to provide “unconfined” recreation opportunities (Manning & Lime, 2000).

For managers of Yosemite wilderness, understanding wilderness day user trail choice decision making will be especially helpful for designing indirect management techniques that target this user group. Currently, the majority of wilderness day use is unregulated in Yosemite National Park. Aside from the Half Dome trail, visitors have the freedom to choose where they would like to hike without restrictions. While visitors currently retain the freedom to choose day hiking trails, some trails are experiencing extremely high levels of use that may comprise the social conditions present in Yosemite wilderness. For example, Irizarry and Hall (2013) estimated that approximately 536 inbound hikers traveled on the

Upper Yosemite Falls trail per day during July 2012. Moreover, hikers on this trail encountered between 50 and 109 people per hour during select sample days in July 2012. These numbers confirm that for some trails in Yosemite wilderness, use is extremely high. As managers work toward creating a contemporary, wilderness stewardship plan for the park, these high use levels may have to be addressed in order to provide the high quality wilderness experiences described in the Wilderness Act.

An understanding of why visitors choose a particular trail for day hiking and what sources of information are influential in making that choice can be helpful in redistributing wilderness day use away from high use areas, bringing the social conditions experienced on trails more in line with those intended for federally designated wilderness. Particularly with regard to park-provided information sources, understanding the impact of these preexisting sources on wilderness day hiker trail choice may also be helpful in understanding current use patterns. Yosemite has already instituted a mandatory permit system for the Half Dome trail, formerly its most popular wilderness day hike (National Park Service, 2012). These use restrictions were not received well by the public (Peterson, 2012; Skindrud, 2012). Additionally, management of Yosemite Valley has also recently come under national media scrutiny due to the release of the preferred alternative for the Merced River Plan, which proposes limits to commercial facilities, camping, and parking in Yosemite Valley. As Yosemite works toward developing its wilderness management plan, indirect management actions may be the best solution for enacting management strategies to redistribute day use in wilderness without instituting additional use limits. Understanding the information search used in day hiker trail choice decision making at Yosemite will provide valuable information about existing patterns for information use in decision making that can be targeted by indirect management strategies.

Chapter Overview

Using decision making theory and information search theory, I employed a pragmatic approach to understanding wilderness trail choice decision making, with the goal of shedding light on the contextual factors, information, and decision making strategies that lead to a day user's decision to enter wilderness. I approached trail choice decision making from a bounded rationality perspective, acknowledging that day hikers are not "perfectly informed rational actors" when making trail choices. Additionally, this study sought to identify specific decision making strategies used by hikers in trail choice. Information theory was used to inform selection of participants across a number of categories to maximize the variation in information use captured by the sample group. This chapter continues with a discussion of bounded rationality and decision making strategies, followed by a discussion of information search theory as it applies to trail choice decision making in Yosemite. Data generation and qualitative analysis techniques are presented, and seven day hiker types are proposed to summarize the findings. Findings are also discussed for managerial relevance, particularly regarding information provision to day hikers in the park. The trustworthiness of the study is addressed, followed by application of the findings to decision making and information search theory.

Bounded Rationality Theoretical Approach

Herbert Simon first introduced the concept of bounded rationality in his 1957 work, *Models of Man*, in criticism of the widely adopted rational-actor assumptions of classical economic theory. Simon argued that, in practice, decision makers are not perfectly informed and therefore cannot make decisions according to the perfectly informed assumption of the rational-agent model. Rather, decision makers construct simplified models in which rational decisions are made. Simon (1957) justified the utility of bounded rationality stating the following:

> The capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required for objectively rational behavior in the real world — or even for a reasonable approximation of such objective rationality (p. 198).

Simon asserted that decision makers are not perfectly informed because computational limits exist on processing systems, including the human brain (Simon, 1990). These limitations prevent an individual from engaging in true optimization in decision making. In order for an individual to select the optimal choice, all possible alternatives would have to be considered on all possible aspects relevant to the decision at hand. Because optimization cannot occur on a routine basis, Simon argued that the next logical approach to decision making is "[to] find techniques for solving our problems approximately," and arriving "at different solutions depending on the approximations we hit upon" (Simon, 1990, p. 6).

Since the development of bounded rationality as a theory for understanding human decision making in the real world, many alternatives to optimization have been explored as alternative processes that simplify decision making. Simon wrote specifically of three "mechanisms for rationality" in a bounded world, including recognition processes, heuristic search, and serial pattern recognition (Simon, 1990). Recognition processes and heuristic search will be discussed here, as they are applicable to wilderness trail choice decision making. Pattern recognition generally applies to analytical or quantitative computations, and thus is not relevant to the phenomenon being studied.

Recognition processes refer to the use of stored knowledge from memory in decision making. These processes are generally used by expert decision makers who are very familiar with the problem and, thus, have stored cues that can be applied to familiar situations. For decision making processes that are unfamiliar, heuristics can be employed, meaning that the search for relevant information used in decision making is guided by rules of thumb that help to simplify the search and narrow the decision space. Within the realm of heuristics, Simon described satisficing, defined as “using experience to construct an expectation of how good a solution we might reasonably achieve, and halting search as soon as a solution is reached that meets the expectation” (p. 9). Satisficing is employed by individuals when other, more structured heuristics, do not exist to aid in simplifying the decision. Due to its lack of specificity, satisficing can be employed in a number of contexts including when the decision is deemed to have too many dimensions to consider, the values of multiple groups are involved, or the individual is unsure of what comprises a favorable or unfavorable outcome.

Bounded rationality as a decision making theory was originally developed in the context of organizational and administrative decision making; however, it has been adapted to explain the decision making process in multiple bodies of literature and at a variety of decision making levels. Relevant to the study at hand, bounded rationality has been applied in the context of tourist trip destination decision making (Dellaert, Ettema, & Lindh, 1998; Sirakaya & Woodside, 2005; Tisdell, 2010).

In an examination of destination decision making and pre-trip knowledge, Tisdell (2010) confirmed bounded rationality's applicability to small-scale decisions such as tourist destination choice. Testing the neoclassical economic theory assumption of perfectly informed, rational decision makers, Tisdell (2010) asked visitors to the Jourama Falls section of the Paluma Range National Park in Northern Queensland, Australia, how much prior knowledge they had of the destination site. A minority of visitors (17.5%) reported that they had good prior knowledge of the site, while more than half of the visitors (52.1%) reported that their knowledge of the site was poor or non-existent (Tisdell, 2010). Because the survey was administered on site, with knowledge gain and information search presumably occurring before visitors arrived, Tisdell concluded that assuming perfectly informed visitors was unrealistic. Additionally, when asked how well informed they typically were before visiting a destination, approximately 63% of visitors answered that they were only moderately informed, adding further support for the use of a framework that accepts choice-set limits. Thus, bounded rationality, which accepts that visitors will not be perfectly informed in decision making, is a realistic framework for examining tourist destination choice and, in this study, trail choice decision making.

Simon noted three main factors that limit human ability to gather and use information. Decision makers are limited by the complexity of the environment in which decisions are made, their limited mental capabilities in comparison to environmental complexity, and the availability of finite resources such as time and money (Ibrahim, 2009; Simon, 1955, 1990). Furthermore, decision rules have the potential to vary temporally and contextually as decision makers tailor decision making processes to individual situations, rather than using the optimization approach in all scenarios (Simon, 1990).

Relevant to trail choice decision making and bounded rationality, Dellaert et al. (1998) introduced a constraint-based framework highlighting the importance of considering the factors that limit a tourist's travel destination choices in relation to understanding tourist decision making. While Dellaert et al. (1998) did not formally acknowledge bounded rationality as a theoretical approach to tourist decision making, their proposed model recognized "the boundaries for the space in which the consumer utility maximization process can take place" (p. 315). The importance of identifying factors that limit tourist decision making in Dellaert et al.'s work confirms the appropriateness of a bounded rationality approach.

In their constraint-based model, Dellaert et al. (1998) stated that travel choices occur as a related sequence of decisions, rather than occurring as independent discrete actions. Because of the relatedness of sequential travel decisions, it is likely that the same limiting factors impact decisions made throughout a trip. Dellaert et al. (1998) proposed that the following three related decisions occur during trip planning: the decision of whether or not to take a trip; decisions regarding various trip aspects such as the trip destination, accommodations, travel companions, mode of travel, timing, and duration; and decisions regarding selection of attraction sites at the destination, expenditures, travel routes, and dining options. The tourist answers these questions sequentially, with the answer to the first question impacting subsequent decisions. Because of the interrelated nature of the decisions, the initial set of limiting factors impacting an individual will impact subsequent trip decisions. In the context of this study, the potential impact of limiting factors across multiple decisions, including trail choice, reinforces the importance of identifying these factors. Specifically, any limiting factors that existed at the time that an individual made the decision to visit Yosemite were likely to influence within trip decision making, such as the trail choice for hiking.

The following hypothetical example demonstrates how a single constraint (i.e., time) can impact decision making at multiple levels. A couple decided to visit Yosemite as part of a larger, three-week trip to the United States, in which they were visiting a number of destinations in the West. In planning their trip, the couple decided to allot only two days for Yosemite, because their travel schedule only permitted a short amount of time in the park. In this instance, time played a role in the initial choices surrounding the visit to Yosemite. Therefore, it is likely that time continued to play a role in decisions made in the park, including the decision to hike on a given trail.

Dellaert et al. (1998) operationalized limiting factors in the context of tourism destination decisions through applying space-time constraints defined by Torsten Hagerstrand to tourist trip planning decision making. According to Hagerstrand (1970), three types of constraints affect the movement of individuals through space: (1) authority, (2) coupling, and (3) capacity. Authority constraints are those imposed by laws or institutions. Coupling constraints are those imposed by outside individuals such as friends and family. Capacity constraints as those related to resource availability, namely the amount of time and money available. As discussed previously, Simon (1957) also defined three limits to decision making that necessitate the acceptance of the bounded rationality framework: the complexity of the environment in which decisions are made; limited processing capabilities in comparison to decision requirements; and the availability of finite, external resources such as time. To explore a full range of factors that might impact trail choice decision making in Yosemite, I merged the external factors that limit decision making proposed by both Hagerstrand and Simon to form a more comprehensive list of factors to explore. Overlap existed between the ideas proposed by both frameworks; for example, both the space-time constraint framework and bounded rationality recognize that the availability of time and financial resources impact decision making.

Ultimately, the space-time constraints described by Hagerstrand provided a more concrete operationalization of these factors of interest. Therefore, in the remainder of this chapter I refer to the external factors that limit decision making as constraints. Additionally, I adopted Hagerstrand's three constraint types to explore the external factors limiting trail choice decision making: authority, coupling, and capacity constraints. Authority constraints were considered to be regulatory factors originating from the National Park Service, or other authoritative organizations, that may have impacted an individual's trail choice decision making. For example, in the past, Yosemite has had to temporarily close day hiking trails for maintenance or visitor safety concerns. Additionally, use of the Half Dome Trail, a popular day hiking destination, is limited to people who obtain permits through a limited-use, rationing system. Coupling constraints were considered to be factors impacting trail choice that originated from friends or family members that were part of the hiking or larger travel group. Finally, capacity constraints were operationalized as the impact of time on an individual's trail choice decision. (Hagerstrand operationalized capacity constraints as the impact of limited time and money on decision making. However, because day hiking is free to visitors once in the park, I focused specifically on the impact of time on decision making.) The exploration of these three constraint areas provided context for understanding wilderness trail choice decision making among day hikers in Yosemite.

Bounded rationality dictates that decisions occur in simplified systems, but what are the inputs into the system that ultimately result in a decision? Decisions are made based on sets of premises that can be classified into two categories: value premises or factual premises. Value premises originate internally, stemming from the existing preferences and desires of the decision maker. Factual premises are defined as “descriptive statements about the environment and how it functions” (Ibrahim, 2009, p. 4). A combination of both types of premises serves as the limited inputs into the constructed decision making model of an individual, leading to the selection of a single decision choice. In the context of trail choice decision making, value premises contributing to the decision to hike on a given trail could stem from a hiker’s personal attitudes and beliefs about the benefits of hiking in wilderness, or his or her desire for personal challenge. Potential factual premises impacting trail choice would be information about trail length and conditions, recommendations from others, or known attractions along the trail.

As discussed earlier, a significant portion of the wilderness literature to date has focused on understanding the value premises of wilderness day users, with many studies identifying wilderness related attitudes, beliefs, and preferences. This study used a different approach, examining wilderness decision making by focusing on the selection and use of factual premises in trail destination choice by wilderness day hikers at Yosemite National Park. In this chapter, factual premises are considered to be the information about hiking in Yosemite National Park considered by wilderness day users when making trail choice decisions. An example of factual premises for the Upper Yosemite Falls trail, one of the locations at which hikers were interviewed, are that the trail is located in Yosemite Valley, is very steep, offers a challenging hiking experience, and provides many views of Yosemite Falls.

In accordance with the bounded rationality theoretical framework discussed above, I assumed that they used some sort of simplified decision model to make a trail choice. That is, I assumed that wilderness day users did not engage in optimization, which would have required that hikers review all of the possible wilderness day hikes in the park, and evaluate each alternative on all of the possible dimensions relevant to making a trail choice. Therefore, I assumed that visitors constructed a simplified decision model that involved the consideration of selected information sources and the selection of relevant factual premises (pieces of information) that were used in making the final trail choice decision.

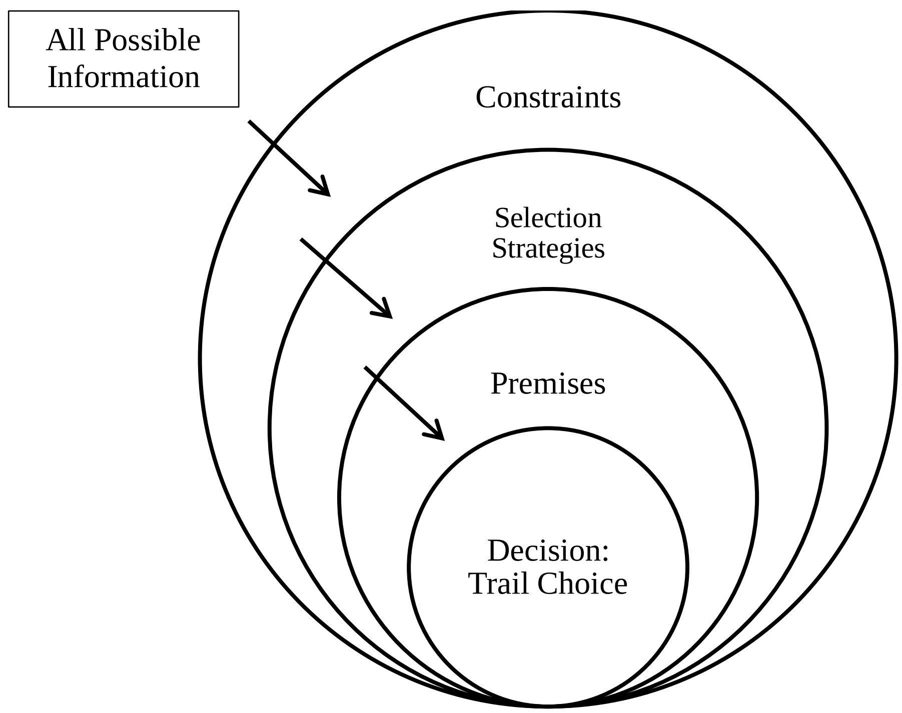
As discussed previously, Simon's recognition processing and heuristic search approaches to bounded rationality decision making are relevant to trail choice decision making. More specifically, five techniques can be used to classify the way in which decision makers may select the factual premises relevant to a decision: *programmed response*, *factorization* and *specialization*, *limiting alternatives*, *selective attention*, and *satisficing* (Ibrahim, 2009). When faced with a familiar problem, a decision maker has the potential to react with a programmed response using a recognition process to solve the problem. Using a programmed, or familiar, response to a problem reduces the decision maker's uncertainty and reduces the effort needed in decision making through the access of available, relevant information. Programmed responses are stored and recalled when a stimulus (the familiar problem) is presented. When recognition processes are not available, decision makers may engage in a heuristic search to assist in decision making. In order to make a decision about a problem more manageable, decision makers engage in factorization and specialization, in which the problem is broken down into individual pieces that can be managed independently. The breakdown of the problem into parts allows for each portion to be addressed in a specialized manner, reducing the complexity of the problem and leading to a resolution. The limiting alternatives selection strategy is used by decision makers when only the first few alternatives that come to mind are considered in decision making. Decision makers can also employ selective attention when they focus exclusively on information that is considered relevant or familiar, rather than focusing on all of the information available. Finally, satisficing is used to make a decision when the first solution that meets criteria from among the limited alternatives is selected. Engaging in satisficing reduces the amount of effort needed when collecting information and making a calculated decision when the decision seems overwhelming in some way (Simon, 1990). One or more of these evaluative techniques enables the decision maker to select the factual premises that will be used in decision making (Ibrahim, 2009).

In the context of the present study, the five techniques for selection of factual premises can be related to a day hiker's trail destination choice. If using a programmed response, a hiker might respond to the familiar decision of choosing a trail by recalling stored information about the trail gained from previous experience in Yosemite or on the trail. For example, the hiker might choose the Mono Pass trail, because she knows from previous experience that it is beautiful and generally not very crowded. If using factorization and specialization, a day hiker might break down the trail destination choice into smaller parts such as time of day to hike, number of people in hiking party, and desired attraction site. Through making these smaller decisions first, the hiker would be able to determine which trail options to consider, limiting the trails to be considered and simplifying the problem. A hiker would be using the limiting alternatives strategy if he or she only considered the day hiking trails that immediately come to mind when faced with making a trail choice decision. A hiker using selective attention in trail choice decision making might only consider a trail that contains an iconic viewshed, such as a view of Half Dome from North Dome. Finally, a hiker might use satisficing to select the first acceptable trail in a limited geographic location. Rather than consider all park trails, a day hiker might decide to only hike from a trailhead located in Yosemite Valley. The hiker would then select the first available option among the limited trail alternatives that satisfies certain criteria. Identifying the strategies used to gather and select the factual premises involved in trail choice decision making helped to reconstruct the simplified decision models used by wilderness day hikers in Yosemite, leading to a better understanding of how and why certain information was used in trail choice decision making.

Examination of the selection strategies used in creating the simplified decision model is supported by Sirakaya and Woodside's (2005) meta-theory analysis of existing travel choice and destination decision making theories, which produced a set of propositions supported by prior theoretical work that can be advanced in future research. The first proposition is relevant to the current study; that is, "consumers follow a funnel-like procedure to narrow down choices among alternatives" (Sirakaya & Woodside, 2005, p. 825). By examining trail destination choice in the context of bounded rationality and the five techniques for selecting factual premises, my study aligns with the above proposition because it recognizes that a decision is derived from a choice set. Bounded rationality recognizes that choice sets vary between individuals because of environmental constraints, but ultimately the formation of a simplified decision model of alternatives is the antecedent to a choice. Exploring the five factual premise selection strategies provides an understanding of how alternatives are "funneled" into the simplified decision model, again aligning with Sirakaya and Woodside's (2005) proposition. Figure 16 illustrates the relationships among constraints, selection strategies, and factual premises as they relate to trail choice.

Figure 16

Selection of Factual Premises



Information Search

An information search strategy is considered to be the combination of information sources used in decision making; furthermore, it is assumed that all visitors engage in some form of information search strategy, even if it is extremely limited (Fodness & Murray, 1998, 1999). In the context of this study, I was interested in exploring the combination of the decision making strategies (driven by bounded rationality) and the information search strategies used by Yosemite wilderness day hikers in making a trail choice.

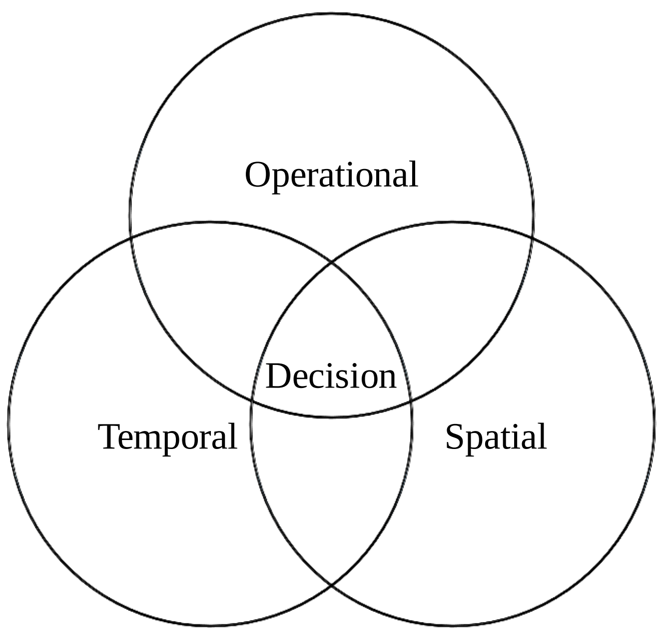
Consumer behavior literature suggests that information sources can be classified on three search strategy dimensions: spatial, temporal, and operational. Fodness and Murray (1998) found support for the application of these three dimensions in understanding the information search strategies of tourists. The spatial dimension refers to whether the information search occurs internally through recall of stored information and memories or externally through the collection of new information. Information search generally begins internally; if a person's internal search is insufficient (not enough information to make a decision) then the decision maker seeks external information to inform decision making. This spatial dimension aligns with Simon's (1990) recognition process as a mechanism for boundedly rational decision making, in which the individual uses stored, relevant knowledge in decision making if it is available. If stored knowledge is not available for decision making, then other mechanisms for rationality such as heuristic search are used to make decisions.

The temporal dimension calls attention to when the information search occurs (Fodness & Murray, 1998). Information search can be conducted prior to vacation planning and/or during the vacation itself (ongoing). Finally, the operational dimension refers to perceived effectiveness of the information source. If the information is valuable to decision making, the source is considered decisive. If the information is helpful, but not as valuable to decision making, the source is consider a contributory source.

Exploring information use across the three dimensions allowed for the classification of tourist information search strategies in a study of automobile tourists in Florida (Fodness & Murray, 1998). Due to the success in classifying tourist information search strategies according to the three dimensions, this approach to understanding information search has been suggested as a mechanism for creating typologies of tourist information use (Fodness & Murray, 1998). The classification of information along the three dimensions provides a comprehensive view of information search behavior as an ongoing process, providing an organizational structure for understanding the selection and use of information in decision making. I applied the three information search strategy dimensions (spatial, temporal, and operational) to my work, classifying information sources across these dimensions using explicit statements made by the visitor or implicit contextual references. Figure 17 provides a visual representation of the relationship between the trail choice decision and the three information dimensions.

Figure 17

Classifying the Information Used in Trail Choice Decision Making



The types of information search strategies a person uses depends the individual's level of familiarity with the decision (Fodness & Murray, 1999; Moutinho, 1987). In the context of Yosemite trail choice decision making, first time visitors may spend a significant amount of time and effort collecting information to make trip decisions due to the a lack of prior knowledge gained from previous experiences. Repeat visitors may engage in limited or routine information search due to the presence of prior knowledge about the site. For example, if the visitor has prior general experience in Yosemite but lacks experience related to a specific hiking trail, he or she probably engages in a limited information search in which the time and effort spent collecting information about hiking trails are reduced by the availability of information from past experiences. Routine decision making is characterized by little information search. If a visitor has both park and trail experience, he or she is likely to engage in routine decision making due to the availability of previous experiences and preferences guiding decision making. Given that familiarity with a destination has been shown to impact information search, past experiences in Yosemite are likely to impact how a hiker approaches information search in trail choice decision making. Therefore, distinguishing between first time visitors and repeat visitors is likely to capture differences in the amount of information used in making based on the type of information search the visitor conducts (Fodness & Murray, 1999).

The type of decision making in which a visitor engages not only indicates the likely amount of information used but also impacts the sources of information used in decision making. A 1990 survey of automobile travelers stopping at a Florida welcome center confirmed that the information search strategy of travelers engaging in limited decision making is characterized by use of a single, decisive source and a smaller number of supporting, contributory sources (Fodness & Murray, 1999). Travelers who engaged in routine decision making were most likely to rely on ongoing, external, decisive sources, particularly information from family and friends. Extensive problem solving, characteristic of first time visitors, was not found to be a significant predictor of information search strategy for travelers. Through identifying the type of visitor to Yosemite (first time, Yosemite repeat, trail repeat), I was able to explore how information usage varied in amount and across information sources, ensuring that maximum variation was captured by selected participants.

Information search strategies can also vary according to group size and age composition of the travel party. Fodness and Murray (1999) found support for different information search strategies among retired couples, couples without children, and couples with children. Retired couples generally relied on ongoing, internal, decisive information search strategies, with auto clubs, friends and family, and personal experience serving as the top three information sources. Couples without children generally used pre-purchase, external, decisive sources, whereas couples with children also used a pre-purchase, external, decisive approach supplemented with a high use of contributory sources. In addition to the three group compositions discussed by Fodness and Murray (1999), I also identified solo hikers as a separate group composition type. Selecting participants across these four groups ensured that a range of information search strategies were captured.

Trip purpose has also been found to be relevant to trip planning information choices (Fodness & Murray, 1999). In one study, travelers who were visiting friends or family were more likely to use information provided by friends or family than travelers who were vacationing. For the purposes of my study, it was therefore important to distinguish hikers on vacation from hikers visiting friends and family living in and around Yosemite, because I was most interested in identifying relevant information sources used by typical park visitors. If the selected participants contained a large number of day hikers visiting family or friends, the range of information sources might be limited due to heavy reliance on personal references and word of mouth by visitors whose purpose was to visit friends and family. To account for this variation I noted trip purpose across the following categories: vacation, visiting friends and family, and park locals making casual visits.

Relationships also exist between trip characteristics and amount of information used (Fodness & Murray, 1999). Specifically, the longer the trip, the more information is used. Additionally, the number of destinations and attractions visited impacts the amount information used. In the context of this study, I asked study participants about the length of their day hike, the length of their stay in Yosemite, and the number of other day hikes they had completed or intended to complete while in Yosemite. By asking these questions, I accounted for trip characteristics that may have impacted information search.

Use of Park Provided Information Sources

In order to be able to provide recommendations to Yosemite wilderness managers regarding the current use of park generated information sources regarding wilderness day hiking, I asked participants whether external information generated by the park was used in decision making. Later, I classified whether that information was decisive or contributory based on context provided in the interview. Yosemite National Park employs traditional, web, and social media in providing visitor information. Recent work by Jacobsen and Munar (2012) examined which information sources tourists use in making a destination decision, specifically focusing on the importance of electronic Web 1.0 and 2.0 sources in addition to traditional information sources such as guidebooks, travel companies, personal contacts, past experience, and news media. Web 1.0 sources were considered to be more traditional online sources such as travel planning websites and hotel and airline websites, while web based social networking sites, travel blogs, wikis, media sharing sites, and trip review sites were classified as Web 2.0. In the context of Yosemite day hikers, a Web 1.0 source of interest was the National Park Service's webpage for Yosemite National Park. Park provided Web 2.0 sources of interest were Yosemite's Facebook page, Twitter feed, and other available media such as Yosemite's Nature Notes series available on Youtube. Park managers have direct control over these Web 1.0 and Web 2.0 information sources, and knowing the extent to which wilderness day hikers used them in decision making will provide information on the current utility of these sources to visitors and the potential to use these information outlets to communicate with day hikers.

Due to the popularity of web sources in decision-making and the variety of web resources available on the Internet, visitor trail choice decision making at Yosemite may also be impacted by popular, unofficial Web 1.0 and 2.0 sources, such as Trip Advisor or Yelp. To determine the prevalence of their use in trail choice decision making, I asked participants if any other web resources aside from those provided by Yosemite National Park were used in trail choice decision making.

In addition to the electronic sources available to visitors, Yosemite uses a number of traditional information sources to reach visitors while at the park. For example, entrance gate attendants provide the *Yosemite Guide* newspaper containing a variety of park information to every vehicle that enters the park. Of particular importance to this study is a section of the newspaper that contains a table of day hiking trails, providing estimated levels of difficulty, distance, and expected trip duration. The majority of day hiking trails listed in this table are wilderness trails. Additionally, the park also freely distributes two pamphlets: (1) "Yosemite Valley Hiking Map" and (2) "Tuolumne Area Day Hikes." These hiking pamphlets provide descriptions of suggested day hikes classified according to level of difficulty (easy, moderate, and strenuous). The park also provides word of mouth communication from interpretive rangers at visitor centers throughout the park and in surrounding communities (Mariposa, Mammoth Lakes, Mono Lake, and Lee Vining), and from campground hosts and other staff. Interpretive rangers are available to answer questions, including providing hiking recommendations. Because the park has control over the type of information provided through both of these services, identifying if these sources (and their factual premises) are used by day hikers is important to determine if they are effective channels for wilderness messaging.

Approach Summary

Applying the concepts of bounded rationality and findings from information selection research allowed me to break down the decision making process of individual day hikers in Yosemite wilderness to understand the constraints that influenced decision making, the selection strategies that contributed to factual premise selection, and the sources of factual premises themselves that led to the choice to take a day hike on a specific wilderness trail. My approach was to work through the theoretical components in reverse. That is, I started with the trail choice decision because I intercepted study participants at their selected trails. Beginning with the knowledge of the final decision, I used a semi-structured interview to guide the participant to recall the components of his or her individual decision making process. Specifically, I attempted to examine the factual premises relevant to decision making because it is these factors that wilderness managers have the potential to influence via their management actions and information provisions. As stated earlier, factual premises are defined as information about trails or day hiking in Yosemite National Park. Sources of information used, decision making strategies, and attributes of the participant and trip were used to create a wilderness day hiker typology, including seven hiker types representing various approaches used by visitors in trail choice decision making.

Central Question

How do wilderness day hikers at Yosemite National Park make a trail destination decision?

Sub Questions

The theoretical construct central to each question is provided in parentheses for clarity.

1. What are the primary limiting factors, authority constraints, and coupling constraints that contribute to wilderness day hikers' simplified decision models?
2. What selection strategies (*factorization/specialization, programmed response, limiting alternatives, satisficing,* and *selective attention*) are used by day hikers in selecting factual premises for consideration in decision making?
3. What is the range of factual premises (*information*) used in making the decision to take a wilderness day trip? In choosing a specific trail?
4. What information sources were used in identifying these factual premises?
    a. What park provided information sources were consulted (*spatial dimension*)? Which were most valuable (*operational dimension*)? When were they consulted (*temporal dimension*)?
    b. What other information sources were consulted (*spatial dimension*)? Which were most valuable (*operational dimension*)? When were they consulted (*temporal dimension*)?

Procedures

Face-to-face, semi-structured interviews were conducted with adult wilderness day hiking groups in Yosemite National Park to explore the research questions derived from my theoretical framework (Appendix F). Using semi-structured interviews allowed me to engage in probing conversations with the study participants while ensuring that the interviews covered the topics relevant to my theoretical framework (Creswell, 2009). Conducting interviews with entire groups rather than individual participants provided additional insight into the decision making process, allowing the understanding of day hiker decision making in this study to capture the reality that decision making is a group process rather than an exclusively individual process.

Interviews were conducted on 14 days between July 14 and August 20, 2013. The number of interviews per day ranged from two to ten, and interviews lasted from two to sixteen minutes. To remain engaged with the data throughout the process, I took field notes at the end of each interview on a theoretical saturation form (Appendix G). The form included check boxes for the screening questions and space for notes regarding each of the interview questions from the semi-structured interview guide. In addition to the theoretical saturation form, I kept a data log for each day of interviews, recording group size (including number of men, women, and children), affiliation with a commercial group, the number of group members who agreed to the interview, the number of members who refused or did not participate in the interview, and the reason for a refusal if provided. Recording these characteristics of each interview group, as well as taking field notes for each interview, allowed me to further document the interview and to engage with the data while I was on site in Yosemite. Due to rustic living conditions and the remote location, I was unable to begin interview transcription and analysis while the data were being collected. However, I was able to review the theoretical saturation forms and revise the interview guide as needed throughout the data generation period. This process contributed to the organic nature of the qualitative design and enabled me to remain familiar with the data as the process evolved.

Potential participants were approached as they exited wilderness trails to increase the likelihood of participation in the study. Because the interviews focused primarily on the information used in decision making rather than on the experience itself, I did not anticipate any significant confounding factors resulting from intercepting day hikers at the end of their hiking experience. Study participants were approached using an IRB-approved script and remained anonymous to protect participant confidentiality (Appendix H). Interviews were recorded with the participants' consent — of the 80 interviews conducted, only two participants agreed to participate in the interview but did not want the interview recorded. In these two cases, I interviewed the participants and recorded extensive field notes of the conversation. Ninety-three groups totaling 210 individuals were asked to participate in an interview for the study. Of the 210 individuals that were approached, 168 participated in a total of 80 interviews, generating a response rate of 80%. Forty-two individuals did not participate in the interviews, generating a refusal rate of 20% for the study. The most common reasons for refusal included that the participant was running late, needed to catch up with other group members, was tired, or needed water.

Trail Selection

Day hikers were intercepted at six wilderness trailheads; two were located in Yosemite Valley, and four were located in the Tuolumne Meadows region of the park. Selecting trails in the two most popular regions of the park contributed to the credibility of the study design through increasing the likelihood of a diverse selection of participants. The number of trails selected in each region of the park reflected the approximate proportion of wilderness trails available in each of the respective regions; Yosemite Valley has fewer wilderness trails to choose from, so fewer were selected. Conversely, Tuolumne Meadows has many more wilderness trails, so more were selected there.

The six selected trails included three high use trails and three moderate use trails. Yosemite National Park's unofficial wilderness trail use classifications (made available by the Visitor Use and Social Science Branch of the Resources Management and Science Division) were used to select high and moderate use wilderness trails in each of the two regions. The variability in the social recreation experience available on high and moderate use trails justified dividing the sample by use category to capture the range of wilderness choices available to hikers. Additionally, selecting participants across the two use levels provided breadth in participant selection, contributing to the overall goal of maximum variation in participant selection. Day users of low use trails were not included in the study because of the limited number of interview days and the difficulty of collecting a sufficient number of interviews from these trails. I conducted 41 interviews at the following high use wilderness trails: Upper Yosemite Falls (n=11), Lyell Canyon (n=15), and Lembert Dome (n=15). I conducted 39 interviews at the following moderate use wilderness trails: Four Mile Trail (n=15), Porcupine Creek (n=10), and Mono Pass (n=14). The target of 80 interviews for the study, with approximately half of the interviews generated in each of the two use level classifications, was based on the size of selected groups in other qualitative works that employed similar data analysis procedures (Speak, 2004; Wickens, 2002).

In addition to considering the trail use level classification, trails were selected to include a variety of features such as the number and type of destination points, waterfalls, and elevation gain. For example, among the three high use trails, Upper Yosemite Falls provided a challenging canyon hike with waterfall views along the way, Lyell Canyon provided a relatively easy flat trail including views of both rivers and meadows, and Lembert Dome provided a shorter hike with the option of visiting a lake and/or dome. The three moderate use trails provided similar variety, with the Four Mile Trail providing a challenging canyon hike leading to Glacier Point, a well-known destination point; the Porcupine Creek Trail provided a moderately strenuous hike to a view of Half Dome, and the Mono Pass Trail provided a flat hike through meadows. Through selecting a variety of trail types, and therefore selecting a variety of wilderness hiking experiences, the goal of maximum variation in participant selection was upheld — the diversity of experiences represented by the wilderness trails selected prevented the systematic exclusion of a potential participant based on his or her desired wilderness experience. The selection of both high and moderate use trails, trails providing a range of recreation experiences, and trails located in the two major geographic areas of the park reinforced the likelihood of shedding light on the phenomenon under study.

Participant Selection

Due to a limited field season, I used a combination of quota selection and convenience selection to generate my participant group (Creswell, 2009). As noted above, Fodness and Murray (1999) found trip purpose and group composition to be factors influencing tourist pre-trip planning information search strategies and decision making. Applying their findings to the current study, participants were selected to include a mix of first time visitors versus repeat visitors, solo hikers versus hikers in groups, and hikers on vacation versus hikers visiting with family or friends. Again, selecting participants across a range of characteristics increased the likelihood of identifying a range of information sources and decision models used in trail destination choice. Participants were asked specific questions about the purpose of their trip and previous experiences in Yosemite— this information was used to classify entire interviews during attribute coding. For other observable attributes such as group size or group composition, I recorded the necessary information rather than directly asking participants additional questions.

The participant groups were diverse across the categories mentioned above (Table 34). The target was set at 40 interviews per trail type and 10 participants per group composition type per trail type (e.g., 10 groups with children on high use trails and 10 groups with children on moderate use trails). For the most part, the number of participant groups for a given characteristic was split evenly between high and moderate use trails. For example, 35 first time visitors to Yosemite were interviewed, with 18 participants from high use trails and 17 participants from low use trails. However, some of the participant group characteristics were skewed toward one of the two trail use types. For example, 17 participant groups contained children, but the distribution of these groups between high and moderate use trails was uneven. Twelve groups with children were intercepted at high use trails while only five groups with children were intercepted at moderate use trails.

While the number of participant groups in an attribute category seemed to be split evenly between high and moderate use trails, the number of participant groups categorized into each attribute type did not match the quotas. The original quotas were set to equally divide the participant attributes among the two trail use categories. For example, the target was set for 40 interviews per trail use type, and 10 participants per group composition type per trail. For example, the 10 participant group quota was exceeded for the adult group composition attribute type, with 38 of the sampled groups being composed of adults who were not considered to be retirees. Twenty of these groups were interviewed at moderate use trails and 18 were interviewed at high use trails, exceeding the original quota of 10 per trail use category. This unequal distribution of group composition types meant that other group composition categories did not meet the original quota, potentially impacting the diversity of decision making strategies reported by participants.

Regarding trip purpose as a descriptive characteristic of participants, the vast majority of interview participants were on vacation. Those groups that were visiting friends and family were also on vacation, rather than staying with friends and family living in close proximity to Yosemite National Park. I did not exclude park employees from participating in the study because I wanted to maximize the variation during participant selection. Because only two of the 80 selected groups were comprised of park staff, I do not feel the themes in the interview corpus were skewed by their inclusion. Due to the lack of variation in trip purpose, this characteristic is not reported in Table 34, nor was it explored as a participant attribute influencing trail choice decision making. On the other hand, country of origin seemed to be an important attribute of survey participants that was not included in the original list of screening and classification questions. Therefore, participants were classified into “USA” or “other” according to their indicated nationality or home country. Overall, more than one-third of the participants were not from the United States. For the most part, these individuals came from Germany, France, or the Netherlands.

Table 34

Participant Group Attributes

Attribute	*Sub-Category*	*Total*	*High Use Trails*	*Mod Use Trails*
Group Composition				
	Group with Children	17	12	5
	Adult Group	38	18	20
	Group of Retirees	13	6	7
	Solo Hiker	11	5	6
Experience In Park				
	First Time Visitor	35	18	17
	Repeat Visitor	37	17	20
	Combination of Experience	8	6	2
Experience on Trail				
	Repeat Visit	22	11	11
	First Visit	58	30	28
Country of Origin				
	USA	54	26	28
	Other	26	15	11
Hiking Group Size				
	Range (People)	1 – 6	1 – 6	1 – 5
Length of Hike				
	Range (Hours)	0.25 – 7.0	0.25 – 7.5	2.0 – 7.0
Length of Trip in Park				
	Range (Days)	1 – 14	1 – 14	1 – 7

The use of human subjects required University of Idaho Institutional Review Board approval of the study's data generation methods. A certification of exemption was awarded June 14, 2013 (Appendix I). Additionally, because research was conducted in Yosemite National Park, a National Park Service research permit was also required before inquiry could begin. Permit number YOSE-2013-SCI-0087 was received June 26, 2013 (Appendix J).

Interview Transcription

Interviews were anonymously recorded in the field using the BejBej Applications Inc. Voice Record HD iPad application. Audio recordings of each interview were downloaded and sent electronically to Rev.com, a professional transcription service. After receiving interview transcripts, I reviewed each transcript for accuracy, correcting any transcription errors such as misspellings or the assigning of incorrect speaker labels. After verifying the accuracy of the transcription with the original audio recording, I created electronic copies of the theoretical saturation field notes, attaching them to the end of each interview transcript. Finally, an Excel spreadsheet of the data log forms was also created for data management purposes.

Coding

The data were coded through multiple rounds of coding, using a variety of coding strategies. Saldaña's (2009) recommendation for using two main coding cycles was applied in making sense of the interview data. The first cycle of coding was aimed at exploring the content of the interviews, using a combination of theory-based coding and open coding to deductively use theory, while exploring emergent themes in the data (Fereday & Muir-Cochrane, 2006; Hsieh & Shannon, 2005; Ryan & Bernard, 2003). Fereday and Muir-Cochrane (2006) advocate for a hybrid of both deductive and inductive use of theory in qualitative inquiry, specifically beginning with codes derived from theory, followed by a second round of inductive coding. They provide step-by-step analysis methodologies, providing transparency to the hybrid coding system that is sometimes lacking in other qualitative inquiry manuals. The hybrid approach was particularly relevant to my study because it is appropriate for a study design rooted in theory, while acknowledging that unknown themes can emerge directly from the data or that the selected theoretical framework may not be a good fit for the data (Fereday & Muir-Cochrane, 2006).

Hsieh and Shannon (2005) describe a similar, two-step data analysis technique that they call directed content analysis. Similar to the hybrid approach presented by Fereday and Muir-Cochrane (2006), directed content analysis is an approach to making sense of qualitative data that is appropriate for inquiry in which theory is used deductively. However, Hsieh and Shannon move further in their discussion, framing the use of directed content analysis as a primary way for furthering theoretical constructs. In terms of the generalizability of the current study, one of the unique factors of the theoretical framework in which the research questions were grounded was the application of decision-making and information search theories to a small scale, specifically a visitor's decision to hike on a specific trail in wilderness. Therefore, the larger study goals warranted an approach that not only examined the data through the lens of the proposed theoretical framework, but also explored the data for new themes and patterns. Furthermore, a directed content analysis approach also allows the researcher to examine which theoretical constructs are relevant to the phenomenon under study – perhaps only a few aspects of the proposed theoretical framework actually manifest in the data. A directed content analysis approach allows for this sort of examination within the data, while accounting for the possibility of the existence of new themes.

I used a combination of the techniques described above. As advocated by Fereday Muir-Cochrane (2006), I used a two-step approach to data analysis. The first phase was a combination of deductive, theory-based coding using codes derived from the proposed theoretical framework followed by a second phase of inductive, data-driven coding when the theory-based codes did not fit the data.

The first phase of coding was termed “provisional coding” following Saldaña’s (2009) terminology. Provisional coding involves the use of a priori or theory-based codes, and was the most appropriate way to begin exploring the data due to the use of a semi-structured interview guide developed from a theoretical framework (Fereday & Muir-Cochrane, 2006; Hsieh & Shannon, 2005; Ryan & Bernard, 2003; Saldaña, 2009). The first provisional codebook contained three sections: (1) an attribute codebook for data bits relevant to participant or trip attributes; (2) a theory-based codebook for data bits relevant to information sources used, constraints, factual premises, and dimensions; and (3) a second theory-based codebook for data bits related to the five selection strategies (Appendix K).

Inter-Rater Reliability and Codebook Evolution

Cohen’s kappa coefficients were calculated for inter-rater reliability across each of the six top-level codes found in the two theory-based codebooks (attribute, source, selection strategy, factual premise, constraint, and dimension; Table 35) as they manifested in the first 10 interviews. Inter-rater reliability was below 0.8, the threshold for “very good” agreement for each of the top-level codes (Krippendorff, 2004; Kurasaki, 2000). My co-researcher and I discussed the discrepancies in coding within each interview, and revised the codebook to include agreed upon interpretations that resulted from our first inter-rater reliability meeting. One of the main discrepancies in coding that produced low Cohen’s kappa coefficients was a misinterpretation of how codes should be applied to the text. Namely, I was only coding text from participants and not coding questions or statements I made as the interviewer. However, my co-researcher was coding any relevant data bit related to the code category, regardless of the speaker. We agreed to code all text, regardless of speaker, in subsequent interviews.

Table 35

Top-Level Theory Based Codes and Definitions

Top-Level Code	*Definition*
Attribute	Applied to data bits that provide essential information about the location of the interview, trip characteristics, and demographic or other characteristics about the participant.
Source	Applied to data bits referencing the consultation of the following source types: other print, other online, other person, park print, park online, park person, past experience, or no information search.
Dimension	Applied to data bits referring to the utility of an information source or when the information source was consulted.
Selection Strategy	Applied to data bits indicating how or why the participant made the decision to hike on the chosen trail.
Factual Premise	Applied to data bits referring to descriptive attributes of any trail that were considered in trail choice decision making.
Constraint	A factor that limited the scope of the trails considered by the participant; sub-codes were derived from Simon's theory of bounded rationality and Hagerstrand's constraints on time and space.

At this stage we decided that the selection strategy code should be applied broadly as a single code rather than using the five selection strategies from the theoretical framework to sub-code selection strategy data bits. We both experienced difficulty in applying the sub-codes, feeling that in many cases the sub-codes overlapped, creating cloudiness in the data rather than meaning. In particular, we were having trouble sequencing the selection strategies and classifying data bits that seemed to fit more than one selection strategy.

Furthermore, we were seeing selection strategies arise with respect to both information sources and trail choice. For example, participants could pay selective attention to only one information source (e.g., a park ranger at a visitor center) and then have multiple criteria for selecting a trail based on the single information source. We agreed that the selection strategy data bits would be later explored using data-driven, emergent coding to understand variations in trail choice decision making among participants. Using a data-driven approach for this aspect of the theoretical framework allowed us to stay true to the content of the data, rather than forcing an ill-fitting portion of the external framework onto the data.

With the decision to set aside the a priori selection strategy sub-codes, the two theory based codebooks were combined, resulting in a second draft of the codebook with two sections: (1) an attribute codebook for participant and trip characteristics, and (2) a theory-based based codebook for constraint, factual premise, source, dimension, and selection strategy coding (Appendix L). We coded another round of 10 interviews using this updated codebook. Three of the top-level categories achieved very good agreement, with coefficients greater than 0.8. Coding discrepancies were analyzed line by line, and the provisional codebooks were updated a third time. One top-level code, constraint, had an agreement coefficient of 0.0 – this occurred because the code was only applicable to a few phrases in the interviews for this round, and these phrases were not agreed upon due to oversight rather than disagreement in the meaning of the code. Furthermore, at this point we decided to add “physical ability” as a sub-code under “constraint.” My co-researcher and I felt that it was a reoccurring consideration in trail choice decision making that should be added to the initial constraints derived from bounded rationality and Hagerstrand’s (1970) constraints.

Another change to the codebook between the second and third round of coding was the elimination of "source dimension" as a top-level code. Dimension was intended to be used to code data bits referring to when a source of information was accessed by the participant and how important the source of information was in decision making. My co-researcher and I were struggling with the identification of this code in its own right because usually this information was implicit in the data rather than explicitly stated. We did not want to force this component of information search strategy theory on the data if it was not originating as a strong code theme. Moreover, we agreed that elements of the dimension code were usually captured by applying the source code, which was applied to data bits referring to individual sources of information, such as the park's web resources or non-park printed materials.

We coded a third round of interviews, using the updated codebook (Appendix M). Two top-level codes (attribute and source) maintained very good agreement, but the other codes fluctuated. As with other rounds, discrepancies were discussed line-by-line. No additional changes were made to the codebook. We agreed to continue coding more rounds and calculating kappa coefficients for agreement until all the interviews were coded. Final kappa coefficients for the top-level codes were adequate (Table 36). Despite variable agreement for the constraint and factual premise codes, we felt these issues were resolved during our coding meeting, with the final codes applied to the data reflecting the application agreed upon during our coding meetings.

Table 36

Cohen's Kappa Coefficients for Determining Inter-Rater Reliability

	Attribute	*Source*	*Selection Strategy*	*Constraint*	*Factual Premise*	*Dimension**
Round 1	0.52	0.49	0.69	0.45	0.77	0.14
Round 2	0.89	0.87	0.81	0.00	0.77	0.41
Round 3	0.81	0.87	0.68	0.36	0.81	
Round 4	0.85	0.84	0.72	0.72	0.63	
Round 5	0.85	0.81	0.80	0.60	0.64	
Round 6	0.92	0.88	0.92	0.83	0.80	
Round 7	0.95	0.92	0.82	0.78	0.74	
Round 8	0.94	0.82	0.77	0.46	0.51	

*Discontinued as a separate coding category after the second round of coding.

The next step in the first cycle of coding involved the development of emergent codes within the selection strategy top-level code using constant comparison analysis. Constant comparison analysis was an appropriate data analysis technique for emergent code development because it dictates that the researcher "reads through the entire set of data, chunks the data into smaller meaningful parts, labels each new chunk of data with a code, … and compares each new chunk of data with the previous codes" (Leech & Onwuegbuzie, 2007, p. 565). In this instance, we employed a modified constant comparison analysis, in that the data bits of interest had already been isolated through application of the selection strategy code during provisional coding. My co-researcher and I used constant comparison analysis to develop sub-codes for the selection strategy code for 10 interviews. We independently reviewed the data, creating as many unique sub-codes as necessary in order to parse out the selection strategy data bits according to specific elements of the decision making process. One of the main goals during sub-development at this stage was to be as descriptive as possible in developing a code label, and to try to use the participant's own words when possible. For example, for example the sub-code "what we always do" was derived from the appearance of this phrase, and similar phrases, in the selection strategy corpus when interview participants were asked why they chose a given trail.

After initial sub-code development, we grouped the sub-codes according to major themes. For example, “convenience” was determined to be prominent theme in choosing a trail. Sub-codes such as “change of plans,” “optimal time,” and “proximity” were grouped under the theme convenience. For the most part, the sub-codes developed independently were quite similar, albeit differences in word choice existed. After agreeing on sub-code organization into themes, I coded the remaining selection strategy data bits, using constant comparison analysis and grouping sub-codes into themes. I discussed the final list of sub-codes and themes with my co-researcher, and we agreed to the data organization. The final list contained 8 themes and 40 sub-codes (Table 37).

Table 37

Themes and Sub-Code Categorization for Selection Strategy Top-Level Code

Theme	Definition
Convenience	Used to group sub-codes referring to trail choice decisions in which the convenience of the trail's geographic location or the estimated amount of time needed to hike the trail played a role in trail choice decision making. Sub-codes: change of plans, optimal time, started late, proximity, bus tour
Heuristics	Used to group sub-codes in which the trail choice decision was simplified in a noticeable way, particularly when the participant paid close attention to recommendations or reputations. Sub-codes: famous, sounded nice, archetypal Yosemite experience, recommendation
Features	Used to group sub-codes referring to trail choice decisions that were made, in part, due to the consideration of the trail's features or characteristics. Sub-codes: so great, away from other people, specific activity, other trails not as good, view, length, other trail features (beauty, elevation, water, loop)
Group Factors	Used to group sub-codes referring to trail choice decisions that were impacted by the wants or needs of members of the hiking group, including the consideration of physical ability Sub-codes: compromise, something we could do, group schedule, one group member wanted
Familiarity	Used to group sub-codes referring to trail choice decisions in which the participant's familiarity with the trail played a role in decision making. Familiarity was viewed as a scale, ranging from familiar to not at all familiar. Sub-codes: we've done it before, nostalgia, something new, what we always do, special
Experience	Used to group sub-codes referring to trail choice decisions in which the participants indicated that seeking a specific experience played a role in trail choice decision making. Sub-codes: share a familiar experience, wanted a true hike, exploration, get away from Valley, thrill, always wanted to do, relaxation, challenge
Environmental Conditions	Used to group sub-codes referring to trail choice decisions that were impacted by environmental conditions such as weather and heat. Sub-codes: weather
When Decided	Used to group sub-codes referring to when the trail choice decision was made by the participant Sub-codes: before arrival in park, once in park, day of hike, spontaneous

Finally, attribute coding was applied to each interview transcript using N*Vivo's node classification function. In N*Vivo, "node" is the term used to refer to an individual code. Generally this type of coding is used for data management purposes, with information such as field work setting, demographics of the participant, data format, time frame, date, and variables of interest being coded for later examination of themes across these categories of interest (Saldaña, 2009). Information from the survey data log such as interview location, date, group size, and participant attributes from the theoretical saturation forms (refer to Table 34: Participant Attributes) were combined into a single Excel spreadsheet and imported as a node classification for a newly created node called "participant," creating a unique node for each interview. I then linked the node classification to each record, so that the attributes for a given interview would be linked to the text of the same interview. Finally, I created an additional attribute referring to interview number — this step allowed me to select specific interviews for later matrix queries.

The second cycle of data analysis involved the development of a wilderness day hiker typology. Typology development can be understood as an analytical approach that seeks to "consider the homogeneity within and the heterogeneity between subgroups of data on some dimension of interest, yielding a set of substantive categories or typologies" (Caracelli & Greene, 1993, p. 198). Participant attributes, sources of information consulted, and selection strategy were the strongest top-level codes in the interview corpus. These top-level codes had the most agreement throughout the first cycle of theory-based coding; furthermore, the interview guide was structured around asking questions regarding these three topic areas. Therefore, these top-level codes were selected as the dimensions for typology development in this study. Similar qualitative works have used two to three dimensions for typology development (Speak, 2004; Wickens, 2002). For example, in her development of typologies describing the phenomenon of homelessness in developing countries, Speake (2004) considered two main components in typology development: (1) degree of choice exercised over the situation, and (2) level of opportunity to improve one's situation (2004). Additionally, Wickens (2002) considered three typology components in her study of tourists in Chalkidiki, Greece: (1) choice of holiday, (2) types of activities in which the tourist engaged, and (3) views about the host community. In accordance with these examples, typology development for this study was based on the following dimensions: (1) theme of selection strategy(s), (2) source(s) of information consulted in decision making, and (3) participant and trip attributes.

N*Vivo matrix queries were used to explore relationships among and between the three typology dimensions. First, a master matrix was created containing all 80 interviews classified according to the sub-categories within each of the three dimensions of interest. Examining this master matrix allowed for an initial exploration of the data, but was not extremely useful in identifying patterns. This matrix showed that, for the most part, participants considered more than one information source and used more than one selection strategy theme in decision making. It also showed that the selection strategy theme, "when decided," did not apply to many of the interviews. Of the selection strategy themes, "features" was the most common, while "environmental conditions" was the least common. Furthermore, use of information sources varied across the seven source categories, with park print sources being considered the most, and non-park online sources being considered the least. The lack of any clear pattern within the interview corpus across the three dimensions reinforced the need for typology development, and confirmed the success of the participant selection process in generating a diverse group of interviews.

In an attempt to explore the subcategories of the dimensions, I created matrices for each selection strategy theme, showing the sources of information used by participants and constraints impacting decision making. Using this approach allowed for the exploration of each theme independently to determine if distinct patterns existed in the types of information consulted by participants using a specific theme. This approach did not produce any clear patterns. Recognizing that most participants used a combination of selection strategy themes, I began isolating groups of interviews that used the same sets of decision making themes. Through this approach I noticed a dichotomy in the way that the themes "convenience" and "heuristics" interacted. Specifically, I noticed that these themes co-occurred in a number of interviews; similarly, a group of participants engaged in one of the themes but not the other (e.g., convenience without heuristics). Categorizing the interviews in this way led to the creation of three distinct participant groups. Looking at the remainder of the interview corpus, another pattern became clear: participants who had hiked a trail before engaged in the same types of decision making – this led to the creation of a fourth category. Finally, I examined the remaining interviews and created a final category of participants who made their trail choice decisions based largely on the presence or absence of specific trail features. These five groups accounted for 72 of the interviews.

To ensure that my categorizations were credible, I examined the constraints, selection strategy themes, information sources, and attributes of each group. Furthermore, I re-read each interview transcript to get an overall feel for the interviews in each group. I re-categorized a few of the interviews into groups that reflected the sentiment of the interview more appropriately. I also carefully considered each of the eight remaining interviews while reviewing the five emergent types, considering whether or not each remaining interview had a place in a pre-existing category. I decided to create two smaller hiker types to accommodate seven of the remaining interviews. I decided to leave one interview uncategorized – in a review of the interview transcript, I realized that the interview transcript and subsequent coding contained too many implicit assumptions about what the participants intended. During the interview I had misinterpreted some participant statements resulting in confusing follow-up questions. The matrix comparison process ultimately led to the creation of seven hiker types, which I labeled as the following: Feature Seeking (n=14), Following Directions (n=13), Time-Driven (n=7), The Right Fit (n=17), Connected Experts (n=21), Checking Off the List (n=3), and Happenstance (n=4). Each is described below, using representative excerpts to illustrate the decision process.

Feature Seeking

This group of wilderness day hikers made their trail destination choices based largely on trail characteristics, or features. Often, participants in this group cited a number of desired features that the selected trail contained; moreover, participants often provided specific reasons for not selecting an alternate trail that was considered. For example, when asked why he decided to select Lembert Dome as his hike for the day, participant 78 provided the following reasons:

Participant: It was the fastest, shortest distance for the day hike.

Me: Did you consider any other trails before deciding on Lembert Dome?

Participant: Yeah. There was ahh… well, there was three. There was Lembert Dome, Pothole Dome… and the one to Elizabeth Lake. But the Elizabeth Lake one was, a little be longer. Like five miles.

This dialogue shows that participant 78 had specific trail characteristics of interest in choosing a hike: fast, short, and day hike. Of the three trails considered, the Lembert Dome trail fit the desired criteria best, leading to its selection. Furthermore, the participant provided a specific reason for not choosing the Elizabeth Lake trail; its distance did not qualify as "short" or "fast" according to the desired criteria. Like participant 78, the majority of interviewees in this category considered two or three trails across multiple criteria before choosing a trail. The following example from interview 40 shows the range of characteristics considered by participants in this group when making trail choice decisions:

Participant 1: Today we drove from Mammoth up to here because we had researched a trail that was not too steep for the first day out, like eight miles seemed fair.

Participant 2: Just half day, easy trail.

Me: When you were looking at moderate hikes today, did you consider any other ones before Mono Pass or before choosing Mono Pass?

Participant 1: Well… I saw some, but… the problem is, you don't have a lot that are in the middle. You either have ten plus miles or it's two. It is like fifteen minutes, twenty minute hike. I wanted a true hike where I will not hear the highway and I want to get far, but I didn't want to do ten miles. You only have two hikes in the area that are around between six and eight miles, I think. The other one I don't remember the name, but the scenery factor [from the website] was only two stars. This one was a four star.

The descriptions provided in both interview excerpts also show the types of trail features on which "Feature Seeking" participants focused. Participants in both of these excerpts mentioned specific trail mileage when discussing trail choice; indeed, 8 of the 14 participants in the "Feature Seeking" group referred to trail length as one of a few trail characteristics relevant to decision making. Furthermore, the majority provided specific mileage details rather than referencing distance relatively using non-specific descriptors of length such as "long" or "short." Participants also mentioned "the view" as an important trail characteristic, with 7 of the 14 participants referencing this specific feature. Often, participants mentioned a specific view of interest such as the view of Upper Yosemite Falls, the view of Half Dome from North Dome, or the view from Lembert Dome. Similar to descriptions of trail length, specificity was a common theme in descriptions of desired views. Participants in this group were also the most likely to mention a desired to be away from other people. Five participants referred to this social condition as a factor in decision making, with four specifically mentioning a form of the word "crowd." Finally, other characteristics of interest included elevation or features such as lakes. A participant from interview 30 said the following:

> *Participant 1:* They said this was one that would lead to that [view of mountains], and probably a lake too. We like seeing that. It seemed like it [the other one] was only just through the forest.

For this group, constraints played a variable role in decision making. Only half of the participants in this group referred to one of the four constraint types (authority, coupling, physical ability, and time). However, for those individuals who mentioned constraints, often more than one constraint category was at play in their decision making. The most commonly mentioned constraint was physical ability (n=6), in which individuals were often considering the length or elevation of the trail in decision making.

"Feature Seeking" hikers generally considered between 1 and 3 information sources; however, for each group of hikers, one information source provided the majority of information and seemed to be the most influential in decision making. For example, participants in interview 1 considered two different information sources: the park newspaper and a park employee. However, in reviewing their use of information sources in trail choice decision making, the newspaper seems to clearly influence decision making the most.

Me: So why did you choose Upper Yosemite Falls as the trail to hike on today? Where there any specific reasons?

Participant 1: We read it in the newspaper… (goes on to describe trail features).

(Later)

Me: You said that you saw the information in a newspaper, was that the park provided newspaper?

Participant 1: Yes.

Me: The one they give you at the entrance gate?

Participant 1: Exactly, yes. When we bought the ticket for all the national parks.

Me: And did you consider any other information sources?

Participant 1: Newspaper, and the tourist information at the bus stop. I asked the park ranger at the bus stop, because we had to wait some minutes, because I was not sure if it was a round trip to the Yosemite Falls or if it was a one-way trip. That is what I asked him.

The type of information source used by members of this group was variable, with print sources from the NPS being used the most (n=7), followed by non-park online resources (n=5), and non-park print resources (n=4). Non-park print and web resources were the most likely to be decisive information sources, with 8 of the 14 participants relying on one of these two types of sources as providing the most useful information in decision making.

Participants in this group generally hiked in groups of two (n=11), and were broadly classified as adults that were not of retirement age (n=9). "Feature Seeking" hikers generally came from the United States (n=10), were first time visitors to Yosemite (n=8), and had no prior experience on the trail (n=14). The use type of the trail varied, with 8 participant groups choosing moderate use trails and 6 participant groups choosing high use trails. No clear patterns existed in the length of overall trip in Yosemite or the length of hike for this group.

The "Feature Seeking" wilderness day hiker makes trail choice decisions based on a variety of desired trail features. Often, this hiker considers a few hiking options, selecting the trail that contains the most trail features of interest. These hikers consider specific trail features, such as trail mileage and distinct views in decision making. The information consulted in decision-making often comes from a few sources, but these wilderness day hikers usually rely on one of the considered sources as the most decisive in decision making. Convenience and recommendations from others rarely play a role, as these hikers know the type of hiking experience in which they want to engage. "Feature Seekers" are most likely to be adults, hiking with one other person, from the United States, and visiting Yosemite for the first time. Their length of stay in Yosemite, length of hike, and selection of a moderate or high use trail varies.

Following Directions

Participants categorized as “Following Directions” generally make a trail choice decision using some form of heuristics. Simon defined heuristics as selective rules of thumb for making a decision making with modest amounts of computation (1990). These wilderness day hikers all made their trail choice decision based on a recommendation from an outside information source. In fact, personal past experience did not play a role in decision making for this group. Hikers in this group chose the trail at which they were interviewed because a personal guidebook, a person affiliated with Yosemite, or a personal friend or family member recommended the trail. Furthermore, recommendations typically contained broad generalizations about the experience the trail provided. For example, participants from interview 32 said the following of their experience at the Tuolumne Meadows Visitor Center:

> *Me:* Why did you decide to come to Mono Pass today?
>
> *Participant 1:* We were lazy and we wanted an easy hike.
>
> *Participant 2:* We went into the ranger station and asked what he recommended and he recommended this and another trail out there but this… seemed more interesting.
>
> *Me:* What did he tell you about Mono Pass?
>
> *Participant 1:* He just asked how long we wanted to hike and we told him we did the eight miles yesterday and he was like, ‘Oh there is this.’ He just said, ‘It’s pretty views, I actually just led a hike up there.’ Also, he told us about the mine sites.

Participants from interview 16 followed the advice of their guidebook:

> *Participant:* Because we have a book. We have a tour book and she [the author] advised this trail. She said it's about 20 kilometers and you can go to the second bridge and come back. So we went to the second bridge. We are good students. We hiked to the second bridge and we stayed a little bit, a very nice place, and we came back.

Another hiker from interview 62 answered similarly:

> *Me:* Why did you decide to hike the Glacier Point Trail today?
>
> *Participant:* My mom did it last year and she said it was really pretty. I've never done it before, so I was just… I thought let's just do it because I've heard it's always been so pretty to do. It's an overview of everything. We thought we'd give it a try.

As seen through these interview excerpts, participants in the "Following Directions" group were likely to respond with an influential information source when I asked them why they chose a particular trail. Rather than providing a list of trail characteristics like hikers in the "Feature Seeking" group, these participants spoke more about general experiences. When details were mentioned, they were often derived from the influential source or recommendation. Indeed, trail features was the next most influential category in decision making for the "Following Directions" group, with 8 of the 13 participants also considering trail features in decision making. However, these trail features were secondary bonuses derived from the influential recommendation, and no clear pattern existed in the type of trail features hikers in this group mentioned.

As another unifying feature for hikers in this group, convenience did not play a role, meaning that factors such as time and geographic proximity to lodging did not play a role in decision making for this group. Additionally, other decision themes such as group factors, experience seeking, environmental conditions, and familiarity with the trail played minimal roles in decision making, with few participants mentioning any of these themes.

Like the "Feature Seeking" group, constraints did not play a strong role in decision making for the "Following Directions" group. Seven of the 13 interviews mentioned a constraint category when describing trail choice decision making. However, no clear patterns exist in the type of constraint. As expected due to the lack of convenience as a decision theme, time as a constraint was only mentioned in one interview.

For the "Following Directions" hikers, recommendations from individuals were the most important in decision making, with 11 of the 13 relying on a recommendation from a person as the most influential source in decision making. The type of person providing the recommendation varied, with six participants relying on personal connections and six participants relying on park staff for a recommendation. Print sources were the next most likely to be used by this group, with five groups using a park-provided print source and five groups using a non-park print source. However, print sources were more likely to be secondary information sources in decision making. None of the park print sources considered were the most influential in decision making. For the two groups that did not rely on a recommendation from a person, the non-park print source was the most influential source. Online resources and past experiences were rarely used among this group, and when used, they were not were not influential in decision making.

Attribute characteristics about both the participants and the hiking trip were variable across all the attribute categories. Hikers relying on heuristic recommendations were no more likely to be hiking on a moderate use trail (n=6) versus a high use trail (n=7) and no more likely to be from the United States (n=7) versus another country (n=6). However, given that about one third of the participants were foreign, this group had an over-representation of hikers not from the United States. Hiking group composition and group size was variable; however, there were no solo hikers in this group. “Following Directions” hikers did not have any prior experience on the trail, but prior experience in the park varied. Finally, like the “Feature Seeking” group, trip length in Yosemite and hiking trip length varied as well.

The “Following Directions” wilderness day hiker relies heavily on the recommendation from a source of authority such as a park staff member, personal friend or family member, or the author of a guidebook in making a trail choice. This group often considers only one or two information sources, with one of the information sources being decisive in decision making. In addition to relying on a recommendation, this group also takes note of interesting or desirable trail features; however, the decision-making and information search processes are not driven by the trail features themselves. Rather, the recommendation, which contains information about a given trail feature, seems to outweigh other components of decision making. The “Following Directions” hiker is not usually affected by time constraints, and convenience does not play a prominent role in decision making. The demographic and trip characteristics of this hiker vary greatly; however, foreign visitors are likely to be in this group. The use of an influential recommendation drives the decision making for this group of hikers.

Time-Driven

The “Time-Driven” wilderness day user makes a trail choice decision based largely on convenience, namely how well the estimated time for hiking the trail fits into the hiker’s preexisting plans. The optimal-time sub-code of the convenience theme was applied to six of the seven participants in this group. Moreover, the majority of participants responded to my question of why they decided to hike on the trail at which they were interviewed with a time-related answer. For example, a solo hiker from interview 80 said the following:

> *Me:* Why did you decide to hike Lembert Dome today?
>
> *Participant:* I was going by myself, and I didn't have much time.

Similarly, a participant from interview 56 stated:

> *Participant:* It's mainly a time thing for us. All of the trails we thought we were more than capable of physically doing. It was just what we could fit in the short time we had here.

Another participant (Interview 29) staying outside the park in Mammoth Lakes said the following about choosing the Mono Pass trail:

> *Participant:* So we can only come up here and do something short, in between what we were doing down there [referencing Mammoth Lakes].

In addition to the optimal-time sub-code, participants in this group considered other aspects of convenience such as proximity of the trail to their lodging. Participant 43 said the following:

> *Participant:* This one fits the bill because it is close. I thought about going to see the big giant sequoia trees, and the Merced Grove is about the same elevation, but it was just too far of a drive. [And] I started to drive there this morning and I just didn't need… My body did not want to sit in a car today.

The sub-code "started late" also played a role in decision making:

Me: And did time play a role in your decision making? Did you want to return by a certain time?

Participant: Yes, we wanted to not to… because we arrived, we are staying outside the valley so we came in and we arrived only at 11 o'clock so we couldn't do the very long hikes, there was the Porcupine hike… (Interview 7)

Like the "Following Directions" hikers, trail features also played a role in trail choice, with five of the seven participants in this group mentioning trail features in discussing their trail choice. The trail characteristic mentioned most often by these participants was a loop trail – many did not want to do out-and-back hikes. Other trail features included specific activities. When considered, trail features played a more central role in decision making than they did for the "Following Directions" group. The theme of convenience in decision making unified this group; however, it did not overshadow the other decision making themes. Convenience was a unifying rather than dominating feature in decision making. This group is also unified by the lack of heuristics playing a role in decision making.

As expected with convenience, and specifically the optimal-time sub-code playing a central role in decision making, this group of hikers was likely to mention constraints in relation to trail choice. Six interviews mentioned time. One participant group mentioned factors related to time, coupling, and physical ability constraints; other than this group no other constraints were mentioned.

Members of this group were more likely to use park information sources than members of other groups, with all of the members of this group using at least one park provided information source. Park print was the most popular (n=5), followed by park online resources (n=3). People not affiliated with Yosemite were not considered in decision making by participants in this group. Past experience was also unlikely to play a role (n=1). These individuals were more likely to make their trail choice decision before arriving in Yosemite, and more likely to describe the decision as part of an overall plan for their vacation. Participants from interview 66 said the following:

Me: Why did you decide to hike the Glacier Point Trail today?

Participant: It was the one that fitted our schedule. We wanted the one that wasn't too long because we're going to San Francisco this afternoon. It was a good trip and we could take the bus up and walk down.

These hikers were more likely to be in small hiking groups (one or two), with no children, and have no prior experience on the trail. The trail use level and country of origin varied between the seven participants, with four moderate trails, three high trails, four foreign travelers, and three participants from the USA. Like the "Following Directions" group, the number of foreign visitors in this group is over-represented given the overall ratio of foreign hikers to those from the USA. These hikers were generally taking shorter trips in the park of three days or less, and hiking trips ranged from two hours to six hours. Notably, this group did not any extremely short hiking trips (one hour or less).

The "Time-Driven" wilderness day hiker approaches trail choice decision making with a plan in mind. The hiker generally has an overall schedule for the visit in Yosemite and is looking for a hike that fits into his or her plan. This hiker does not rely on personal recommendations for making hiking decisions; rather, decisions are generally made before arriving in Yosemite after information has been consulted. This hiker is likely to rely on park provided information sources, favoring print and online park sources over speaking with park staff. The "Time-Driven" hiker is usually in a small group without children, is visiting Yosemite for a few days, and is more likely to be a from a country other than the United States.

The Right Fit

Hikers in the "Right Fit" category selected trails based on a combination of convenience and heuristics – all hikers in this group mentioned both themes in decision making. Regarding the theme of convenience, the proximity sub-code was the most influential for this group, with 14 of 17 participants referring to proximity to lodging or Tioga Pass as a factor in decision making. Participants in this group often said things similar to the following:

> *Participant:* We came in from the eastern entrance, from Tioga. It [the trail] was the closest one. (Interview 19)
>
> And:
>
> *Participant:* Because we come from Mammoth Lake, and it was the first on the road. That way, we came by this one. (Interview 10)

The participant's campground also played a similar role, with participants making statements similar to the following:

> *Me:* Why did you decide to hike on the Porcupine Creek trail today?
>
> *Participant:* Because I'm staying at the nearest campsite at Porcupine. (Interview 47)

Convenience alone was not the only decision making theme; participants also relied on heuristics, with recommendations playing a role in decision making for 16 of 17 participants in this group. An excerpt from Interview 77 shows a link between the two themes:

Me: Why did you decide to hike on the Lembert Dome Trail today?

Participant: Our friend had a book. We decided to hike up, first to Dog Lake and we noticed that Lembert Dome was a branch off of that and it sounded like it would be nice view so that was sort of it.

(Later)

Me: What made you decide against the other two trails you considered?

Participant: I think the Elizabeth Lake sounded like it would have a water crossing that didn't sound… it was kind of dry, super dry… but on the off chance. The Cathedral Trail was on the longer side. I think it was seven and a half. While we knew we could do it, it sounded like this might be a little more easily accomplished by the times we wanted to be in and out.

As the excerpt demonstrates, most trail choice decisions in this group were made in consultation with one influential source that provided recommendations. The recommendation(s) was considered, and ultimately selected because it also was convenient for the hiker. Another participant from another country stated similar reasons for choosing the Lembert Dome trail:

Participant: [in reference to his Internet search] Tuolumne Meadows, just type it in. And then it pops up. Wikipedia came up first. I think that [it] was the third or fourth of the entries. Looking at this, several, there's 117 reviews, just for the recent reviews. And I click on that. And the good thing is that one is very updated. There's visitors, they update their blogs, and it was just one week ago. So I know here is pretty good.

Co-Researcher: Ok. Did you look at other trails as well, or was this the one that you wanted to come to?

Participant: This one was mentioned very often. Another trail was called Soda Springs, it was right across the street. Another one people are mentioning is Gaylor Lakes.

Me: Why did you pick this one instead?

Participant: This one was on the way home. It's about two hours and a half. It's fit for a family. Right next to this one there's a creek down the road, so a half hour. There'll be a trip right after this trip.

Both interview excerpts demonstrate that one, central source played a role in trail choice. For participants in interview 77, it was the friend's book that was consulted for trails. Ultimately, the Lembert Dome trail was chosen because it fit the time they wanted to be done hiking, showing that convenience also played a role in the trail choice. For participants in Interview 11, the recent comments posted online served as an authority on which trail to choose. Additionally, the Lembert Dome trail was "on the way home" and appeared to fit into the family schedule of visiting the creek after hiking. Unlike interviews categorized into the "Following Directions" group that made trail choices based primarily on recommendations without focusing on convenience factors, hikers in "The Right Fit" group chose a trail due to a combination of a recommendation and the convenience of the trail.

The excerpts also show that convenience and heuristics were not the only themes at play. Trail features also played a role in decision making, with 11 of the 17 participants also considering them in decision making. Often trail choices were a combination of balancing convenience and trail features using information from one or two influential sources. For this group, non-park print materials (n=11) and park staff (n=10) were the two most consulted information sources. Like the "Following Directions" group who relied solely on heuristics, this group also relied on an influential source. Of the 17 participant groups, only two did not rely on either non-park print materials or park staff as the influential source in decision making. Decision making among these group members occurred at variable times, with some participants making trail choice decisions before arriving in Yosemite and others collecting information while in the park, making a decision on the fly. Regardless of the time that the trail choice was made, the factors considered in decision making were similar. The selected trails just seemed to be the right fit for the participants.

Constraints also play a larger role in decision making for this group than in other categories described (Feature Seeking, Time-Driven, and Following Directions); 11 of the 17 participants mentioned one of the four constraint categories. Time was most likely to be mentioned (n=7), which is to be expected in a group whose trail choice decisions are influenced by convenience. Authority was also more likely to play a role in this group than any of the other groups, with three participant groups mentioning an authority constraint.

The "Right Fit" hikers were more likely than the other hiking types to be on high use trails (n=13) and be first time visitors to the park (n=11) with no prior experience on the trail (n=17). Group size was variable, but participants in this group were more likely to be in larger groups than participants in other groups. Group composition, country of origin, length of trip in Yosemite, and length of hike were all variable among participant groups, showing no clear patterns.

The "Right Fit" hiker is looking to strike a balance in making a trail choice. Often, this hiker is influenced by the convenience of a particular trail in terms of fitting into a schedule or geographic proximity to the hiker's lodging. This hiker is also likely to be balancing interest in particular trail features. To balance competing factors in decision making, this hiker is likely to rely on one, authoritative information source that is probably a personal guidebook or a park staff member. This hiker is more likely to choose a high use trail, be a first time visitor, and may be part of a larger hiking group.

Connected Experts

Hikers classified as "Connected Experts" shared two unifying traits: they relied on previous experience as their primary information source and they had previously hiked the trail on which they were interviewed. Past experience served as the main source of information for this group, with all participants using some form of previous experience to make their trail choice. The six other types of information sources were rarely used in decision making (non-park online n=2, non-park print n =4, non-park person n=2, park online n=2, park person n=2, park print n=3). Often, participants indicated that their knowledge of the trail and Yosemite was derived from the collection of information over time. For example, participants from interview 51 said the following of their information search and trail choice:

> *Me:* When you were thinking about hiking today, did you consider any other trails before deciding on this one?
>
> *Participant 1:* We've done an awful lot of trails in the park by now. We've done Half Dome, we've done all the waterfall ones, we've done Panorama…
>
> *Participant 2:* The waterfalls aren't too good this year, so not those.
>
> *Participant 1:* The waterfalls are not good, and of course you don't want to be in the Valley on a Saturday or Sunday. You want to avoid the crowds a bit.

Me: When you were looking at this trail, you had hiked it before, but did you consider any guidebooks or information sources today when you were…

Participant 2: He's read every guidebook.

Participant 1: I'll have read every guidebook, don't worry.

Participant 1: We've done an awful lot of things in the past and equally there's one or two things I haven't done which I think we'd like to do before we go.

This excerpt demonstrates the depth of the knowledge possessed by the interviewees. The couple participating in the interview was from the United Kingdom and had visited Yosemite five times previously. A combination of in-park experiences and research conducted over time led to the body of knowledge and past experience that supported their choice to hike on the Porcupine Creek Trail. Another hiker (Interview 22) responded in a more emotive way, referring to her love of the trail:

Me: Why specifically did you decide to hike on the Lyell Canyon Trail today?

Participant: I've been up here before and Twin Bridges sends me. I love that. We went further to Elizabeth Lake today. But Twin Bridges, I could just sit there and sit there. I could build my cabin there and live there. I love it.

For this participant, no information search was needed. She knew that she wanted to hike to the Twin Bridges on the Lyell Fork as part of her experience in Yosemite. Given the previous experiences of all participants in this group, it is not surprising the theme familiarity with the trail played a role in decision making, with 14 of 21 hikers specifically referring to their experience with the trail. Like the woman quoted above, many hikers expressed emotion when speaking about the trail. Sub-codes such as nostalgia, specialness, and “what we always do” came out strongly in this group. For example, the following participant from interview 31 described familiarity in choosing Mono Pass:

Me: Why did you choose Mono Pass today?

Participant: It is like an annual hike. Every time we come up here, we take a quick little hike to get used to the elevation again.

Me: Is this what you always do?

Participant: (laughing) Yes…

Another woman responded:

Participant: It is one of my favorites, one of my regulars. (Interview 33)

These types of emotional responses were unique to this group of participants.

Trail features (n=17), experience seeking (n=9), and group factors (n=10) also influenced the trail choice of participants in this group. In fact, experiencing seeking and group factors were stronger themes for this group than among of the other hiker types. Participants mentioning trail features were more likely to describe specific trail features, with knowledge of the feature being derived from past experiences. For example, one participant from interview 23 said:

Participant: That’s why I come back to it. You know, you like to get off by yourself a little bit.

This participant was referencing a favorite fishing spot when speaking about his trail choice. His statements reveal an expectation that his fishing spot will remain unchanged, providing solitude. Other participants also stated that they choose a trail because they knew they would be able to engage in a specific activity such as fishing, photography, birding, or picnicking. For example, a participant from interview 38 noted:

Me: What about the trail brought you back today?

Participant: We wanted to go catch 40 brook trout with nobody around.

When group factors played a role in decision making, they generally originated from a compromise between another member of the group (n=7) or the consideration of the group's physical ability (n=5). Additionally, coupling was the constraint category that impacted decision making the most in this group, with 8 of the 21 participant groups mentioning a coupling constraint. Thirteen of the groups were impacted by one or more types of constraints. Time (n=6) and physical ability (n=5) were considered somewhat infrequently, while an authority constraint was only mentioned by one group.

As mentioned previously, one of the main unifying features of participants in the "Connected Experts" group was that all had visited Yosemite before, and had previous experience on the trail. Additionally, the majority were from the United States (n=18). Moreover, all the participants who considered themselves to be locals were classified into this group. Patterns did not exist in group composition, group size, trip length in Yosemite, or hike length in this group. These hikers were split nearly equally between high use (n=10) and moderate use (n=11) trails.

The "Connected Expert" hiker is likely to have some preexisting connection to Yosemite. Whether they have visited the park multiple times, or live near the park, these visitors possess prior knowledge of Yosemite and of the trails on which they hike. They are likely to rely heavily on previous experience and prior knowledge when making trail choice decisions; however, they are also likely to consider a number of factors in decision making such as trail features, a desired experience, and group factors. Furthermore, when trail features are considered, they generally refer to experiential factors such as the availability of a particular activity, reliving a memory, or experiencing a particular setting they know the trail offers. The "Connected Expert" is likely to be from the United States, with other demographic factors varying among this group of hikers.

Happenstance

This small group of hikers made their trail choices essentially on the spot, with spontaneity playing a major role in the timing of trail choice. Two of the participant groups took the shuttle bus to Glacier Point, and then on impulse decided to hike down the Four Mile Trail, rather than taking the bus down. This decision was not premeditated, as seen in the following excerpts:

Me: Why did you all decide to hike the Four Mile trail today?

Participant: The Four Mile trail? We wanted to go on the tour. We wanted to see the Glacier Point, see the views, and it was only when we were actually going to book it that we were told there was the option of just doing a one-way trip and hiking down. So we thought we'd give it a go. (Interview 57)

And:

Participant: They dropped me off in a bus on the top. I figured it was better than taking the bus back down. (Interview 59)

The other two participant groups made trail choices based on park signage, with no other information sources consulted. These groups simply passed the trailhead sign, and based on the hike's length (Interview 61) or a specific viewpoint (Interview 72), decided to hike the trail. One participant said:

Me: And why did you decide to hike the Four Mile Trail today?

Participant 1: Actually, no special reason. It's the first hike I got into here. I parked my car. I saw it was 4.6 miles to the top. (Interview 61)

In response to my question about why they decided to hike Upper Yosemite Falls, the other group responded:

Participant: Just by chance, you know we went to the…

Participant 2: The lower part of the falls.

Participant 1: And then we didn't see anything so we thought we would try…

Participant 2: We just saw the sign there…

Participant 1: Yeah, we saw the sign called Columbia Point and then we went up there. We just decided to go up. (Interview 72)

The only unifying participant characteristic among these four groups was that all were first time visitors. Interestingly, two of the groups were foreign visitors, while two were from the United States. All of the hikes occurred in Yosemite Valley, with three on the Four Mile Trail and one on the Upper Yosemite Falls Trail. In general, the "Happenstance" hiker makes a spontaneous trail choice decision, with little consideration for contextual factors or information.

Checking Off the List

Three groups were categorized as "Checking Off the List" hikers, meaning that they hiked on a given trail because it was one of the last activities they had not yet done in Yosemite Valley. These groups did not use any non-park information sources and generally accessed park information on site. Each group decided to hike the trail at the end of their trip. One group said:

> *Participant:* We looked at the Yosemite Guide… just to see what we had not hiked. We weren't really planning on hiking this; doing Half Dome we thought we'd probably be pretty sore. But it was his birthday, and he wanted to do it so we did it.
>
> (Later)
>
> *Participant:* Yesterday we came out here to the lower [falls] and were sitting there. And then this morning when we woke up it was a day when we didn't really have anything planned for, and so when we got up we ate breakfast and at breakfast we decided to do it. (Interview 6)

The other groups interviewed expressed similar sentiments of making the decision the day of the hike. All of the participants in this group were from the United States, had no prior trail experience, and selected a trail that began in Yosemite Valley. Otherwise, the demographic factors among this group varied. Table 38 provides a summary of the typology, classifying each hiker type according to the dimensions that manifested within that group.

Table 38

Wilderness Day Hiker Trail Choice Typology Summary

Hiker Type	*n*	*Decision Themes*	*Information Sources*	*Attributes*
Feature Seekers	13	trail features	non-park print or web decisive	adult groups of two, likely American, 1st time visitor
Following Directions	14	heuristics, trail features	park staff or non-park guidebook decisive	likely foreign, otherwise variable
Time-Driven	7	convenience, trail features	park print and web sources common	small groups without children, likely foreign, short visit to park
The Right Fit	17	convenience and heuristics, trail features	park staff or non-park guidebook decisive	high use trail, 1st time visitor, large group
Connected Experts	21	familiarity, trail features, group factors, experience seeking	prior knowledge and past experience common	likely American, otherwise variable
Happenstance	4	This hiker makes a spontaneous trail choice, with little consideration for contextual factors or information.		
Checking Off the List	3	This hiking group chooses a trail because it is the only thing left to do in Yosemite Valley on the last day of their trip.		

Decision Making Themes Summary

The emergence of seven hiker types from among 80 interviews with wilderness day hikers shows the diversity in decision making strategies and information sources used in choosing a wilderness trail for a day hike. Across the groups, trail features played a prominent role as a decision making theme. For participants classified into the “Feature Seeking” and “Time-Driven” hiker types, trail features played a central role in decision making. “Feature Seeking” hikers were in search of a few specific trail characteristics, while

“Time-Driven” hikers made decisions based on a combination of trail features and the convenience of a trail. For the “Following Directions,” “The Right Fit,” and “Connected Experts” hiker types, trail features played a secondary role in decision making. For “Following Directions” and “The Right Fit” groups, trail features were of interest, but other factors such as recommendations and proximity of the trail to lodging influenced trail choice over desires to seek a specific trail feature. For the “Connected Expert” hikers, trail features played a role, but these hikers did not actively conduct information searches to seek out information on trail characteristics. Rather, trail features as a decision making theme was closely related to the hiker’s previous experience and personal knowledge of the trail.

In addition to being a component of decision making for many of the hiker types, trail features contained a diversity of sub-codes that hikers mentioned while discussing trail choice. Characteristics such as mileage, views, crowdedness, elevation, difficulty rating, presence of lakes/domes/meadows, being able to hike a loop, and beauty were all mentioned by hikers in discussing why they choose a particular trail. For some groups, like the “Feature Seeking” group, specific trail features such as mileage played a role in decision making. However, for most participants the types of trail feature mentioned varied.

The majority of park-provided information sources include summary descriptions of hiking trails, providing information on many of the trail features mentioned by wilderness day hikers in this study. Most of the park’s hiking information describes mileage, elevation gain, estimated hiking time, and a difficulty rating. In addition to these important trail features considered in trail choice, perhaps the park can provide information on the other types of trail characteristics mentioned, such as descriptions of views, activities, or beauty in their hiking information. This work shows that a variety of trail features play a role in decision making.

Convenience also played a role in decision making, with 24 interviews mentioning proximity to lodging or optimal time as a reason for choosing a specific trail. Hikers in the "Time-Driven" group were more likely to plan their hikes before arriving to Yosemite; however, it is telling that this group of planners was small, with only seven groups making trail choices based primarily on how the time needed to complete the hike fit into their schedules. Seventeen of the participants were in "The Right Fit" group, which considered convenience and heuristics equally in decision making. The small percentage of "Time-Driven" hikers combined with the larger percentage of "The Right Fit" hikers among the participant group indicates that information related to proximity, in addition to estimated time, should also play a role in the park's communication with visitors about hiking. The park already provides information based on geographic location; for example, separate hiking brochures are available for Wawona, Yosemite Valley, and Tuolumne Meadows. Moreover, the campground hosts residing in more remote areas also provide information to visitors about trails close to these campgrounds. This type of information is relevant to day hiker decision making, and the park should continue to provide this type of information in combination with information about trail features.

Of the 80 participant groups interviewed, 30 relied heavily on a recommendation in trail choice decision making. Furthermore, for many of the visitors, recommendations from visitor center staff or campground hosts were important in decision making. The large number of wilderness day hikers relying on these types of recommendations shows that many hikers approach wilderness day hiking looking for some sort of direction. Rather than approaching trail choice with a specific set of criteria, many hikers look for an authoritative or trusted source to provide assurance in decision making. The park can view this group of wilderness day hikers as a potential group that may be influenced by the park-provided information provision. Day hikers in this group are looking for authoritative or trusted sources of information about hiking in the park; if the park can provide this type of information, it may be able to more directly influence visitor behavior.

Other themes present such as environmental conditions, experience seeking, familiarity with the trail, and group factors played a lesser role in decision making for interviewees. Environmental conditions were only mentioned by six participant groups, and their consideration was not characteristic of a particular hiker type. Perhaps these considerations were captured by more fully by trail features or convenience. For example, a hiker may have been looking for a shorter trail because of impending weather. The length of the trail would have been classified as a “trail feature.” Indeed, each of the six groups that mentioned an environmental condition in decision making also mentioned either trail features or convenience.

Experience seeking was mentioned in 24 interviews, but did not show patterns in the way it manifested in the hiker typology. The “Connected Experts” were the most likely to mention experience seeking, perhaps because of their prior knowledge of the type of experiences available in the park. Similarly, the group factors theme did not show any noticeable patterns in the way it occurred in the hiker typology. Two groups were more likely to consider group factors, the “Connected Experts” and “The Right Fit” hikers. However, there was no uniformity in the way that group factors were considered.

Finally, familiarity with the trail manifested as a prominent theme only in those hikers who had been to Yosemite previously and had previous experience on the trail. Any statements related to a participant's familiarity or unfamiliarity with a trail were coded under this decision theme. However, for the majority of participants this theme manifested toward familiarity rather than looking for a new experience.

Managerial Applications: Information Provision

Information use varied across the participants. Park-provided print sources were consulted the most (n=33), followed by non-park print materials (n=29), past experience (n=28), park staff (n=25), park online resources (n=18), other people not affiliated with the park (n=16), and non-park online resources (n=11). Many participants consulted more than one information source; however, most of the hiker types relied on one information source as being decisive, whereas other information sources were viewed as contributory, meaning that they were not as influential in decision making. Furthermore, in discussing information sources used during with participants, the majority of participants were able to recall the information sources considered and the relevant pieces of information quite easily. In fact, only two participant groups indicated that they used a source but could not remember the exact name of the source or the specific information obtained from that source.

In terms of the decisiveness of park-provided sources, consulting a park staff member was the most decisive in decision making among these sources; moreover, park online resources were never viewed as decisive sources and park print sources were rarely considered decisive sources. Conversely, when consulted, non-park print and online resources were overwhelmingly considered decisive sources for decision making.

The discrepancy between the value of park online and print resources versus non-park online and print sources may stem from the impersonal nature of the park's print and online materials compared to the non-park sources of the same type. Heuristics played a large role in decision making among two hiker types: the "Following Directions" and "The Right Fit" groups. Both of these groups used a heuristic in which the recommendation of a single authoritative source was central in decision making. For many of these individuals, a non-park print source or online source was viewed as decisive. The online resources were often valued for the rating systems they provided or the timeliness of reviews. The park's online resources lack this value added to the information provided – the park does not provide up-to-date information regarding trail conditions on its website nor does it provide comments from other visitors. In fact, when they did mention park websites, most of the time participants referenced the park's resources regarding reservations or park closures. Rarely did participants actually consult the park's web resources for the specific purpose of hiking. Conversely, the non-park web resources consulted such as YosemiteHikes.com, Trip Advisor, and Yelp were all accessed specifically for the hiking reviews and ranking systems they provided. If the park wants to increase its online traffic for hiking decision making, perhaps it should include more of these features that increase the value and relevance of information.

At the outset of the study, I was interested in seeing whether Web 2.0 resources such as the park's Twitter and Facebook accounts were consulted by participants in decision making. Not a single participant mentioned accessing these resources when I asked about the park's website or other online resources. While this study did not comprehensively examine Web 2.0 resources, it is telling that none of the 80 participant groups mentioned using these sources of information in related to trail choice.

The non-park print resources considered to be decisive were often guidebooks. Many foreign visitors used guidebooks in trip planning that also described hiking opportunities. Additionally, some participants even referred to guidebook authors using personal pronouns, particularly when the participant was relying on the direct recommendation of the guidebook. Again, the park's print resources lack the personal touches of guidebooks. They are designed to streamline the process of trail choice; however, this study shows that for the people I interviewed, the park's print resources were not considered to be overly valuable. Perhaps the streamlined process has removed too much context. The sections mentioned most frequently among the printed resources were those containing maps rather than textual descriptions. In fact, many participants showed me pieces of the park newspaper and pamphlets containing maps they had used to find the trail or estimate mileage.

To increase the decisiveness of its print and online information sources, the park should consider incorporating some of the characteristics of non-park provided information sources that were mentioned by participants into the information it already provides. For example, the park could provide an online message board of weekly conditions and recommendations provided by park staff in addition to the standard information about trails already published online. Publishing a message board would provide the public with updates on recent conditions and add a personal touch to the information, while still allowing the park to maintain a degree of quality control regarding its online content.

Hiking in Wilderness?

Regardless of the decision making themes or information used in trail choice, the fact that the day hike was located within wilderness did not play a central role in trail choice decision making. At the end of the majority of interviews, I informed participants that the trail on which they had hiked was located in federally designated wilderness and asked the participants if they were familiar with federal wilderness designation. Of the 56 participant groups asked, 38 reported that they were unfamiliar with wilderness or did not know about the designation at all. Some of these respondents thought that the whole park was designated wilderness, and seemed surprised that different designations existed within Yosemite. Additionally, three participants described aspects of wilderness character in response to my questions about wilderness, even though they reported that they were unfamiliar with the meaning of federal wilderness designation. For example, one participant expected the hiking trail to be “un-manicured” and natural, stating that he also did not expect to see a lot of people.

For those who indicated that they were familiar with wilderness, I asked them to describe what the concept means to them. Some described a narrow view of wilderness, describing specific experience expectations, such as encountering wildlife. Others described wilderness as an all-encompassing designation for the park. Thirteen participants stating that they were familiar with wilderness seemed to also have a clear understanding of wilderness as a unique management entity, describing aspects of wilderness character when prompted to expand on their understanding of wilderness. Common themes mentioned included naturalness, being away from crowds, and preservation. Some participants also discussed management practices specific to wilderness, such as not being able to recreate with motorized vehicles, not being allowed to bring dogs into National Park Service wilderness, and using Leave No Trace principles when staying in the backcountry. Finally, if the participant seemed to have a clear understanding of federally designated wilderness as a unique management entity (e.g., described aspects of wilderness character), I asked if the designation played a role in trail choice. Only one participant indicated that the wilderness designation of the trail played a role in her trail choice decision making.

The mixed wilderness awareness among day hikers in Yosemite National Park raises a few points. First, it confirms the utility of using a pragmatic approach to studying wilderness day users, focusing on their trail choice decision making rather than asking questions related directly to wilderness-centric concepts. With more than half of the groups that I interviewed stating that they were unfamiliar with wilderness, it is unlikely that these unfamiliar groups would have been able to answer subsequent questions about wilderness experience with a clear understanding of wilderness as a management entity. By understanding the factors that influence decision making, the information relevant to trail choice, and the information sources considered to be decisive, the park can begin to understand how to communicate with this group of wilderness users that may be unfamiliar with the concept of wilderness. For example, trail features, recommendations, and convenience played prominent roles in the development of the hiker typology. In the future, the park can use the knowledge of these important factors in visitor decision making to improve the utility of park communication outlets for trail choice decision making. Specifically, the park should tie wilderness-related messaging to the factors identified in this study that are known to play a direct role in decision making.

Secondly, a number of participants consulted park information sources in decision making, yet many of these visitors did not know they were hiking in wilderness. In reviewing free print materials such as the hiking pamphlets and the *Yosemite Guide* hiking section available to park visitors, I noticed that the word "wilderness" was not mentioned in reference to any of the trails. The park has a captive audience in these visitors who use park-provided information sources that is currently being under-utilized for wilderness education. These visitors already look to the park for advice; therefore, if park managers want to increase wilderness awareness among visitors, this captive audience is a great place to begin introducing wilderness messaging.

Trustworthiness of the Study

Erlandson, Harris, Skipper, and Allen (1993) describe trustworthiness as the ability of inquiry to "demonstrate its true value, provide the basis for applying it, and allow for external judgments to be made about the consistency of its procedures and the neutrality of its findings or decisions" (p.29). Throughout the process of data generation, participant selection, coding, and typology development, measures were taken to ensure the trustworthiness of the research findings produced from this inquiry into wilderness day hiker trail choice decision making. Three aspects of trustworthiness were considered throughout the study: credibility, dependability, and transferability. The procedures and analysis adhered to each of the components of trustworthiness, allowing my co-researcher and me to assert that the research findings produced from this work are trustworthy.

Credibility

The credibility of qualitative inquiry can be assessed by looking at the focus of the research and determining how well the data generation and analysis processes adhered to the intended research focus (Creswell, 2009; Graneheim & Lundman, 2004). Aspects of the study design such as context for participant selection, data gathering approach, and data analysis should be evaluated to determine the appropriateness of each decision for achieving the overall goal of the qualitative inquiry, in this case understanding the phenomenon of wilderness day hiker decision making in Yosemite. In their literature review, Smallman and Moore (2009) called for the use of qualitative methodologies to understand tourist decision making as a process. The authors claimed that using quantitative methods reduces the complexity of decision making and generates results out of context. Furthermore, recognition that decision making styles vary between individuals has led to a call for analysis of distinct decision making typologies (Sirakaya & Woodside, 2005). Both qualitative and quantitative analyses (Chen, 2003) have been used to create tourist typologies; however, because this inquiry used semi-structured interviews, qualitative content analysis was the most appropriate method for creating the day hiker typology. Through selection of qualitative methods, this study overcame the limits of many quantitative studies, generating knowledge about trail destination choice that is more reflective of the complexity and dynamic nature of the decision context than a quantitative approach would provide. Moreover, the use of typology development as a way of making sense of the data is supported in the tourism and decision making literature (Cohen, 1972, 1974; Redfoot, 1984; Sirakaya & Woodside, 2005; Smallman & Moore, 2009).

In the context of this study, the selection of semi-structured face-to-face, on-site interviews with participants contributed to the credibility of the study. I was interested in learning, in the participants' own words, why they had selected a certain trail for hiking and what information sources were used in making the decision. The use of semi-structured interviews enabled me to maintain a level of consistency in the type of questions being asked of participants. Moreover, participants were able to easily answer the majority of questions on the semi-structured interview guide. When asked to explain why they chose their hiking trail, participants often provided responses right away. Similarly, when asked about information sources used, the majority of groups were able to list the sources and recall how they were used. The interview guide also kept each interview focused on the research phenomenon of interest, allowing me to maintain a focus on relevant questions despite some participants bringing up items that were unrelated to decision making or information search. Finally, the selection of study participants at trailheads increased the likelihood that participants would remember more about the decision making process than if they were asked to participate in data generation at a later date. I intercepted visitors at the earliest opportune time they could be approached, while still ensuring that the participants had made and acted on a trail choice decision (i.e., he or she went hiking).

Credibility was also achieved by selecting participants across a variety of hiking experiences and visitor types, increasing the possibility that the inquiry would generate information on the phenomenon of interest through a variety of different perspectives. Through selecting visitors at high and moderate use trailheads in two different areas of the park that contained different geographic features and/or trail destinations, I included a large cross-section of possible wilderness experiences in the selected group. Furthermore the number of interviews conducted at each location (between 9 and 15) added to the depth of understanding the decision making phenomenon at each trail.

Visitors were also categorized on a number of factors known to be relevant to information selection and use in the quantitative literature on tourist information search strategies. Participants were selected across differences in group size and composition, familiarity with Yosemite National Park and its hiking trails, and reason for travel. Again, choosing participants with various experiences contributed to credibility by increasing the possibility that wilderness day hiker decision making would be studied from a variety of perspectives and visitor types (Graneheim & Lundman, 2004).

The number of interviews conducted was grounded in literature employing similar data analysis techniques. Eighty was selected as the appropriate number of interviews because a qualitative inquiry by Wickens (2002) producing a tourist typology used 86 interviews to generate five types regarding three dimensions of the tourist experience: choice of holiday, types of activities, and views about the host community. Wickens employed similar data collection methodologies, using a semi-structured interview guide; therefore, I felt that conducting a similar number of interviews would generate enough data to create a wilderness day hiker decision making typology. Due to the seven emergent types of hikers, I feel the selected participant group succeeded in containing enough diversity to differentiate between groups while containing enough homogeneity within the developed types. A slightly larger sample may have reinforced the two smaller emergent types: “Happenstance” and “Checking Off the List.”

The multi-phase coding approach used to examine the data also adds credibility to the findings through generating a thorough representation of the categories and themes present in the data (Graneheim & Lundman, 2004). The use of three different coding strategies (attribute coding, provisional coding, and emergent coding), two phases of data analysis (coding and typology development) and two different coders allowed for an examination of multiple aspects of the data, including themes both explicitly stated by participants and those derived implicitly from the text. Particularly, the use of multiple passes through the data using the provisional codebook(s) allowed my co-researcher and me to accurately identify theoretical constructs and relationships. Following theory-based coding with an open coding, constant comparison analysis as needed added to credibility by allowing me to capture and explore themes that were not anticipated at the outset of the study. The development of a visitor typology provided a summarizing aspect to the analysis, aiding in the process of making sense of the relationships between the identified top-level codes. Throughout the coding process, inter-rater reliability was taken into consideration with multiple meetings between coders to discuss the interpretation of theory-based codes and the development of data-driven codes during the open coding phase. Cohen's kappa coefficients were calculated for each round of provisional coding, achieving acceptable levels of agreement for top-level codes during most of the coding rounds (Krippendorff, 2004; Kurasaki, 2000).

Dependability

Dependability refers to the researcher's efforts to take into account potential inconsistencies in data generation from the iterative process of qualitative inquiry when discussing findings (Graneheim & Lundman, 2004). Essentially, the researcher must address the flaws or mistakes in study design openly, discussing rigor and accountability in overcoming such limitations. In the context of this study, I tried to ensure dependability in a number of ways, including the use of a semi-structured interview guide, theoretical saturation forms throughout on-site data generation, and coding memos to document changes in the meaning of codes. The use and review of a semi-structured interview guide provided a concrete mechanism for documenting the evolution of questions while maintaining homogeneity in the types of questions being asked. After conducting the first seven interviews, my co-researcher and I reviewed the interview guide and listened to the interview recordings to discuss how the interview protocol could be improved. The content of the questions did not change after this review session, but the way in which I asked the questions and engaged with participants evolved as I became more comfortable interviewing visitors and responding to unique or unexpected answers. After reviewing the first seven interviews, my co-researcher and I participated as co-interviewers for a number of on-site interviews. This process allowed her to understand how I was moving through the interview guide, and enabled us to further refine my interviewing techniques. After this process, I conducted the remainder of the interviews independently, incorporating the stylistic changes we had agreed upon.

In addition to engaging in on-site reviews with my co-researcher, I also investigated the types of information sources available to Yosemite wilderness day hikers on site. I visited the Yosemite Valley and Tuolumne Meadows Visitor Centers, speaking with rangers and volunteers at each location to gain a better understanding of the visitor experience at these locations. Furthermore, I familiarized myself with the print resources available to visitors on site, including the free *Yosemite Guide* newspaper distributed at entrance gates, the free official Yosemite National Park brochure distributed at entrance gates, and paper copies of recommended day hikes available for free at each of the visitor centers. I looked at the hiking books available in the stores, and purchased a few of the more popular hiking pamphlets in the Tuolumne Visitor Center. Engaging in this familiarization provided insight into the information search options available in the park, enabling me to ask more refined questions about the type of information provided by the National Park Service on location.

While this did not result in changes to the interview guide itself, it did produce changes in way I discussed information sources with the visitors.

At the end of each interview I filled out a theoretical saturation form to review the content of the interviews and classify each interview according to the participant attributes discussed previously. Engaging in this process allowed me to remain involved with the data while in a remote location. Due to rustic living conditions, I could not begin the data review and analysis process as the data were generated; however, the theoretical saturation forms enabled me to take detailed field notes after each interview and review the interview corpus at the end of each day of interviews. This continued engagement with the data added to the dependability of the interviews over the study period.

Transferability

Transferability refers to the degree to which the findings can be applied, or transferred, to other settings, groups, or inquiry efforts (Graneheim & Lundman, 2004). Transferability was achieved through the inclusion of a detailed description of how the data were generated, the trail and participant selection process, the coding scheme and codebooks, and the development of typologies. I tried to present as accurate an account of the data generation process as possible in this manuscript, outlining each step in the evolving process of data generation and analysis to contribute to the understanding of wilderness day hiker decision making in Yosemite National Park. Furthermore, while the day hiker typology presented here is not intended to be generalized to the entire wilderness day hiker population at Yosemite, the themes generated from this inquiry can help managers understand the process of trail choice decision making in their park. Furthermore, the findings are transferable from a theoretical perspective, meaning that they can be used to discuss shortcomings or strong points of the theories applied in this study. In discussing generalizability in the context of qualitative inquiry, Polit and Beck (2010) discuss the merits of analytic generalization, in which researchers apply qualitative findings to broader constructs or theory. Due to the underlying theoretical framework of bounded rationality and information search theory used to develop the interview guide, the findings were examined in light of these theories, and transferred to the constructs when appropriate.

Theoretical Contributions: Decision Making

As discussed earlier, the categorization of trail choice decision making using the five initial, literature-based selection strategies did not fit the interview data well. Namely, my co-researcher and I had trouble distinguishing between the individual strategies when engaging with the interview corpus. This arose largely from the simplicity of the five strategies. Individually, each of the strategies seemed plausible; however, applying selection strategy codes to individual data bits was challenging, as numerous factors seemed to impact decision making. Indeed, as seen from the seven hiker types developed from the interview corpus, many factors were at play in decision making for hikers in each of the categories.

While the initial selection strategy approach to categorizing the interviews was not appropriate for this interview corpus, the overall application of the theory of bounded rationality in trail choice decision making for wilderness day hikers fit very well. Each hiker type engaged in some form of decision simplification. Whether that simplification manifested as relying on previous knowledge and experience in decision making instead of conducting an information search, or whether it stemmed from relying on a recommendation for a trail choice, each hiker type exhibited characteristics of bounded rationality. Furthermore, none of the hiker types engaged in optimization decision making, which is what would be expected under the rational-agent model of decision making (the converse of bounded rationality). While optimization in decision making was not exhibited by the hikers, each hiker type demonstrated some sort of uniformity in the way that information was considered and the type of information considered. For the most part, the decision making themes that emerged from the interview corpus showed forethought in decision making, with important factors for decision making emerging from each hiker type. This somewhat systematic approach apparent within each hiker type also supports bounded rationality. As Simon (1957, 1990) argues, humans are not completely irrational decision makers; they simply cannot or do not engage in full optimization when choices can be made using a limited set of alternatives.

The manifestation of the four constraint categories also supports the use of bounded rationality, which attributes the inability to engage in optimization to limiting factors. In this study, 50 participants mentioned at least one of the four constraint areas. Capacity, which was operationalized as time in this study, was mentioned most often; 24 participants mentioned a limited amount of time as a factor impacting trail choice decision making. Coupling constraints, or those constraints originating from other group members, and limits originating from physical ability were mentioned by 19 participants each. Authority constraints were mentioned the least (n=7), with most mentioning the inability to get a Half Dome permit as leading them to select a given trail. The small impact of authority constraints on trail choice decision making was expected, due to few such existing constraints in Yosemite. The manifestation of constraints did not show distinct patterns according to the hiker types developed; however, their presence in the overall dataset supports the bounded rationality assumption that limiting factors constrain the trail choice decisions made by Yosemite day hikers.

The emergence of "physical ability" as a constraining factor in trail choice decision making contributes a new category to the factors that may limit or constrain decision making. Initially, three constraint types, derived from a combination of Simon's (1957) limiting factors and Hagerstrand's (1970) three space-time constraints, were used in a priori coding of the interview corpus: capacity, coupling, and authority. However, when engaging with the data, my co-researcher and I felt that physical ability also manifested as a concern among participants when making a trail choice. Particularly, physical ability was mentioned as a reason for not considering certain trails in decision making. Because physical ability seemed to restrict the trail choice options under consideration, we decided to include it as a constraint rather than an emergent decision theme.

Moreover, physical ability differs from the capacity constraint a priori code because capacity refers specifically to limits on the available resources of time and money in decision making. While one's physical ability may be interpreted as his or her physical capacity for hiking, this use of the word capacity is inconsistent with the existing literature. Therefore, physical ability stands alone as its own type of constraint in this work. Indeed, 19 hiking groups indicated that physical ability played a role in decision making, demonstrating that the addition of this new constraint type added significantly to our ability to understand trail choice decision making among day hikers. In future qualitative inquiry into decision making, researchers should seek to identify any situation-specific constraints that may emerge in decision making to ensure that the decision making phenomenon under study is fully described.

Effort-Reduction Framework

Bounded rationality as a broad theoretical framework informed the approach of this exploration of wilderness day hiker decision making in Yosemite; however, the initial framework used for identifying selection strategies was not a good fit for the interview corpus, and therefore I returned to the literature to search for alternative theoretical frameworks to interpret my data. In future works exploring decision making from a bounded rationality perspective, I propose using Shah and Oppenheimer's (2008) effort-reduction framework to better understand the process of arriving at a particular decision. Like Simon, Shah and Oppenheimer argue that people engage in bounded rationality due to environmental constraints and limits to cognitive processing. They move beyond bounded rationality by saying that, because of the constraining factors, individuals must engage in behaviors that reduce the effort required to make a decision. Therefore, understanding the process of effort reduction allows for the understanding of how a decision is reached in the context of bounded rationality. Furthermore, Shah and Oppenheimer claim that if bounded rationality is at work in decision making, then the individual automatically employs some form of a heuristic. Therefore, engaging in heuristic decision making is an underlying assumption for examining decision making using the effort-reduction framework. In the context of this study, then, Shah and Oppenheimer would argue that all of the participants engaged in heuristic decision making, rather than merely the subset of the participants who were coded as using heuristics in decision making.

Shah and Oppenheimer (2008) outline five steps in the effort reduction process, which was developed using the weighted additive rule. This rule is an accepted algorithm that imitates the process of optimization decision making, in which the decision maker considers all possible alternatives across all possible cues. The weighted additive rule process qualifies as an approximation of optimization because the user must assign weights to aspects of the alternative (i.e., cues) being considered — these weights are derived from personal judgments regarding how the individual aspects of the alternative contribute to the overall value of the alternative. The values of the cues of the alternative under consideration are multiplied by the weights, and the weighted value scores for each cue are summed to produce an overall score for the alternative. The decision maker then selects the alternative with the highest score; in other words, the optimal alternative is selected.

Using the processes that achieve optimization in the weighted additive rule, the effort-reduction framework identifies areas where decision making deviates from optimization, and therefore, where heuristics are used instead. The weighted additive rule for decision making requires decision makers to expend effort at five stages: identifying all cues, recalling and storing those cues, assessing the importance of each cue, integrating the cues for all alternative choices, and comparing the alternative choices and choosing the one that scores highest (Shah & Oppenheimer, 2008). Conversely, if an individual engages in effort reduction, the decision making process would reflect compromises at one or more of the stages. Using this logic, the effort-reduction framework is comprised of the following five amended stages: considering fewer cues, reducing the effort needed to access and store cues, simplifying the process of setting cue importance, integrating less information across alternatives, and ultimately examining fewer alternatives.

Shah and Oppenheimer (2008) proposed the effort-reduction framework to unify the study and understanding of heuristic decision making. The concept of heuristic decision making is widely debated in the decision making literature; the term has been interpreted conservatively (in the case of Simon's description of heuristic search cited earlier) or very broadly (Gigerenzer & Gaissmaier, 2011; Shah & Oppenheimer, 2008). Shah and Oppenheimer cite three main problems with the current understanding and application of heuristic decision making: (1) redundancy exists, with researchers developing multiple heuristics that ultimately represent the same process; (2) the theoretical application of heuristics is not always accurate, due to overextension of constructs to explain more than can actually be explained; and (3) little research exists on how heuristics reduce the effort required for decision making. Indeed, the first and second reasons discussed by Shah and Oppenheimer may have played a role in the difficulty of interpreting decision making in this work. Using the initial selection strategy framework, I proposed to include five mechanisms for making a decision within the context of bounded rationality. However, the five strategies were difficult to apply due to their simplicity; perhaps a more structured discussion of how the effort was reduced in decision making within each strategy would have aided in their application to the interview corpus. Further, in my own review of the heuristics decision making literature I identified a number of competing frameworks for understanding heuristic decision making. Some research focused on the application of specific heuristics, such as those involving moral cues in decision making, while others attempted to organize heuristics into broad categories by theme (Gigerenzer & Gaissmaier, 2011). As Shah and Oppenheimer discuss, I saw redundancy in the frameworks with little discussion of competing interpretations. For this reason, I propose Shah and Oppenheimer's effort-reduction framework for future exploration of trail choice decision making. Their framework provides a unifying structure for understanding heuristic decision making, shedding light on the mechanisms that reduce effort while also grouping of decision making strategies.

Shah and Oppenheimer (2008) have classified the majority of existing heuristics found in the literature according to their proposed effort-reduction framework. This classification would facilitate the application of their framework to trail choice decision making. Specifically the effort-reduction framework not only expands on the current knowledge of the processes underlying heuristic decision making, but it also provides a direct link to existing heuristic decision making literature. For example, Shah and Oppenheimer examined the heuristic "choice by most attractive aspect," developed by Svenson (1979), across the five components of effort reduction. They concluded that three of the effort-reduction framework components were applicable to this heuristic: simplifies determination of importance, integrates less information, and examines fewer alternatives (Shah & Oppenheimer, 2008). For my interview corpus, the missing link between the process and the selection strategy made the initial proposed selection strategies such a poor fit. Therefore, the linkage between the heuristics literature and the effort-reduction strategy makes the effort-reduction framework particularly useful because it provides a mechanism for not only understanding the decision making process, but also a direction for the consideration of existing heuristics in explaining the data.

Additionally, the effort-reduction framework would be especially useful in examining trail choice decision making because it allows for the classification of decision making across multiple stages of the framework in a non-linear fashion. Shah and Oppenheimer (2008) acknowledge that decision making is not a linear process; individuals may or may not engage in each step of the proposed effort-reduction framework. This freedom to assign multiple categories to the decision making process as they occur overcomes the limitations of the five selection strategies proposed in this study. The five strategies proposed did not allow for overlap; they were proposed as discrete classifications for decision making processes. This created difficulty in applying strategy labels to seemingly more complex processes; conversely, using the effort-reduction framework to understand decision making recognizes the complexity of the decision making process.

Regarding the hiker typology developed from this study, the effort-reduction framework could be used to further examine the process of effort-reduction in wilderness day hiker decision making. For example, when considering the "Following Directions" hiker type in the context of the effort-reduction framework, three of the framework components seem evident. In making a trail choice, the "Following Directions" hiker simplifies the determination of importance for cues by seeking a recommendation from a trusted or authoritative source. This group of hikers does not need to determine the importance of information about hiking directly; rather an outside source provides the evaluation of importance. This hiker type also probably integrates less information in decision making, tending to rely on one decisive source in making a trail choice. Finally, this group examines fewer alternatives (or no alternatives) in making the trail choice. Looking at the table of existing heuristics categorized according to the applicable effort-reduction framework components provided by Shah and Oppenheimer (2008), the following heuristics (found in the literature) were also classified as decision simplifications that engage in the same effort-reduction components: choice by most attractive, choice by least attractive, and satisficing. Using the effort-reduction framework to understand the "Following Directions" hiker type opens up potential links between the decision making of this hiker type and the literature.

For example, the three relevant heuristics from Shah and Oppenheimer's classification can be explored more deeply to determine if they actually fit the hiker typology. Moreover, this example represents the possibility for examining the developed typology as a whole in the context of effort reduction and existing heuristics. Rather than combing the literature for heuristics that may fit each hiker type, using the effort-reduction framework narrows the search. Furthermore, if existing heuristics do not fit the data, the framework provides justification for the potential creation of additional heuristics for decision making.

Theoretical Contributions: Information Search Theory

Participants were selected across a number of attributes to maximize the potential for identifying the variety of information used in decision making. However, many of the attributes found to significantly impact information search and use in previous studies did not manifest as important characteristics in this examination of day hiker trail choice decision making. For example, Fodness and Murray (1998) found group composition to impact the number and type of information sources used by visitors in decision making. However, in this study, group composition within the seven hiker types was rarely uniform. Furthermore, when examining the coding matrices, segmenting the participants by group composition did not produce any distinct patterns in the types of information sources considered. Similarly, group size also did not manifest as a unifying factor among the seven hiker types developed.

Trip length was also expected to impact the information search of hikers, with those individuals taking longer trips (either in Yosemite or a longer hike) using more information in trail choice decision making. To standardize this characteristic across the interviews, the number of days of the participant's trip in Yosemite and the number of hours the individual hiked were both recorded. Again, these factors did not show unifying patterns in the way that information was consulted or in the way that decisions were made. This may be a result of the wide variability in the overall trip length and hike length present in the interview corpus. Participants visited Yosemite for less than half a day to upwards of two weeks. Similarly, participants took hikes that lasted less than 30 minutes to more than seven hours. This variability may have prevented the classification of hikers into meaningful groups based on these two trip characteristics. Additionally, these two trip characteristics are continuous rather than discrete, categorical characteristics. The relationship between these factors and trail choice decision making may be better understood using quantitative methods that allow for more refined exploration of continuous data.

Another explanation for the lack of influence of these two trip characteristics is that trail choice decision making does not directly involve financial transactions. Length of trip has been shown to influence information search behavior in the context of tourism trip planning, with individuals taking longer trips engaging in a more extensive information search (Fodness & Murray 1999). Often, trip planning is studied in the context of purchasing choices made by tourists, such as the purchase of airfare tickets or other travel expenditures. Because trail choice decision making does not involve such large scale expenditures and generally does not require reservations or the purchase of tickets, trip length may not be relevant to decision making in this application of information search. Day hikers essentially have the freedom to choose day hiking trails as they desire, without suffering any negative consequences for not making reservations or reserving tickets in advance.

One characteristic that played a significant unifying role among the groups was the individual’s familiarity with Yosemite and with the trail on which he or she hiked. One of the hiker types, the "Connect Expert," was uniquely identified by previous experience with Yosemite and the chosen trail. This group engaged in very little external information search, relying primarily on prior knowledge and previous experience to inform decision making. This relationship between experience and information search reflects the presence of the spatial dimension of information search strategy that Fodness and Murray (1998) proposed. As discussed previously, this dimension relates to the location of information search, with individuals first engaging in internal search followed by external search. In this application, participants with more experience both in the park and on the trail tended to engage in internal search. Conversely, the majority of participants did not have previous stored knowledge or information about the park or the trail and, therefore, engaged in external information search. While the interview corpus generated from this study was not intended to represent all wilderness day hikers in Yosemite, the manifestation of the spatial dimension of information search strategy in the interview corpus speaks to the transferability of this component of information search strategy to understanding trail choice decision making among hikers.

The operational dimension of information search strategy proposed by Fodness and Murray (1998) also manifested in the interview corpus. This dimension refers to how influential an information source was to the final decision. Many of the hiker types developed, including the "Feature Seekers," "Following Directions," and "The Right Fit" hikers, relied on a single, decisive information source for decision making. Additionally, patterns emerged in the way that certain types of information sources were used. For example, park-provided online and print resources were usually considered to be contributory sources, whereas park staff, non-park online, and non-park print sources were usually considered to be decisive when considered. The manifestation of the operational dimension both in the developed typology and within information source demonstrates the transferability of this theoretical construct to understand trail choice decision making.

The temporal dimension of information search strategy, referring to when information sources were considered, was less evident in the interview corpus than the other two dimensions (spatial and operational). Trail choice decisions were made at varying times from being planned out before arrival in Yosemite to being made spontaneously upon arrival at the trailhead. In typology development, this dimension played an important role in unifying the “Happenstance” and “Checking Off the List” hiker types. Both of these groups made trail choice decisions somewhat impulsively. The “Happenstance” hiker type makes trail choice decisions without any information search at all. The “Checking Off the List” hiker consults information the morning of the hike to determine what activities remain in a limited geographic area. Unlike the other types where the consultation of information for decision making was variable, these two groups were united by a reduced information search and impulsive decision making. Future work seeking to understand the temporal dimension of information search strategy should ask more direct questions regarding the timing of information consultation and decision making. In this interview corpus, this type of information was usually implicit within the context of the interview rather than explicitly stated by the participant, making it more difficult to identify than the operational or spatial dimensions.

The transferability of the three dimensions of information search strategy developed by Fodness and Murray (1998) to the decision making hiker typology provides a linkage between information search theory and decision making theory. One of the goals of this study was to combine the two theoretical frameworks to inform the study of trail choice decision making by wilderness day hikers in Yosemite. The semi-structured interview guide was designed to elicit information about the trail choice decision making process from participants, covering a range of topics from the role of constraints in decision making to the types of information sources used. The developed hiker types not only show uniformity in the decision themes that manifested within each type, but they also show uniformity across the information search theory dimensions as discussed above. The integration of decision making and information search paints a more complete picture of trail choice decision making than either theoretical approach would on its own. The successful application of components from both decision making and information search theory in the development of the hiker typology speaks to the necessity of including both topics in future decision making research.

Conclusion

This study sought to understand the phenomenon of trail choice decision making by wilderness day users in Yosemite National Park. Ultimately, a hiker decision making typology was developed based on a prior codes for types of information sources consulted and participant characteristics, along with data driven codes for decision making themes. The seven emergent types show that day hiker decision making is complex, and that diversity exists in the types of information sources consulted, the constraints to decision making, and the factors considered in decision making. Overall, constraints and simplified decision making manifested as a theme in the interview corpus, confirming the applicability of bounded rationality to this study. While the initial decision strategy framework did not fit the data well, decision making themes were developed through emergent coding that provided an understanding of the factors relevant to decision making for wilderness day hikers in Yosemite. Factors such as trail features, convenience, and recommendations from trusted or authoritative sources played a role across a number of hiker types, whereas group factors, environmental conditions, and experience seeking played lesser roles within the interview corpus. Familiarity with the park and trail also emerged as an important decision theme linking information search strategies and decision making across the developed hiker types.

Overall, information use varied across the categories. However, of the sources provided by the park, only park staff were considered to be decisive in decision making. Park print and online sources, when consulted, were not considered to be the most important sources in decision making. Conversely, non-park online and print sources were more likely to be decisive when considered. These information sources were valued for the rating systems, up to date information, and previous experience implicit in them. If the park wants to increase the decisiveness of its print and online sources, it may consider adding these components to hiking information.

Finally, the wilderness designation of a trail did not play a central role in decision making for the majority of wilderness day hikers. The lack of focus on wilderness among the participant group confirms the necessity of using pragmatic approaches that go beyond wilderness-centric concepts to understand wilderness day hikers. While some hikers were familiar with wilderness designation, a general sense of uncertainty or confusion pervaded discussions about wilderness. Furthermore, the park's existing hiking information lacks a focus on wilderness. The park can overcome this lack of wilderness understanding by providing wilderness education in conjunction with information about day hiking. Through connecting influential factors to wilderness-centric messages, the park may be able to increase wilderness awareness among its day user population, and potentially impact visitor wilderness trail choice.

Chapter 4

Summary of Research Contributions and Methodological Recommendations for Yosemite National Park

The motivation behind the research questions targeted in this thesis was using a pragmatic approach to studying wilderness day users in Yosemite National Park, applying new methods for collecting and analyzing data and new theoretical frameworks for understanding the decisions of day users. At the outset of this work, I justified the exploration of wilderness day user travel patterns, the occurrence of micro-level site displacement among day users, and trail choice decision making citing known gaps in the wilderness literature discussed by Roggenbuck et al. (1994) and identified again as modern concerns by McCool and Dawson's (2012) focus-group discussions with wilderness practitioners. Ultimately, this thesis sheds light on each of the areas identified in Chapter 1; below is a summary of the relevant findings in the context of the identified knowledge gaps.

Roggenbuck et al. (1994) stated that, among other areas, more information was needed on the spatial and temporal distribution of day use in parks. While much research has explored day use since 1994, my work uniquely contributes by applying GPS technology to study the movements of wilderness day users (Chapter 2). The application of GPS tracking technology generated objective data regarding visitor use, providing insight into the variation of use across space and time on trails and at attraction sites. Moreover, my work provides Yosemite managers with a snapshot of wilderness day use during the summer 2012 use season that can be used to understand baseline use of key wilderness trails under the park's current wilderness management protocols. Yosemite managers can use the spatially explicit data in my study to track changes in use on the sampled trails over time.

Additionally, managers may be able to incorporate GPS tracking on select indicator trails into the overall wilderness monitoring program used to evaluate the effectiveness of wilderness management in the park.

If Yosemite moves forward with incorporating GPS tracking into a wilderness monitoring framework, managers should consider the following recommendations for use and analysis of GPS data. First, the igotU 120 GPS units currently owned by Yosemite should be programmed to collect GPS signals every 15 or 20 seconds, producing approximately three or four GPS points per minute. During the summer 2012 field season, the units collected data at an interval of every two seconds; this was the baseline setting for the units. The two-second interval for data collection produced extremely large datasets for analysis that ultimately proved to be unnecessary for accurately representing travel patterns and troublesome during analysis. An interval of 15 to 20 seconds would still allow for high resolution visitor tracking while reducing processing time and file sizes.

Furthermore, to incorporate GPS tracking into a monitoring framework, park researchers would need to develop standard protocols for data analysis. The methods for data cleaning and analysis that I developed for this work will be made available to the park. I encourage the establishment formal standards for data collection, acceptable levels of sensor accuracy, and analytical procedures consistent with the park's overall research goals. The exploratory nature of this work was one of the most difficult parts of working with the GPS data; namely I did not initially have clear direction regarding the specific research questions of interest for the collected data. Developing an agreed-upon protocol and purpose for future work will speed up the analysis process and allow the park to make concrete generalizations about the distance traveled and time spent in wilderness by users.

Findings from Chapter 2 also contribute to three of the knowledge gaps identified by McCool and Dawson (2012): (1) research on capacity issues that get away from simplistic number approaches; (2) what is "appropriate" in wilderness in terms of behavior and visitor crowding at varying use levels; (3) day use and how to manage it, including tools that might be effective for lowering crowding among day users. The GPS tracking study provides additional information about visitor use that moves beyond simplistic numerical approaches to understanding use on trails. While the GPS data reported are numerical, the distance traveled and amount of time spent in wilderness provide managers with information about how the "number" of day users that enter wilderness actually use the trail system. My work provides managers with overall descriptive statistics for the seven sampled trails, discusses use in relation to known wilderness attraction sites, and provides insight into the degree off-trail travel and use of wilderness trail networks by day users. This type of information can be used to inform managers on the use behaviors of current day users in wilderness, moving away from a simplistic descriptive approach that only provides data on the number of users entering wilderness.

The micro-level site displacement work contained in Chapter 2 provides limited insight toward gaps in the knowledge regarding behavior and visitor crowding. Specifically, this work documents the occurrence of micro-level site displacement, to some degree, at three popular wilderness attraction sites at Yosemite: Dog Lake, May Lake, and Sentinel Dome. Moreover, my work provides researchers and managers with a new method for studying visitor behavior at attraction sites, incorporating automated data collection techniques to explore the social impacts of use. This method can also be incorporated into the park's wilderness monitoring framework if desired, particularly for tracking the impact of any management actions taken to reduce use at these popular locations.

This work also highlights the discrepancy between visitor behavior and visitor perceptions of their wilderness experiences, adding support to the consideration of both visitor opinions and actual visitor behaviors in determining wilderness management standards. While my work by no means provides definitive answers for the knowledge gaps identified by McCool and Dawson (2012) related to use levels and crowding among day users, it contributes knowledge using new methods, providing Yosemite managers with novel avenues for the study of visitor use within wilderness.

The exploration of wilderness day user trail choice in Chapter 3 provides data on why day users enter the backcountry (Roggenbuck et al., 1994) and the different roles and effects of information on wilderness experience (McCool & Dawson, 2012). Using a bounded rationality theoretical approach to understanding decision making among wilderness day users, I identified seven decision themes relevant to trail choice for day users in Yosemite. These seven themes shed light on the factors relevant to day hiker decision making, providing information on why day users enter the backcountry. For example, a variety of trail features, ranging from anticipated use levels on a trail to scenery to the availability of opportunities to engage in specific activities, played a role in decision making for these day hikers. While this finding was expected, the variety of trail features discussed by interviewees provides the park with a spectrum of the factors known to be valued by current day users of wilderness. Furthermore, other decision themes unrelated to the physical conditions of the park provide managers with knowledge of the contextual factors influencing a trail choice. Convenience and heuristics emerged as relevant decision factors across many hiker types in the overall day hiker decision making typology that was developed. The emergence of these themes provides managers with information about the other competing factors that are considered in addition to the physical characteristics of wilderness itself (i.e., the trail features).

The exploration of the information sources considered in decision making across the operational, temporal, and spatial dimensions of the information search strategy framework provides Yosemite managers with information regarding the value of sources considered and the timing of information search. Furthermore, through asking interviewees questions specific to the value of park-provided and non-park sources, my work provides managers with information about the way in which existing communication channels are being used by visitors. The classification of information sources into seven categories and the exploration across three dimensions of search directly contributes knowledge toward understanding the effect of different types of information on wilderness day hiker experience, identified by McCool and Dawson's work. Yosemite managers should take the data provided in Chapter 3 into consideration when evaluating their current communication efforts with wilderness users and / or when considering making content changes.

Through targeting identified gaps in the current wilderness literature, the results of my research contribute knowledge that may be useful to Yosemite managers as the park continues to develop its Wilderness Stewardship Plan. While the work included in this thesis was largely exploratory in nature and therefore cannot be used to generalize to the entire wilderness day hiker population in Yosemite, the methods used and emergent themes can be used by managers to better understand this large segment of wilderness users in Yosemite.

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Appendix A

University of Idaho Institutional Review Board Letter of Exemption: 2012 GPS Work

July 12, 2012

University of Idaho

Office of Research Assurances (ORA)
Institutional Review Board (IRB)
PO Box 443010
Moscow ID 83844-3010

Phone: 208-885-6162
Fax: 208-885-5752
irb@uidaho.edu

To: Hall, Troy
Cc: Irizarry, Susan

From: IRB, University of Idaho Institutional Review Board

Subject: Exempt Certification for IRB project number 12-226A

Determination: July 11, 2012
Certified as Exempt under category 2 at 45 CFR 46.101(b)(2)
IRB project number 12-226A: Social science to support wilderness planning at Yosemite National Park Component A

This study may be conducted according to the protocol described in the Application without further review by the IRB. As specific instruments are developed, each should be forwarded to the ORA, in order to allow the IRB to maintain current records. Every effort should be made to ensure that the project is conducted in a manner consistent with the three fundamental principles identified in the Belmont Report: respect for persons; beneficence; and justice.

It is important to note that certification of exemption is NOT approval by the IRB. Do not include the statement that the UI IRB has reviewed and approved the study for human subject participation. Remove all statements of IRB Approval and IRB contact information from study materials that will be disseminated to participants. Instead please indicate, "The University of Idaho Institutional Review Board has Certified this project as Exempt."

Certification of exemption is not to be construed as authorization to recruit participants or conduct research in schools or other institutions, including on Native Reserved lands or within Native Institutions, which have their own policies that require approvals before Human Subjects Research Projects can begin. This authorization must be obtained from the appropriate Tribal Government (or equivalent) and/or Institutional Administration. This may include independent review by a tribal or institutional IRB or equivalent. It is the investigator's responsibility to obtain all such necessary approvals and provide copies of these approvals to ORA, in order to allow the IRB to maintain current records.

This certification is valid only for the study protocol as it was submitted to the ORA. Studies certified as Exempt are not subject to continuing review (this Certification does not expire). If any changes are made to the study protocol, you must submit the changes to the ORA for determination that the study remains Exempt before implementing the changes. The IRB Modification Request Form is available online at: http://www.uidaho.edu/ora/committees/irb/irbforms

University of Idaho Institutional Review Board: IRB00000843, FWA00005639

Appendix B

Approach Script for Participation in GPS Study

When approaching the visitor, the study participant must use the following script:

> *"Hello, my name is ______________________. I am a graduate student from the University of Idaho [or park volunteer] and I am conducting a study for the National Park Service at Yosemite. This study will help the Park Service adopt management practices that provide enjoyable experiences for wilderness visitors, while protecting and preserving the natural resources for future generations to enjoy. The study has been approved by the University of Idaho. You have been randomly selected to participate in the study. If you agree, you will be asked to carry a portable GPS unit that will collect information about your wilderness trip. Your identity will be completely anonymous. Would you be willing to carry the GPS unit and participate in the study today?"*
>
> If "NO" then, *"Thank you, I hope you enjoy your visit."*
>
> If "YES" then, *"Thank you. Here is the portable GPS unit that will collect information regarding your trip. All you have to do is clip the unit to your day pack. The unit is already functioning and you do not need to take any further action to begin the study. We also ask that you wear this yellow smiley face sticker so that study administrators can easily spot participants in the study. Please return the GPS unit to me or another study administrator. If a study administrator is not present when you finish your hike, please return the GPS unit to a drop box* (visitors were shown the drop box location). *I'll be happy to answer any questions about the study."*

When the exit survey component was added to the GPS portion of the study, the following statements were added to the script:

> *"Thank you for your participation in the GPS portion of our study. If you have a few minutes, we also have an optional exit survey related to your wilderness experience. The survey will only take a few minutes, and it is completely confidential. Would you like to participate in the optional exit survey portion of the study?"*

Appendix C

Yosemite National Park Research Permit: GPS Study

First and last page of permit included, please contact researcher for copy of full permit

SCIENTIFIC RESEARCH AND COLLECTING PERMIT

Grants permission in accordance with the attached general and special conditions

United States Department of the Interior
National Park Service

Yosemite NP

Study#: YOSE-00542
Permit#: YOSE-2012-SCI-0125
Start Date: Jun 06, 2012
Expiration Date: Dec 31, 2012
Coop Agreement#: n/a
Optional Park Code: n/a

Name of principal investigator:

Name: Troy Hall **Phone:** (208) 885-9455 **Email:** troyh@uidaho.edu

Name of institution represented:

University of Idaho

Co-Investigators:

Name: Susan A. Irizarry **Phone:** (208) 885-7911 **Email:** iriz0370@vandals.uidaho.edu

Project title:

Social Research to Support Wilderness Planning in Yosemite National Park: Spatial Component

Purpose of study:

Social science research in support of park planning and management is mandated in the National Park Service (NPS) Management Policies 2006 (Section 8.11.1, â Social Science Studiesâ). NPS policy mandates that social science research will be used to provide an understanding of park visitors, the non-visiting public, gateway communities and regions, and human interactions with park resources. Such studies are needed to provide a scientific basis for park planning and development. At Yosemite National Park, social science research is needed to understand patterns of wilderness visitation as part of a new effort to create a wilderness management plan. Managers at Yosemite want to know about visitor and trip characteristics, as no such wilderness-wide social data have been collected in Yosemite in recent decades. The purpose of the spatial component of this research is to collect information on wilderness day use in Yosemite National Park. This study will collect information on wilderness trip characteristics such as trip duration, distance hiked, and areas visited and provide Yosemite National Park managers with quantitative visitor use data that can be used in improving wilderness management throughout the park.

Subject/Discipline:

Social Science

Locations authorized:

Research will take place at wilderness trailheads identified as low, medium, and high use for day user groups through consultation with wilderness managers and social scientists at Yosemite.

Transportation method to research site(s):

Trailheads will be accessed by vehicle where appropriate. Researchers will park in the nearest established parking lot, and hike on foot to the trail head where sampling will be conducted.

Collection of the following specimens or materials, quantities, and any limitations on collecting:

n/a

Name of repository for specimens or sample materials if applicable:

n/a

Specific conditions or restrictions (also see attached conditions):

Park contact for this permit is Bret Meldrum 209-379-1216

This permit is valid thru December 2012. Park entrance fees are waived while conducting the research. Each member of the investigator's team (i.e. field crews) must carry a copy of this permit and NPS conditions at all times while conducting has not been open for more than six weeks due to its rapid degradation.

Used disinfecting chemicals should be disposed of safely, such as in a sanitary sewer.

When using quaternary ammonium compound 128, rinse the disinfected equipment at least 100 feet from any aquatic area and over organic matter where the compound will break down (e.g., trail soil, decomposing log, duff). Rinse water should be obtained from the next water body.

When using bleach, the chemical does not have to be rinsed from the equipment after disinfection if the equipment is allowed to dry between water bodies. If it does not dry, rinse the treated equipment at least 100 feet from any aquatic area over inorganic substrates (e.g., rocky trail). Rinse water should be obtained from the next water body.

NOTE: completely drying equipment prior to moving between sites is probably not effective if chytrid has a resting stage. Do not substitute the disinfection procedure with drying.

Please contact the Aquatic Ecologist (heather_mckenny@nps.gov, 209-379-1438) or Wildlife Biologist (Steve_Thompson@nps.gov, 209-379-1437) with any questions or concerns.

Sources:

Johnson, M.L., L. Berger, L. Philips, and R. Speare. 2003. Fungicidal effects of chemical disinfectants, UV light, desiccation and heat on the amphibian chytrid Batrachochytrium dendrobatidis. Diseases of Aquatic Organisms 37: 255-260.

US Fish and Wildlife Service Revised Guidance on Site Assessments and Field Surveys for the California Red-legged Frog August 2005 Appendix B. Recommended Equipment Decontamination Procedures.

Recommended by park staff(name and title): Research Permit Committee

Reviewed by Collections Manager: Yes ✓ No ___

Approved by park official: Linda C. Mazzu

Date Approved: 6-5-12

Title:

Chief, Resources Management & Science

I Agree To All Conditions And Restrictions Of this Permit As Specified
(Not valid unless signed and dated by the principal investigator)

(Principal investigator's signature) (Date)

THIS PERMIT AND ATTACHED CONDITIONS AND RESTRICTIONS MUST BE CARRIED AT ALL TIMES WHILE CONDUCTING RESEARCH ACTIVITIES IN THE DESIGNATED PARK(S)

Appendix D

Exit Survey Questions Used in Micro-Level Site Displacement Work

1. About how many <u>hiking</u> groups did you see while you were traveling on the trails during your wilderness trip? (Enter a question mark "?" if you do not remember.)

   Number of hiking groups while in the wilderness: ________
   OR
   O I did not see any hiking groups today.

2. Please indicate how crowded you felt in the following locations during this visit to the Yosemite Wilderness.

	Not at all Crowded	Slightly crowded	Moderately crowded	Very crowded	Extremely crowded
While traveling on trails	1	2	3	4	5
At destinations (such as lakes or viewpoints)	1	2	3	4	5

3. How did the **number** of groups you saw during this trip add to or detract from each of the following aspects of your experience?

	Encounters added			Encounters detracted	
	greatly	somewhat	No effect	somewhat	greatly
Your enjoyment	+2	+1	0	-1	-2
Your sense that you were in Wilderness	+2	+1	0	-1	-2
Your sense of solitude	+2	+1	0	-1	-2
Your sense of freedom	+2	+1	0	-1	-2

Appendix E

GIS Layers Used in Chapter 2

Title, data type, source, and web access address for all auxiliary GIS data layers:

Title	*Data Type*	*Source*	*Web Address*
Yosemite Park Boundary	Shapefile	NPS	https://irma.nps.gov/App/Reference/Profile/2170436
Yosemite Trails	Shapefile	NPS	https://irma.nps.gov/App/Reference/Profile/2180706
Yosemite Wilderness Trailheads	Shapefile	NPS	https://irma.nps.gov/App/Reference/Profile/2170447
10m DEM Yosemite National Park	Raster	NPS	https://irma.nps.gov/App/Reference/Profile/1047787
Yosemite Area Water bodies	Shapefile	NPS	https://irma.nps.gov/App/Reference/Profile/1047775 (National Hydrography Dataset)

Appendix F

Semi-Structured Interview Guide

Is this your first time to Yosemite National Park, or have you visited Yosemite before?

- How many times have you previously visited Yosemite?
- Why did you decide to visit Yosemite National Park?
  - For example, are you on vacation or are you visiting friends and family in the area?
- How long do you plan to stay in Yosemite?
- Have you hiked in the park before?

Is this your first time hiking on the ___________ trail, or have you hiked this trail before?

- How long was your hike today?
- Have you hiked on any other trails in the park?
- Do you have plans to hike on any other trails?

Following questions only asked if not apparent:

- Were you hiking with a group today?
  - How many hikers were in your group?
  - If you were hiking with a group, were there any children?

Tell me about why you chose to hike this trail today?

In planning for your hike today, did time play a role in determining which trail you decided to hike on today?

- If time constraints did play a role, how did they impact your decision?
- From where did they originate?
- Why was time a factor in your decision making?

When planning for your hike today, what other trails did you consider?
Why did you consider these trails?

- What features led you to decide on this trail?
- Where you looking for a certain experience?
- Where you looking to hike in a specific geographic area?

What is type of information did you use to decide to take a day hike in Yosemite?

What information about this trail led you to choose it for your hike today?

What information sources were useful?

- What park provided information sources were consulted (*spatial dimension*)?
- Which were most valuable (*operational dimension*)?
- When were they consulted (*temporal dimension*)?
- What other information sources were consulted (*spatial dimension*)?
- Which were most valuable (*operational dimension*)?
- When were they consulted (*temporal dimension*)?

Regarding your hike today, were there any other factors that led you to decide to hike on this trail?

I have one last question, the trail you were hiking on is part of the federally designated National Wilderness Preservation System. Are you familiar with federally designated wilderness?

If yes:

- What does wilderness mean to you?
- Can you describe it for me?

Appendix G

Theoretical Saturation Interview Form

Screening Questions:

_____ First Time Visitor OR _____ Repeat Visitor

_____ Vacation OR _____ Visiting Family/Friends OR _____ Local

_____ Length of Stay in Park _____ Length of Hike Today

Hiked Before? _____ YES OR _____ NO

_____ Group Size

_____ Group w/ Children _____ Group w/out Children _____ Retired _____ Solo Hiker

Constraints:

_____ Authority _____ Coupling _____ Capacity

Information Sources

_____ Park Provided? _____ Web 1.0 _____ Web 2.0 _____ Ranger _____ Newspaper

When Consulted?____

Other Park Provided? ____

Other Information Sources? ____

Selection Strategies:

_____ Factorization

_____ Programmed Response

_____ Limiting Alternatives

_____ Satisficing

_____ Selective Attention

Other Notes:

Appendix H

IRB Approved Interview Approach Script for Interviews

I used the following script when approaching day hikers to participant in an interview:

"Hello, my name is Susie Irizarry and I am a graduate student from the University of Idaho. I am here in Yosemite conducting my thesis research. Given the variety of wilderness day hiking options in the park, I am interested in learning more about how day hikers in Yosemite decide on which trail they would like to hike through having conversations with day hikers. Because you just finished a day hike, would you be interesting in speaking with me about your decision making process for selecting this trail? Our interview should only last about 15 minutes, and you will remain completely anonymous. I will take notes during the interview, and with your permission I will record our conversation so that I can accurately represent our conservation in my data. My research has been approved by the University of Idaho and Yosemite National Park. Would you be willing to participate in a recorded, fifteen-minute interview today?"

If "NO" then, *"Thank you, I hope you enjoy your visit."*

If "YES" then, *"Thank you. Let's find a comfortable spot for us to speak. If at any point during the interview you have questions or feel uncomfortable, please let me know, and I'll be happy to answer any questions about the study."*

Appendix I

IRB Letter of Exemption for Interviews

University of Idaho

Office of Research Assurances (ORA)
Institutional Review Board (IRB)
875 Perimeter Drive, MS 3010
Moscow ID 83844-3010

Phone: 208-885-6162
Fax: 208-885-5752
irb@uidaho.edu

June 12, 2013

To: Troy Hall
Cc: Susan Irizarry

From: IRB, University of Idaho Institutional Review Board

Subject: Exempt Certification for IRB project number 13-146

Determination: June 3, 2013
Certified as Exempt under category at 45 CFR 46.101(b)()
IRB project number 13-146: Understanding day hiker trail choice decision making in Yosemite National Park

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University of Idaho Institutional Review Board: IRB00000843, FWA00005639

Appendix J

Yosemite National Park Research Permit: 2013 Interview Work

SCIENTIFIC RESEARCH AND COLLECTING PERMIT

Grants permission in accordance with the attached general and special conditions

United States Department of the Interior
National Park Service

Yosemite NP

Study#: YOSE-00593
Permit#: YOSE-2013-SCI-0087
Start Date: Jun 26, 2013
Expiration Date: Dec 31, 2013
Coop Agreement#: n/a
Optional Park Code: n/a

Name of principal investigator:

Name: Troy Hall **Phone:** (208) 885-9455 **Email:** troyh@uidaho.edu

Name of institution represented:

University of Idaho

Co-Investigators:

Name: Susan Irizarry **Phone:** 7722142879 **Email:** iriz0370@vandals.uidaho.edu

Project title:

Understanding Wilderness Day Hiker Trail Choice Decision Making in Yosemite National Park

Purpose of study:

This study seeks to explore trail choice decision making of day hikers in Yosemite wilderness. Understanding how wilderness day users make their trail destination decision will be helpful in the creation of future management strategies that target day trips in crowded areas of wilderness. Knowledge of the timing of trail destination choice, the sources and information used in decision making, and the range of context dependent factors influencing visitor decisions to take day trips in wilderness will enable managers to target specific aspects of visitor decision making when designing communication campaigns, engaging in site management, and enacting management decisions. Focusing on day user decision making will not only provide Yosemite managers with knowledge that can be directly used in planning, but it will also fill gaps in the wilderness day use literature. Examining day user decision making will contribute to the decision making and information theory literature by demonstrating a new application of theory to wilderness users and through linking decision making and information theory in a single application.

Applying the concepts of bounded rationality and findings of information selection research will allow me to break down the decision making process of individual day hikers in Yosemite wilderness to understand the limiting factors/constraints that produce the simplified decision model, the selection strategies contributing to information selection, and the sources of information leading to the choice to take a day hike on a specific wilderness trail. My approach will be to work through the theoretical components in reverse. That is, I will start with the simplified decision model output of trail choice because I intend to intercept study participants at trailheads. Beginning with the knowledge of the final decision, I intend to use a semi-structured interview to guide the participant to recall the construction of his or her individual decision making model. Specifically, I will be examining the information sources influencing the decision, because it is these factors that wilderness managers have the potential to influence via their management actions and decisions. Sources of information used and factors contributing to the limited choice models will be used to classify Yosemite day hikers into typologies representing various approaches used by visitors in trail choice decision making.

The proposed study will use qualitative, semi-structured interviews to understand the range of factors influencing visitors' decision to take day trips in Yosemite wilderness and the information sources used in trail destination choice. Bounded rationality and information theory will guide development of the interview script, and content analysis performed in NVivo, a qualitative data analysis software, will be used to generate day hiker typologies based on the factors influencing the decision. Analysis will also identify key information sources used by visitors throughout the decision making process.

Subject/Discipline:

Social Science

Locations authorized:

Semi-structured interviews will be conducted at three high day use wilderness trail heads and three moderate day use wilderness trail heads in Yosemite National Park. The following is a list of proposed trails: Upper Yosemite Falls Trail, Cathedral Lake, Dog Lake, Porcupine Creek, Mono/Parker Pass, and the 4 Mile Trail.

Transportation method to research site(s):

Appendix K

Draft Codebooks for Round 1 Coding

DRAFT CODEBOOK 1 2/3/2014 - 2/8/2014
Version 1 **Attribute Codebook** Round 1, 10 Interviews

This codebook will be used to code essential information about the location of data generation, trip characteristics, and demographic or other characteristics about the participant for future management and reference.

Code	Sub-Code/Label	Working Definition
The wilderness day use classification category (Use)	High Use Trail	This code should be applied to the following three interview locations: Upper Yosemite Falls, Lyell Canyon, Lembert Dome (Dog Lake)
	Moderate Use Trail	This code should be applied to the following three interview locations: Four Mile Trail, Mono Pass, Porcupine Creek
Individual's level of familiarity with the park and/or trail (Familiarity)	First Time Visitor	This code should be applied to all participants that are visiting Yosemite for the first time
	Repeat Visitor	This code should be applied to all participants that have visited Yosemite previously, but have not previously hiked the trail on which they were interviewed Repeat visitor to park, first time to trail
	Repeat Trail	This code should be applied to all participants that have visited Yosemite previously, and that have previously hiked the trail on which they were interviewed Repeat visitor to park, repeat hiker on trail
The purpose of the individual's trip to Yosemite (Purpose)	Vacation	This code should be applied to all participants that are visiting Yosemite as part of a vacation; this can be explicitly or implicitly stated
	Visiting	This code should be applied to all participants that are visiting Yosemite as part of a larger visit with friends and family in the park or surrounding area This can include visiting friends and family in the surrounding communities of El Portal, Mariposa, Oakhurst, Mono Lake, Lee Vining, Mammoth Lakes, or San Francisco Any participant that indicates the primary reason for being in Yosemite is due to family
	Local	This code should be applied to all participants that live in Yosemite National Park permanently or as seasonal employees This code should also be applied to those participants that refer to themselves as locals, or indicate that they live in one of Yosemite's gateway communities (Mariposa, Oakhurst, El Portal, Lee Vining, Mono Lake, Mammoth Lakes, June Lake)
Trip Length (Length)	In Park	This code should be applied to data bits related to the amount of time the participant has stayed, or intends to stay in Yosemite National Park
	Day Hike	This code should be applied to data bits related to the amount of time spent hiking or the distance traveled while hiking

Group Size (Size)	Hiking Size	This code should be applied to any data bits regarding the size of the hiking group
	Travel Size	This code should be applied to any data bits regarding the size of the overall travel party present in Yosemite
Group Composition (Composition)	Children	This code should be applied to interviews from groups that were hiking with children A child was considered any individual under the age of 18 (teenagers were considered children, adult children were considered as adults)
	Adult	This code should be applied to interview from groups of more than one individual, that did not contain children, and did not contain a majority of elderly members
	Retired	This code should be applied to interviews from groups containing a majority of elderly members This includes hiking parties containing only one elderly member (they will be double coded as retired and as solo)
	Solo	This code should be applied to interviews from participants that were hiking alone regardless of age This does not include interviews in which only one person participated, or in which the rest of the hiking group was present for the majority of the hike
Number of other hikes (Number)	Number	This code should be applied to data bits that refer to other hikes that the participant has already done on this trip This can include hikes that have been completed, or hikes that the participant plans to do This hikes can be within Yosemite or in the surrounding area (Mammoth Lakes, Saddlebag Lake, Mono Lake)

Provisional (A Priori, Theory-Based) Codebook 1

This codebook was developed from the theoretical framework and supporting literature included in my thesis proposal. This codebook should be used for the first pass through of the data. The codes here will be used to identify relatively simple theoretical constructs.

Theoretical Construct	Code/Label	Working Definition/Example
Constraints	Authority	A factor, imposed by laws or institutions, that impacts the participant's trail choice decision making process Ex. A hiker wanted to hike on the Half Dome Trail, but they could not get a Half Dome permit
	ability? Coupling	A factor, imposed by outside individuals such as friends and family, that impacts the participant's trail choice decision making process Ex. My wife is afraid of heights, so we never hike on any trails with steep cliffs
not just for the trail	Time	This code should be used to code data bits that refer to the impact of time on the participant's trail choice decision making process Ex. We were looking for a trail that would take us about 3 hours, because we wanted to get back to the hotel to have a swim
content all info Factual Premise *	Trail Information	This code should be used to code data bits that refer to descriptive attributes of the trail Ex. In describing the trail, the participant mentions that they read the trail was challenging and had great views. "The trail was challenging" and "had great views" would both be coded as trail information
consider info source as well	Park Online	This code should be used to code data bits related to park online information sources Ex. "I did not use the park's online resources" or "I did not find the website to be helpful"
	Park Print	This code should be used to code data bits related to NPS provided print information sources such as the Yosemite Guide newspaper, hiking pamphlets, or the official park brochure Ex. "We used the time estimates for hiking in the newspaper"
type of use	Park Person	This code should be used to code data bits related to getting information from a park ranger or a Visitor Center volunteer, including visitor centers in Mammoth Lakes and Mono Lake Ex. "We talked to a ranger at the Tuolumne Visitor Center and they recommended Soda Springs"
Source	Other Online	This code should be used to code data bits related to any online resources, other than the park website, used to get hiking information Ex. "My wife looked at Trip Advisor to get reviews of the hikes"
every time you code a source	Other Print	This code should be used to code data bits related to any print sources used to get information about hiking Ex. "We looked at the Lonely Planet guide, but did not find it very helpful"
look at dimension	Other Person	This code should be used to code data bits related to getting hiking information from another person that is not affiliated with the park Ex. "We spoke to other German tourists in San Francisco, and they told us the Four Mile Trail was a good, challenging trail"
	Past Experience	This code should be used to code data bits referring to the use of past experience in Yosemite or on the trail that provided information Ex. "I have been hiking to this fishing spot for the past 50 years. I just always go to the same place." – implicit statements #37
* Operational Dimension	Utility	This code should be used to code data bits referring to the utility (or not) of any information sources considered – be sure to apply the code to the entire phrase including the information source and the utility
* Temporal Dimension	Consulted	This code should be used to code data bits referring to when the information source was considered – be sure to apply the code to the entire phrase including the info source used

*consider also whether should be selection

Provisional (A Priori, Theory-Based) Codebook 2

This codebook was developed from the theoretical framework and supporting literature included in my thesis proposal. This codebook should be used for the second pass through of the data. The codes here will be used to identify more complex theoretical constructs in the data.

Theoretical Construct	Code/Label	Definition	Context/Example
Selection Strategy	Factorization Specialization (Factors)	The decision is broken down into individual, smaller decisions that can be made independently; once individual decisions are made, the larger decision can be made much more easily	In this study: the participant breaks down the overall trail choice decision into a few, smaller decisions Ex. The hiker makes a decision that the want to hike about 10 miles, they want to be in Tuolumne meadows, and they want to see wildflowers, so they consider and select a trail that fits those criteria
	Programmed Response (Programmed)	A response to a stimulus that is stored and used repeatedly when faced with similar decisions	In this study: the hiker chooses a trail due to familiarity with the trail Ex. The hiker is in Yosemite and wants to go fishing, the hiker returns to the same fishing spot that he/she has gone to for the past 20 years
	Limiting Alternatives (Limiting)	Only the first few alternatives that come to mind are considered when presented with a decision	In this study: the hiker only considers the first few hikes that come to mind, and makes a decision among these trails Ex. The hiker knows of a few trails in Yosemite Valley, the hiker chooses Yosemite falls because it is the only trail name he can remember Ex. The hiker is in Yosemite Valley and chooses the first hiking trail he sees, the Four Mile Trail
	Satisficing (Satisficing)	The individual purposefully limits the number of alternatives considered for making a decision; the selection made is the best alternative among a group of limited alternatives	In this study: the hiker selects a trail from among a group of purposefully limited trails Ex. The hiker wants to hike ~~walk~~ to a trail from the Tuolumne Meadows campground because ~~they are~~ are is staying in the campground – the hiker only considers trails in the area and selects the best one from among the limited set of trails in the geographic area
	Selective Attention (Selective)	The individual focuses exclusively on information that is relevant or familiar - how many factors for selective attention?	In this study: the hiker selects a trail because he/she is fixated on one aspect of the trail Ex. The hiker selects the Porcupine Creek trail because they wanted to see a close-up view of Half Dome, and that trail is the only trail providing such a view
Sequence	1, 2, 3 …	The individual engages in multiple stages of decision making, using a combination of selection strategies	After coding data bits with a selection strategy in a given interview, review the process used in selecting the trail. If a sequence of selection strategies is evident, code the data bits sequentially using the codes 1, 2, 3… to indicate the sequence of the decision making

Appendix L

Draft Codebooks for Round 2 Coding

DRAFT CODEBOOK 1 Version 2

Attribute Codebook

This codebook will be used to code essential information about the location of data generation, trip characteristics, and demographic or other characteristics about the participant for future management and reference. These codes should be applied with a blue highlighter.

Code	Sub-Code/Label	Working Definition
The wilderness day use classification category (Use)	High Use Trail	This code should be applied to the following three interview locations: Upper Yosemite Falls, Lyell Canyon, Lembert Dome (Dog Lake)
	Moderate Use Trail	This code should be applied to the following three interview locations: Four Mile Trail, Mono Pass, Porcupine Creek
Individual's level of familiarity with the park and/or trail (Familiarity)	First Time Visitor	This code should be applied to all questions and data bits that indicate that the participant(s) is visiting Yosemite for the first time First time visitor to park and trail
	Repeat Visitor	This code should be applied to all questions and data bits that indicate that the participant(s) has visited Yosemite previously, but has not previously hiked the trail on which he/she was interviewed Repeat visitor to park, first time to trail
	Repeat Trail	This code should be applied to all questions and data bits that indicate that the participant(s) has visited Yosemite previously, and has previously hiked the trail on which he/she was interviewed Repeat visitor to park, repeat hiker on trail
The purpose of the individual's trip to Yosemite (Purpose)	Why did you choose Yose? Vacation - code "where are you staying in park?" during trip purpose	This code should be applied to all questions and data bits that indicate that the participant(s) is visiting Yosemite as part of a vacation; this can be explicitly or implicitly stated Example Explicit: "We are in Yosemite as part of a three week vacation in the western United States." Example Implicit: "We are from the Netherlands visiting."
	Visiting	This code should be applied to all questions and data bits that indicate that the participant(s) is visiting Yosemite as part of a larger visit with friends and family in the park or surrounding area This can include visiting friends and family in the surrounding communities of El Portal, Mariposa, Oakhurst, Mono Lake, Lee Vining, Mammoth Lakes, or San Francisco This code is not mutually exclusive with the "vacation" code. If the participant explicitly states that they are both on vacation and visiting family, then both codes can be applied to the data bit. It is important to capture both the family aspect of the trip and the vacation aspect of the trip. Ex. "We are here for a family reunion. Four different families decided to travel here for a trip to Yosemite."

Purpose (continued)	Local	This code should be applied to all questions and data bits that indicate that the participant(s) lives in Yosemite National Park permanently or as seasonal employees This code should also be applied to all questions and data bits that indicate that the participant(s) considers themselves to be a local, or indicates that he/she lives in one of Yosemite's gateway communities (Mariposa, Oakhurst, El Portal, Lee Vining, Mono Lake, Mammoth Lakes, June Lake)
Trip Length (Length)	In Park	This code should be applied to any questions or data bits related to the amount of time the participant has stayed, or intends to stay in Yosemite National Park
	Day Hike	This code should be applied to any questions or data bits related to the amount of time spent hiking or the distance traveled while hiking The distance can be an exact distance, or a relative distance. Ex. "We hike 3 miles today." (Exact Distance) Ex. "We hiked to the lake, and then we hung out for a bit, and then we headed back down the trail." (Relative Distance)
Group Size (Size)	Hiking Size	This code should be applied to any questions or data bits regarding the size of the hiking group
	Travel Size	This code should be applied to any questions or data bits regarding the size of the overall travel party present in Yosemite
Group Composition (Composition)	Children	This code should be applied to interviews from groups that were hiking with children A child was considered any individual under the age of 18 (teenagers were considered children, adult children were considered as adults)
	Adult	This code should be applied to interviews from groups of more than one individual, that did not contain children, and did not contain a majority of elderly members
	Retired	This code should be applied to interviews from groups containing a majority of elderly members This includes hiking parties containing only one elderly member (they will be double coded as retired and as solo)
	Solo	This code should be applied to interviews from participants that were hiking alone regardless of age This does not include interviews in which only one person participated, or in which the rest of the hiking group was present for the majority of the hike
Number of other hikes (Number)	Number	This code should be applied to data bits that refer to other hikes that the participant has already done or plans to do on this trip The hikes do not have to take place in Yosemite National Park. Hikes can be within Yosemite or the surrounding area (Mammoth Lakes, Saddlebag Lake, Mono Lake) Hikes do not have to be in wilderness, they can be walks in non-wilderness areas or in other parks Ex. "Yesterday, we walked around Mirror Lake and did the lower Yosemite Falls loop."

DRAFT CODEBOOK 2 Version 2

Provisional (A Priori, Theory-Based) Codebook

This codebook was developed from the theoretical framework and supporting literature included in my thesis proposal. This codebook should be used during the first cycle of coding to identify relatively simple theoretical constructs.

Theoretical Construct	Code/Label	Working Definition/Example
Constraints physical capacity - own	Authority	A factor, imposed by laws or institutions, that impacts the participant's trail choice decision making process Ex. A hiker wanted to hike on the Half Dome Trail, but they could not get a Half Dome permit
	Coupling	A factor, that stems from restrictions faced by household members, friends, or colleagues that impacts the participant's trail choice decision making process The factor is something that is considered in the discussion of trail decision making, even if it did not impact the specific trail choice today. If the participant brings up another individual's limitations in this context, apply the code. Ex. My wife is afraid of heights, so we never hike on any trails with steep cliffs
	Time	This code should be applied to all questions and data bits that refer to the impact of time on the participant's trail choice decision making process Ex. We were looking for a trail that would take us about 3 hours, because we wanted to get back to the hotel to have a swim
Factual Premise **ORANGE**	Trail Information	This code should be used to code data bits that refer to descriptive attributes of any trail that was considered in the trail choice decision making Ex. In describing the trail, the participant mentions that they read the trail was challenging and had great views. "The trail was challenging" and "had great views" would both be coded as trail information *When applying this code, also consider applying a source code or selection strategy code to the larger block of text. In most cases, factual premises codes will be within larger text blocks.*
Source **PINK** *When coding for source, consider coding for dimension*	Past Experience	This code should be used to code all questions and data bits referencing the use of a past experience in Yosemite or on the trail that provided information The reference to past experience can be explicit or implicit in the dat. Example Explicit: "I have been hiking to this fishing spot for the past 50 years. I just always go to the same place." In this statement, the participant is directly stating a familiarity with the trail, and the intent to come back to the same place as he always has. Example Implicit: "We wanted to go catch 40 brook trout with nobody around." This statement indicates that the participant has some previous experience that created this expectation of an experience on the trail
	Park Online	This code should be used to code all questions or data bits related to park online information sources regardless of whether they were used for hiking or accommodations Ex. "I did not use the park's online resources" or "I did not find the website to be helpful"

Source (cont.) **PINK** *When coding for source, consider coding for dimension*	Park Print	This code should be applied to all questions and data bits related to NPS provided print information sources such as the Yosemite Guide newspaper, hiking pamphlets, or the official park brochure Ex. "We used the time estimates for hiking in the newspaper"
	Park Person	This code should be applied to all questions and data bits related to getting information from a park ranger or a Visitor Center volunteer, including visitor centers in Mammoth Lakes and Mono Lake Ex. "We talked to a ranger at the Tuolumne Visitor Center and they recommended Soda Springs" Ex. "They (referring to person at visitor center) said we would be able to hike to a lake from this trail."
	Other Online	This code should be applied to all questions and data bits related to the use of any online resources, other than the park website, for hiking information Ex. "My wife looked at Trip Advisor to get reviews of the hikes"
	Other Print	This code should be applied to all questions and data bits related to any print sources used to get information about hiking Ex. "We looked at the Lonely Planet guide"
	Other Person	This code should be applied to all questions and data bits related to getting hiking information from an individual that is not affiliated with the NPS Ex. "We talked to some other German tourists in San Francisco, and they recommended this as a challenging trail."
hold off Operational Dimension **GREEN**	Utility sub code	This code should be applied to all questions or data bits referring to the utility (or not) of any information sources considered – be sure to apply the code to the entire phrase including the information source and the utility
Temporal Dimension **GREEN**	source Consulted	This code should be applied to all questions or data bits referring to when the information source was considered – be sure to apply the code to the entire phrase including the info source used
Selection Strategy **PURPLE** *When coding for selection strategy, also consider factual premise and source*	Decision	This code should be applied to all questions and data bits referring to how or why the participant made the decision to hike on the trail Ex. (Susie) "Why did you decided to hike the Glacier Point today?" (Participant) "It was the one that fitted our schedule. We wanted the one that wasn't too long because we're going to San Francisco in the afternoon." This code should also be applied to all questions and data bits referring to why the participant did not choose to hike on a different trail, or why other trails weren't considered Ex. (Susie) " You mentioned that when you were at the Mammoth Lakes Visitor's Center, the woman was telling you about some other hikes. Why did you choose those hikes?" (Participant) "They seemed boring. It seemed like it was only just through the forest. They were also shorter." Be as inclusive as possible when applying this code to a section of text. Include follow up questions, and even whole paragraphs in order to provide the full picture of the participant's explanation.

Appendix M

Final Codebooks

Attribute Codebook

This codebook will be used to code essential information about the location of data generation, trip characteristics, and demographic or other characteristics about the participant for future management and reference. These codes should be applied with a blue highlighter.

Code	Sub-Code/Label	Working Definition
The wilderness day use classification category (Use)	High Use Trail	This code should be applied to the following three interview locations: Upper Yosemite Falls, Lyell Canyon, Lembert Dome (Dog Lake)
	Moderate Use Trail	This code should be applied to the following three interview locations: Four Mile Trail, Mono Pass, Porcupine Creek
Individual's level of familiarity with the park and/or trail (Familiarity)	First Time Visitor	This code should be applied to all questions and data bits that indicate that the participant(s) is visiting Yosemite for the first time First time visitor to park and trail
	Repeat Visitor	This code should be applied to all questions and data bits that indicate that the participant(s) has visited Yosemite previously, but has not previously hiked the trail on which he/she was interviewed Repeat visitor to park, first time to trail
	Repeat Trail	This code should be applied to all questions and data bits that indicate that the participant(s) has visited Yosemite previously, and has previously hiked the trail on which he/she was interviewed Repeat visitor to park, repeat hiker on trail
The purpose of the individual's trip to Yosemite (Purpose)	Vacation	This code should be applied to all questions and data bits that indicate that the participant(s) is visiting Yosemite as part of a vacation; this can be explicitly or implicitly stated Example Explicit: "We are in Yosemite as part of a three week vacation in the western United States." Example Implicit: "We are from the Netherlands visiting." The following questions were asked to help add context to the participant's trip purpose: *Why did you choose to visit Yosemite? Where are you staying in the park?* Code these questions and answers according to the information they reveal (or don't) about a participant's trip purpose.
	Visiting	This code should be applied to all questions and data bits that indicate that the participant(s) is visiting Yosemite as part of a larger visit with friends and family in the park or surrounding area This can include visiting friends and family in the surrounding communities of El Portal, Mariposa, Oakhurst, Mono Lake, Lee Vining, Mammoth Lakes, or San Francisco

		This code is not mutually exclusive with the "vacation" code. If the participant explicitly states that they are both on vacation and visiting family, then both codes can be applied to the data bit. It is important to capture both the family aspect of the trip and the vacation aspect of the trip. Ex. "We are here for a family reunion. Four different families decided to travel here for a trip to Yosemite."
Purpose (continued)	Local	This code should be applied to all questions and data bits that indicate that the participant(s) lives in Yosemite National Park permanently or as seasonal employees This code should also be applied to all questions and data bits that indicate that the participant(s) considers themselves to be a local, or indicates that he/she lives in one of Yosemite's gateway communities (Mariposa, Oakhurst, El Portal, Lee Vining, Mono Lake, Mammoth Lakes, June Lake)
Where are they from?	Origin	This code should be applied to all questions and data bits that indicate where the participant is from. This can be the location of their permanent residence, or a country.
Trip Length (Length)	In Park	This code should be applied to any questions or data bits related to the amount of time the participant has stayed, or intends to stay in Yosemite National Park
	Day Hike	This code should be applied to any questions or data bits related to the amount of time spent hiking or the distance traveled while hiking The distance can be an exact distance, or a relative distance. Ex. "We hike 3 miles today." (Exact Distance) Ex. "We hiked to the lake, and then we hung out for a bit, and then we headed back down the trail." (Relative Distance)
Group Size (Size)	Hiking Size	This code should be applied to any questions or data bits regarding the size of the hiking group
	Travel Size	This code should be applied to any questions or data bits regarding the size of the overall travel party present in Yosemite
Group Composition (Composition)	Children	This code should be applied to interviews from groups that were hiking with children A child was considered any individual under the age of 18 (teenagers were considered children, adult children were considered as adults)
	Adult	This code should be applied to interviews from groups of more than one individual, that did not contain children, and did not contain a majority of elderly members
Group Composition	Retired	This code should be applied to interviews from groups containing a majority of elderly members

(Continued)		This includes hiking parties containing only one elderly member (they will be double coded as retired and as solo)
	Solo	This code should be applied to interviews from participants that were hiking alone regardless of age This does not include interviews in which only one person participated, or in which the rest of the hiking group was present for the majority of the hike
Number of other hikes (Number)	Number	This code should be applied to data bits that refer to other hikes that the participant has already done or plans to do on this trip The hikes do not have to take place in Yosemite National Park. Hikes can be within Yosemite or the surrounding area (Mammoth Lakes, Saddlebag Lake, Mono Lake) Hikes do not have to be in wilderness, they can be walks in non-wilderness areas or in other parks Ex. “Yesterday, we walked around Mirror Lake and did the lower Yosemite Falls loop.”

Provisional (A Priori, Theory-Based) Codebook

This codebook was developed from the theoretical framework and supporting literature included in my thesis proposal. This codebook should be used during the first cycle of coding to identify relatively simple theoretical constructs. Colors under theoretical construct refer to the corresponding highlighter for coding.

Theoretical Construct	Code/Label	Working Definition/Example
Constraints **YELLOW**	Authority	A factor, imposed by laws or institutions (park, private companies, etc.), that impacts the participant's trail choice decision making process Ex. A hiker wanted to hike on the Half Dome Trail, but they could not get a Half Dome permit Ex. "We've got a wee camper van, and we weren't sure if we could take the camper van… because we don't have insurance for like… forest tracks."
	Coupling	A factor, that stems from restrictions faced by household members, friends, or colleagues that impacts the participant's trail choice decision making process The factor is something that is considered in the discussion of trail decision making, even if it did not impact the specific trail choice today. If the participant brings up another individual's limitations in this context, apply the code. Ex. My wife is afraid of heights, so we never hike on any trails with steep cliffs
	Time	This code should be applied to all questions and data bits that refer to the impact of time on the participant's trail choice decision making process Ex. We were looking for a trail that would take us about 3 hours, because we wanted to get back to the hotel to have a swim
	Physical Ability	This code should be applied to all data bits in which the participant refers to a personal physical ability as a component in trail choice decision making. The reference can be a direct reference to the consideration of the participant's own physical ability, or it can refer to safety/other physical concerns that were important in decision making. Ex. "I selected this trail because it was flat. I thought it was one I could do." Ex. "We thought if we went for medium, then we should be safe instead of trying something too hard. We don't hike really."

Factual Premise **ORANGE**	Trail Information	This code should be used to code data bits that refer to descriptive attributes of any trail that was considered in the trail choice decision making. This code can also be applied to specific features of interest that the participant wanted to see. Ex. “We read about hiking to Columbia Rock, and wanted to go there.” Columbia rock would be coded because it is a specific location of interest accessed via the trail. Ex. In describing the trail, the participant mentions that they read the trail was challenging and had great views. “The trail was challenging” and “had great views” would both be coded as trail information Ex. “This trail was supposed to provide an overview. It seemed like a good, first hike in the park.” The phrases, “provide an overview” and “a good, first hike in the park” would be coded because they are descriptive statements that refer to the trail overall. *When applying this code, also consider applying a source code or selection strategy code to the larger block of text. In most cases, factual premises codes will be within larger text blocks.*
Source **PINK**	Past Experience	This code should be used to code all questions and data bits referencing the use of a past experience in Yosemite or on the trail that provided information The reference to past experience can be explicit or implicit in the dat. Example Explicit: “I have been hiking to this fishing spot for the past 50 years. I just always go to the same place.” In this statement, the participant is directly stating a familiarity with the trail, and the intent to come back to the same place as he always has. Example Implicit: “We wanted to go catch 40 brook trout with nobody around.” This statement indicates that the participant has some previous experience that created this expectation of an experience on the trail
	Park Online	This code should be used to code all questions or data bits related to park online information sources regardless of whether they were used for hiking or accommodations Ex. “I did not use the park’s online resources” or “I did not find the website to be helpful”
	Park Print	This code should be applied to all questions and data bits related to NPS provided print information sources such as the Yosemite Guide newspaper, hiking pamphlets, or the official park brochure Ex. “We used the time estimates for hiking in the newspaper”
	Park Person	This code should be applied to all questions and data bits related to getting information from a park ranger or a Visitor Center volunteer, including visitor centers in Mammoth Lakes and Mono Lake

		Ex. "We talked to a ranger at the Tuolumne Visitor Center and they recommended Soda Springs" Ex. "They (referring to person at visitor center) said we would be able to hike to a lake from this trail."
Source (cont.) **PINK**	Other Online	This code should be applied to all questions and data bits related to the use of any online resources, other than the park website, for hiking information Ex. "My wife looked at Trip Advisor to get reviews of the hikes"
	Other Print	This code should be applied to all questions and data bits related to any print sources used to get information about hiking Ex. "We looked at the Lonely Planet guide"
	Other Person	This code should be applied to all questions and data bits related to getting hiking information from an individual that is not affiliated with the NPS Ex. "We talked to some other German tourists in San Francisco, and they recommended this as a challenging trail."
Selection Strategy **PURPLE** *When coding for selection strategy, also consider factual premise and source*	Decision	This code should be applied to all questions and data bits referring to how or why the participant made the decision to hike on the trail Ex. (Susie) "Why did you decided to hike the Glacier Point today?" (Participant) "It was the one that fitted our schedule. We wanted the one that wasn't too long because we're going to San Francisco in the afternoon." This code should also be applied to all questions and data bits referring to why the participant did not choose to hike on a different trail, or why other trails weren't considered Ex. (Susie) "You mentioned that when you were at the Mammoth Lakes Visitor's Center, the woman was telling you about some other hikes. Why did you choose those hikes?" (Participant) "They seemed boring. It seemed like it was only just through the forest. They were also shorter." *Be as inclusive as possible when applying this code to a section of text. Include follow up questions, and even whole paragraphs in order to provide the full picture of the participant's explanation.*