The 2004 Mount Rainier Climber Study: Selecting Indicators of Climber Experience Quality for the High Use and Moderate Use Climbing Zones

Mark Husbands

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This is to certify that I have examined this copy of a master's thesis by

Mark Husbands

and have found that it is complete and satisfactory in all respects,
and that any and all revisions required by the final
examining committee have been made.

Committee Members:

_____
Gordon Bradley

_____
Darryll Johnson

_____
Mark Vande Kamp

Date:_____

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Chapter 1. Introduction

A half century ago, "excessive use" on Mount Rainier might have struck climbers as an unwarranted concern. Climbing to Mount Rainier's upper slopes was difficult, dangerous, and required uncommon skills. More often than not, groups of mountaineers attempting Rainier's summit would have had the mountain to themselves—for better or for worse.

Today climber numbers are a central concern for climbers planning an ascent and for park managers planning for the future of climbing activity on Mount Rainier. Between 1950 and 2000, climbing attempts grew from 238 documented summit bids to a peak of 13,114, fifty times the half century figure (Figure 1). As the number of climbers has increased, particularly on the most popular summit routes, concern has been raised about how these numbers have changed the experience of climbing Mount Rainier, the extent to which this change is acceptable, and the steps the National Park Service can and should take to manage for high quality climbing experiences.

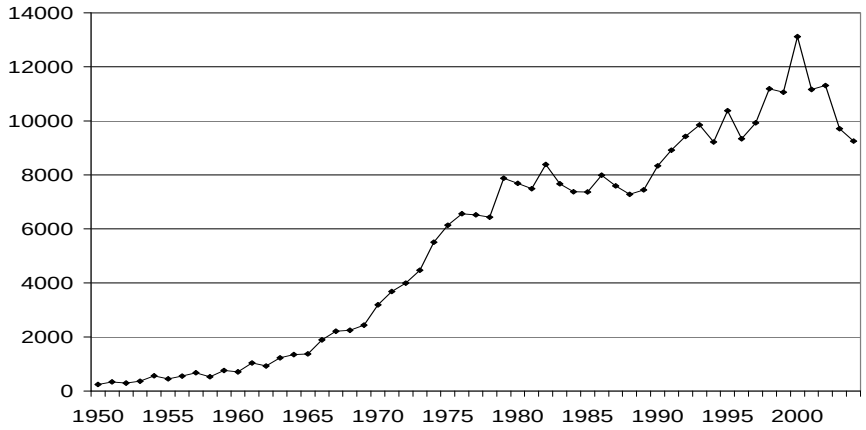

Figure 1. Summit Attempts 1950-2004
(http.//www.nps.gov/mora/climb/cl_stats.htm)

The relationship between the quantity of visits and quality of visits is a well-explored theme in studies of outdoor recreation. The most important and lasting conceptual framework for understanding this relationship is "visitor carrying capacity". This study adopts a particular visitor carrying capacity framework employed by the National Park Service: the Visitor Experience and Resource Protection framework, or VERP (USDI 1993). NPS defines *VERP* as:

> …a planning and management framework that focuses on visitor use impacts on the visitor experience and the park resources. These impacts are primarily attributable to visitor behavior, use levels, types of use, timing of use, and location of use (USDI 1997, VERP Handbook).

VERP is the preferred carrying capacity framework for units of the National Park System, but it is not the only carrying capacity framework currently in use by land management agencies. The Limits of Acceptable Change (LAC) framework, in use in many US Forest Service Wilderness areas and in some NPS administered areas, was developed first and remains the most prominent example (Stankey et al. 1985). VERP shares several important characteristics with LAC and other contemporary carrying capacity frameworks, including the use of ***indicators*** to monitor impacts to social and resource conditions (Cole & Stankey 1997, Hof & Lime 1997, Nilsen & Tayler 1997). In VERP, ***carrying capacity*** is defined as:

> ...the type and level of visitor use that can be accommodated while sustaining acceptable resource and social conditions that complement the purpose of a park (USDI 1997, VERP Handbook).

Following the guidelines established in the VERP framework, this study seeks to identify important ways in which the experiences of climbers on the three most popular climbing routes are impacted by the number or behavior of other climbers. The goal is to identify quantitatively those conditions reported by climbing visitors that detract from climber experience quality and are correlated with visitor use. When this statistical correlation coincides with a logical cause-effect relationship, it can be reasoned that visitor use—type, timing, amount, or behavior—is causing an experience impact. Such an experience impact could prove to be a useful ***indicator*** of climbing experience quality. The NPS defines an ***indicator*** as:

> …specific, measurable physical, ecological, or social variables that reflect the overall condition of a zone. Resource indicators measure visitor impacts on the biological, physical, and/or cultural resources of a park; social indicators measure visitor impacts on the visitor experience (USDI 1997, VERP Handbook).

As this definition indicates, social variables are only one means to measure the impact of visitor use. Ecological variables, such as measures of vegetation impact or water quality, are commonly used to monitor the impact of recreational use, often in concert with social variables, so that a complete picture of resource conditions is acquired through monitoring.

In some wilderness environments, depending on management goals, ecological standards may be constraining, meaning that goals for ecological conditions are the primary drivers of capacity decisions by managers. Mount Rainier climbing zones present a unique circumstance because the majority of visitor use takes place on durable surfaces—snow or ice—and ecological impacts are therefore limited.

The two primary ecological concerns are destruction of alpine vegetation (Edwards 1980, Rochefort 2000) from camping and hiking off of snow surfaces below 10,000 feet, and the improper disposal of human waste, a multi-faceted problem that affects water quality, human health (Ells 1997), and the aesthetic quality of visitor experiences (Swearingen & Johnson 1985). The management approach has been to ban camping off snow and to require the use of "blue bags[1]" or latrines—a strong response by managers to a natural resource impact, and one that could largely eliminate these problems if high compliance was achieved.

By comparison, social problems related to climbing use are not well-understood and lack an obvious and direct solution. This study proposes that such understanding is needed to make well-informed capacity decisions for the Mount Rainier climbing zones. However, it does not argue that social conditions should have a higher priority as a management goal than natural conditions. Rather, it suggests that social conditions may ultimately be a more important determinant of carrying capacity in this environment.

Objective

The objective of this study is to identify social variables that are related to visitor use and represent aspects of the climbing experience that are important to current climbers. These variables will be proposed to park managers as indicators for the Visitor Experience and Resource Protection Planning framework for two climbing management zones on Mount Rainier National Park.

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[1] In this program climbers are provided bags to contain feces. Barrels are provided at some camp locations for climbers to deposit their bags. This program supplements the latrines that are available at some camp locations, such as Camp Muir.

Organization of this document

Chapter 2 provides background on the planning context of this study and the current use and management of climbing at Mount Rainier National Park. Chapter 3 discusses the concept of carrying capacity, which is the theoretical framework used in this study. A variety of past studies have employed this framework, primarily for use in developing indicators for traditional wilderness areas. The state of knowledge generated by these studies, and a brief discussion of two climbing studies conducted at Mount Rainier, are covered in Chapter 4. In Chapter 5 the direction taken in this study is explained; namely, a shift in emphasis from solitude and crowding-based indicators towards indicators based on congestion and hazardous behavior, which are believed to be more relevant to the climbing zones. Chapter 6 describes the methods employed in this study, which used an online survey questionnaire to gather information about climbers' experiences and observations on three Mount Rainier climbing routes. Chapter 7 presents the findings obtained from this questionnaire. Suggestions for monitoring approaches and future data collection are also included. Chapter 8 discusses some of the problems encountered in this study, and the impact these problems had on the analysis and interpretation of study results. Chapter 9 provides a discussion of these results and presents specific recommendations for selecting indicators for the three climbing routes. The statistical analysis of one of the primary limitations of this study—potential nonresponse bias—is covered in Appendix A. Appendix B presents an abbreviated version of the survey questionnaire used in this study. Appendix C provides more detailed information about the desirable qualities of variables used as VERP indicators.

Chapter 2. Background

2.1. Mount Rainier National Park General Management Plan

In 2001, Mount Rainier National Park published a new General Management Plan, replacing the Mount Rainer National Park Master Plan, a twenty-seven year-old document. Among the reasons cited for replacing the 1974 plan was the great increase in use of some park areas which was not anticipated or addressed in the old document (USDI 2001 p.3).

Establishing visitor carrying capacities using the VERP framework is therefore one of the central elements of the new plan, which includes the initial steps of the VERP process (USDI 2001 p.23). Among these steps are a statement of Mount Rainier National Park's purpose and significance, definitions of current resource conditions and visitation patterns, delineation of prescriptive management zones, and statements of desired future conditions for those zones (see next Chapter).

A VERP implementation plan that will follow the GMP will complete the VERP process by developing measurable indicators for significant park resources and experiences, and establishing minimum acceptable standards for those indicators. Monitoring methods and potential management responses to out-of-standard conditions will also be included.

In VERP, original research is one of several sources of information used to select social and resource indicators. This study supports the process of selecting social indicators for two prescriptive management zones—the High Use and Moderate Use climbing zones—that contain the Disappointment Cleaver, Emmons Glacier, and Kautz Glacier routes.

2.2. Desired Condition Statements for Climbing Zones

Preparing desired condition statements is a critical element of the VERP process and a starting point for indicator development. In writing desired future conditions, planners begin to prescribe, rather than describe, conditions for park areas. These statements about the future of specific zones act as management objectives for those zones, and shape the selection of indicators, the setting of standards, and choices about future management actions in those zones.

The 2001 GMP includes descriptions of desired future conditions for all park zones, including the High Use Climbing Zone and Moderate Use Climbing Zones (from 2001 GMP, Appendix C). The descriptions of visitor experiences in those zones are as follows:

> Moderate Use Climbing Zone
>
> Main activity in this zone would be mountaineering, but there could be day hikers, and commercial guide services might be permitted; visitors could sense a high degree of adventure and exploration while encountering a moderate number of other visitors; many opportunities for solitude, but also potential for much social interaction; high amounts of self-reliance and outdoor skills needed because of inherent dangers in terrain and climate; most travel would be cross-country but could be some way trails or routes, and some routes would have no commercial use; limits on public and commercial day and overnight use and party size; permits needed for wilderness camping and climbing; camping primarily dispersed but possibly designated trailside camps and a few designated campsites to protect sensitive alpine environment;

adherence to Leave No Trace standards required except in areas with designated campsites; no onsite interpretation or signs, but offsite interpretation and education available.

High Use Climbing Zone

Same as moderate use climbing zone except that more people would be encountered; few opportunities for solitude, and potential for a high degree of social interaction.

These desired condition statements provide limited direction for the investigation of experience indicators. I can conclude in these zones that 1) climbing is the principal activity, 2) mountaineering values such as challenge, adventure, self-reliance, and skill are important, and 3) contact with other climbers is probable, especially in the high use zone (i.e., the Disappointment Cleaver). The third conclusion is important, because, as will be discussed in Chapter 4, preference for low numbers of encounters has been a point of departure for indicator development in many "conventional" wilderness environments where providing solitude is a primary management objective. If, as the desired condition descriptions suggest for the climbing zones, providing solitude is not a primary management objective, then new points of departure for indicator development must be sought. These may be based on the activity of climbing and the values of challenge, skill, self-reliance, or adventure.

2.3. Current Climbing Use and Management

By today's standards climbing use remained limited in numbers until the early seventies, when the number of summit attempts rose to over 7,000 persons. This number has continued to rise steadily to the recent past, reaching a zenith in 2000

(13,114 registered climbers). During the season in which this study was undertaken, that number had dropped to 9,251 registered attempts. This drop has coincided with a decrease in overall visitation to the National Park System (http://www.nps.gov/pub_aff/refdesk/10MVUNP.pdf). Despite this short term drop in climbing numbers, it is anticipated that demand for access to climbing areas and other park areas will continue to increase in the future. Even if demand does not increase, managers have a responsibility to assess whether current use is consistent with desired conditions.

Climbing use is spatially and temporally concentrated on Mount Rainier (Figure 2). Park records from 2004 show that out of the 17 regularly attempted routes (and 39 routes documented with more than a single ascent) on Mount Rainier (Gauthier 1999), approximately 5400 climbers (58%) registered to climb the Disappointment Cleaver route, 1700 (18%) registered for the Emmons Glacier route, and 450[2] (5%) registered to climb the Kautz Glacier route (www.nps.gov/mora/climb/Climb04.htm). Climbers of these three climbing routes—the three most popular routes on the mountain—are the focus of this study. Over 80% of all Mount Rainier climbers therefore attempted the routes of interest to this study. The great majority of climbers attempt the mountain in the summer months of June, July, and August (Gauthier, M., personal communication, March 2004); therefore, it is assumed that problems associated with climber use level or climber interactions will be most common during these times.

[2] This figure aggregates Kautz Glacier climbers and Fuhrer Finger climbers. The actual number of Kautz climbers may be somewhat lower.

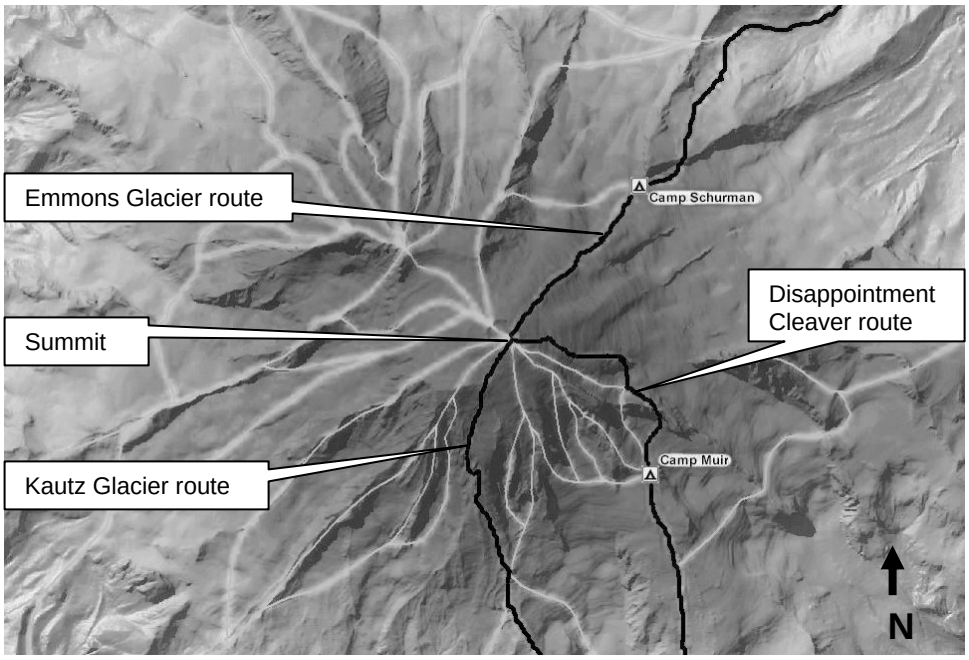

Figure 2. Climbing route map. Study routes are black and labeled, non-study routes are gray.

While NPS has not yet established capacities for climbing zones based on VERP processes, it does ration climbing use. All climbers are required to register and to pay a fee for a climbing permit. On the Disappointment Cleaver, Emmons Glacier, and Kautz Glacier routes, rationing is accomplished by limiting the number of individuals permitted to camp at specific camp areas or in the zone (Table 1). On many other infrequently climbed routes, rationing is accomplished by limiting the number of parties permitted to camp within the zone. Current camping limits have developed over time as a judgment by climbing managers about the physical capacity (i.e. space requirement) of the camping sites and about the rangers' capacity to handle human-waste, rescues, and other climbing related problems (Gauthier, M., personal communication, March 2004).

Table 1. Permit Limits by Zone, Route, and Camp (Gauthier, 1999)

Zone	Route	Camp	Permit Limit
High Use	Disappointment Cleaver	Camp Muir Public Shelter	25*
		Camp Muir (Tent)	85*
		Ingraham Flat	35
		Muir Snowfield	36
Moderate Use	Emmons Glacier	Camp Schurman	48
		Emmons Flat	24
Moderate Use	Kautz Glacier	Kautz Alpine Zone	36

*110 permits are issued for Camp Muir. Public Shelter capacity is 25 and usually fills first.

In the future, Mount Rainier managers wish to use the VERP framework to establish capacities based on social or ecological standards as well as management capacity.

Chapter 3. The Development of Social Carrying Capacity for Recreation Settings

For many climbers, the term "carrying capacity" conjures images of permit quotas or use limits. Although use limits (or stricter limits) could be employed as a means to control impacts from climbing, they are not an inevitable result of VERP planning, nor is reducing climbing use below current use levels a goal of VERP planning for the climbing zones. An understanding of the conceptual modifications that the term has undergone helps to clarify the distinction between the VERP approach and the setting of a rigid numerical "capacity".

The concept of carrying capacity was first developed for the management of biological resources such as range, forests, agriculture, and fisheries. Based on the condition of the biophysical environment and the resource needs of the species of interest, a "carrying capacity" could be expressed in terms of the maximum number of animals per resource unit that could be supported without degrading the biophysical resource (Shelby & Heberlein 1986 p.7-8, Manning 1999 p.41).

As early as the 1930s, some land mangers began to raise the question of how unregulated use might exceed the capacity of recreation areas (Manning 1999 p.41, Cole 2001). Wagar (1961, 1964) was perhaps the first researcher to formally apply the concept of carrying capacity to recreation areas. Wagar and others expressed concern about the limitations of social carrying capacity in its initial formulation. Chief among their concerns was the incorrect implication that identifying the "correct" number of persons was a technical or scientific problem rather than a problem of compromising competing values (Wagar 1974, Manning et al. 1996, Manning 1999 p. 46, Cole 2001).

According to the view that began to develop among carrying capacity researchers, scientific research could reveal the consequences of alternative management choices, such as different levels of visitor use, but the choices, such as how much impact from visitor use ***should*** be tolerated, were inherently subjective and value driven. "Carrying capacity" was no longer viewed as a quality of the environment that could be identified through objective scientific observation, but rather as a product of research, informed judgment, and social dialogue (Manning 1999 p. 44-45, Cole 2001). Scientific research could objectively describe ***relationships*** between use and impacts, and could inform managers and affected groups, but the final selection of a carrying capacity would still represent a subjective, collective decision about how much impact is acceptable in a given environment.

Researchers also recognized that to define carrying capacity one must clearly identify and focus on desired social and resource conditions (i.e., the planning outcome) rather than a desired numbers of visitors (Wagar 1974, Manning et al. 1996, Lindberg et al. 1997). Early on, it was observed that managers exerted significant control over the impact of recreational use through various management actions (e.g. campsite design or trail routing), and could increase the capacity of an area (Manning 1999 p. 45-46). Therefore, it was more appropriate to manage for targeted social and resource conditions than for visitor numbers, and it was critical that those targets were unambiguous (Cole & McCool 1997, Hof & Lime 1997).

The focus on resource and social conditions (rather than visitor numbers) is a defining characteristic of VERP and other contemporary approaches to carrying capacity (Cole 1997, Hof & Lime 1997, Nilsen & Tayler 1997). Likewise, measuring changes to these conditions by monitoring indicators is characteristic of VERP, LAC and other modern approaches.

Chapter 4. Social Carrying Capacity Research Efforts

While carrying capacity is a well-explored topic in recreation research, no work to date has focused specifically on experience indicators for Mount Rainier climbing experiences. The majority of past carrying capacity research across all recreation areas has focused on visitors to low-density Wilderness environments where backpacking and day hiking were the principal activities. Although the existing literature provides some potential insight into climber experiences and the methods for exploring these experiences, key differences in the activity and purpose of climbers makes additional investigation of this user group important.

Two studies completed in 1985 did focus specifically on Mount Rainier climbers (Ewert, Swearingen & Johnson). Ewert examined the role that experience plays in influencing climber motivations. While some of the motivations investigated in this study are beyond the scope of the current work, Ewert does establish that a range of motivations beyond the experience of solitude motivate Mount Rainier climbers. Swearingen and Johnson's purpose was to collect information specifically aimed at informing a waste management plan on Mount Rainier. They examined sources of information that climbers used for trip planning, climbers' use and acceptance of waste disposal facilities, and the impact of waste sightings on climber experiences. The latter is the closest overlap with the purpose of this study. Beyond the impact of waste sightings there is limited guidance for investigating potential social indicators.

4.1. Satisfaction as a Measure of Quality

An early line of research looked at the effects of use-density on visitor satisfaction with outdoor recreation experiences. In general, findings either did not support such relationships or relationships were found to be statistically significant but weak in the magnitude of effect (Manning 1999, pp. 49-54, Cole 2001). As a

result, "satisfaction" as a measure of experience quality fell out of favor with some researchers.

More recent work has concluded that visitor satisfaction can be measured, provided that visitors are asked to evaluate specific conditions or aspects of their experiences (Whisman & Hollenhorst 1998, Haas 2001). For example, relationships have been demonstrated between reported encounter numbers and reported satisfaction with the number of visitors encountered. The expected relationship—an inverse relationship between encounter numbers and satisfaction—has been supported. More global measures of satisfaction have remained problematic (Haas 2001).

The implication for the current study is that questions about impacts (things that detract from climber experience quality) must be phrased to refer to specific aspects of climber experiences. Questions about impacts to overall trip experience quality are unlikely to yield strong relationships with measures of climbing use.

4.2. Crowding and Encounter Numbers

Motivated in part by the problems associated with the satisfaction model, another line of research has employed a "crowding" model (Haas 2001). Recreation researchers have adopted the dominant social psychology definition of crowding as a subjective, negative evaluation of the proximity of others in a physical setting (Sundstrom 1978, p. 32, Manning 1999, p.62, Cole 2001, Lee & Graefe 2003). Crowding is distinguished from objective measures of density, and increases in crowding perception may or may not correlate with increasing density.

This line of research sought to identify relationships between the number of encounters reported by visitors and their perception of crowding. As in studies

employing the satisfaction model, situational and environmental variables complicated the relationship between crowding and use/density. This was also found to be true in frontcountry environments (Lee & Graefe 2003). As a rule, stronger relationships were demonstrated between reported contact numbers and crowding than between actual contacts and crowding (Kuss et al. 1990 p. 199). However, reported contacts may be of limited use in higher density recreation environments because visitors find it difficult to accurately report encounters after a relatively small number of encounters has been reached (Manning 1999, p. 73, Cole & Stewart 2002, Cole & Daniels 2004).

This in part explains why ***encounter numbers*** was not investigated as a potential indicator in this study: visitors were unlikely to accurately recall and/or report the large number of encounters they experienced while climbing Mount Rainier. A more fundamental reason why encounters were not investigated pertains to the experience dimension—solitude—that ***encounter numbers*** is typically intended to operationalize as a VERP indicator.

4.3. Solitude as an Aspect of Recreation Experiences

For most recreation settings in which carrying capacity research has been conducted there has been little reason to speculate about the mechanisms by which encounters create annoyance or otherwise degrade visitor experiences. The desired experience in these environments is that of wilderness or semi-wilderness experience, and encounters are considered inherently negative.

Many studies have supported the idea that visitors to wilderness type environments optimally experience zero encounters and give increasingly negative experience evaluations as encounters increase (Shelby & Heberlein 1986, p. 77-78). Indicators related to encounters at camps and along trails have been found to be

important determinants of experience quality in Wilderness environments (Manning et al. 1996). Special sensitivity to encounters has been noted at campsites (Stankey 1973, Cole et al. 1997). Such findings support the use of solitude as a management objective for Wilderness and other "pristine" recreation environments. In addition, the specific identification of solitude in the Wilderness Act has likely discouraged investigation of alternative aspects of the Wilderness experience for these environments (Freimund & Cole 2001). Indicators related to such alternative aspects of wilderness experiences are therefore atypical.

However, encounter estimates in high use areas may not explain visitor evaluations of experience quality (Gramann & Burdge 1984). Other variables, such as threatening or unsafe behavior, constraints on mobility (Gramann & Burdge 1984), or biophysical impacts (when recognized) attributed to others persons (Cole et al. 1997) may be more important determinants of experience quality, and therefore a better basis for indicator development. Hof & Lime (1997) elaborate on this theme. Speaking specifically of social indicator research for urban, frontcountry, or developed Park environments, they ask, "in such settings to what extent does the quality of the visitor experience have less to do with the number of contacts between visitor groups and more to do with other physical manifestations of use intensity such as traffic congestion, full campgrounds, and waiting in lines?" The same question is posed of the climbing setting in this study.

4.4. Previous Research on Mount Rainier Climbing

Ewert 1985

A study at Mount Rainier (Ewert 1985) examined the relationship between recreation motivation and experience level for climbers. Primary attention was given to the difference in importance of motivation between two groups—experienced and inexperienced climbers. The difference in importance ***among***

motivational factors was not a primary focus. However, Ewert's findings provide a useful means to compare motivational factors.

Using factor analysis, Ewert identified six dimensions of motivation, which he labeled Physical setting, Challenge/Risk, Catharsis, Locus of control, Creativity, and Recognition. Ewert examined some highly personal dimensions—such as creativity and self-expression—that were not examined in this study, largely because these motivations were felt to be outside of management influence and not related to climbers' interpretations of congestion or other route conditions. Likewise, motivations related to recognition were felt to be unrelated to park management goals.

Two aspects of the climbing experience explored in this study used questionnaire items worded similarly to the motivation dimensions that Ewert found to be the most important (see questions 7, 8, 11, 12, Appendix B). Physical setting, loading on items Enjoy the wilderness, To view the scenery, and To be close to nature, received the highest mean score; Challenge/Risk, loading on Personal Testing, Excitement, and Accomplishment, received the next highest mean score.

Solitude was examined as a component of the Catharsis factor with other items such as Relaxation, Slow Mind, Escape Authority, Disengagement, and Personal Values. Solitude had a lower mean score than any item in the Physical Setting factor, and lower mean than five out of six items in the Challenge/Risk factor. Although the question was not addressed by Ewert, these findings support the idea that motivations other than the experience of solitude are of primary importance to Rainier climbers.

Swearingen and Johnson 1985

A study from the same year (Swearingen & Johnson 1985) focused on climber attitudes about human waste and human waste management. The closest overlap with the current climber study was examination of the impact of human waste sightings on climber experiences.

Forty-four percent of respondents sighted human waste at some point during their trip. Of these, a majority (57%) felt that sighting human waste detracted from the enjoyment of their trip. However, only nine percent of the total sample reported a moderate to great decrease in enjoyment. Climbers were deemed to be tolerant of limited waste sightings. Climbers who described their sightings as "excessive" were more likely to experience diminished enjoyment.

Impacts on trip satisfaction were less conclusive. Only 16% of climbers agreed that their sightings of human waste decreased their overall trip satisfaction. Unlike trip enjoyment, overall trip satisfaction was not associated with the amount of human waste that climbers perceived.

It is commonly believed that the "blue bag" human waste management program and climber education program that was instituted around the time of this study has substantially reduced the number of sightings (and the amount) of human waste at Mount Rainier (Gauthier, M., personal communication, March 2004). The current study does examine the impact of human waste sightings on climber experiences, albeit in a limited way.

Chapter 5. This Study's Investigation of Potential Indicators

Ninety-seven percent of Mount Rainier National Park is designated Wilderness, including most of the areas where visitors engage in climbing (which is defined as any glacier travel and all travel above 10,000 ft.). The Muir Snowfield, used to approach Camp Muir, and the Camp Muir Historic District itself are notable exceptions. Because of development at Camp Muir and high day-use on Muir Snowfield, these areas were left out of the Wilderness proposal in 1973 and out of the Washington Park Wilderness Act of 1988 (Catton 1996, Ch.19). Nonetheless, once Disappointment Cleaver climbers depart from high camp on summit day, they enter designated Wilderness, and climbers on other routes enter Wilderness as soon as they leave developed facilities. At the same time, the alpine Wilderness areas of Mount Rainier differ in many respects from other Wildernesses and create a unique management situation. For example, climbers face substantial dangers from elevation, weather, falling rock and ice, steep slopes, and crevasses. The potential for accidents and injuries in this environment has led NPS to accept manmade objects and structures—such as ladders, wands, fixed ropes, and emergency caches and shelters—that enhance climber safety but are considered inappropriate in other parts of the Mount Rainier Wilderness.

Mount Rainier is also the most notorious and popular mountain in the Northwest. At the time of Wilderness designation in 1988, Mount Rainier already received a high level of climbing use on the Disappointment Cleaver and Emmons Glacier routes. Attempts in the 1970s to limit use in the Rainier alpine zones led to legal challenge, and a relaxation of use restrictions on the most popular routes, although the principle of use limits was upheld (Catton 1996, Ch.19). Since this time

Rainier managers have taken the approach of permitting high use in some climbing areas while managing for other experience opportunities—including solitude—in other climbing areas.

Research has shown that many visitors to traditional wildernesses share a common conception of wilderness that includes limited human encounters (Kendra and Hall 2000). As pointed out in Chapter 4, indicators based on solitude or crowding have already been applied to traditional wilderness areas for some years. Yet Kendra and Hall's findings also support the idea that visitors to areas that differ from the traditional wilderness may define wilderness experiences differently; visitors to their most developed study site differed significantly from other respondents in the way they defined wilderness, and felt that seeing other people was part of the experience. And, as Ewert (1985) discovered, Rainier climbers had diverse motivations, and reported that factors related to challenge and risk-taking were more important than solitude, relaxation, disengagement, and other factors he labeled "catharsis".

The desired condition descriptions in the 2001 Mount Rainier GMP acknowledge the unique nature of the climbing zones by emphasizing values such as challenge and deemphasizing solitude. The logical step for managers is to consider social indicators based on the aspects of the climbing experience that are consistent with the special circumstances of the Mount Rainier climbing environment, and not rely on indicators that are based on solitude or related aesthetic concerns. This study therefore examined the degree to which solitude is a desired or anticipated condition largely to confirm earlier studies and management assumptions that solitude was not a primary motivation of climbers. Other motivational factors—challenge, skill development, companionship, and enjoyment of nature/scenery—

were investigated in parallel with solitude, and were hypothesized to be more important to climbers on these three routes.

As part of this study's goal to assess potential VERP indicators, it was also assumed that the extent to which other climbers physically interfere in the ability of individuals to achieve their climbing goals—safely ascending to the mountain's summit under their own power and on their own terms—could also provide a fruitful direction for the investigation of indicators of experience quality. Accordingly, this study looked at the occurrence of delays or hazards caused by the presence or actions of other groups that could directly interfere with a safe ascent. In a high density recreation environment where substantial hazards are common, it is believed that such direct effects of other visitors could have greater impacts on climbers' experience quality than simply observing or encountering other visitors.

This study also examined the impact of man-made modifications to the climbing environment such as tent platforms, wands, and a shoveled boot track. These traces of earlier climbers were thought to have the potential to decrease the sense of challenge and self-reliance from route finding, which was believed to be an important aspect of the climbing experience. Traces of earlier climbers thus represented potential indicators of indirect negative impacts of past climbers on later climbers' experiences.

Finally, evaluation of crowding in camp and at other route locations was also investigated. Because solitude achievement was not believed to be an important motivation for climbers on the three study routes, these conditions were hypothesized to have minor impact to climber experience quality.

Chapter 6. Methods

Survey research methods allow researchers to answer questions about a *population* of individuals, such as Mount Rainier climbers, by asking those questions of a *sample*, or subset, of those individuals. To extend observations made about the sample to the population, researchers develop a sampling plan that ensures that the sample is as representative of the population as possible, given practical constraints (such as time, money, or reasonable means for contacting members of the population). Because no sample will be exactly like the population, statistical techniques are used to assess the magnitude of potential error in extending observations from the sample to the population.

The population for this study is all private climbers on the Disappointment Cleaver, Emmons Glacier, and Kautz Glacier routes during July and August, 2004. Because route conditions play an important role in the experience of climbers in terms of both the difficulty and danger associated with travel, findings should be applied cautiously to months at the beginning and end of the summer climbing season. For example, use levels in June are relatively high, but deeper snow cover at this time of year decreases certain problems, such as rockfall caused by other parties, because some areas of loose rock are stabilized by snow cover. In September, use levels taper sharply, but conditions become icier and more loose rock is exposed as snow cover melts, making rockfall a more serious concern.

6.1. Procedure

Sampling Sites

The initial sampling plan called for participant recruitment at five locations: 1) Jackson Visitor Center, 2) Longmire Wilderness Information Center, 3) Paradise Old Station, 4) White River Ranger Station, and 5) the office of Rainier

Mountaineering Incorporated (RMI). These sites issue virtually all of the climbing and overnight camping permits for the three relevant routes. During the sample periods, the goal was to obtain a census of climbers. In practice, Jackson VC and Longmire WIC issued so few permits for climbing that these sites were eliminated from sampling after the second sample period (7/12 – 7/18).

Sampling Schedule

Because of the practical difficulty in administering an on-site random sampling plan, it was decided to sample selected weeks across the season of interest (July and August). In this way both weekdays and weekend users were represented in the sample. There is no theoretical reason to suspect that climbers during the weeks chosen for sampling differed from climbers during weeks not chosen for sampling, since my sampling weeks were distributed across the peak season. Therefore, it is unlikely that this sampling approach introduced no significant bias in to the study findings.

Contact Procedure

Ranger Division staff recruited climbers at park permit sites during the month of July, which included the first two sample periods. University survey workers were used to recruit climbers at park permit sites for the final two sampling periods in August. RMI desk staff recruited RMI clients during all sampling periods.

All climbers at Mt. Rainier are required to personally check-in with rangers (or guides) during the permitting process. After each group received its permit, climbers were asked to participate in a study conducted by University of Washington researchers on behalf of the park. Those willing to participate completed a contact sheet that asked for each climber's first name, email address (or physical mail address), the intended route of travel, and the number of persons

in the party. Those refusing to participate were recorded as refusals. However, this refusal information was only accurately recorded by survey workers. Refusal information was not accurately recorded by park staffers at park permit sites during the first two sample periods, and was not accurately recorded by RMI staff in any of the four sample periods.

Contact and Response Summary

Table 2 includes the sampling periods, dates, total number of study recruits, total number of completed questionnaires, total number of bad emails, and final response rate, sorted by route. Bad emails resulted primarily from illegible handwriting, full email inboxes, and misspellings. However, some bad emails may reflect deception on the part of climbers who did not wish to complete the questionnaire. Despite the presence of a few such indirect refusals, response rate calculations followed a convention used with mail-back questionnaires: returned email invitations were subtracted from total contacts before calculating response rate. Table 2 response rates do not reflect refusals for sample periods 1 and 2. Sampling for these periods was conducted by park staff; accurate records of refusals were not maintained for samples 1 and 2. For Samples 3 and 4, in which university survey workers performed recruitment, refusal rates were less than 1%. Because a high proportion of RMI clients did not participate in the study and accurate refusal information was not maintained for any RMI samples (thereby eliminating a principal means of assessing potential nonresponse bias), RMI respondents were dropped from future analysis. The study therefore includes only private climbers. For a brief discussion of nonresponse problems, see Chapter 8 Limitations. For a complete treatment of statistical tests used to identify response bias, see Appendix A.

Table 2. Sampling Periods and Response Rates for 2004 Mount Rainier Climber Survey. Samples conducted by PASRU survey workers in bold. RMI contacts are excluded. Because of the small sample size of Kautz Glacier respondents, a confidence interval as large as +/- 17% is possible. Data based on the Kautz sample should be interpreted with caution.

*ROUTE**	*SAMPLE*	*PERIOD*	*TOTAL*	*COMPLETE*	*BAD EMAIL*	*RESPONSE RATE*
DC	1	7/2 – 7/8	122	82	6	71%
EG	1	7/2 – 7/8	32	25	3	86%
KG	1	7/2 – 7/8	14	9	1	69%
DC	2	7/12 – 7/18	84	62	7	81%
EG	2	7/12 – 7/18	32	19	1	61%
KG	2	7/12 – 7/18	2	1	1	100%
DC	**3**	**8/2 – 8/8**	**158**	**86**	**11**	**59%**
EG	**3**	**7/26 – 8/1**	**152**	**91**	**12**	**65%**
KG	**3**	**8/2 – 8/8**	**29**	**19**	**3**	**73%**
DC	**4**	**8/19 – 8/21**	**62**	**34**	**6**	**61%**
EG	**4**	**8/19 – 8/21**	**17**	**12**	**2**	**80%**
KG	**4**	**8/19 – 8/21**	**2**	**1**	**0**	**50%**
DC TOTAL			426	264	30	67%
EG TOTAL			233	147	18	68%
KG TOTAL			47	30	5	71%
TOTAL			**706**	**441**	**53**	68%

* DC = Disappointment Cleaver, EG = Emmons Glacier, KG = Kautz Glacier

6.2. Instrument Content

A representative questionnaire is provided in Appendix B.

Questionnaire items focused on 1) reasons for choosing to climb Rainier and for choosing a specific route on Rainier, and 2) impacts to climbing experience related

to the presence, behavior, numbers, or distribution of other climbers or climbing groups.

Motivation items (questions 7-27, Appendix B) were used to develop an understanding of climbers' recreational motivation. These variables were thought to potentially influence climbers' responses to impact questions.

Impact items (questions 30-40, 43-51, 53-61, 73-86, Appendix B) were used to understand how climbers were affected by the presence or behavior of other climbers and by the physical impacts caused by other climbers. Many of the experience impact questions were written to refer to geographic locations unique to each route. Impacts were tied either to 1) specific camp areas, 2) specific sections of the climbing route, or 3) the overall condition of the route during the climber's summit attempt.

Some items also requested demographic or group information (questions 1-6, 100-103, Appendix B).

6.3. Instrument Format

Both multiple choice (quantitative) and a few open ended (qualitative) question formats were used in the questionnaires, but the current analysis has employed only the quantitative information obtained in questionnaire responses due to the limited time available to analyze qualitative data.

Scales

Likert scales were used for the majority of questionnaire items in order to develop continuous variables from climber responses. For items related to conditions or events (questions 30-40, 43-46, 57-61, 67-71, 77-86, Appendix B), the scale

included a "did not see" or "did not experience" category, followed by four degrees of perceived impact: "did not detract", "detracted slightly", "detracted moderately", or "detracted greatly". For items related to perceived hazard from other groups (questions 43-46, 53-56, 63-66, 73-76, Appendix B), the scale included only degrees of perceived concern: "not concerned", "slightly concerned", "moderately concerned", "very concerned", or "extremely concerned".

Variables derived from responses

The use of the "did not experience" response category allowed assessment of the frequency with which climbers recalled experiencing certain impacts (such as human waste or garbage), and identification of those that did or did not observe or experience a given condition or event. My analysis often employed a recoded dichotomous variable equating to "did experience" or "did not experience" a given event or condition, such as waiting for other climbers who blocked the way ahead. The remaining response categories were recoded into a continuous variable measuring the impact severity from these events (such as waiting) when they did occur (i.e., 1 – 4, from "did not detract" = 1, to "detracted greatly" = 4).

For hazard variables, the responses were retained as a measure of impact severity only (i.e., 1 – 5, from "not concerned" = 1, to "extremely concerned" = 5). The choice was made not to include a "did not experience" response, because in my judgment certain types of hazards may be of concern even if other parties are not in view. For example, the belief that another party may be above one's group could lead to concern about rockfall from that party, even if that party is not in view or their position or presence is uncertain.

It will therefore not be possible to distinguish between respondents that experienced no concern about a hazard because they believed themselves to alone on the route, and those who observed the outward manifestation of a hazard (such as falling rocks) but nonetheless experienced no fear or worry.

Variables derived from other sources

Several variables related to use level were derived from permit data rather than response data. On the Emmons and Kautz Glacier routes, where guided use is uncommon, private party permit data were used to develop a measure of use equivalent to "the number of climbers who obtained permits for the climbing zone on that calendar day".

For the Disappointment Cleaver, separate records are kept of guided and private climbing permits. Therefore two variables were produced, one equivalent to "number of private climbers permitted to be in the climbing zone on that calendar day" and one equivalent to "number of guided climbers permitted to be in the climbing zone on that calendar day". These variables were also combined to create a measure of overall use.

The dates provided by climbers for their summit day were used to match climber response records to the levels of use calculated from permit records for each calendar day during the climbing season. This provides an indirect measure of use that is believed to weaken the models that employ these measures as predictors (See Chapter 7).

This is one of the limitations discussed in Chapter 8 Limitations. Other limitations include a) the loss of RMI response data, b) the small size of the Kautz Glacier sample, c) the modest overall response rate. Appendix A documents statistical

tests used to identify potential response bias. Based on these tests, no changes in interpretation of results are believed to be necessary to account for response bias. However, data from the Kautz sample should be interpreted cautiously due to the small sample size.

Chapter 7. Results

7.1. Demographics

Several types of descriptive demographic information were collected. Climbers were asked to provide their year of birth, gender, highest level of education, and home zipcode. Year of birth was recoded into ***age category*** and zipcode was recoded into ***home region***. Table 3 summarizes demographic variables for climbers on the three study routes[3].

Table 3: Climber demographics

	Disappointment Cleaver	*Emmons Glacier*	*Kautz Glacier*
AGE CATEGORY	*n** = 261	*n* = 146	*n* = 30**
18-29	22.2%	28.8%	30.0%
30-39	32.6%	20.5%	36.7%
40-49	25.3%	28.1%	30.0%
50-59	16.1%	19.2%	3.3%
60-69	3.8%	3.4%	0.0%
GENDER	*n* = 264	*n* = 147	*n* = 30*
Female	12.8%	13.6%	10.0%
Male	88.2%	86.4%	90.0%
EDUCATION LEVEL	*n* = 263	*n* = 147	*n* = 29*
Fewer than 12 years	3.0%	0.7%	0.0%
High school diploma	4.9%	3.4%	0.0%
Some college/vocational training	14.4%	16.3%	10.3%
College degree	34.2%	34.0%	58.6%
Graduate/professional degree	43.3%	45.6%	31.0%

*n is equal to the number of climbers on which the statistic is calculated

**Due to the small sample size, the confidence interval for Kautz Glacier findings is as high as +/- 17%. Caution should be used in interpreting these findings.

[3] Only the responses of private climbers were analyzed. For a more complete discussion, see Chapter 8: Limitations.

Table 3. Climber Demographics, continued

	Disappointment Cleaver	*Emmons Glacier*	*Kautz Glacier*
HOME REGION	*n* = 262	*n* = 146	*n* = 30*
Puget Sound	36.3%	49.0%	23.3%
Other U.S.	30.5%	34.7%	56.7%
Oregon & California	15.3%	6.1%	16.7%
Other Washington	8.8%	1.4%	0.0%
Other/Unknown	8.8%	8.8%	3.3%

* Due to the small sample size, the confidence interval for Kautz Glacier findings is as high as +/- 17%. Caution should be used in interpreting these findings.

The mean age of climbers[4] was found to be about 40 years on the Disappointment Cleaver (a) and Emmons Glacier (b) (a. $M = 39.05$, SD = 11.83; b. $M = 39.52$, SD = 11.63). On the Disappointment Cleaver, this represents an increase in mean age from 33 years in 1985 (Swearingen & Johnson); this increase is statistically significant ($t(260) = 8.26$, $p < .001$)[5]. This finding would be consistent with the aging of the overall community of wilderness recreationists (Watson et al. 1995). Mean age on the Kautz was calculated to be slightly younger ($M = 35.47$, SD = 8.92), but this difference was not significantly different from the other two routes.

Rainier climbers are predominately male, a situation unchanged since the 1985 climber study (86% male, Swearingen & Johnson). Female participation rates in "conventional" wilderness activities rose from 25% in 1978 to 31% in 1990 (Watson et al. 1995).

Climbers, like other wilderness recreationists, have a higher level of educational attainment than the general public (Watson et al. 1995). The 2004 study found that

[4] Only persons over 18 years were sampled in the 1985 and 2004 climber studies.

[5] This test assumes equal variances and uses a one-sample *t*-test.

well over half of DC, Emmons, and Kautz climbers completed at least an undergraduate college degree and more than half of these college graduates went on to completed graduate or professional degrees. In the general population, 18 years and older, 26.3% had at least a bachelor's degree, and 9.4% had a graduate or professional degree (US Census 2005). Because different approaches were used by the 1985 and 2004 studies to quantify educational attainment, direct comparison is not possible. However, the 1985 study found the mean number of years of education to be about 16 years (i.e., completed undergraduate degree).

Mount Rainier attracts climbers from all parts of the nation and the world, but the largest percentage comes from Washington. The 1985 study found 56% of Disappointment Cleave climbers came from Washington, somewhat higher than in 2004 (45.1%). A larger percentage of Emmons climbers were from Washington than Disappointment Cleaver climbers. Because the Disappointment Cleaver sample does not include guided climbers, this result is not due to the larger number of guided climbers on the Cleaver.

7.2. Reasons for Climbing Mount Rainier and for Selecting a Summit Route

Climbers rated the importance of potential reasons for choosing to climb Mount Rainier and for selecting their summit route. Ten questionnaire items concerning reasons for climbing Rainier were written to correspond to the experiential values mentioned in the desired future condition description for the two climbing zones, such as challenge and solitude. (see Chapter 2.2). Reasons for selecting the route focused on practical concerns, such as perception of route hazard or availability of permits. The importance of summiting as an end in itself was investigated both as a reason for climbing Rainier and for selecting the route as the "best chance" to get to the summit.

As hypothesized, solitude was a less important reason for climbing Mount Rainier than using or developing skills, experiencing challenge, companionship, or experiencing Rainier's' natural features and scenery (Figure 3). These findings are also consistent with Ewert (1985). Mean responses (Table 4) for the two solitude items—***experiencing solitude*** and ***getting away from other people***—were significantly lower (all *p*s < .001) than all other motivation items for the Disappointment Cleaver and the Emmons and all but one item (train for other climbing goals, $p = .726$; all other *p*s < .05) for the Kautz. On the Kautz, experiencing solitude ($M = 3.37$) was more important than on either the Disappointment Cleaver ($M = 2.43$; $t(293) = 3.977$, $p < .001$) or Emmons ($M = 2.58$; $t(174) = 3.262$, $p = .001$).

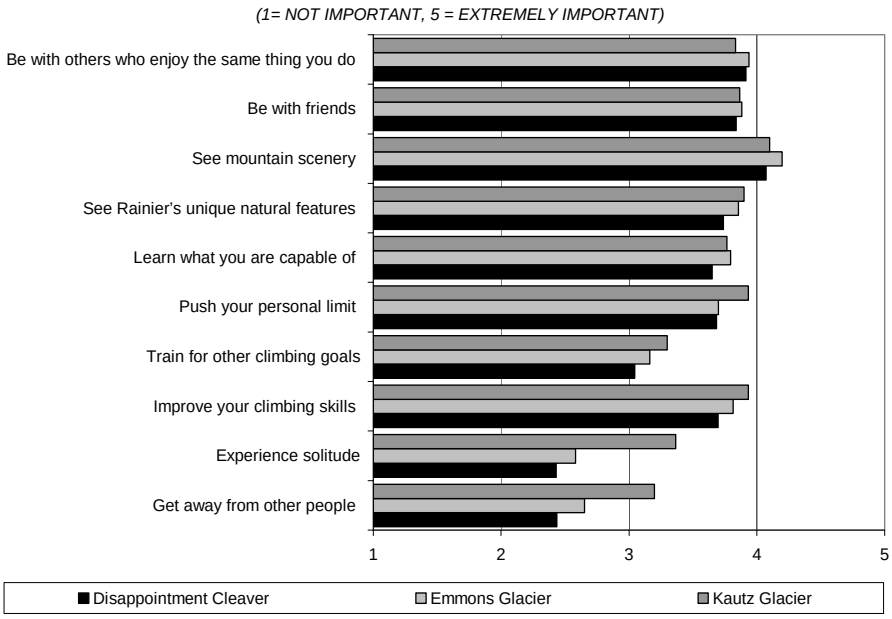

Figure 3: Mean importance of reasons for climbing Mount Rainier. Due to the small sample size, the confidence interval for Kautz Glacier findings is as high as +/- 17%. Caution should be used in interpreting findings for the Kautz route.

Table 4. Mean importance of reasons for climbing Mount Rainier.

	Disappointment Cleaver			*Emmons Glacier*			*Kautz Glacier*		
QUESTIONNAIRE ITEM	*n*	*M**	*SD***	*n*	*M**	*SD*	*n****	*M**	*SD*
Q10. Get away from other people	264	2.44	1.18	147	2.65	1.31	30	3.20	1.27
Q16. Experience solitude	265	2.43	1.24	146	2.58	1.22	30	3.37	1.10
Q13. Improve your climbing skills	264	3.70	1.11	147	3.82	0.99	30	3.93	0.98
Q15. Train for other climbing goals	265	3.05	1.31	147	3.16	1.28	30	3.30	1.44
Q11. Push your personal limit	264	3.69	1.20	147	3.70	1.18	30	3.93	0.87
Q8. Learn what you are capable of	264	3.65	1.21	147	3.80	1.05	30	3.77	1.04
Q7. See Rainier's unique natural features	265	3.74	0.96	147	3.86	0.94	30	3.90	0.84
Q12. See mountain scenery	265	4.07	0.85	147	4.20	0.84	30	4.10	0.71
Q9. Be with friends	265	3.84	1.03	145	3.88	1.10	30	3.87	0.78
Q14. Be with others who enjoy the same thing you do	265	3.92	0.93	147	3.94	0.95	30	3.83	0.70

* Items were measured on a five point scale from "1 = not important" to "5 = extremely important"

***SD* equals standard deviation, which is a measure of the variation in the data used to calculate the statistics for the questionnaire item (e.g., the mean (*M*), or average). Higher standard deviation scores are equal to greater dispersion, or spread of responses.

*** Due to the small sample size, the confidence interval for Kautz Glacier findings is as high as +/- 17%. Caution should be used in interpreting these findings.

Climbers on the Disappointment Cleaver, Emmons Glacier, and Kautz Glacier shared some reasons for selecting their route, but there were also some notable differences (Figure 4, Table 5). The sense that the route was the most appropriate route for the technical ability of the group received the highest mean response as a reason for selecting a route for climbers overall; averaged across all three routes, this response had a higher mean than the next two highest mean responses, ***best chance to get to the summit*** ($F(4, 436) = 11.43, p < .001$) and ***fewer objective hazards than other routes*** ($F(4, 435) = 52.80, p < .001$).

Climbers were asked about the importance of making it to the summit as a reason to climb Rainier and in their choice of routes; climbers on all three routes strongly valued summiting (M = 3.60, SD = 1.04, 4 = highly important) as a reason for climbing Rainier, but Disappointment Cleaver climbers placed a higher emphasis on summiting as a reason to select their route (M = 3.57) than either Emmons climbers (M = 3.14; t(409) = 3.649, $p < .001$) or Kautz climbers (M = 2.43; t(292) = 5.441, $p < .001$).

Emmons and Disappointment Cleaver climbers felt their route was safer (M = 3.45) than Kautz climbers (M = 2.79; t(438) = 3.039, $p = .003$). Kautz climbers emphasized getting away from people (M_a = 3.57) and evidence of people (M_b = 2.93) more than Emmons climbers (M_a = 2.68, t(174) = 3.723, $p < .001$; M_b = 2.27, t(175) = 2.83, $p = .005$) who emphasized these factors more than Disappointment Cleaver climbers (M_a = 1.54, t(228) = 10.298, $p < .001$; M_b = 1.45, t(221) = 7.677, $p < .001$). Meeting others (a), route history (b), and permit availability (c) were not important factors in route selection ($M_{a,b,c} < 2$, "slightly important").

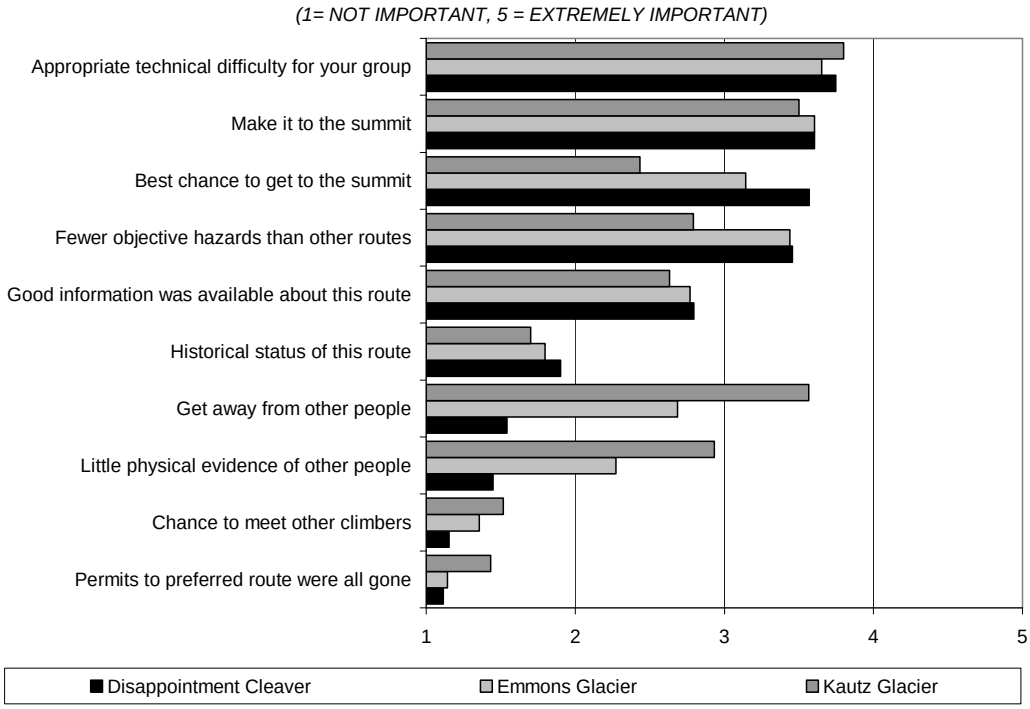

Figure 4: Mean importance of reason for selecting a climbing route. Due to the small sample size, the confidence interval for Kautz Glacier findings is as high as +/- 17%. Caution should be used in interpreting findings for the Kautz route.

Table 5: Mean importance of reasons for selecting a climbing route

	Disappointment Cleaver			*Emmons Glacier*			*Kautz Glacier*		
	n	*M**	*SD*	*n*	*M**	*SD*	*n****	*M**	*SD*
Q18. Appropriate technical difficulty for your group	265	3.75	1.12	147	3.65	1.08	30	3.80	0.96
Q17. Make it to the summit**	258	3.60	1.04	147	3.61	1.04	30	3.50	0.97
Q21. Best chance to get to the summit	264	3.57	1.10	147	3.14	1.19	30	2.43	0.90
Q19. Fewer objective hazards than other routes	265	3.46	1.14	146	3.44	1.12	29	2.79	1.01
Q26. Good information was available about this route	263	2.79	1.35	147	2.77	1.27	30	2.63	1.10
Q27. Historical status of this route	263	1.90	1.18	147	1.80	1.13	30	1.70	0.79
Q20. Get away from other people	262	1.54	0.84	146	2.68	1.18	30	3.57	1.17
Q22. Little physical evidence of other people	265	1.45	0.78	147	2.27	1.16	30	2.93	1.23
Q23. Chance to meet other climbers	262	1.15	0.62	146	1.36	0.95	29	1.52	0.74
Q25. Permits to preferred route were all gone	262	1.11	0.51	146	1.14	0.65	30	1.43	0.94

*Items were measured on a five point scale from "1 = not important" to "5 = extremely important"
**This item referred to reason for choosing to climb Rainier
***Because of the small sample size of Kautz respondents, a confidence interval of up to +/- 17% is possible for Kautz findings. These findings should be interpreted cautiously.

7.3. Conditions Encountered in Camp and on the Summit Route

Conditions in High Camp

Climbers were asked to respond to certain conditions or events that may have occurred in their high camp. Table 6 identifies the percentage of all respondents that reported seeing or experiencing each condition or event.

Table 6. Percent of climbers who experienced or observed the following events or conditions in camp

	Disappointment Cleaver		*Emmons Glacier*		*Kautz Glacier*	
QUESTIONNAIRE ITEM	*n*	*Yes*	*n*		*n**	*Yes*
Q30. Heard noise from other groups	249	88.6%	125	95.2%	17	76.5%
Q39. Multiple dug out tent platforms	249	88.4%	134	78.4%	26	84.6%
Q40. Large dug out tent platforms	245	76.7%	133	69.9%	26	65.4%
Q35. Felt privacy was limited	246	73.2%	125	72.8%	17	52.9%
Q 33. Felt crowded	249	68.3%	125	68.0%	17	58.8%
Q32. Discussion with other groups about when to start climbing	248	65.7%	125	77.6%	17	58.8%
Q31. Competition for tent space	248	57.3%	125	64.8%	17	88.2%
Q37. Urine	249	45.0%	134	57.5%	26	30.8%
Q38. Garbage	248	42.3%	133	41.4%	26	53.8%
Q36. Feces	249	20.9%	133	38.3%	26	26.9%
Q34. Saw other groups break park rules	248	20.2%	124	25.0%	17	0.0%

* Because of the small sample size of Kautz respondents, a confidence interval of up to +/- 17% is possible for Kautz findings. These findings should be interpreted cautiously.

Table 7 identifies the mean response of those climbers who reported seeing or experiencing each condition or event.

Table 7. Mean responses by climbers who experienced or observed the following events or conditions in camp

	Disappointment Cleaver			*Emmons Glacier*			*Kautz Glacier*		
	n	*M**	*SD*	*n*	*M**	*SD*	*n***	*M**	*SD*
Q30. Heard noise from other groups	222	1.87	0.93	119	1.89	0.95	13	1.46	0.66
Q39. Multiple dug out tent platforms	223	1.22	0.46	105	1.11	0.40	22	1.18	0.50
Q40. Large dug out tent platforms	191	1.16	0.41	93	1.09	0.35	17	1.18	0.53
Q35. Felt privacy was limited	182	1.68	0.83	91	1.62	0.70	9	1.78	0.83
Q 33. Felt crowded	171	1.85	0.94	85	1.66	0.81	10	1.60	0.70
Q32. Discussion with other groups about when to start climbing	164	1.17	0.48	97	1.18	0.46	10	1.40	0.70
Q31. Competition for tent space	144	1.67	0.80	81	1.65	0.82	15	1.73	0.80
Q37. Urine	113	1.51	0.70	77	1.53	0.79	8	1.25	0.46
Q38. Garbage	106	1.94	0.83	55	1.67	0.70	14	1.64	0.74
Q36. Feces	53	2.04	0.83	51	2.18	0.93	7	2.00	0.58
Q34. Saw other groups break park rules	51	2.08	1.11	31	2.13	0.99	0		

* Items were measured on a four point scale from "1 = did not detract" to "4 = detracted greatly"
**Because of the small sample size of Kautz respondents, a confidence interval of up to +/- 17% is possible for Kautz findings. Caution should be taken in interpreting these findings.

The three most infrequently reported observations—observing others break park rules, observing feces, and observing garbage—were found to be more objectionable campsite experiences than multiple dug out tent platforms, large tent platform, or discussion with other climbers (all *p*s < .001).

Logistic Regression Analysis

Regression analysis is a method for determining the association between a dependent variable, such as climber responses to various questionnaire items, and an independent variable (or variables), such as the number of climbers permitted to climb on a respondent's summit day.

When the dependent variable is dichotomous (i.e., "did experience" or "did not experience") logistic regression is used. Logistic regression has the generic form:

$$\ln \left(\frac{p}{1 - p} \right) = \text{constant} + \beta_1 [6] \text{ (predictor variable)}$$

Where: p is the probability that climbers observed or experienced a given event or condition, and β_1 is the logistic coefficient for the first predictor variable, such as number of climbers.

There are several ways to evaluate whether a logistic regression model is good fit to the data. In the omnibus chi-square test of the model coefficients a significant chi-square indicates that the predictor variable significantly predicts the dependent variable.

The Hosmer & Lemeshow's Goodness of Fit test statistic[7] offers a second means of evaluating the fit of the model to the data. This can be computed only for continuous predictor variables, in this case, the number of guided climbers. The Hosmer & Lemeshow's Goodness of Fit test statistic is a measure of the difference between the data predicted by the model and the observed data. A significant Hosmer & Lemeshow's Goodness of Fit test statistic indicates that the

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[6] In logistic regression, regression coefficients are interpreted as the change in the log odds of the predicted event for a 1 unit change in the predictor variable. Because the dependent variable is not the probability of the event occurring, interpreting the regression coefficient as the amount of change in the likelihood oft an event due to a 1 unit change in the predictor variable is not correct.

[7] The Hosmer and Lemeshow's Goodness of Fit test examines the null hypothesis that the data were generated by the model fitted by the researcher. The test divides subjects in to deciles based on predicted probabilities, and then computes a chi-square from observed and expected frequencies. If the computed test statistic has a probability of .05 or less, the null hypothesis that there is no difference between the observed and model-predicted values of the dependent variable is rejected. Well-fitting models generate data that do not differ from what was observed and their Hosmer and Lemeshow's Goodness of Fit Test statistic is not significant.

data predicted by the model differ significantly from the observed data. Significant Hosmer & Lemeshow test statistics therefore show that the model is not a good fit to the data.

Finally, the percent of cases correctly classified by the model is an indicator of the goodness of fit of the model. Higher percentages correctly classified indicate a better fitting model.

Because of the low number of responses in the Kautz Glacier survey, only Emmons Glacier and Disappointment Cleaver responses were analyzed with regression techniques.

The five dependent variables in the response set for campsite conditions were tested for (logistic) relationships with use level: 1) ***heard noise from other groups,*** 2) ***had discussion with other groups about when to start climbing***, 3) ***felt privacy was limited***, 4) ***felt crowded,*** and 5) ***competition for tent space.*** These were variables that I hypothesized might vary in likelihood of occurrence with use level. For the Disappointment Cleaver, three independent variables—private use, guided use, and an interaction variable—were tested as logistic regression models. For the Emmons, an aggregate variable for all climbing use was used.

Regression Analysis for Disappointment Cleaver Responses

Backward stepwise regression[8] revealed that only the number of guided climbers was a significant predictor of the log-likelihood of three variables: ***had discussion with other groups about when to start climbing, felt privacy was limited,*** and ***felt crowded*** (all ps < .05). Of these, ***felt crowded*** was shown to have a significant

[8] Backward stepwise regression begins with all model terms and eliminates the least significant term in each step.

Hosmer and Lemeshow statistic, leading to doubts about the model's fit to the data. Table 8 summarizes model coefficients and statistics for ***had discussion with other groups about when to start climbing*** and ***felt privacy was limited.***

Table 8. Coefficients and test statistics for two logistic regression models

Predictor variable = number of guided climbers

Predicted Condition	Constant	*β**	Chi-Sq *p*-value	Hosmer & Lemeshow	% classified
Q 32. Had discussion with other groups about when to start climbing	-1.02	0.045	0.042	0.522	58.9%
Q35. Felt privacy was limited	-1.08	0.057	0.018	0.312	66.9%

Missing cases deleted listwise

The first model correctly classified 49.4% of climbers who did have discussion with other groups about when to start climbing and 63.9% of those who did not. Using this model for prediction, there is the potential for both false positives and false negatives, but there is a greater chance that a climber predicted to not discuss starting times with other groups will in fact discuss starting times. As a practical point it should be noted that climbers did not as a whole object to these discussions (see Table 7) In the second model, 73.9% of climbers who did feel privacy was limited were correctly predicted by the model, while 47.6% of those who did not feel privacy was limited were correctly predicted. Larger numbers of guided climbers is a good predictor that private climbers will feel privacy was limited, but smaller numbers is a poor predictor that private climbers will not feel privacy was limited.

Figure 5 represent the impact that guided numbers had on the probability of feeling privacy was limited in high camp by private climbers.

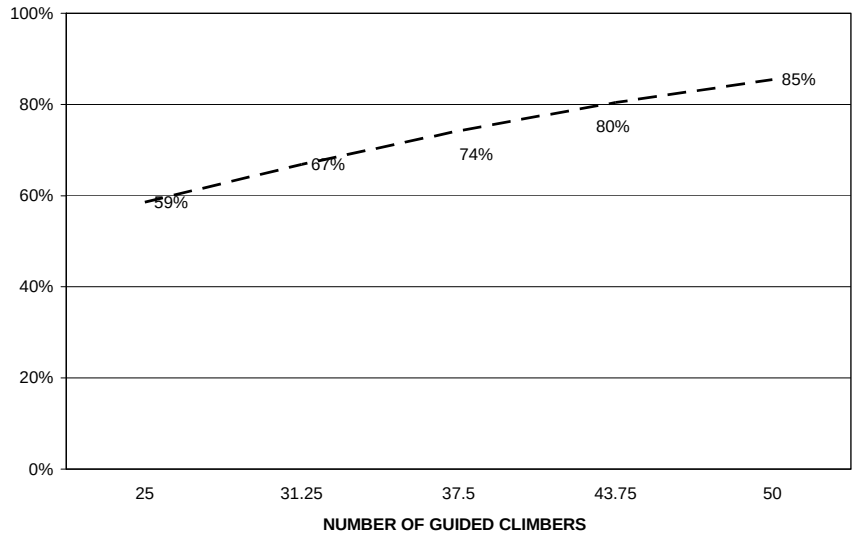

Figure 5. Probability that private climbers will feel that privacy is limited as a function of guided use. This graph represents the range of climbing use that was reported during sample days.

One can cautiously conclude that the presence of guided climbers contributed to the feeling by private climbers that privacy was limited, perhaps due to the simple addition of numbers (although the number of private climbers, ranging from 11 to 110 persons, was not a predictor).

Regression Analysis for Emmons Glacier Responses

Logistic regression analysis did not reveal statistically significant relationships between *number of climber*s and dichotomous response variables related to observations or experiences in high camp.

Conditions on Summit Day

Climbers were asked about observations they may have made while climbing on their summit day and the impact these observations may have had on their experience in general and on the specific experience of "finding your own way".

Table 9 summarizes the percentage of climbers of climbers who made these observations of those climbers that attempted the summit.

Table 9. Percent of climbers who observed the following conditions on their summit day climb

	Disappointment Cleaver		*Emmons Glacier*		*Kautz Glacier*	
QUESTIONNAIRE ITEM	*n*	*Yes*	*n*	*Yes*	*n***	*Yes*
Q86. Observed route markings	221	96.8%	123	97.6%	21	90.5%
Q84. Observed signs of previous climber	222	92.3%	122	94.3%	21	90.5%
Q85. Observed climber ahead on route*	222	86.5%	123	76.4%	21	33.3%
Q83. Observed garbage*	222	26.6%	122	28.7%	21	19.0%
Q82. Observed feces*	220	20.0%	123	44.7%	20	20.0%

* Items referring to experience of "finding your own way"[9]
** Because of the small sample size of Kautz respondents, a confidence interval of up to +/- 17% is possible for Kautz findings. These findings should be interpreted cautiously.

As in camp, observations of feces were more common on the Emmons than on the other routes ($t(111) = -4.225$, $p < .001$). Observations of signs of climbers (such as a compacted track) and route marking (such as wands) were common on all routes. A majority of climbers on the Disappointment Cleaver and Emmons Glacier reported seeing other climbers ahead on the route; a minority reported this on the Kautz, although the small sample size makes the interpretation of Kautz data speculative.

Observations of wands, a compacted boot track, or other climbers did not detract from climber experience quality or the enjoyment of routefinding[10]. Observing

[9] "Finding your own way" referred to the experience of choosing a route to the summit that overcomes various mountaineering obstacles (e.g., crevasses, cliffs, steep slopes). This activity, "route finding", was believed to be related to the desired experience of adventure, exploration, and self-reliance identified in the 2001 Mount Rainier General Management Plan.
[10] We cannot conclude if routefinding is not an important source of enjoyment or if these observations did not detract from that enjoyment.

feces or garbage detracted slightly; for Emmons climbers observing feces detracted slightly or moderately (Table 10).

Table 10. Mean response of climbers who observed the following conditions on their summit day climb

	Disappointment Cleaver			*Emmons Glacier*			*Kautz Glacier*		
QUESTIONNAIRE ITEM	*n*	*M**	*SD*	*n*	*M**	*SD*	*n*	*M**	*SD*
Q86. Observed route markings	218	1.21	0.57	120	1.16	0.43	19	1.11	0.32
Q84. Observed signs of previous climber	209	1.23	0.57	115	1.17	0.42	19	1.16	0.37
Q85. Observed climber ahead on route*	194	1.29	0.63	94	1.10	0.33	7	1.14	0.38
Q83. Observed garbage*	60	1.95	0.77	35	1.97	0.82	4	1.50	0.58
Q82. Observed feces*	45	1.98	0.81	68	2.60	0.93	4	1.25	0.50

* Items referring to experience of "finding your own way"
** Items were measured on a four point scale from "1 = did not detract" to "4 = detracted greatly"
Because of the small sample size of Kautz respondents, a confidence interval of up to +/- 17% is possible for Kautz findings. These findings should be interpreted cautiously.

7.4. Hazards Caused by Other Groups

Climbers were asked about their concern regarding several types of hazards they may have experienced at locations on their climbing route.

Hazards Caused by Other Groups on the Disappointment Cleaver

Rockfall was reported as the type of hazard that was of greatest concern at all locations on the Disappointment Cleaver route except the upper mountain (Table 11). This was anticipated, because Rainier's upper summit cone is a sustained snow and ice slope, largely free of rock features. The highest mean responses were for rockfall at Cathedral Gap (M = 2.57) and the Disappointment Cleaver[11] (M =

[11] The Disappointment Cleaver is the namesake mountain feature on the Disappointment Cleaver route. The Cleaver is a long rock and snow ridge that provides access from the Ingraham Glacier to the upper summit cone.

2.97), both areas known by climbers and NPS Rangers to contain potentially hazardous loose rock. More than half of Disappointment Cleaver climbers experienced at least moderate concern about rockfall from other groups at these sites.

Table 11. Mean responses to four categories of hazards on four sections of the Disappointment Cleaver route

	Crossing Cathedral Gap Q43-6			*Passing below the Ingraham Icefall Q53-6*		
QUESTIONNAIRE ITEM	*n*	*M**	*SD*	*n*	*M**	*SD*
Rockfall triggered by another group	206	2.57	1.14	199	2.21	1.24
Getting hit by falling climber(s) from another group	205	1.51	0.83	199	1.47	0.83
Avalanche triggered by another group	205	1.52	0.81	198	1.62	0.91
Delay in a hazardous location caused by another group	204	2.00	1.09	198	2.05	1.20

	On the Disappointment Cleaver Q63-6			*On the upper mountain Q73-6*		
QUESTIONNAIRE ITEM	*n*	*M**	*SD*	*n*	*M**	*SD*
Rockfall triggered by another group	204	2.97	1.33	184	1.28	0.65
Getting hit by falling climber(s) from another group	204	1.69	0.99	184	1.34	0.67
Avalanche triggered by another group	204	1.49	0.82	183	1.43	0.71
Delay in a hazardous location caused by another group	203	2.25	1.27	183	1.63	0.97

*Items were measured on a five point scale from "1 = not concerned" to 5 = extremely concerned"

Figure 6 shows the distribution of responses to ***rockfall triggered by another group*** by climbers of the Disappointment Cleaver route for Cathedral Gap and the Disappointment Cleaver locations.

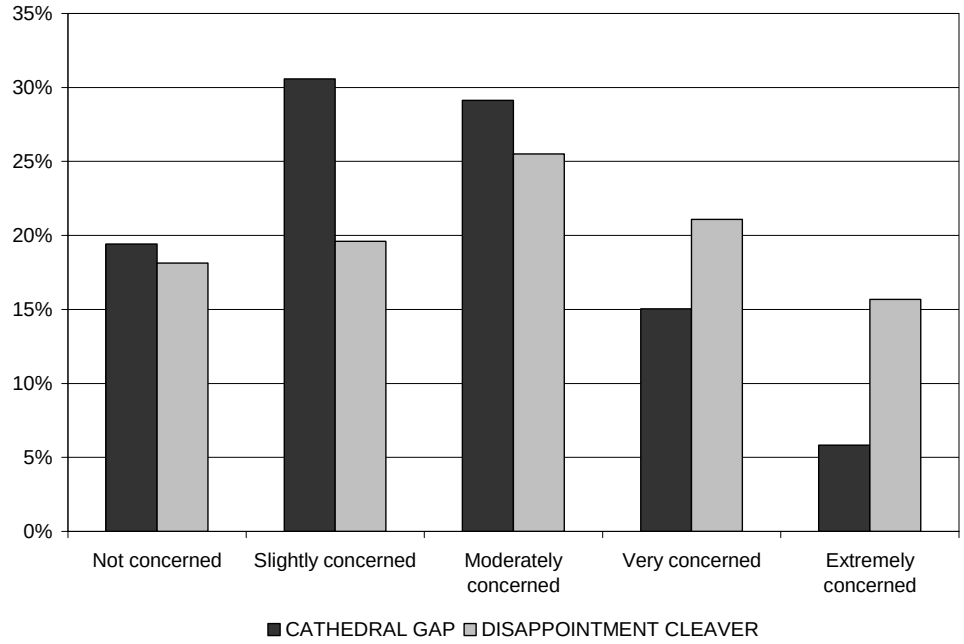

Figure 6. Frequency of Disappointment Cleaver climber responses to rockfall triggered by another group.

Hazards Caused by Other Groups on the Emmons Glacier and Kautz Glacier Routes

Climbers reported less concern about hazards caused by other groups on the Emmons and Kautz Glacier routes than the Disappointment Cleaver route. The Emmons Glacier is a route of moderate steepness that is almost entirely snow and ice, with the exception of the approaches used to reach high camp. This portion of the route received the highest mean response to ***rockfall triggered by another group***, but this mean is still less than the value corresponding to the "slightly concerned" response (Table 12).

Table 12. Mean responses to four categories of hazards on four sections of the Emmons route

	On the approach Q43-6			*In the Corridor Q53-6*		
QUESTIONNAIRE ITEM	*n*	*M**	*SD*	*n*	*M**	*SD*
Rockfall triggered by another group	144	1.65	0.90	111	1.14	0.46
Getting hit by falling climber(s) from another group	143	1.38	0.74	110	1.29	0.64
Avalanche triggered by another group	144	1.32	0.72	111	1.24	0.61
Delay in a hazardous location caused by another group	144	1.50	0.80	110	1.50	0.78

	On the upper mountain Q63-6			*At the Bergschrund Q73-6*		
QUESTIONNAIRE ITEM	*n*	*M**	*SD*	*n*	*M**	*SD*
Rockfall triggered by another group	112	1.13	0.49	95	1.11	0.47
Getting hit by falling climber(s) from another group	112	1.25	0.62	95	1.15	0.50
Avalanche triggered by another group	112	1.22	0.61	95	1.16	0.53
Delay in a hazardous location caused by another group	112	1.40	0.74	94	1.31	0.69

*Items were measured on a five point scale from 1 = "not concerned" to 5 = "extremely concerned"

The Kautz Glacier route is a steeper and more challenging route known for a particularly spectacular and hazardous feature: the Kautz Ice Cliff. To complete the Kautz route, climbers must pass beneath the ice cliff; while doing so they are exposed to potentially lethal releases of seracs calving from the Kautz Glacier. Logically, the category of greatest concern to Kautz climbers was being delayed by other groups beneath the Ice Cliff (Table 13). Eleven Kautz respondents stated they were not concerned, five respondents stated they were moderately concerned, and two respondents stated they were very concerned about being delayed in this location.

Table 13. Mean responses to four categories of hazards on four sections of the Kautz Glacier route. Because of the small sample size of Kautz respondents, confidence intervals of up to +/- 17% are possible for Kautz findings. Findings should be interpreted cautiously.

	While ascending the Fan Q43-6			*Traversing below the Kautz Ice Cliff Q53-6*		
QUESTIONNAIRE ITEM	*n*	*M**	*SD*	*n*	*M**	*SD*
Rockfall triggered by another group	15	1.60	0.74	18	1.72	0.96
Getting hit by falling climber(s) from another group	15	1.47	0.92	18	1.11	0.32
Avalanche triggered by another group	15	1.47	1.06	18	1.44	0.70
Delay in a hazardous location caused by another group	15	1.33	0.72	18	1.89	1.18

	In the Chute Q63-6			*On the upper mountain Q73-6*		
	n	*M**	*SD*	*n*	*M**	*SD*
Rockfall triggered by another group	17	1.53	0.87	14	1.00	0.00
Getting hit by falling climber(s) from another group	17	1.24	0.56	14	1.00	0.00
Avalanche triggered by another group	17	1.18	0.39	14	1.00	0.00
Delay in a hazardous location caused by another group	17	1.53	0.80	14	1.21	0.58

*Items were measured on a five point scale from 1 = “not concerned" to 5 = “extremely concerned"

7.5. Waiting, Difficulty Passing, and Inexperienced Groups

Using the same location descriptions presented in the hazard questions, climbers were asked to identify whether they waited for other groups or had difficulty passing other groups in a given location and how strongly this detracted from their climbing experience. Tables 14, 15, and 16 present the percentage of those climbers who reached the given location who answered yes to the listed response category. Climbers were also asked if causing other groups to wait detracted from their experience, or if they felt “uncomfortable” being passed by other groups.

These questions provided a counterpoint to the questions of primary interest, which related to the experience of delay. Finally, climbers were asked the separate question asking whether they felt concern about the presence of inexperienced groups.

Table 14. Percent of climbers who experienced the following situations on four sections of the Disappointment Cleaver route

	Crossing Cathedral Gap Q47-51		*Passing below the Ingraham Icefall Q57-61*		*On the Disappoint-ment Cleaver Q67-71*		*On the upper mountain Q77-81*	
QUESTIONNAIRE ITEM	*n*	*Yes*	*n*	*Yes*	*n*	*Yes*	*n*	*Yes*
Felt concerned about the presence of inexperienced groups	201	40.8%	197	41.1%	200	48.5%	180	42.8%
Waited for other groups before starting the section	201	37.3%	197	37.1%	201	36.3%	180	34.4%
Felt uncomfortable when passed by another group	202	27.7%	197	28.4%	201	34.8%	179	32.4%
Was behind a slower group and could not pass	203	27.6%	197	28.9%	200	39.5%	179	27.4%
Caused other groups to wait before starting the section	203	21.2%	197	21.8%	201	25.3%	181	22.7%

Table 15. Percent of climbers who experienced the following situations on four sections of the Emmons Glacier route

	On the approach Q47-51		*In the Corridor Q57-61*		*On the upper mountain Q67-71*		*At the Bergschrund Q77-81*	
QUESTIONNAIRE ITEM	*n*	*Yes*	*n*	*Yes*	*n*	*Yes*	*n*	*Yes*
Felt concerned about the presence of inexperienced groups	146	40.4%	111	33.3%	112	22.3%	94	14.9%
Waited for other groups before starting the section	145	32.4%	111	27.9%	112	18.8%	95	12.6%
Felt uncomfortable when passed by another group	145	31.7%	111	25.2%	112	16.1%	93	5.4%
Was behind a slower group and could not pass	145	22.8%	111	23.4%	111	7.2%	95	4.2%
Caused other groups to wait before starting the section	146	21.2%	111	14.4%	111	13.5%	95	6.3%

Table 16. Percent of climbers who experienced the following situations on four sections of the Kautz Glacier route. Because of the small sample size of Kautz respondents, confidence intervals of up to +/- 17% are possible for Kautz findings. Findings should be interpreted cautiously.

	While ascending the Fan Q47-51		*Traversing below the Kautz Ice Cliff Q57-61*		*In the Chute Q67-71*		*On the upper mountain Q77-81*	
QUESTIONNAIRE ITEM	*n*	*Yes*	*n*	*Yes*	*n*	*Yes*	*n*	*Yes*
Felt concerned about the presence of inexperienced groups	15	6.7%	18	27.8%	17	0%	15	0 %
Waited for other groups before starting the section	15	6.7%	18	27.8%	17	29.4%	15	6.7%
Felt uncomfortable when passed by another group	15	6.7%	18	11.1%	17	5.9%	15	0%
Was behind a slower group and could not pass	15	0.0%	18	16.7%	17	23.5%	15	0%
Caused other groups to wait before starting the section	15	6.7%	18	16.7%	17	5.9%	15	6.7%

Judging from these responses, being delayed by another group is not an unusual experience on the Emmons Glacier or Disappointment Cleaver routes. The Disappointment Cleaver location stands out as a problem area for more than a third of climbers in terms of passing, waiting, and concern about inexperienced

groups. On the Emmons, the approach to the route appears to be more problematic than areas on the route itself. Importantly, 58.2% of Disappointment Cleaver climbers and 47.9% of Emmons climbers indicated that they were delayed or had difficulty passing at some point during their climb.

On the Kautz, more than a quarter of respondents waited for other groups before starting the traverse blow the Ice Cliff and before entering the Chute; both are points encountered soon after departing from the typical high camps for the Kautz route. Again, all conclusions about the Kautz are speculative because of the small sample size of Kautz respondents.

Use Levels and the Probability of Experiencing Delays

For the Disappointment Cleaver and Emmons Glacier, variables *waited for other groups before starting the section* and *was behind a slower group and could not pass* were tested for (logistic) relationships with use level at each of the four locations identified in Tables 14 and 15. I hypothesized that these variables might vary in probability of occurrence with use level. For the Disappointment Cleaver, three independent variables—private use, guided use, and an interaction variable—were included in the logistic regression models. For the Emmons, an aggregate variable for all climbing use was used. A total of eight models (i.e., two dependent variables at four locations) were therefore tested for each route, although the models tested for the Disappointment Cleaver included more predictors (i.e., three independent variables).

Using logistic regression, relationships between climber numbers and the probability of experiencing delays at specific route locations were supported only for waiting for other parties before crossing Cathedral Gap on the Disappointment Cleaver route, and waiting at the approach, waiting to start the

Corridor, waiting on the upper mountain, and waiting at the Bergschrund on the Emmons Glacier route (see Table 17).

Table 17. Coefficients and test statistics for four logistic regression models

Predictor variables = a. number of guided climbers, b. number of private climbers, c. interaction (Emmons analysis uses only b.)

Predicted Condition	Constant		*β**	Chi-Sq *p*-value	Hosmer & Lemeshow	% classified
Q 47. Waited at Cathedral Gap (Disappointment Cleaver)	-11.343	a.	0.268	0.002	0.474	58.0%
		b.	0.127			
		c.	-0.003			
Q47. Waited on the approach	-1.82	b.	0.022	0.006	0.07	61.7%
Q57. Waited in the Corridor	-2.69	b.	0.033	0.001	0.172	68.5%
Q67. Waited on the upper mountain	-2.82	b.	0.025	0.011	0.195	68.8%
Q77. Waited at the Bergschrund	-3.48	b.	0.027	0.018	0.274	75.8%

Missing cases deleted listwise

I then elected to test two aggregate variables: ***waited at some point on the route***, and ***waited or had difficulty passing at some point on the route***. Use levels were significant predictors of both the likelihood of waiting for other climbers at some point on both routes and the likelihood of experiencing any kind of delay at some point on both routes. Again, analysis for the Disappointment Cleaver used three independent variables—guided use, private use, and an interaction variable—and Emmons analysis used only an aggregate variable for total climbing use. In the aggregate, climber numbers did increase the probability of experiencing congestion on both the Disappointment Cleaver and Emmons Glacier routes (Table 18).

Table 18. Coefficients and test statistics for four logistic regression models

Predictor variables = a. number of guided climbers, b. number of private climbers, c. interaction (Emmons analysis uses only b.)

Predicted Condition	Constant		*β**	Chi-Sq *p*-value	Hosmer & Lemeshow	% classified
Waited at some point on the Disappointment Cleaver	-8.93	a.	0.213	<.001	0.158	60.0%
		b.	0.133			
		c.	-0.003			
Waited or had trouble passing at some point on the Disappointment Cleaver	-7.58	a.	0.184	0.004	0.704	58.8%
		b.	0.106			
		c.	-0.002			
Waited at some point on the Emmons Glacier	-1.70	b.	0.031	<.001	0.297	62.2%
Waited or had trouble passing at some point on the Emmons Glacier	-1.33	b.	0.026	0.002	0.228	61.3%

Missing cases deleted listwise

Interpreting the results for Emmons Glacier climbers is straightforward. As the number of climbers increases, the probability that climbers will experience some sort of delay also increases (Figure 7). Two records were dropped from this analysis because the number of permitted climbers on their summit day was very low: 4 and 7. The range for all other records was from 21 to 124.

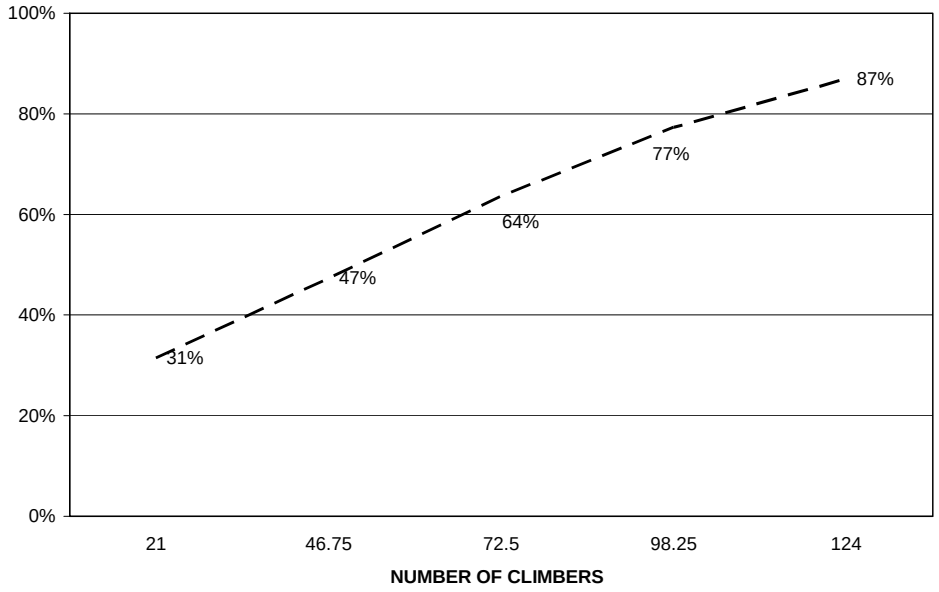

Figure 7. Probability that Emmons Climbers will be delayed by other climbers at some point during their climb. This graph represents the range of climbing use that was reported during sample days, eliminating two records (4 other climbers, 7 other climbers).

The Disappointment Cleaver model is more complex. This model included separate variables for guided and private climber numbers and includes a statistically significant negative interaction variable. Guided use was more consistent than private use across the course of the week, showed a narrower range of use levels across the season, and was not significantly correlated with private use ($p = .21$). Overall, increasing use of either type was associated with higher probabilities of delay, but certain mixes of use yielded unexpected results (Figure 8).

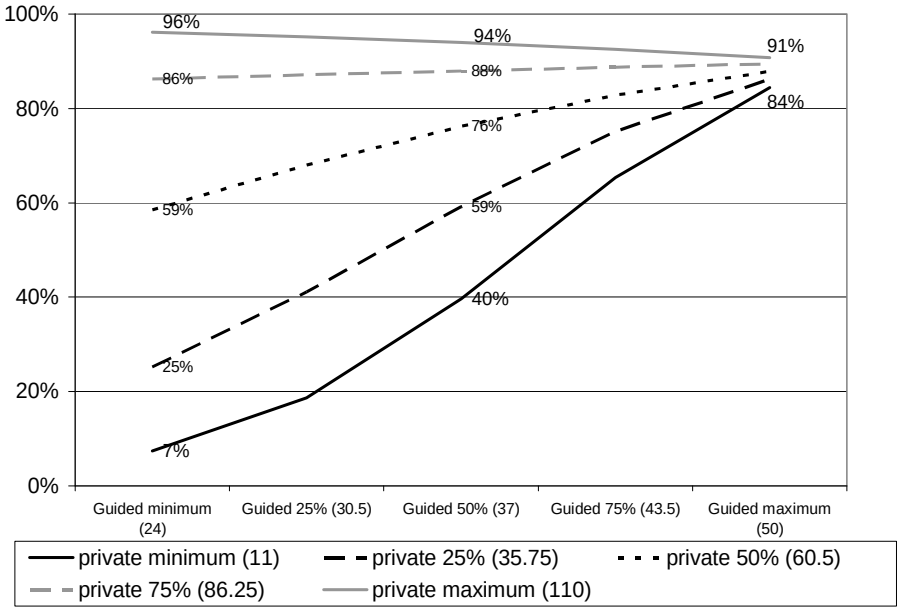

Figure 8. Probability that private climbers will experience one or more delays at some point during their climb at different level of private and guided use. This graph represents the range of climbing use that was reported during sample days.

When private use was low, increasing levels of guided use had a strong impact on the probability of experiencing delays, all else being equal. If guided use was held constant, higher levels of private use resulted in greater probabilities of experiencing delay, as anticipated. Due to the negative interaction variable, probabilities of experiencing delays converged when both private and guided use was near its observed maximum. Increasing guided use, for example, had relatively little impact once private use was at its maximum, and the probability of experiencing a delay was predicted to ***decrease*** slightly with increasing guided use on those days where private use was at its maximum.

An additional conclusion from this data is that waiting at least once on the Disappointment Cleaver was very common. This presents a challenge for

standard setting, because a majority of climbers experienced at least one delay on a majority of days. Only the lowest combinations of guided and private use result in predictions of fewer than 50% of climbers experiencing a delay at least once during their trip. Simply put, there appears to be no readily defensible standard that would not result in an "out-of-standard" condition under 2004 use levels.

An additional variable for Disappointment Cleaver climbers was therefore explored. This took the form of the next level of delay frequency, the occurrence of two or more delays. Experiencing two or more delays, either from difficulty passing or from waiting for other groups, was reported by 43.4% of Disappointment Cleaver climbers. Again using binary logistic regression, the relationship between use levels (guided, private, and an interaction variable) and waiting two or more times during the climb was found to be statistically significant (Table 19).

Table 19: Coefficients and test statistics for one logistic regression model

Predictor variables = a. number of guided climbers, b. number of private climbers, c. interaction

Predicted Condition	Constant		β*	Chi-Sq *p*-value	Hosmer & Lemeshow	% classified
Was delayed at least twice during the climb	-7.34	a.	0.164	.001	0.164	58.4%
		b.	0.084			
		c.	-0.002			

Missing cases deleted listwise

Although the model was strongly significant, the interaction term was weakly significant (p = .087). An alternative model not employing the interaction term was examined, but this model appeared to fit the data poorly (Hosmer & Lemeshow = .039). Because the interaction term played an important role in the previous model and in this one, it was retained.

The interaction term again causes probabilities of experiencing two or more delays to converge at high combinations of private and guided use (Figure 9).

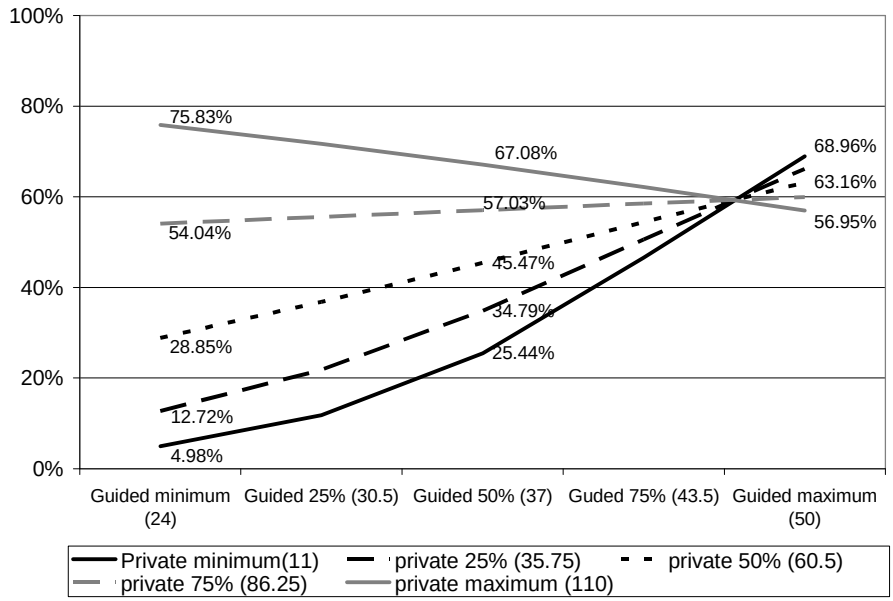

Figure 9. Probability that private climbers will experience two or more delays at some point during their climb at different level of private and guided use. This graph represents the range of climbing use that was reported during sample days.

As in the model based on one or more instances of delay, increasing levels of guided use has the curious effect of reducing the probability that private climbers will experience two or more delays when private use is near its observed maximum.

Impact of Delays and Inexperienced Groups on Experience Quality

Disappointment Cleaver

For Disappointment Cleaver climbers, the Cleaver and the area beneath the Ingraham Icefall were the locations where waiting, problems passing, and presence of inexperienced climbers were judged to detract most from their experiences; mean responses correspond to just above the "detracted slightly"

response level (Table 20). Other mean responses fell somewhat below this threshold, and no mean responses reached the "detracted moderately" response level.

Table 20: Mean responses to delay categories at four locations on the Disappointment Cleaver route

	Crossing Cathedral Gap Q47-51				*Passing below the Ingraham Icefall Q57-61*			
QUESTIONNAIRE ITEM	*n*	*M**	*SD*	*SE*	*n*	*M**	*SD*	*SE*
Waited for other groups before starting the section	75	1.85	0.93	0.11	74	2	1.01	0.12
Caused other groups to wait before starting the section	43	1.65	0.92	0.14	44	1.6	0.84	0.13
Was behind a slower group and could not pass	56	1.82	0.99	0.13	58	2.1	1.07	0.14
Felt uncomfortable when passed by another group	56	1.45	0.81	0.11	57	1.5	0.8	0.11
Felt concerned about the presence of inexperienced groups	82	1.91	1.07	0.12	83	2	1.12	0.12
	On the Disappointment Cleaver Q67-71				*On the upper mountain Q77-81*			
	n	*M**	*SD*	*SE*	*n*	*M**	*SD*	*SE*
Waited for other groups before starting the section	73	2.11	1.01	0.12	62	1.7	0.85	0.11
Caused other groups to wait before starting the section	51	1.78	0.9	0.13	41	1.5	0.75	0.12
Was behind a slower group and could not pass	79	2.15	0.98	0.11	49	2	0.96	0.14
Felt uncomfortable when passed by another group	70	1.6	0.86	0.1	58	1.5	0.84	0.11
Felt concerned about the presence of inexperienced groups	97	2	1.13	0.11	78	1.7	0.89	0.1

* Items were measured on a four point scale from "1 = did not detract" to "4 = detracted greatly"

In terms of waiting, 28% and 34% of Disappointment Cleaver climbers felt that the waits they experienced at least moderately detracted from their experience at the Ingraham Icefall and Disappointment Cleaver, respectively (Figure 10).

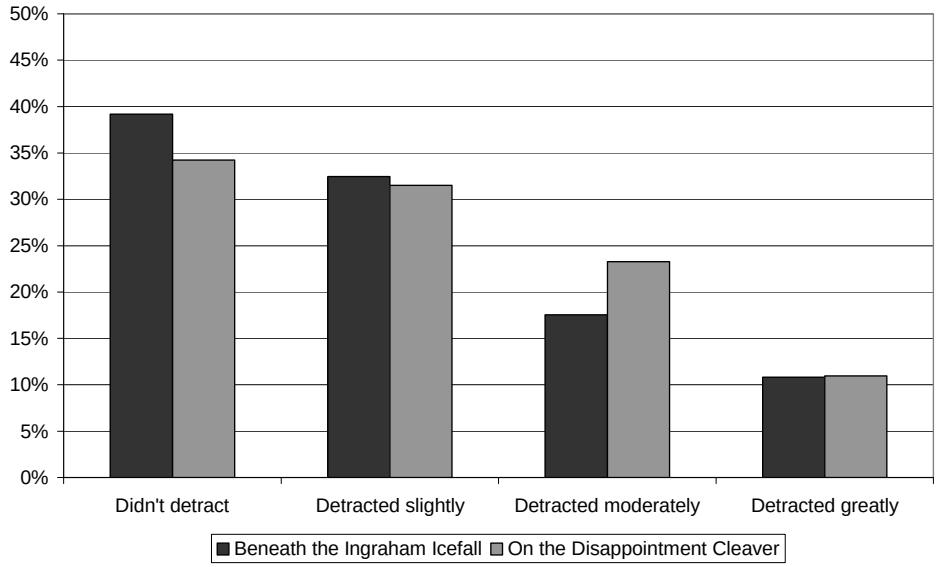

Figure 10. Frequency of Disappointment Cleaver climber responses to waiting for other groups before starting the route section

Likewise, 34% of climbers at the Ingraham Icefall and 38% at the Cleaver felt that difficulty passing other groups detracted at least moderately from their experiences (Figure 11).

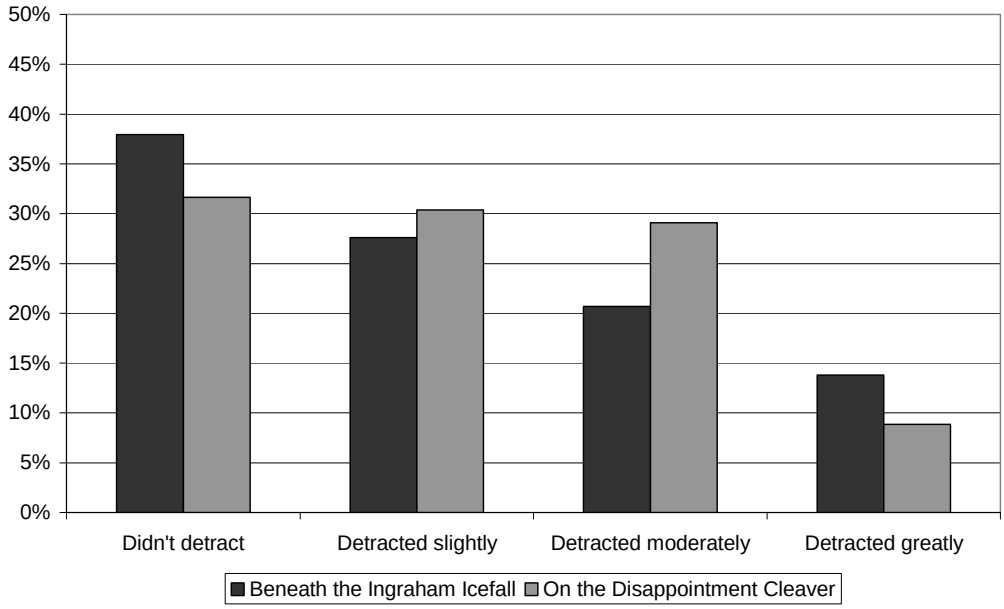

Figure 11. Frequency of Disappointment Cleaver climber responses to having difficulty passing slower groups on route section

Showing a different distribution, climbers' responses to the presence of inexperienced groups showed that while most climbers were minimally bothered by the presence of inexperienced groups, a minority of climbers (16-17%) found inexperienced climbers detracted greatly from their experiences at these locations (Figure 12). It should be noted that the interpretation of other climbers as "inexperienced" was left to the subjective judgment of the respondent, and should be viewed as a belief about a problem rather than as an objective measure of climber experience levels.

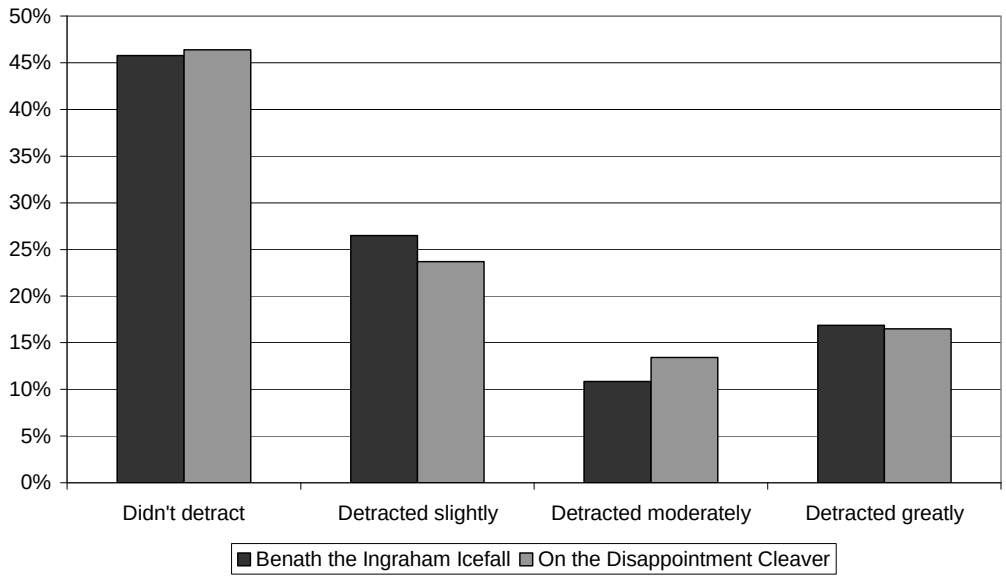

Figure 12. Frequency of Disappointment Cleaver climber responses to concern about the presence of inexperienced groups on route section

Emmons Glacier

On the Emmons, none of the reported incidents, on average, was evaluated at or above the "detracted slightly" response level. The highest mean response represented only 7% of climbers (those who could not pass a slower group on the upper mountain). Waiting for other groups before starting the Corridor was perhaps the most important concern in terms of frequency and severity of impact (Table 21).

Table 21: Mean responses to delay categories at four locations on the Emmons Glacier route

	On the approach Q47-51				*In the Corridor Q57-61*			
QUESTIONNAIRE ITEM	*n*	*M**	*SD*	*SE*	*n*	*M**	*SD*	*SE*
Waited for other groups before starting the section	47	1.57	0.58	0.08	31	1.8	0.75	0.13
Caused other groups to wait before starting the section	31	1.45	0.57	0.1	16	1.4	0.5	0.13
Was behind a slower group and could not pass	33	1.55	0.67	0.12	26	1.7	0.84	0.16
Felt uncomfortable when passed by another group	46	1.22	0.51	0.08	28	1.3	0.46	0.09
Felt concerned about the presence of inexperienced groups	59	1.69	0.88	0.11	37	1.6	0.77	0.13
	On the upper mountain Q67-71				*At the Bergschrund Q77-81*			
	n	*M**	*SD*	*SE*	*n*	*M**	*SD*	*SE*
Waited for other groups before starting the section	21	1.52	0.6	0.13	12	1.6	0.51	0.15
Caused other groups to wait before starting the section	15	1.4	0.51	0.13	6	1.7	0.52	0.21
Was behind a slower group and could not pass	8	1.88	0.99	0.35	4	1.3	0.5	0.25
Felt uncomfortable when passed by another group	18	1.33	0.59	0.14	5	1	0	0
Felt concerned about the presence of inexperienced groups	25	1.4	0.71	0.14	14	1.4	0.74	0.2

* Items were measured on a four point scale from "1 = did not detract" to "4 = detracted greatly"

A majority of Emmons climbers who waited for other climbing groups in the Corridor found it to be negative, but few found the experience to detract more than slightly from the quality of their climbing experience (Figure 13).

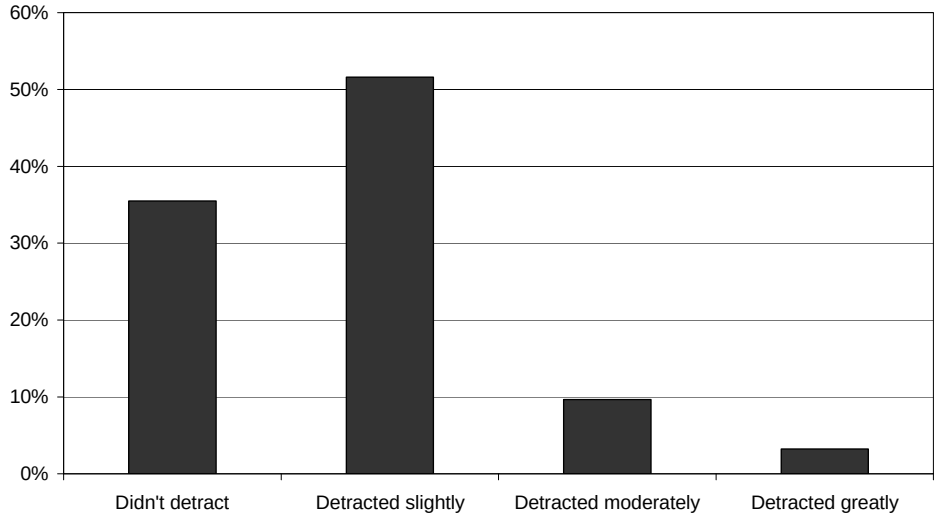

Figure 13. Frequency of Emmons Glacier climber responses to waiting for other groups before starting the route section (the Corridor).

Kautz Glacier

On the Kautz, the small number of respondents is not a sufficient basis to accurately represent the likely responses of all Kautz climbers to the survey questions concerning delays.

7.6. Relationship between Hazards Caused by Other Groups and the Impact of Delays on Climber Experience Quality

Neither climber motivation nor measures of climbing use were found to predict climber reactions to delays using linear regression technique. However, climbers' assessment of concern about rockfall (from not concerned to extremely concerned) was found to be a significant linear predictor of their assessment of waiting and difficulty passing at a number of locations (from 1 = did not detract to 4 = detracted greatly).

On the Disappointment Cleaver, climbers' concern about rockfall significantly predicted their response to delays at Cathedral Gap, beneath the Ingraham Icefall, and on the Disappointment Cleaver (Table 22). Models are fairly weak, explaining 6% to 19% of response variation.

Table 22: Relationship between concern about rockfall from other groups and evaluation of waiting or having difficulty passing other groups

Predictor variable = concern about rockfall caused by another group

Predicted Response		Constant	β	F	p-value	R^2
Detraction due to waiting	Q47. at Cathedral gap	1.248	0.211	4.356	0.040	0.058
	Q57. beneath the Ingraham Icefall	1.254	0.274	10.683	0.002	0.134
	Q67. on the Disappointment Cleaver	0.998	0.319	12.68	0.001	0.153
Detraction due to difficulty passing	Q49. at Cathedral gap	0.714	0.391	11.975	0.001	0.187
	Q59. beneath the Ingraham Icefall	1.415	0.255	5.701	0.021	0.097
	Q69. on the Disappointment Cleaver	1.369	0.221	5.755	0.019	0.070

Because hazards were judged to be of limited concern to Emmons climbers, similar relationships were not examined for those data. Likewise, the small size of the Kautz sample was not sufficient for this analysis.

Chapter 8. Limitations

8.1. Potential Response Bias

The most significant limitations of this study are 1) the undocumented, but possibly high refusal rate in the first two of four sampling periods, and 2) the modest total response rate of the latter two well-documented sample periods. A variety of tests were conducted to test for potential bias in the selection of respondents (Appendix B). While these tests did not conclusively identify any response bias, I cannot rule out the possibility that such bias exists.

However, there is no obvious connection between the reasons climbers would choose to participate or not in this study and the types of information that forms the backbone of my recommendations. Thus, there is no indication that response bias had an effect that would alter the interpretation of my principal findings.

One line of questioning was eliminated from analysis because of the theoretical potential for bias. This was a set of questions that related to climbers' opinions about use limits as potential solutions to capacity problems. My results showed moderate to strong support for use limits. However, it seems reasonable to believe that respondents (those willing to "help" the Park Service) by completing the questionnaire, would be more prone to support restrictive management actions. Although this relationship is not verifiable from the data, these questions were eliminated from analysis.

8.2. Loss of RMI Data

Another obvious limitation of this study was the loss of data from clients of Rainier Mountaineering Inc. I encountered a similar problem with low recruitment and poor documentation with RMI clients as with private users, but was not able

to rectify this problem in the last two samples. I therefore lacked a means of examining, even in a tentative way, the potential for response bias. Rather than create greater doubts about the validity of my findings, I elected to eliminate RMI records from my analysis and limit the study conclusions to non-guided climbers. This is an important limitation for park managers wishing to select indicators and set standards on the Disappointment Cleaver, where as many as a third of climbers are believed to be guided.

8.3. Model Weakness

As a rule, the linear and logistic models that were found to be statistically significant were not found to explain a high percentage of the total response variation. As Chapter 4 mentioned, this has been a limitation of many studies in outdoor recreation. The reason seems clear: there are many factors unrelated to visitor use that influence both the probability that climbers will observe or experience certain conditions and the reactions climbers have to those conditions. For example, weather and snow conditions could contribute to the probability of delays, and personal attributes (e.g., impatience) not examined in this study could contribute to the evaluation of delays.

However, this is does not suggest that the Park Service should ignore the role that visitor use plays in these relationships. The Park Service has no control over the weather, snow conditions, or visitors' personal characteristics, but the agency can control visitor use and behavior to some degree. And they are obligated to do so to meet their requirement to establish visitor carrying capacities.

8.4. Use of Permit Data to Estimate Use Level

An additional reason for the weakness of some visitor use models is that no direct measure of visitor use was available. As discussed in Chapter 6 Methods, my

measure of climber use was based on the number of permitted climbers in the zone on the day that my respondents attempted the summit. It is believed that this number correlates with the number of climbers that attempted the summit that day, but it is not a direct measure. For example, many climbers might be permitted in the zone on a given day, but poor weather could result in few parties departing for the summit.

Because I looked at congestion on a smaller scale, at the level of route area, even an accurate measure of summit attempts on a given day would not perfectly correlate to congestion at a specific time and place. I believe that weak models resulted in part from this relatively crude measure of use. More exacting information about use, I speculate, would result in models that better explain the total variation in responses.

On the other hand, the Park Service relies on permit data as an ongoing measure of use. Although it would benefit statistical tests to model use with highly accurate visitor use data, the agency will likely rely on imperfect measures of use to estimate use density in the future.

8.5. Small Kautz Sample Size

Kautz climbers were sampled during the same sampling periods as DC climbers. Because very few climbers attempt the Kautz compare to Disappointment Cleaver climbers, few (30) respondents were obtained for the Kautz, while a much larger sample was obtained for the DC (264). As a result, data obtained for Kautz climbers has a confidence interval as high as +/-17%, if calculated on a 50% response split. All data from the Kautz sample must be viewed as speculative. This also points out a special limitation for the Kautz: future research must sample

a much larger number of days to obtain a Kautz sample with a narrower confidence interval and large enough to perform more complex statistical procedures, such as regression techniques.

Chapter 9. Discussion

In Chapter 2 it was noted that the desired future condition descriptions for the high use and moderate use climbing zones identify several important experience opportunities that would be available under the post-2001 management prescriptions. Climbers would have the opportunity to experience challenge, self-reliance, and adventure, and would need to use mountaineering skills to cope with the inherent dangers of the mountain environment. In the high use zone, opportunities for solitude would be uncommon; in the moderate use zone, there would be many opportunities for solitude, but also the potential for much social interaction.

My findings suggest that current Disappointment Cleaver climbers agree that solitude is not an important experience opportunity compared to other aspects of climbing. For the high use zone, congruence between climbers' desired experiences and the desired future conditions for the management zone supports the selection of an indicator or indicators other than encounter numbers.

The case of the moderate use zone is more complex. My findings suggest that climbers on Kautz and Emmons routes have different attitudes about solitude. Emmons climbers, like Disappointment Cleaver climbers, did not cite solitude as more than a slightly important reason for climbing Rainier. For Emmons climbers, an indicator aimed at monitoring solitude opportunity may not be relevant to their desired experiences. For Kautz climbers, solitude was at least moderately important, and getting away from other people was a moderately or very important reason for choosing the route. This may provide a rationale for considering encounter standards for the Kautz. Although the two routes lie in the

same management zone, the park may benefit from applying a different mix of indicators to the two routes.

9.1. Variables Not Important to Climber Experience Quality

This study examined several aspects of climber experiences that were thought to potentially provide new grounds for indicator development. Some of the variables that were examined did not appear to be important to climber experience quality. For example, I speculated that observing route markings, signs of other climbers, other climbers ahead on the route, and a compacted path in the snow might detract from the enjoyment of route finding because self-reliance and use of mountaineering skills were identified as important aspects of the climbing experience. My results suggest that although self-reliance and use of skills are important, and although many climbers observe route markings and other evidence of climbing use, these conditions were not considered more than slightly detrimental to experience quality.

9.2. Human Waste and Garbage Sightings

Human waste sightings and garbage sightings remain an issue on all three routes despite many years of effort by climbing rangers to deal with these problems[12]. Sighting human waste was particularly common and bothersome on the Emmons route according to the findings of this study.

For these problems, the park can take one of two approaches regarding indicators. First, the park could select VERP indicators based on human waste or garbage.

[12] The findings of this study should not be interpreted as an evaluation of the success of the management program for human waste and refuse. No attempt was made in this study to draw a comparison of current conditions to conditions that existed in the past.

Based on this study, the indicators, a) ***percent of parties who observe human waste during the peak season,*** and b) ***percent of parties who observe garbage during the peak season,*** would be most appropriate. The park would then need to set a standard for waste sightings, and be willing to take additional action beyond its current management to solve these problems if the standard was exceeded. My findings suggest that use levels on the Disappointment Cleaver and the Emmons Glacier routes do not predict the frequency of human waste or garbage sightings. Therefore, based on this data, reducing use levels would not be a defensible solution to human waste or garbage sightings. Given that the park already has banned improper human waste disposal and littering on these routes, and has an active education program related to human waste, it is not clear what other management actions would be effective in reducing waste or garbage sightings (other than enlarging current efforts).

I argue that a second approach is more consistent with the park's current management and the findings of this study. This is to view human waste and garbage sightings as a compliance problem rather than a capacity problem. In essence, by banning improper human waste disposal and littering, the park has decided that no amount of garbage or human waste is acceptable. A process such as VERP is unnecessary when a management goal (i.e., to reduce or eliminate human waste sightings) will not be compromised (Cole & Stankey 1997). The goal now is not to identify the appropriate balance between visitor capacity and resource conditions, but to maximize compliance with the current regulations.

If the park elects to view human waste sightings as a compliance problem rather than a capacity problem, then VERP indicators for human waste or garbage sightings are not appropriate. However, VERP is not the only context in which monitoring can be useful. In this case, the information provided in this study can

be viewed as a 2004 baseline, and human waste and garbage sightings could be monitored as a means to evaluate the success of the management programs that are already in place. The park may use the findings of this study as a rationale for increasing management efforts on one or more of the routes in this study, but need not set (or violate) a standard in order to justify this action.

9.3. Privacy and Discussion with Other Groups in Camp

Weak evidence suggests that for private Disappointment Cleaver climbers guided use may contribute to the probability of experiencing a loss of privacy in camp and the probability of having a discussion with other groups. Other private use did not appear to have the same effect. The reason for this is not clear from the results of this study, but it does support the conclusion that more between-group interaction occurred when guided use was high.

Other research has noted conflict relationships, often asymmetric, between user groups (e.g., hikers object to stock users, cross country skiers object to snowmobilers) that may be based on perceptions (accurate or inaccurate) of other users that are apart from any specific on-site interactions (Jacob & Schreyer 1980, Watson et al. 1993, Watson 2001). Anecdotal information suggest that some private climbers object to guided use or find guided parties bothersome (Gauthier, M., personal communication March 2004). It is also possible that some on-site behaviors, perhaps related to the larger size of some guided parties or their high visibility, contribute to the feeling of diminished privacy on the part of private climbers. Research that provides a better understanding of the source of conflict (if any) between guided and private climbers could be useful to park managers if they wished to mitigate this conflict. However, as the previous discussion suggests, such conflict may not be a capacity problem. The argument presented in this discussion is that solitude is less important to Emmons and Disappointment

Cleaver climbers than other experiential goals. And, neither loss of privacy nor discussion with other groups was reported as a strongly negative experience. Moreover, there are practical reasons why climbers should be concentrated in designated camps (e.g., to facilitate human waste management). Taken together, managing for privacy in camp would appear to be inconsistent with other management objectives. An indicator based on this variable is therefore not recommended.

9.4. Climber-caused Hazards

Concern about hazards caused by other climbers does not appear to be a capacity issue, because use levels were not found to be significant predictors of climber concern about hazard on either the Emmons Glacier or Disappointment Cleaver routes. However, a better understanding of climber-caused hazard could be of interest to managers because of the finding that concern about human-caused rockfall is related to negative evaluation of delays. Moreover, the park may have an interest in managing these hazards for safety benefits apart from climbers' subjective concerns. Future research might rely on more objective means of collecting data about climber-induced hazards rather than the subjective, experience-oriented approach taken in this study.

The relationship between delays and objectively-measured hazards could be better explored in a study that focused strictly on those factors. While the current study shows that climbers more strongly object to delays when they also perceive a hazard, future research could examine the possibility that increased delay times are perceived of as increasing exposure to hazards, human-caused or natural. It is believed that this is the case, and that this fact adds importance to delays as a management focus beyond the impact on experience quality noted in this study.

9.5. Delays Caused by Other Groups

The most promising direction for indicator development identified in this study focuses on the occurrence of delays caused by other groups from waiting or the inability to pass. The probability of delays is at least in part predicted by climber numbers, and is therefore demonstrated to be a capacity issue. These events are common enough to be of concern to managers, and climbers respond to these events negatively, although not strongly under current conditions. Delays in certain locations may also expose climbers to objective hazards or hazards from other climbers.

Three variables examined in this study were shown to be related to climbing use and to the quality of climber experiences. These are the a) ***percent of climbers who experience one or more delays during their climb*** on the Disappointment Cleaver, b) ***percent of climbers who experience two or more delays during their climb*** on the Disappointment Cleaver, and c) ***percent of climbers who experience one or more delays during their climb*** on the Emmons Glacier route. For reasons discussed below, indicators b) and c) are recommended.

However, while the findings of this study strongly support the occurrence of delays as a basis for indicator development, there are important limitations to these specific formulations that require an adaptive approach if managers are to employ them. First, there are alternative measures of delay that may better relate to the quality of climber experiences. Second, the data on which the Disappointment Cleaver models are based are incomplete because of the loss of RMI data. Both of these issues are an argument for applying these indicators cautiously, by a) setting standards based on current conditions, b) using monitoring information to refine indictors and standards, and c) considering additional, focused data collection to

gather guided climber data and examine alternative measures of delay as potential indicators.

Choosing standards for delay

In setting a standard, park managers must first make a judgment about the acceptability of current conditions. If there is consensus among managers and the affected public that a problem needs to be addressed immediately, then managers may choose a standard that is more stringent than current conditions. If managers have sufficient information to believe that a problem will not reach an unacceptable condition until some future time, then a more relaxed standard could be set. Often, managers choose the practical approach of limiting impacts to current conditions. Conditions are prevented from becoming worse, but politically unpopular management actions are not immediately necessary.

While the judgment about the acceptability of current conditions is ultimately left up to park managers and the public, I do not interpret this study's data as an indication that current conditions are unacceptable. Given this and the lack of data on guided climbers' delay experiences, setting a standard based on current conditions would be a cautious and reasonable approach.

Relationship between standards and days exceeding standards

The result of selecting a given indicator and a standard based on current conditions was evaluated by inputting the use level estimates obtained from 2004 permit data for each day during the months of July and August into each logistic regression model predicting probability of delay. In this way one can estimate the percent of days that would be within standard under July and August 2004 conditions. This matches a common formula used for VERP standards: No more than X% of visitors will experience a given condition on X% of days.

Figure 14 shows the relationship between potential standards and percent of days within standard for the indicator ***percent of climbers who experience one or more delays*** on the Disappointment Cleaver.

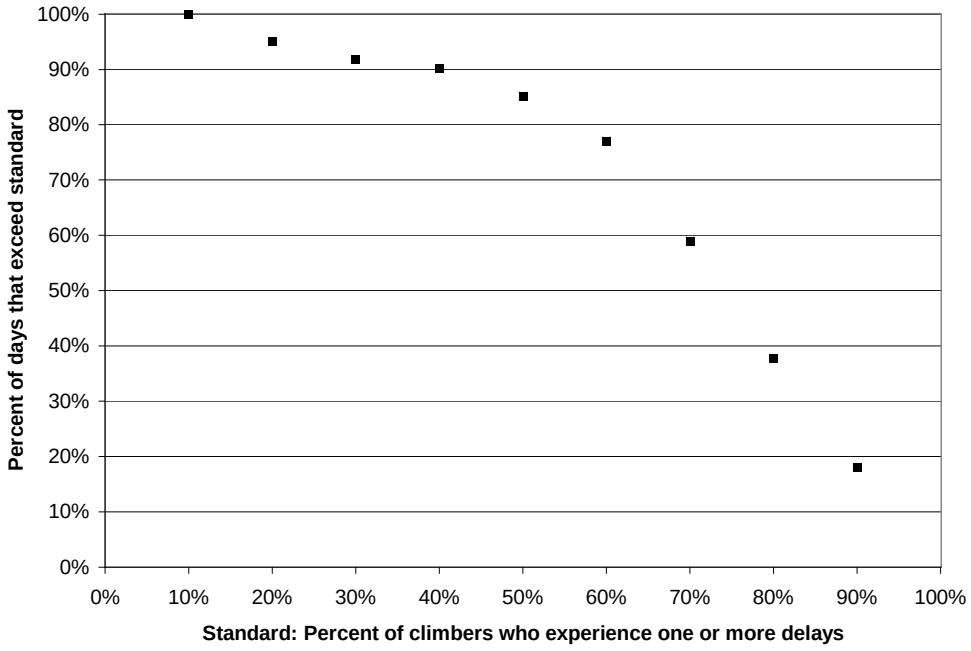

Figure 14. Relationship between potential standards and predicted percentage of days that exceed standard for the indicator *percent of climbers who experience one or more delays on the Disappointment Cleaver*.

Again, it is clear that delays are very common on the Disappointment Cleaver route. This fact limits the usefulness of this indicator, because any standard that protects a majority of visitors on a majority of days would be out-of-standard according to 2004 data, and would therefore require immediate action to reduce delay events. Standards that would result in an in-standard condition for 2004 data are difficult to defend. For example, with this indicator a standard that required that no more than 30% of climbers experienced a delay during their climb would

be violated on 92% percent of peak season days (given 2004 use levels). And, in order to be in standard on at least half of all peak season days, more than 70% of climbers would have to be allowed to experience one or more delays.

The indicator *percent* ***of climbers who experience two or more delays during their climb*** offers a more practical means for standard setting. Figure 15 illustrates potential standards and days in violation for this indicator.

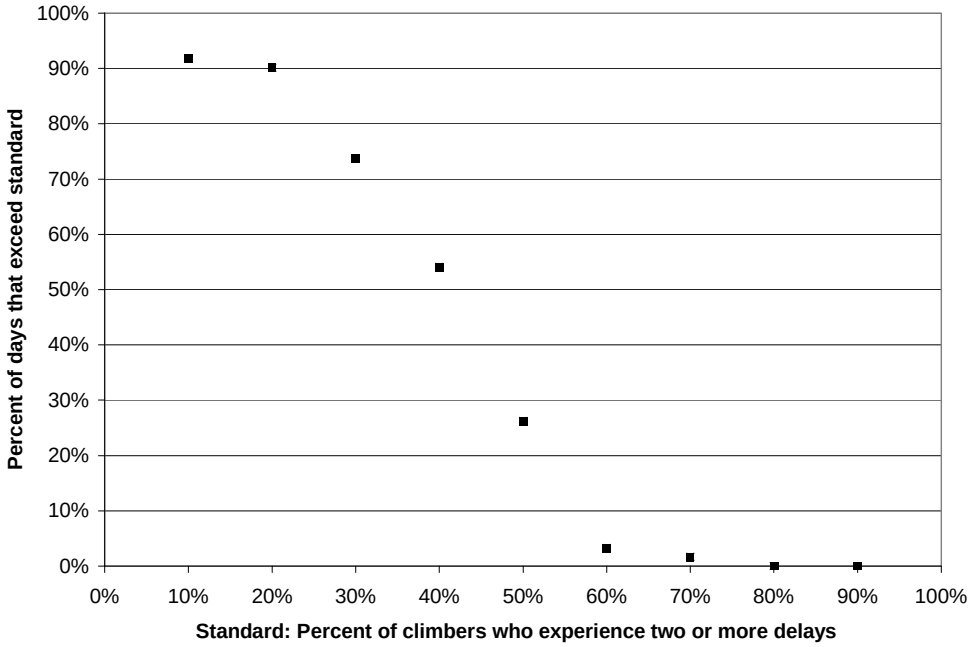

Figure 15. Relationship between potential standards and predicted percentage of days that exceed standard for the indicator ***percent of climbers who experience two or more delays on the Disappointment Cleaver***.

A large percent of climbers still experience two or more delays on many peak season days. However, the percent of days in violation of standard does not become high (over 70%) until a standard of less than 30% of climbers is established.

A similar distribution exists for Emmons Glacier climbers (Figure 16).

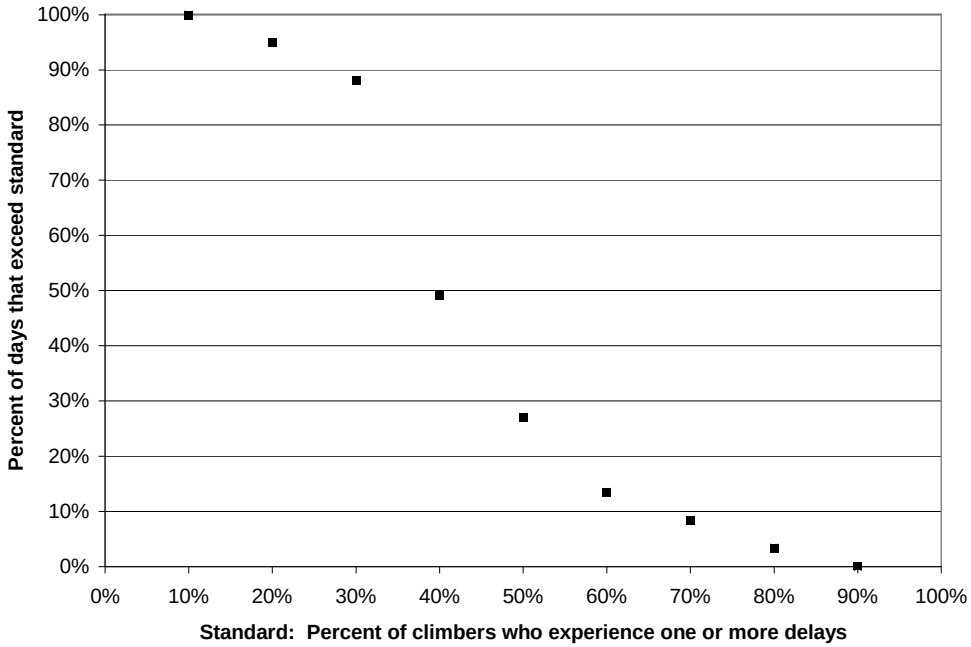

Figure 16. Relationship between potential standards and predicted percentage of days that exceed standard for the indicator *percent of climbers who experience one or more delays on the Emmons Glacier*.

Again, at low standards (less than 40%) a high percentage of peak season days will exceed standard. At moderate standards a majority of days would be in standard.

Any of the points in Figures 14, 15, and 16 represents a potential standard that would allow for the occurrence of delays on peak season days comparable to those associated with 2004 use levels. These standards would allow managers to accept current conditions and prevent delay events from becoming more common.

Implication of missing RMI respondents

As discussed in Chapter 8, this study's findings, including the predicted probabilities of experiencing delays, apply only to private climbers. This creates a challenge for managers faced with supporting indicator selections with this data. It may be argued that an indicator based only on private climber unjustly ignores guided climber concerns, and could conceivably result in restrictive management action that only protects private climber experiences.

Additional research may be necessary to describe the impact of delays on guided climber experiences, and to identify the relationship, if any, between use levels and the predicted probability of guided climber delays. It is anticipated that such a relationship exists, given the common sense connection between the variables: larger numbers of climbers increase congestion which is manifested in delays. Whether guided climber delays are more or less probable than private climber delays at different use levels would need to be determined with additional data collection.

It is assumed that slower parties are less likely to experience delays (and more likely to cause delays) than faster parties. Although we did not analyze data about guided parties, the common perception is that guided parties are often slower than the average private party, due to the larger party size and more limited climbing experience of the guided groups. If these assumptions are true, guided parties may be less likely to experience delays than those climbers on whom the current predictive models are based. If so, one perspective might be that the current models are overly protective by generating higher delay probabilities at given use levels than models that would incorporate guided climbers. A second perspective might be that the model rightly represents the groups most likely to experience the negative impact of congestion.

If the previous assumptions are incorrect, and climbers experience delays in a manner similar to private climbers, then the models in this study may be only slightly changed by the addition of guided climber data.

A third possibility is that guided climbers experience delays more often than private climbers. This is considered unlikely (since guided groups are not believed to be among the fastest groups), but it would imply that a model incorporating guided climber data would generate higher delay probabilities at the same use levels than the current models. Standards based on current use levels and current models would be lax compared to standards based on current use levels and models incorporating guided climber data.

Another issue is whether guided climbers experience the same negative experience impact from delays as private climbers. One line of speculation is that guided climbers share private climbers' objection to delays. A standard based on private climber delay events would work to protect guided climber experiences until additional data about these experiences is obtained. Alternately, guided climbers may not find delays as objectionable as private climbers (or may not recognize certain stops as delays because they are instigated by guides). In this case park managers would need to evaluate whether current conditions are unacceptable from the standpoint of guided climbers. On the other hand, if delays do not detract from guided climbers experiences, this still does not provide a sufficient argument for dismissing the experience impact to private climbers documented in this study.

To summarize, not enough is currently known about delays to guided climbers to predict the outcome of applying the proposed indicators, and standards based on

current conditions, to all climbers on the Disappointment Cleaver. More information is desirable. However, the risks of applying such indicators and standards are minimal. If delays are an important issue for guided climbers, then standards set on private climber data provide short term protection for guided climber experiences. If delays are unimportant to guided climbers, the park may still have justifiable reason to protect private climber experiences using the existing data.

Politically, the commitment to fill gaps in the existing data would demonstrate the park's concern for the experience of guided climbers. Indeed, this study's attempt to collect guided climber data reveals the same concern. The failure to recruit a sufficient number of RMI respondents and to maintain good recruitment records makes clear the special challenge in accessing this population. One approach may be for RMI to allow a trained survey worker to contact guided climbers at their offices (where RMI staff performed recruitment during this study). At a minimum, this would be expected to result in good records of recruitment, even if response rates were not high. A second alternative is to contact climbers at Camp Muir, which is a neutral and public location. This approach worked for the 1985 study (Swearingen & Johnson), although there are obvious environmental challenges associated with Camp Muir.

Another way to allay concern about the impact of the proposed indicator is to begin monitoring the proposed indicators, but to delay standard setting until one or more seasons has elapsed. This would allow time for additional dialogue with all affected groups about how to set an appropriate standard on the Disappointment Cleaver.

Alternative forms of delay indicators

For the reasons discussed above, these proposed indicators may be best viewed as an interim solution until more is understood about delay events and the impact of delays on climber experiences, including guided climbers. For example, these are not the only forms that a delay based indicator might take. Other potential forms for a delay indicator may be ***the average number of delay events that occur to climbers on a given day***, or ***the average reported time lost by climbers due to delay events each day***. A fruitful line of research might determine whether the number of delay events, the time lost from delays, or some other delay variable is most associated with negative evaluations of climber experience quality.

Monitoring delay events and collecting more information about delays could be accomplished using the climber checkout card[13] submitted by each group after their climb. Climbers could be asked if they experienced one or more delays caused by other groups during their climb. Potentially, climbers could also be asked about the number of delays, the total time lost to delays, and how strongly delays detracted from their climbing experience. This could serve to identify the most appropriate form of indicator for delays. In this way managers could begin monitoring the proposed indicator but adapt if new information suggests another indicator is more representative of experience quality.

[13] The climber checkout card is used to ensure that climbers have safely returned from their climbing trip. Some post-trip information is currently collected on this card (e.g., summit success or failure). A small number of additional questions could be included to monitor VERP indicators, provided that the additional burden of answering these questions did not jeopardize the primary purpose of providing for climber safety.

Interpretation of Interaction Variable

The identification of a statistically significant ***negative*** interaction variable was not anticipated for the logistic regression models for Disappointment Cleaver waiting and delays. The anticipated result was that the interaction, if significant, would be positive; the mix of party sizes and speeds (guided groups are believed to be larger and slower than many private groups) was expected to exacerbate congestion. This did not appear to be the case. Instead, interaction appeared to mitigate congestion effects at high levels of guided and private use.

The mechanism that caused this mitigating effect is not clear from the data collected in this study. One possible explanation is that guides shared information about route conditions and planned departure times with other groups that improved private group planning for summit day (such as departure times from high camp), and better enabled private groups to avoid trouble spots—the Ingraham Icefall and Disappointment Cleaver—when other parties were likely to be there. This is consistent with another finding—that having discussion with other groups was more probable when guided use was high. While these interpretations are speculative, the possibility that sharing information about departure times of groups could help Disappointment Cleaver climbers avoid delays is consistent with practice already common among Climbing Rangers, which is to contact groups and discuss their anticipated pace, planned departure time, and possible trouble spots on the route ahead.

An alternative possibility is that at the highest combinations of guided and private use private climbers cease to be delayed because "saturation" has occurred. Saturation refers to the point at which climbers are so evenly distributed along the route that groups give up attempts to pass other groups and become resigned to

the pace established by overall traffic. This study did not investigate the occurrence of this condition or the impact of this condition on experience quality (if it occurs), although it is assumed that this condition would be more objectionable to climber than delays, and would result in even longer exposure to a range of natural and human-caused hazards.

It is also clear that the effects of congestion on climbers could be more completely studied and understood. One potential line of research could examine the effect of use levels on climbers' elapsed times from camp-to-summit. Other condition being equal, climbers mean summit times would be predicted to move later in the day as delays became longer and/or more common. Moreover, if saturation occurred, less variance in camp-to-summit times would be predicted.

Conclusion

The suggestions are not based on infallible data and should be viewed as a reasonable starting point given our current state of knowledge. Monitoring these indicators will generate better information, and an adaptive management approach will allow changes to indicators and standards that better protect visitor experiences. It will be particularly important to integrate information about guided climbers into the indicators and standards that are set for the Disappointment Cleaver.

Additional research could clarify the nature of user group conflict, if any exists, between guided and private climbers. Also, research aimed at objectively measuring the relationship between human caused hazards and user capacity might produce more meaningful results than the subjective approach used in this study. Research specifically aimed at gathering information about guided climbers, and

about investigating alternative delay indicators, is perhaps the most pressing need for park managers to implement VERP in the climbing zones.

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Appendix A. Analysis of Potential Response Bias

A series of tests was conducted to analyze potential nonresponse bias in the samples of Disappointment Cleaver and Emmons Glacier climbers. Figure A1 identifies the variables that were used to make comparisons between respondents and the population, respondents and contactees, respondents and non-respondents, and respondents in one aggregated sample to respondents in another aggregated sample.

	DATA SOURCE				
	POPULATION	*CONTACT DATA*		*SAMPLES 1 & 2*	*SAMPLES 3 & 4*
	PARTY	*PARTY*	*INDIV.*	*INDIV.*	*INDIV.*
Party size	X	X	X	X	X
Location of origin	X			X	X
Gender				X	X
Previous Rainier experience				X	X
Education level				X	X
Age				X	X

Table A1. Variables, data sources, and unit of analysis (individual or party)

Party Size Analysis

No Seasonal Variation in Party Size

I first wished to know if the Disappointment Cleaver and/or Emmons Glacier populations showed a true variation in party size across the summer season. Permit data was divided into four periods that coincided with sampling periods (7/1-7/11, 7/12-7/31, 8/1-8/16, and 8/17-8/31) to allow for later comparison with samples, if desired. One-way comparison of means shows no significant difference in the average size of parties across temporal population periods for either the Disappointment Cleaver ($F(3, 267) = 2.21$, $p > .05$) or the Emmons

Glacier ($F(3, 187) = .98$, $p > .05$) populations. Both populations were therefore treated as a homogenous group for all subsequent party size comparisons.

No Difference in Average Party Size for Respondents/Non-respondents

Using contact data, respondents and non-respondents were then compared by average of climber's reported party size, an average of the *individual* responses to the party size query in the contact questionnaire. For the aggregated samples 3 and 4, in which the refusal rate was near zero, no difference was detected for this variable between respondents and non-respondents in either the Disappointment Cleaver ($t(220) = -1.30$, $p > .05$) Emmons Glacier ($t(167) = -.47$, $p > .05$).

No Difference in Average Party Size for Respondents/Contactees

I wished to determine if there was a difference between the "average party size" of contactees and the "average party size" of the population. Again, I compared the aggregated contactee samples 3 and 4 to the population with the *group* variable "average party size". No significant difference was detected between the aggregated sample and the population for the season for Disappointment Cleaver data ($t(75) = 5.43$, $p > .05$) or Emmons Glacier data ($t(49) = -6.36$, $p > .05$). This bolsters my confidence in the representativeness of these two samples

No Difference in Average Party Size for DC Contact Samples; Significant Difference for Emmons Contact Samples

Using contact data, no difference in "average of climber's reported party size" was identified between combined sample periods 1 and 2 and combined sample periods 3 and 4 for the Disappointment Cleaver sample ($t(425) = -1.53$, $p > .05$). However, employing contact data from the Emmons samples, a significant difference was detected between aggregate samples 1 and 2 and aggregate samples 3 and 4 ($t(240) = 2.31$, $p < .05$).

No Difference in Average Party Size for Response Samples

A second analysis was performed using response data; this analysis revealed no difference in "average reported party size" for either the Disappointment Cleaver ($t(247) = 1.09$ $p > .05$) or the Emmons ($t(145) = 1.57$, $p > .05$). Therefore, despite the findings in the contact data, there is no rationale for weighting the data from Emmons respondents to correct any bias from the contact process.

No Difference in Average Party Size for Respondents/Non-respondents for Aggregate Sample 1 and 2

A final comparison was made between respondents and non-respondents in aggregate samples 1 and 2. Once again, no significant difference was detected between the "average reported party size" for either Disappointment Cleaver ($t(203) = .75$, $p > .05$) or Emmons ($t(62) = -.62$, $p > .05$) respondents and non-respondents.

The overall impression given by the analysis of group and individual party size data is that response data from all four sample periods appears representative of the population.

Location of Origin

A second line of analysis employed zip code data that were collected for individuals in my survey response data and for groups in park population data. Zip codes were not collected during the survey recruitment process and are therefore absent from the contact data.

To perform this analysis, zip codes were recoded into two variables that categorized respondents and permittees into location of origin. The first variable coded respondents into five location categories: Local, Other Washington, Oregon and California, Other U.S., and Non-U.S. The second variable further

refined these categorized into eleven subgroups: Seattle, Bellevue, Other King County, Tacoma, Other Pierce County, Snohomish County, Lewis County, Yakima County, Other Washington, Oregon, California, Other U.S., Non-U.S., and Unknown.

Disappointment Cleaver study respondents were not found to differ significantly from the Disappointment Cleaver population (i.e., permitted parties) in their distribution of origin using either the five-category variable (χ^2 (4, N = 594) = 2.44, p = .655) or the eleven-category variable χ^2 (13, N = 594) = 7.216, p = .891)

For Emmons climbers, analysis of location of origin using the five-category variable revealed that "Local" and "Oregon and California" climbers were under-represented in the response data ($p < .05$). Local climbers in particular comprised 62.5% of the permitted climbing population but only 53.7% of respondents.

Using the distribution obtained for the Emmons permit population I developed correction coefficients for each of the five categories and weighted the response data accordingly. I then compared means for 106 questionnaire response variables. I found that weighting the data to account for the under-sample of local climbers did not result in a significant (all ps > .05) difference in means for any response variables. Because using weighted data resulted in a loss of several respondent records (those for whom zipcode was a missing response), and weighting did not appear to influence the interpretation of findings, I elected not to employ weighted data in subsequent response analysis.

Additional Response Variables

I used several response variables to compare samples 1 and 2 (high refusal rate) to samples 3 and 4 (low refusal rate). The five variables used for these comparisons

were: Gender, Zipcode (Location of Origin), Mount Rainier Experience, and Level of Education, and Respondent Age.

Gender: No significant difference in gender distribution of climbers was detected between samples 1 and 2 and samples 3 and 4 for the Disappointment Cleaver In both segments 18% of climbers were female (χ^2 (1, N = 260) = .002, p = .961). For Emmons respondents the proportion of women in the first two samples was higher (18%) than in the last two samples (12%), but this difference was not statistically significant (t (92, N = 260) = -.991, p = .324)

Location of Origin: Using the nine-category variable for location of origin, I found no significant difference between samples on the Disappointment Cleaver (χ^2 (4, N = 261) = 4.394, p = .355) or the Emmons Glacier (χ^2 (12, N = 147) = 16.166, p = .184)

Experience: I found no significant difference in 1) the number of times respondents had climbed or attempted Mt. Rainier or Disappointment Cleaver climbers (χ^2 (5, N = 243) = 2.929, p = .711) or Emmons Glacier climbers (χ^2 (15, N = 147) = 17.687, p = .279), or 2) the number of times respondents had climbed or attempted the Disappointment Cleaver route (χ^2 (5, N = 242) = 2.792, p = .732) or the Emmons Glacier route (χ^2 (12, N = 147) = 9.479, p = .662).

Education: No significant difference in category of educational level was detected between segments for Disappointment Cleaver climbers (χ^2 (2, N = 259) = .470, p = .791) or Emmons Glacier climbers (χ^2 (12, N = 147) = 12.944, p = .373)

Age: For both routes, a significant difference between combined samples 1 and 2 and combined samples 3 and 4 was detected by comparing age categories of respondents (Disappointment Cleaver (χ^2 (3, N = 256) = 7.703, p = .034) and Emmons Glacier (χ^2 (12, N = 146) = 21.439, p = .044)).

Climbers under 30 years of age comprised a lower percentage of responses than other age groups during the first two sample periods (segment 1). These samples had high (but poorly documented) refusal rates. One possible explanation for the variation between segments is that PASRU survey workers were more successful at recruiting young climbers than park employees.

Correction coefficients were developed to adjust the distribution of age categories in the first two samples to mirror the age category distribution found in the more reliable samples (3 and 4) conducted by PASRU survey workers. Using the weighted data, I found neither a change in the rank order of response variables from the analysis of unweighted data, nor a meaningful change in the magnitude of response means. I therefore elected not to employ weighted data for statistical analyses.

Appendix B. Questionnaires

For brevity, the three questionnaires used in this study have been provided as a single, edited, generic version. The Disappointment Cleaver questionnaire is used as the model version. Differences are noted with square brackets: "[edit]". In brackets, lower case "a" indicates language used in the Emmons Glacier version. Lower case "b" indicates language used in the Kautz Glacier version

2004 Mount Rainier Climber Survey:
[Name of route]

[Privacy Act information here]

Welcome to the 2004 Mt. Rainier Climber Survey. The following questions refer to a climbing trip you recently took on either the [name of route] route on Mt. Rainier. Please complete this survey only if you climbed or attempted one of these routes. If you climbed or attempted a different route, please contact us at:

PASRU
Box 352100
College of Forest Resources
University of Washington
Seattle, WA 98195

We will provide you with the correct survey.

Please watch for instructions to SKIP ahead or to CONTINUE with the next question.

Please answer the following general questions about your climb on Mt. Rainier.

1. What was the date of your summit day during your climb of Mt. Rainier? (Please answer MM/DD/YYYY)_____

2. Including yourself, how many people were included on your climbing permit?_____

3. On your summit day, how many people were on your rope team, including yourself (give the most common arrangement)? _____

4. Which of the following types of groups did you climb with? (check one)

- ☐ Guided group
- ☐ Private group
- ☐ Club or other organized group

5. Including this climb, how many times have you climbed or attempted Mt. Rainier? _____

6. Including this climb, how many times have you climbed or attempted this route? _____

Please answer the following questions about your reasons for taking this trip to Mt. Rainier.

7-17. On this trip, how important to you were the following **reasons for climbing Mt. Rainier**? Please circle your best response. If a reason does not apply to you, please circle "Not important".

7. See Rainier's unique natural features	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
8. Learn what you are capable of	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
9. Be with friends	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
10. Get away from other people	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
11. Push your personal limit	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
12. See mountain scenery	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
13. Improve your climbing skills	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
14. Be with others who enjoy the same thing you do	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
15. Train for other climbing goals	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*

16. Experience solitude	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
17. Make it to the summit	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*

18-27. On this trip, how important were the following **reasons for selecting this route?** Please circle your best response. If a reason does not apply to you, please circle "Not important".

18. Appropriate technical difficulty for your group	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
19. Fewer objective hazards than other routes	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
20. Get away from other people	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
21. Best chance to get to the summit	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
22. Little physical evidence of other people	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
23. Chance to be part of a guided group [omitted for Kautz]	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
24. Chance to meet other climbers	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
25. Permits to preferred route were all gone	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
26. Good information was available about this route	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*
27. Historical status of this route	*Not Important*	*Slightly Important*	*Moderately Important*	*Very Important*	*Extremely Important*

Please answer the following questions about your climbing experience on this trip. Consider both your ascent and descent in your answers.

28. Where did your group make high camp?

- ☐ Did not make high camp. Please SKIP to question 41
- ☐ Camp Muir [(EG) Camp Schurman; (KG) Camp Hazard]
- ☐ Ingraham Flats [(EG) Emmons Flats; (KG) Other]

29. Were any other groups camped within hearing range of your group's camp?

- ☐ Yes. Please CONTINUE with question 30.
- ☐ No. Please SKIP to question 36.

30-35. During your time at high camp, how much (if at all) did the following experiences with other groups detract from your climbing experience? Please circle your response.

30. Heard noise from other groups	*Didn't experience*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
31. Competition for tent space	*Didn't experience*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
32. Discussion with other groups about when to start climbing	*Didn't experience*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
33. Felt crowded	*Didn't experience*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
34. Saw other groups break park rules	*Didn't experience*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
35. Felt privacy was limited	*Didn't experience*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*

36-40. Sometimes people see evidence or signs of previous climbers. During your time at high camp, how much (if at all) did the following signs of previous climbers detract from your climbing experience? Please circle your response.

36. Feces	*Didn't see*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
37. Urine	*Didn't see*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
38. Garbage	*Didn't see*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
39. Multiple dug out tent platforms	*Didn't see*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
40. Large dug out tent platforms	*Didn't see*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*

41. Did you travel beyond Camp Muir [(EG) Camp Schurman; (KG) Camp Hazard)]?

- ☐ Yes. Please CONTINUE with the following questions.

- ☐ No. Please SKIP to question 91.

42. Did you cross Cathedral Gap [(EG) ascend to Camp Schurman?'; (KG ascend the Fan?)]

- ☐ Yes. Please CONTINUE with the following questions.
- ☐ No. Please SKIP to question 52.

43-46. While crossing Cathedral Gap [(EG) on your approach route; (KG) ascending the Fan], how concerned (if at all) were you about the following types of hazards?

43. Rockfall triggered by another group	*Not concerned*	*Slightly concerned*	*Moderately concerned*	*Very concerned*	*Extremely concerned*
44. Getting hit by falling climber(s) from another group	*Not concerned*	*Slightly concerned*	*Moderately concerned*	*Very concerned*	*Extremely concerned*
45. Avalanche triggered by another group	*Not concerned*	*Slightly concerned*	*Moderately concerned*	*Very concerned*	*Extremely concerned*
46. Delay in a hazardous location caused by another group	*Not concerned*	*Slightly concerned*	*Moderately concerned*	*Very concerned*	*Extremely concerned*

47-51. While crossing Cathedral Gap [(EG) on your approach route; (KG) ascending the Fan], how much (if at all) did the following experiences with other groups detract from your climbing experience?

47. Waited for other groups before starting the section	*Didn't experience*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
48. Caused other groups to wait before starting the section	*Didn't experience*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
49. Was behind a slower group and could not pass	*Didn't experience*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
50. Felt uncomfortable when passed by another group	*Didn't experience*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
51. Felt concerned about the presence of inexperienced groups	*Didn't experience*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*

52. Did you pass below the Ingraham Icefall (to reach the Disappointment Cleaver) [(EG) reach the Corridor; (KG) traverse below the Kautz ice cliff]?

- ☐ Yes. Please CONTINUE with the following questions.

- ☐ No (or don't know). Please SKIP to question 62.

53-56. While passing below the Ingraham Icefall [(EG) in the Corridor; (KG traversing below the Kautz Ice Cliff], how concerned (if at all) were you about the following types of hazards?

[Same response matrix as questions 43-46]

57-61. While passing below the Ingraham Icefall [(EG) in the Corridor; (KG traversing below the Kautz Ice Cliff], how much (if at all) did the following experiences with other groups detract from your climbing experience?

[Same response matrix as questions 47-51]

62. Did you reach the Disappointment Cleaver [(EG) upper mountain above the Corridor; (KG) climb/descend the Chute]?

- ☐ Yes. Please CONTINUE with the following questions.
- ☐ No (or don't know). Please SKIP to question 72

63-66. From the traverse onto the Disappointment Cleaver to the top of the Cleaver Cleaver [(EG) While on the upper mountain above the Corridor; (KG) While climbing/descending the Chute], how concerned (if at all) were you about the following types of hazards?

[Same response matrix as questions 43-46]

67-71. From the traverse onto the Disappointment Cleaver to the top of the Cleaver[(EG) While on the upper mountain above the Corridor; (KG) While climbing/descending the Chute], how much (if at all) did the following experiences with other groups detract from your climbing experience?

[Same response matrix as questions 47-51]

72. Did you reach the upper mountain above the Disappointment Cleaver [(EG) reach the Bergschrund; (KG) reach the upper mountain (above the Chute)]?

- ☐ Yes. Please CONTINUE with the following questions.
- ☐ No (or don't know). Please SKIP to question 83.

73-76. While on the upper mountain above the Disappointment Cleaver [a. passing the Bergschrund; b. on the upper mountain (above the Chute)], how concerned (if at all) were you about the following types of hazards?

[Same response matrix as questions 43-46]

77-81. While on the upper mountain above the Disappointment Cleaver [a. passing the Bergschrund; b. on the upper mountain (above the Chute)], how much (if at all) did the following experiences with other groups detract from your climbing experience?

[Same response matrix as questions 47-51]

82-84. While climbing on your summit day, how much (if at all) did the following signs of previous climbers detract from your climbing experience?

82. Feces	*Didn't see*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
83. Garbage	*Didn't see*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
84. Other signs of previous climbers (e.g. wands, bootrack)	*Didn't see*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*

85-86. During your summit day, how much (if at all) did the following signs of other climbers detract from the enjoyment of finding your own way?

85. Seeing other climbers ahead on the route	*Didn't see*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*
86. Seeing route markings (e.g. wands, boot track)	*Didn't see*	*Didn't detract*	*Detracted slightly*	*Detracted moderately*	*Detracted greatly*

87. Aside from your group, how many large groups (9-12 people) did you encounter during your climb? _____

88. How did your encounters with large groups affect your experience?

OR

If you encountered no large groups, how did the absence of large groups affect your experience?

- ☐ Added greatly
- ☐ Added slightly
- ☐ Did not add or detract

- ☐ Detracted slightly
- ☐ Detracted greatly

89. Did any *particular* types of groups have an impact on your climbing experience? Please identify and explain, indicating whether the impact was positive or negative.

[Space for open response]

90. Did you reach the summit of Mt. Rainier?

- ☐ Yes. Please SKIP to question 92.
- ☐ No. Please CONTINUE with the following question.

91. What was the main reason you did not reach the summit?

[Space for open response]

92-96. Would you agree or disagree with the following statements about the route you took? (Check one box per question)

92. When guides are present the route is safer.

- ☐ Don't know
- ☐ Disagree strongly
- ☐ Disagree
- ☐ Neither agree nor disagree
- ☐ Agree
- ☐ Agree strongly

93. When Climbing Rangers are present the route is safer.

- ☐ Don't know
- ☐ Disagree strongly
- ☐ Disagree
- ☐ Neither agree nor disagree
- ☐ Agree
- ☐ Agree strongly

94. It would be appropriate for the Park Service to limit the number of climbers allowed if it increased the safety of climbers.

- ☐ Don't know
- ☐ Disagree strongly
- ☐ Disagree
- ☐ Neither agree nor disagree
- ☐ Agree
- ☐ Agree strongly

95. It would be appropriate for the Park Service to limit the number of climbers allowed if it provided better climbing experiences.

- ☐ Don't know
- ☐ Disagree strongly
- ☐ Disagree
- ☐ Neither agree nor disagree
- ☐ Agree
- ☐ Agree strongly

96. It would be appropriate for the Park Service to limit the number of climbers allowed if it decreased ecological impact.

- ☐ Don't know
- ☐ Disagree strongly
- ☐ Disagree
- ☐ Neither agree nor disagree
- ☐ Agree
- ☐ Agree strongly

97. After this experience climbing Mt. Rainier, would you recommend a climb of Mt. Rainier to a friend?

- ☐ Definitely yes.
- ☐ Maybe.
- ☐ Definitely not.

98. After this climbing experience, would you climb the same route again?

- ☐ Definitely yes.
- ☐ Maybe.
- ☐ Definitely not.

99. What was your role in planning this trip?

- ☐ Had primary responsibility for planning the trip
- ☐ Shared responsibility for planning the trip
- ☐ Had no responsibility for planning the trip

Please answer the following demographic questions. The information will be used for statistical purposes only.

100. Are you:

- ☐ Female
- ☐ Male

101. What year were you born? _____

102. What is your home zipcode (or country name if not a US citizen)? _____

103. What is the highest level of formal schooling you have completed?

- ☐ Fewer than 12 years
- ☐ High school diploma
- ☐ Some college/vocational training
- ☐ College degree
- ☐ Graduate/professional training

104. We may wish to talk to some of the climbers who completed this survey to help clarify the survey results. This follow-up interview will take about 30 minutes. If you are willing to be contacted for a follow-up telephone interview, please provide your first name and telephone number in space provided below, and an appropriate time of day to telephone you. Your contact information will be used only for the purpose of this study. Within four weeks your responses to this questionnaire will be given a code, and your email and name (or pseudonym) will be deleted. If you provide contact information below then that information will be given the same code, and stored in a separate place from your answers to this questionnaire. If you are called for an interview, we will give the same code to the interview responses and store those responses separate from your questionnaire responses. Within four weeks of completing the interview, we will delete your telephone contact information. If you are not called for an interview, your telephone information will be automatically deleted by January 1st, 2005. There will be no long-term link between your answers to the questionnaire and interview and the contact information you give to us. Again, participation in a follow-up interview is voluntary, and providing your contact information does not guarantee that you will be called.

Name_____

Telephone Number_____

Time to call_____

105. Please provide any other comments you care to make about this survey, your climbing trip, or management of climbing at Mt. Rainier National Park.

[Space for open response]

Thank you for your contribution to this study.

If you have any questions, please contact:
PASRU

Box 352100

College of Forest Resources

University of Washington

Seattle, WA 98195

Appendix C. VERP Guidance for Indicator Selection

The VERP Handbook is the most comprehensive single text available to park planners to guide application of the VERP methodology to visitor carrying capacity planning in units of the National Park System.

VERP Elements

Nine "elements" comprise VERP (see Table C1). These elements are described in detail in the VERP Handbook. While VERP elements represent a logical sequence, the process is intended to be iterative. In application, feedback between VERP elements may be necessary to achieve the best final planning results.

Table C1: VERP Steps (Explanatory language is included for two elements (numbers 5 and 7) that are central to the purpose of this study.

VERP Element	**Element Description** (selected)
Framework Foundation	
1. Assemble an Interdisciplinary Project Team	
2. Develop a Public Involvement Strategy	
3. Develop Statements of Park Purpose, Significance, and Primary Interpretive Themes; Identify Planning Constraints	Potential zones are described by different desired visitor experience opportunities and resource conditions that could be provided in a given park, consistent with the park purpose and significance. The zone descriptions prescribe the appropriate kinds and levels of activity, development, and management. These potential zones are described in text only; they are applied to specific geographical areas in element 6.
Analysis	
4. Analyze Park Resources and the Existing Visitor Use	

Prescriptions	
5. Describe a Potential Range of Visitor Experiences and Resource Conditions (potential prescriptive zones)	
6. Allocate the Potential Zones to Specific Locations in the Park (prescriptive management zoning)	
7. Select Indicators and Specify Standards for Each Zone; Develop a Monitoring Plan	Indicators (specific, measurable variables that will be monitored) and standards (minimum acceptable conditions) are identified for each zone. A monitoring plan is developed that identifies priorities, methods, funding, and staffing strategies and analysis requirements.
Monitoring and Management Action	
8. Monitor Resource and Social Indicators	
9. Take Management Action	

Criteria for Evaluating the Usefulness of Indicators

The VERP Handbook identifies eight primary and seven secondary criteria for evaluating the quality of VERP indicators. The primary criteria identify important measurement properties of variables that might be evaluated as potential resource or experience indicators. The secondary properties address practical concerns in monitoring or managing indicator variables. These criteria are listed in Table C2: Primary and Secondary criteria for the selection of VERP indicators.

Table C2: (USDI 1993)

Primary and Secondary criteria for the selection of VERP indicators

Primary Criteria

1. Specific
2. Objective
3. Reliable and repeatable
4. Related to visitor use
5. Sensitive
6. Resilient
7. Low-impact
8. Significant

Secondary Criteria

1. Easy to measure
2. Easy to train for monitoring
3. Cost-effective
4. Minimal variability
5. Responds over a range of conditions
6. Large sampling window
7. Availability of baseline data

Criteria of special concern to this study are 1) relationship to visitor use, 2) sensitivity, and 3) significance.

Relationship to Visitor Use

A characteristic of good experiential indicators is that change in the indicator is related to the behavior of visitors or the amount, type, or timing of visitor use. Many other factors influence the quality of visitor experiences. To use an obvious example, it is often said that weather "makes or breaks" a climbing trip at Mount Rainier. The impact of poor weather conditions on climber experiences is not, however, related to visitor use or subject to management influence. Therefore, an indicator measuring the number of trips spoiled by inclement weather would be a poor VERP indicator.

Sensitivity

Indicators should be sensitive to visitor use over a short time scale. Some types of impacts may be related to cumulative visitor use over long time periods, and not show significant change to fluctuations in visitor use over days, weeks, or even seasons. Better indicators change with fluctuations in visitor use over the shortest time scales.

This study found that some variables, such as sighting human waste, had an impact on climber experiences but is not related to short-term fluctuations in visitor use. Other variables, such as those related to the occurrence of delays, were related to daily fluctuations in climber use.

Significance

Indicator variables should measure concerns, impacts, or problems that are important to park resources or to visitors. One of the questions addressed in this study is whether solitude, a social variable identified in the Wilderness Act and found to be important to visitors in traditional wilderness, is a useful starting place for indicator development in the climbing setting.

By defining the high use zone as an area where opportunities for solitude will be uncommon, the park has made a practical judgment that solitude cannot or will not be provided at all times in all areas of the park. In the high use zone, therefore, solitude is not a significant park objective; in other wilderness zones solitude may be significant and solitude variables may be used as experiential indicators. This study concludes that solitude is not a significant variable to visitors in the high use and moderate use zones.

The opportunity to engage in the activity of mountaineering, experience challenge, use and develop skills, and act self-reliantly is identified as significant park resource in the management zone descriptions. Limiting the exposure of climbers to hazards within the control of managers is also assumed to be a park goal. This study concludes that climbers share these objectives.