AN ANALYSIS OF OFF-TRAIL HIKING IN RESPONSE TO SELECTED SOCIAL CONTROL TECHNIQUES AT PARADISE MEADOWS, MOUNT RAINIER NATIONAL PARK

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ABSTRACT Although a single instance of off-trail hiking may be seen as minor rule breaking behavior, over an extended time period such depreciative behavior causes severe damage to fragile natural environments. At locations where off-trail hiking frequently occurs, trailside signs and barriers and other social control techniques such as the presence of a uniformed park employee represent the last opportunity for managers to deter such activity. The sparse literature suggests that the use of trailside signs will reduce such instances of depreciative behavior, and alternate sign texts will have different effects. Little research documents the effectiveness of barriers or the uniformed presence in controlling such minor rule breaking activity in a recreational setting. To test these and related hypotheses, several experiments were administered in a popular frontcountry day use area of Mount Rainier National Park. The behavior of 17,416 visitors was observed in a sign experiment, and a barrier experiment included behavioral data on 6,006 subjects. The results indicated that signs, barriers, and uniformed employees' presence all significantly reduced off-trail hiking. There were significant differences in the effectiveness of signs and barriers. The most effective sign was a threatened sanction sign ("OFF-TRAIL HIKERS MAY BE FINED"), and the second most effective sign was an ethical appeal ("STAY ON PAVED TRAILS...AND PRESERVE THE MEADOW"). The most effective barrier was a rope barrier. The presence of a uniformed employee reduced off-trail hiking more than any other treatment studied. The effectiveness of other signs and barriers and noncompliant visitor characteristics are also discussed.

Key Words: depreciative behavior, signs, barriers, uniforms, rule and regulation violations, national parks, social control techniques, visitor characteristics (violators of park regulations)

TABLE OF CONTENTS

LIST OF TABLES

EXECUTIVE SUMMARY

At locations where extensive off-trail hiking causes severe damage to fragile natural environments, trailside signs, barriers, and other social control techniques such as the presence of a uniformed park employee represent the last opportunity for managers to deter such visitor activity. To test the effectiveness of these managerial strategies, several experiments were administered in 1987 at Paradise Meadows in Mount Rainier National Park by the University of Washington Cooperative Park Studies Unit. This executive summary briefly highlights the results of that study.

This summary contains 7 sections: (1) an overview of the experimental design of all components of the study, (2) results of a sign experiment assessing the effectiveness of several trailside sign texts, (3) the presence of a uniformed park employee as a deterrent to off-trail hiking, (4) the results of an experimental assessment of the effectiveness of different barrier types, (5) an analysis of differential rates of off-trail hiking by site, (6) a brief description of the characteristics of noncompliant visitors, (7) the results of a visitor interview assessing the acceptance of and subjective judgements of the effectiveness of audio trailhead messages.

Experimental Design for Analysis of Visitor Control Techniques

The behavior of 17,416 visitors was observed in a sign experiment at three sites in the meadow. A barrier experiment included behavioral data on 6,006 subjects at three sites. Recorded information included estimated age and gender of all subjects, group race or ethnicity, tour group or military group status, individual behavior in response to the experimental treatments (compliance or noncompliance to the signs or barriers), and behavior of other proximate parties. The results of a related visitor survey are described in a companion report (Johnson and Swearingen, 1988).

The sign experiment research design utilized one stake and six sign treatments, a control (no sign), a nested experimental treatment to test the effect of the presence a uniformed person at one site, and another nested treatment to consider the effect differing levels of exposure to unusual signs (single vs. multiple exposures to the unfamiliar experimental signs).

The sign texts used in the experiment consisted of the following: (1) Standard NPS text - "No Hiking - Meadow Repairs", (2) New NPS text - "STAY ON THE PAVED TRAILS AND PRESERVE THE MEADOW", (3) Symbolic message - an international red circle and cross-hatch design over a hiker's profile, (4) Hybrid text - the symbolic message with a prohibitory message, "No Off-Trail Hiking", (5) Threatened Sanction text - "Off-Trail Hikers May Be Fined", (6) Symbolic text on stake - short stake (app. 1') with a small version of the symbolic sign, (7) Humorous sign - "DO NOT - TREAD, MOSEY, HOP, TRAMPLE, - STEP, PLOD, TIPTOE, TROT, - TRAIPSE, MEANDER, CREEP, - PRANCE, AMBLE, JOG, TRUDGE, - MARCH,

STOMP, TODDLE, JUMP, - STUMBLE, TROD, SPRINT, OR - WALK ON THE PLANTS", (8) Control - no sign present

The barriers used in the experiment consisted of the following: (1) a split rail fence, (2) a yellow polypropylene rope barrier supported by lath posts just above knee height, and (3) a control (no barrier). All treatments for both studies were rotated at several sites by time to avoid complications of time, day of week, or month of season in interpretation of the results.

In addition to the experiments, a survey was conducted in the field near the beginning of an access trail to determine visitor attitudes toward an audio message broadcast at the trailhead sign. The purpose of the interview was to determine visitors' recall of the audio message and their subjective evaluation of the effectiveness of the message in comparison to written trailhead signs. The primary findings of the experimental part of the project are summarized below.

Sign Experiment Results[1]

Trailside signs reduce noncompliance (off-trail hiking) in comparison to a control (no sign), and different sign texts vary significantly in observed rates of noncompliance. The threatened sanction sign was significantly more effective than any other treatment, reducing off-trail hiking by 75 percent. The new NPS sign with an ethical appeal was the next most effective sign, reducing noncompliance by approximately 52 percent. However, the rate of noncompliance for the new NPS sign nearly doubled in comparison with the threatened sanction sign. Other signs not statistically different in effectiveness from the new NPS sign were the humorous and hybrid signs. The old standard "Meadow Repairs" sign was the least effective sign. Off-trail hiking rates did not differ significantly when visitors were exposed to the stake.

Deterrent Effect of Uniformed Personnel

Noncompliance almost disappeared in the presence of a uniformed NPS employee.[2] However, signs still had a significant, although slight, deterrent effect on off-trail hiking in the presence of the uniformed person. These data suggest that off-trail hikers as a group are not ignorant of Agency expectations regarding such behavior.

These findings do not mean that off-trail hikers are motivated to act in defiance of the Park Service. It is possible that their behavior stems from a lack of understanding of the basis for the rules and the amount of impact their behavior causes in the meadow (ignorance of consequences). The fact that

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1 The sign data were extensively analyzed at both the individual and the party level employing a variety of statistical procedures. Regardless of the approach, the results were nearly identical, and the recommendations are the same.

2 The employee, a female of small stature, was dressed in a Class A uniform with green jeans or shorts, an NPS short sleeve shirt, and a forest green NPS baseball cap. She did not wear the traditional Ranger uniform.

the ethical appeal of the new NPS sign worked well suggests these explanations may have some validity, a supposition partially supported by the survey results (Johnson and Swearingen, 1988).

Barrier Experiment Results

The yellow polypropylene rope barrier was more effective in deterring off-trail hiking than the split rail fence. Both barriers significantly reduced off-trail hiking in comparison to the control. Although not directly compared to the signs in this study, rope barriers may not be more effective than threatened sanction signs in deterring off-trail hiking. The rope barrier reduced off-trail hiking at a popular snow play area, but noncompliance remained very high.

Noncompliance by Site

Using an estimated rate of off-trail hiking at the Panorama Point site based on limited data from that site, the average rate of noncompliance with the control (no sign present) at the different sign sites would be: (1) Lower Meadow - 5.4%, (2) Dead Horse (middle meadow) - 6.9%, (3) Panorama Point (upper meadow) - 8.6%. These data present tentative evidence that there is a site effect related to noncompliance. The density of vegetative cover, quality and salience of the trail, and amount of visible human impact all change as one ascends the meadow. The estimated proportion of noncompliance also increases as one ascends the meadow. These data offer qualitative support for the hypothesis that environmental cues such as amount of vegetative cover or visible human impact may play an important role in prompting or deterring noncompliant behavior. However, signs, especially the threatened sanction sign, reduce off-trail hiking across all sites.

Noncompliant Visitor Characteristics

At the experimental sites, the majority of all off-trail hikers were white adults. However, a disproportionate number of noncompliers were non-white (a large percent of whom are of foreign origin) and estimated to be under the age of twenty years.

Trailhead Interview Results

A trailhead interview was conducted to determine visitor acceptance and perceived effectiveness of the audio trailhead message. A message was played through speakers mounted on the trailhead written sign on the north side of the Paradise parking lot. Of those visitors contacted on the random interview days when the audio message was on, nearly 68 percent recalled hearing the audio message, and 13.7 percent of these visitors did not remember or correctly recall the content (missed at least one of the content questions). Thus 46.2 percent of all visitors either did not recall hearing the message or did not recall the content of the message.

Of those visitors who had correctly answered at least one of the content questions during the interview (54 percent of all contacted visitors), 85 percent felt the message would affect

their behavior, and 15 percent felt the message would not affect their behavior. A majority favored using the audio sign (52 percent), and an additional 13 percent favored using written and audio trailhead messages.

INTRODUCTION AND PROBLEM STATEMENT

This document reports the results of an experiment testing the effectiveness of selected social control techniques designed to deter off-trail hiking at Paradise Meadows, a popular subalpine day hiking area in Mount Rainier National Park. Related work began with a preliminary quasi-experimental study in 1985. This study builds on the earlier research and represents a culmination of those efforts. Consequently, some sections of this report are adapted and modified versions of the 1985 study report.

Off-trail hiking is a major source of the current human impact problem at Paradise Meadows. With up to 5000 visitors a day during peak use periods, even a small proportion of these visitors deviating off-trail onto the meadow will have a significant impact upon the subalpine meadow. The Park efforts at rehabilitation of the resource (e.g., high standard trails and meadow restoration) can only be effective if the continuing problem of human impact is also contained.

The Park has attempted to influence visitor behavior with naturalist programs and passive communications which emphasize the importance of low impact use. An implicit assumption of this strategy is that depreciative visitor behavior (e.g., off-trail hiking) is caused by a lack of knowledge about, or appreciation for, proper use of the resource. If given the proper information, the visitors will presumably be positively influenced and eventually will accept agency guidelines for behavior. The objective of this communication approach is to motivate behavior by

creating a pro-social psychological state in which recreationists view behavior desired by park managers as satisfying personally desired goals. This congruity occurs when the values and attitudes implicit in management guidelines are accepted by visitors.

Many park visitors are undoubtedly influenced by this method. However, exposure to communication does not ensure that it will be accepted or understood by all people. If visitors lack commitment to the values appealed to, or do not understand the communication, another type of communication may prove more effective. For example, the motivation to comply with a communication containing threatening sanctions is derived from visitors' desire to avoid penalties.

The last chance to influence undesirable behavior of dayhikers on a park trail occurs with their exposure to behavioral cues located at or near areas where such behavior occurs. Barriers and signs represent an opportunity to affect the behavior of those visitors who were not influenced by or exposed to other park communication efforts. Similarly, the presence of a uniformed employee may also create a salient reminder of "appropriate behavior". To accomplish their purpose, these behavioral cues must provide motivational incentives that are understood and effective among diverse populations.

In designing behavioral cues, reliance upon assumptions that visitors possess homogeneous attitudes or values toward use of the resource may result in miscommunication and a continuance of undesired visitor behavior. A hypothetical example may help to illustrate this reasoning. The standard sign previously used to

protect impacted areas off-trail in Paradise Meadows contained the "NO HIKING, MEADOW REPAIRS" text (Figure 3, p.22). The sign is based on the assumption that the visitor understands the meaning of "MEADOW REPAIRS". The visitor's motivation to comply is assumed to be derived from a desire to avoid a depreciative act which may impact the "MEADOW REPAIRS" or possibly to be in deference to an abstract prohibitory command, "NO HIKING". In the second instance, it is assumed that the authority of the source of the command (the Park Service) is accepted as valid. The visitor must also understand the English language. Because these assumptions can be expected to be erroneous for an unspecified number of visitors, it should be expected that some noncompliance to the sign will occur.

Problem Statement

This research was designed to address the general problem of designing a social control strategy to discourage off-trail hiking in the Paradise area. As such, it is an expanded effort designed in large part on the 1985 preliminary research.

In the 1985 pilot study, it was found that trailside signs significantly affected off-trail hiking rates at one site but not at another (Johnson and Swearingen, 1986). The lack of a sign effect at the second site was attributed to much a lower overall rate of off-trail hiking resulting in very low variance. Threatened sanction and symbolic signs were found to be most effective in reducing instances of off-trail hiking at the site where significant differences were found. This work also found that off-trail hiking rates were higher among people estimated to be under 20 years of age and among people in groups larger than

three. There were no differences in off-trail hiking rates between males and females.

Based on these preliminary results and related additional concerns, the primary research questions of this study are:

(1) Do trailside signs affect off-trail hiking rates (departures from designated trails) in a National Park Service (NPS) frontcountry day use area?

(2) Are there differences in effectiveness between selected types of trailside signs in controlling off-trail hiking (departures from designated trails) in a National Park frontcountry day use area?

(3) Do physical barriers affect off-trail hiking rates (departures from designated trails) in a National Park frontcountry day use area?

(4) Are there differences in effectiveness between selected types of physical barriers in controlling off-trail hiking (departures from designated trails) in a National Park frontcountry day use area?

(5) What is the effect of the presence of a uniformed NPS employee on the rates of visitor off-trail hiking in an NPS frontcountry day use area?

(6) Does the encounter of a single novel sign text affect sign effectiveness in controlling off-trail hiking in an NPS frontcountry day use area?

(7) Does the presence of people, other than those in the visitor's party, affect off-trail hiking rates?

(8) Do instances of off-trail hiking increase the probability of other instances of off-trail hiking?

(9) Is a narrow stake as effective a deterrent to off-trail hiking as the standard sign size used by the NPS when both are of the symbolic type?

(10) Given selected characteristics which can be derived by observation, what are the observed characteristics of the noncompliant park visitor?

REVIEW OF THE LITERATURE[3]

Much of the research pertaining to communication in the recreation field concentrates on the effectiveness of different media in enhancing visitors' knowledge with emphasis on knowledge retention and attitude change (e.g., Mahaffey, 1970; Wagar, 1971; Wagar, et.al., 1976; Tai, 1981). Other studies have concentrated on effective communication techniques to instill knowledge that will presumably affect behavior such as dispersal in backcountry areas (e.g. Burgess, et.al, 1971; Canon, et.al, 1979; Christensen, 1981; Fazio, 1974, 1979; Krumpe, 1979; Lucus, 1981; Oliver, et.al., 1985; Robertson, 1980; Roggenbuck and Berrier, 1980; Schomaker, 1975).

Sign Effectiveness

Studies dealing specifically with the effectiveness of signs in outdoor recreation settings are less common, (e.g. Brown and Hunt, 1969; Nelson, 1979; Tai, 1981; Ormrod and Trahan, 1982; Petersen, 1985). There has been relatively little study of the effectiveness of alternate sign texts in deterring minor rule violations and depreciative behavior[4] (e.g., Schwartzkopf, 1984; Johnson and Swearingen, 1986; Martin, 1987).

There have been many studies of the effectiveness of symbolic (graphic only) and verbal (text only) signs in highway settings. Many of these studies use experimental designs in controlled

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3 This section is a revised version of a review of the literature which is contained in the report on the pilot study of sign effectiveness conducted at Mt. Rainier in 1985 (Johnson and Swearingen, 1986).

4 Depreciative behavior is here defined as any normative violation which may impact the resource.

environments where subjects' rate of sign comprehension is measured. An Australian study found sign comprehension by subjects ranged from 74% to 93% for a variety of verbal and symbolic sign types (MacDonald and Hoffman, 1982). Other comparative studies of the effectiveness of prohibitory symbolic and verbal signs have found the comprehension rates range from 89.9% for verbal signs to as high as 99.5% for some symbolic signs (George, 1970; King and Tierney, 1970). In general, symbolic signs or hybrid signs (symbolic sign with a written, usually prohibitory, text) are more effective as measured by subject comprehension (George, 1970; King and Tierney, 1970; MacDonald and Hoffman, 1982; Walker, Nicolay, and Stearns, 1965).

Freen, Chandler, Mouton, and Blake (1955) found that the strength of the prohibition in a sign had an effect on the behavior of subjects in directing them from a front to a side door. Social pressure also was found to have an effect on behavior, but there was no interaction between these variables. Similarly, Struckman-Johnson (1978) found that high threat and moderate threat signs were significantly more effective in controlling shoplifting than low threat and a control. Caution, however, is warranted in comparing shoplifting to minor rule-breaking behavior such as off-trail hiking. In an experiment conducted in grocery stores, Bickman and Green (1977) found no impact of signs on witnesses' reporting of instances of shoplifting. Harris and Mayer (1973) found differences in the number of people giving information at a shopping center in response to dependency and threat sign messages.

In outdoor recreation research, Lucus (1983) found registration rates in response to signs at voluntary trail registers to be highly variable (from 7 to 36 percent) according to type of visitor, season, and location. Leatherberry and Lime (1981) found higher compliance rates for trailhead registration stations in general. They found compliance rates varied with mandatory (61 percent) and voluntary (70 percent) instructions. In an effort to improve compliance to voluntary registration at trail registration stations, Petersen (1985) improved sign design with the use of better graphics and an improved explanatory text. The result was a significant improvement in compliance rates (up to 88 percent) due to sign design and location. Location was found to be the most significant effect with trailside applications being more effective than trailhead locations. Similarly, the effectiveness of trailside signs has been noted in other studies and discussions (Fazio, 1979; Lucus and Kovalicky, 1981; Nelson, 1979; Sharpe, 1982; Tai, 1981).

In a national park setting, Schwartzkopf (1984) found that a sign noting the danger of contacting bubonic plague and other diseases was almost twice as effective in:

> deterring [feeding of ground squirrels] as the sign which emphasized that the squirrels' natural foods were better for them than human food. The latter sign, in turn, was found to be twice as effective in keeping visitors from feeding the squirrels as no signs at all.

Schwartzkopf thought that the sign emphasizing the plague was most effective due to the threats stated to individual welfare. He concluded that signs cannot eliminate all park regulation violations by visitors but can have a significant effect on the

behavior of park visitors. He also believed his evidence strongly indicated that different sign texts can determine how effectively park signs deter visitors from feeding wildlife.

Ormrod and Trahan (1982) found a negative sign text emphasizing probable crowding was not as effective as a text emphasizing positive aspects of more solitary experience in redistributing visitor use. Comparisons in this study, however, are tentative because of a small sample size and statistical techniques.

In a study of threatened sanctions and littering, Heberlein (1971) found that roadside littering behavior was unaffected by a prohibitory sign text or by sign frequency. The same study also found no correlation between recall of litter control signs along highways and individual littering behavior on a city street. Neither comparison considered specific observed on-site behavior in the presence of a threatened sanction sign for determination of the effectiveness of that type of sign.

A preliminary study of sign effectiveness at Paradise Meadows in Mount Rainier National Park was conducted in 1985 (Johnson and Swearingen, 1986). The sign observation data were collected at a meadow rehabilitation site and at a social trail which shortcut a designated, paved trail. The general findings (subject to the design and data limitations) were: (1) a threatened sanction sign and a symbolic sign were the most effective sign texts in deterring off-trail hiking, (2) the standard NPS ("NO HIKING, MEADOW REPAIRS") sign was the least effective of the three treatments studied, and (3) all signs reduced off-trail hiking when compared

to the control (no sign) when sufficient noncompliance was present to measure sign effects. Signs and other social controls were also found to reduce off-trail hiking and play at an informal snow play area. There were methodological limitations associated with this study which make direct comparisons with the present study tenuous.

In an experiment inspired in part by the 1985 NPS study, Martin (1987) found that a sanction sign was significantly more effective than three other signs and a control (no sign) in deterring pumice removal at Mt. St. Helens National Monument. The message and the proportion of noncompliance to the sign texts were: (1) control (12.3 percent), (2) standard sign "PLEASE DO NOT REMOVE ASH OR PUMICE" (3.3 percent), (3) a social influence sign "PLEASE REPORT VIOLATORS WHO REMOVE ASH OR PUMICE" (3.9 percent), and (4) a sanctions sign "VIOLATORS WHO REMOVE ASH OR PUMICE WILL BE PROSECUTED" (0.9 percent). Martin concluded that: (1) signs significantly deterred pumice collecting, (2) the sanctions sign had a significantly greater deterrent effect than the other two signs, and (3) there were no significant differences in the deterrent effects of the standard and social influence sign. The most effective behavior control technique in the Martin study was the combined presence of a uniformed employee, a verbal message, and a prohibitory sign. There was an insufficient sample size to statistically test the effectiveness of this combined strategy in comparison to a sanctions sign only.

In summary, research indicates that signs affect behavior in an outdoor recreation setting, but do not eliminate noncompliance to agency behavioral expectations. Location of the sign relative

to the desired behavior and different sign texts affect compliance rates. Highway sign research has found that symbolic and hybrid signs increase message understanding and retention. In a few limited studies, threatened sanction signs were the most effective treatment in deterring minor rule violations. One study found the visual presence of a uniformed employee in conjunction with signs reduced noncompliance below the lower limits associated with signs only.

Effect of Barriers on Behavior

A review of literature was conducted consisting of a computer search in several bibliographical computer databases and review of other recreation literature for information pertaining to research on the effectiveness of barriers. No research was located pertaining to barrier effectiveness in controlling depreciative behavior in a recreational setting.

Effect of Uniformed Presence on Behavior

Little research has been conducted on the effect of a uniformed employee presence on behavior in a recreational setting. There is, however, a body of literature concerning the effect of uniformed police officers on attitudes towards an authority figure. This research indicates that uniformed police officers are viewed as symbols of authority and a representation of the law and government (Muchmore 1975, Tenzel, et. al., 1976). Because uniformed Park rangers are very similar in appearance to police officers, it is logical to hypothesize that people react similarly to Park rangers.

The perceived authority of police officers' militaristic uniforms has been shown to hinder people's feelings of autonomy (Muchmore 1975, Tenzel, et. al., 1976). When police officers' uniforms were changed from a militaristic style to a more civilian style, people's anxieties created by the authority symbol decreased (Tenzel, et. al., 1973, Seib et al, 1985). Communication between the community and the police increased, and the public attitudes toward the police force improved (Tenzel, et. al., 1976). The research reviewed did not test for the effect of the uniform as a deterrent to undesirable behavior.

In a study of visitors' perceptions of security and safety issues at recreational areas around an Army Corps of Engineers reservoir in Texas, Fletcher (1984) found that the increased presence of uniformed park rangers, law enforcement personnel, and controlled access (entrance fees) reduced occurrences of security and safety problems. Visitors' attitudes toward the presence of the uniformed police or park rangers were also reported to be positive. The positive reaction of visitors to the presence of the uniformed rangers and law enforcement personnel might be related to a perceived need for their authoritarian presence as a means to maintain order. However, the security problems addressed in the Fletcher study are not directly comparable to undesirable visitor behavior that degrades the natural environment.

Reasons for Noncompliance to Low Impact Guidelines in an Outdoor Recreation Setting

Ignorance of behavioral guidelines has been suggested as one source of noncompliance. Even the best communication may fail to reach some visitors (Fazio, 1974; Young, 1978). When compliance to behavioral guidelines is dependent on a learning process, it is contingent on both the educational stimuli and the receptiveness of the visitor. There may be a "selective listening" wherein the visitor simply refuses to pay attention to any message that is contrary to personal expectations or attitudes (Bem, 1970; Wenger, 1964; Triandis, 1971). Selective bias will prevent the assimilation of the requisite knowledge that is the basis for an attitude change desired by the agency. This tendency suggests that subpopulations of visitors whose attitudes and values create resistance to agency behavioral expectations may be difficult to reach in the communication process - especially if that communication is complex or threatening to currently held values, beliefs, or expectations.

When people are unaware of the negative consequences that occur when a rule is not followed, the rule may appear arbitrary. If perceived to be arbitrary, visitors' sense of obligation to uphold a rule is removed, and they may break the rule ("uninformed violations" - Gramman and Vander Stoep, 1986). It is conceivable that a sign text may contribute to a visitor's perception of a rule as arbitrary. Two signs used in this study are illustrative of this possibility. The proposed new NPS sign used in this study ("STAY ON THE PAVED TRAILS... AND PRESERVE THE MEADOW") clearly

states the consequences of noncompliant actions. The standard NPS sign in use in the meadow ("NO HIKING - MEADOW REPAIRS") is ambiguous as to the impact of one's behavior upon the meadow. With the second sign, people may not understand the meaning of "meadow repairs" and, therefore, the consequences of their actions. Thus, they may feel no obligation to obey the prohibitory command.

Norm conflict may occur as a result of divergent personal and agency attitudes and values (Hendee, et al, 1978; Clark, et al, 1971b). (Norms are socially defined behavioral expectations.) In a park situation, the conflict exists between the norms of the managing agency (institutional norms) and visitors' norms. It is probable that when norm conflict occurs, visitors will be resistant to any persuasive communications contrary to their views (Haaland and Venkatesan, 1968). An example of conflict between individual and institutional norms in a recreational setting occurs when a pet owner consciously defies agency rules and takes a pet into a restricted area. Despite agency rules, the pet owner may not think the animal's presence is damaging, and may believe that the agency expectations are inappropriate. For the reasons explained above (i.e., selective bias), communication may also have little impact. In this case, control measures and communication that prompt behavior without relying on attitude change may be more successful.

Noncompliance to low impact guidelines that ignores agency communication may also be related to individual cognitive or moral development. Kohlberg (1976), Kohlberg, et.al., (1983), and Gilligan (1977, 1982) have developed theories of moral stage development, reasoning, and maturity that have implicit relevance

to behavioral decisions. Kohlberg postulated that individual moral development evolves through stages in which moral judgements are made in terms of progressively more abstract, principled criteria ranging from fear of punishment in very early stages (preconventional reasoning), to reactions of others and accommodation of society (conventional reasoning), and finally to abstract considerations of principles and justice (post-conventional reasoning). Not all people develop to the higher stages of justice reasoning.

If one can assume that communications should directed toward a subject's level of moral reasoning, Kohlberg's theory can be applied to the design of signs for controlling visitor depreciative behavior in parks. The theories suggest that sign texts should correspond to the subject's level of moral development to be effective (Christensen and Dustin, 1986). A sign appealing to abstract conservation ideals would presumably not be effective with individuals whose moral reasoning evolved around maximizing individual pleasure, fear of punishment, or the avoidance of negative reactions by others. Moral development theories, however, relate to personal and social contexts, not to an individual's perceptions of the natural environment.

Releasor cues are environmental cues that stimulate or encourage the release of people's inhibitions towards certain actions (Samdahl & Christensen, et al, 1986; Zimbardo, 1973). The attractive off-trail snow play area at Alta Vista in Paradise Meadow with extensive evidence of visitor use could be considered a releasor cue. There are characteristics of the area around

Panorama Point in the meadow (barren fell fields, unclear designated trails) which could be considered examples of environmental cues with much the same effect. The Park's expectations for visitor behavior may be perceived as less well-defined without the deterrence provided by more immediate situational cues to inhibit depreciative behavior.

Malicious noncompliance to low impact guidelines at Mt. Rainier is probably an insignificant source of visitor impact on the meadows. Any such instances would be isolated and thus not subject to observation in the current study. This study does not examine the potential for problematic behavior of this nature.

In summary, some proportion of the visitor population in a recreational setting can be expected to lack an orientation or basis of understanding to comply with agency behavioral guidelines. Several sources of depreciative behavior in recreational settings have been identified:

1) Ignorance of agency communications regarding low impact guidelines (rule ignorance).

2) Selective bias due to visitor expectations or values that precludes learning and attitude change that might prompt desired behavior.

3) Ignorance of the consequences of the undesirable behavior (consequence ignorance).

4) Norm conflict when the visitor does not perceive his behavior as being depreciative or does not accept the agency behavioral norms.

5) Individual levels of moral development and justice reasoning.

6) Releasor cues or circumstances which indicate implicit situational acceptability of depreciative behavior.

7) Malicious intent (usually associated with vandalism, not depreciative behavior).

Current Study Research Hypotheses

Drawing from the preceding literature review and the 1985 preliminary study at Mount Rainier, the research hypotheses for the sign experiment predicted:

(1) All trailside signs will reduce instances off-trail hiking in comparison to a control (no sign)

(2) There will be differences between the relative effectiveness of the sign treatments.

(3) The threatened sanction sign will be the most effective sign as an off-trail hiking deterrent.

(4) The sanction, hybrid, and symbolic signs will be more effective deterrents than the standard NPS sign.

(5) A uniformed employee's presence will reduce off-trail hiking.

(6) All barriers will reduce off-trail hiking.

No predictions of the effect of the other sign treatments were made due to the lack of prior research concerning the particular sign texts or sign design. Similarly, no predictions were made regarding the "novelty effect" of singular exposure to unique signs, and no hypotheses were advanced as to the relative effectiveness of barrier types.

RESEARCH DESIGN[5]

The primary objective of the various experimental components of the 1987 Mt. Rainier study was to test the effectiveness of different social control techniques in reducing instances of off-trail hiking.

Site Selection Criteria

Site selection for all components of the experiment (sign and barrier sites) was based on three criteria. First, the sites were from different biological zones in the meadow ranging from lush vegetation in the lower meadow to very sparse fell fields at Panorama Point. Second, several types of behavior were represented. The Dead Horse sign site was located at a social trail which was a shortcut across switchbacks along the paved, designated trail. At the Lower Meadow sign site, off-trail hiking does not lead to a specific destination and does not appear to be motivated as a matter of personal convenience to shorten walking distances. The Devil's Triangle barrier site was a viewpoint and photography vista. The Alta Vista barrier site was an informal snow play area early in the summer season. The Dead Horse barrier site presented an attractive environmental cue (climbing rock) in an area of highly visible human impact that adjoined a series of social trails radiating from the site to other designated and social trails across the meadow. The Panorama Point sign site was a rocky area of higher elevation and very sparse vegetation with considerable evidence of human impact. The third criterion was

5 Those unfamiliar with statistics and hypothesis testing should refer to Appendix 6 prior to reading the research design and results sections of this paper.

that there should be sufficient noncompliant behavior (variation in the dependent variable) so that statistical differences between social control techniques were possible given the anticipated sample sizes.

Sign Experimental Design

The sign experiment consisted of a procedure to observe visitor behavior in response to selected experimental trailside sign texts at three sites in the meadow. These were: (1) a site located on the Dead Horse Creek Trail (the DH1 site from the 1985 pilot study), (2) another site located in the lower meadow near the RMI "A" frame, and (3) a site in the upper meadow at Panorama Point. The research design utilized one stake and six sign treatments, a control (no sign), a nested experimental treatment to test the effect of the presence a uniformed person at one site (Lower Meadow), and another nested treatment at the Dead Horse sign site to consider the effect of unique signs (single vs. multiple exposures to the unusual experimental signs).

One member of each research team observed visitor behavior in response to experimental treatments from an inconspicuous vantage point near the treatment site. A second observer was involved in a visitor contact procedure for a related visitor survey, reported in a companion report (Johnson and Swearingen, 1988). Subjects were not aware they were under observation. The observer recorded data onto an observation form (Appendix 1) for all parties passing the treatment site in one direction (facing the signs - traveling uphill). Recorded information included estimated age, gender, group race or ethnicity, tour group or military group status,

individual behavior (compliance/noncompliance) in response to the experimental treatments (compliance or noncompliance to the signs), and behavior of other proximate parties. Pretests of the observation form were used to enhance accuracy and speed of field data collection and to facilitate data entry procedures.

The direction of the signs was based on observations in the 1985 study that more noncompliance occurred when subjects were walking uphill. It was also much more difficult to fail to notice the signs because the signs were immediately in the hikers' field of vision when ascending the trail.

The sign texts used in the experiment consisted of the following:

a) Old Standard NPS text - "NO HIKING - MEADOW REPAIRS" (Figure 3, p. 22).

b) New NPS text - "STAY ON THE PAVED TRAILS AND PRESERVE THE MEADOW" (Figure 4, p. 22).

c) Symbolic message - an international red circle and cross-hatch design over a hiker's profile (Figure 5, p. 23).

d) Hybrid text - the symbolic message with a prohibitory message, "NO OFF-TRAIL HIKING" (Figure 6, p. 23).

e) Threatened Sanction text - "OFF-TRAIL HIKERS MAY BE FINED" (Figure 8, p. 24).

f) Symbolic text on stake - short stake (app. 1') with a small version of the symbolic sign (Figure 7, p. 24).

g) Humorous sign - "DO NOT - TREAD, MOSEY, HOP, TRAMPLE, - STEP, PLOD, TIPTOE, TROT, - TRAIPSE, MEANDER, CREEP, - PRANCE, AMBLE, JOG, TRUDGE, - MARCH, STOMP, TODDLE, JUMP, - STUMBLE, TROD, SPRINT, OR - WALK ON THE PLANTS" (Figure 9, p. 25).

h) Control - no sign present

The signs, constructed by the sign shop at Mount Rainier, were of a design currently employed in the meadow (aluminum sign about 12"W by 8"H, engraved with black or red letters. They were mounted approximately knee high on a 3" by 3" brown steel post and were located just off the trail at the point of access to an impacted site. The placement of the signs was such that the subjects could not ascend the trail and deviate onto the social trail or impacted area without seeing them.

Sign texts and nested treatments to be used in the experiment were selected for several reasons. The standard NPS sign was selected because it has been the primary sign text employed in the meadow and is also a reference to the 1985 preliminary data. The symbolic and hybrid signs were included due to their effectiveness as reported in prior research. The stake was chosen because it represents an easy-to-install, cheap, unobtrusive social control technique. The symbol used on the stake, the symbolic sign, and the hybrid sign was chosen from the manual of suggested NPS signs approved by the Department of Interior. Thus the stake and symbolic treatments are not directly comparable to the existing stake in use in the meadow or to the 1985 symbolic sign (both of which employ a hiking boot sole symbol). The threatened sanction sign was included due to the effectiveness of that sign in the pilot 1985 study and in other studies. The new NPS sign was suggested by the Park staff and includes an ethical appeal to explain the prohibitory message that is intuitively easier to understand than the old NPS sign "Meadow Repairs" statement. The humorous sign (again suggested by Park staff) is very similar to a

sign used at the San Diego Zoo and reported to be effective in that setting. A control (no sign) is dictated by experimental design.

There were also two nested treatments in the sign experiment; the presence or absence of a uniformed NPS employee and a "novelty treatment" to test for the effect of singular or multiple exposure to the experimental signs. A uniformed roving interpreter from the park was present and then absent during randomly assigned alternating observation periods (days) at the Lower Meadow site during the experiment to assess the impact of the uniformed presence on off-trail hiking. At another site (Dead Horse), the effect of repeated exposure to the experimental signs was compared to the effect of singular exposure to the same experimental treatments. This procedure was designed to consider the possibility that novel signs are more effective (i.e., visitors are more attentive and thus more compliant when exposed to an unusual sign text).

Barrier Experiment Design

The barrier experiment sites were: (1) Devil's Triangle, (2) Dead Horse, and (3) Alta Vista. There were two treatments; (1) a split rail fence, (2) a rope barrier supported by lathe posts just above knee height, and (3) a control (no barrier). The observation and visitor contact procedures were the same as outlined above for the sign experiment.

Trailhead Sign Survey

A third component of the 1987 Paradise research was a visitor contact procedure and field interview to determine the effectiveness of an audio (recorded) message as measured by visitor

recall of the relevant message. The recorded message was broadcast over speakers attached to the trailhead sign on the north side of the Paradise parking lot (Figure 2, p. 21). The tape player was located in an outbuilding near the trailhead. Frequency of the playback of the message was synchronized with the frequency of visitors passing the site. Both male and female voices were used on different recordings. The actual message briefly related information on research into the impact of human trampling on a subalpine meadow and on the need for visitors to stay on the trail to avoid further impacts to the resource.

The survey procedure involved random contacts of visitors by field personnel to explain the nature of the survey and to conduct an interview. The procedure consisted of a brief (two or three minutes) visitor interview (Appendix 4) to assess message recall and attitudes toward the type of media used to deliver the message. Contact of subjects occurred near the trailhead location of the sign and speakers on a random number of days distributed over the summer.

Sampling Design

The following discussion is a description of the procedure which was followed to randomize the treatment schedule and to plan employees' work schedules.

The first three days of the data collection period were devoted to an instrument pre-test and employee orientation. Thereafter, the first day of data collection was randomly selected for each team. Using a random table of numbers, a random day of the week was chosen (days numbered 1 - Sunday to 7 - Saturday), for

each research team, and this day was the start of the five day work week for the team. This procedure coincidentally established a work schedule which assured that no days off overlapped between teams or occurred on weekends. Thus, the large weekend park use is over-represented in the data observation.

The observation period ran from the last week in June to the first full week after Labor Day (June 24 to September 11, 1987).

The rotation of sign treatments was such that there was a systematic procedure for control of time of day, day of week, and month of visitor season for each treatment at each site. Based on an eight hour period of observation per day, a systematic rotation of five sign treatments by site in one and one-half hour intervals was planned (the last time interval of the day was two hours, 3 P.M. to 5 P.M.). The sign treatments were assigned consecutive numbers to establish a predetermined sequence of treatments. Then the initial treatment for each site was chosen from a table of random numbers. This was the first treatment at a specific site, and thereafter the chronological sequence of treatments rotated with five treatments per day. Exceptions were the control (no sign) and stake treatments, which were randomly distributed by full day periods over the entire season. Since these treatments did not require the sign posts, this convention was adopted to avoid set up and removal of all the sign posts at each site once every day (the posts were buried firmly in the ground, and removal was difficult). This procedure ensured an adequate distribution of treatments by time of day and day of week for each treatment, at each site, over the entire data collection period.

The nested treatment testing for a "novelty effect" was at the Dead Horse site. Single experimental signs were present only at the observation site for one complete rotation of treatments. During the next treatment rotation, all signs occurred two additional times prior to reaching the observation site on the same trail corridor. When the additional experimental signs were not deployed, standard NPS meadow signs ("NO HIKING - MEADOW REPAIRS") were installed on the otherwise vacant posts along the trail corridor below the observation site. The presence of the standard NPS sign was not an unusual occurrence; a visitor could not hike in the meadow and fail to pass the sign several times.

At the Lower Meadow site, the deterrent effect of the presence of uniformed NPS personnel on visitor off-trail hiking was tested. The uniformed employee was absent and present for alternate sign treatment rotations.

Since it was not practical to erect and remove barrier treatments on a daily basis, the planned rotation of treatments for this component of the study was by blocks of days, with the blocks of days for each treatment randomly distributed across sites throughout the season. Due to problems associated with availability of the materials for the fences, it was not possible to follow the planned schedule. Further elaboration on this point occurs in the data limitations section of this paper.

Observer Training and Supervision

To enhance interobserver reliability, employee orientation included training sessions, use of procedural manuals, observation sheet pretests, and site specific definition of all variables

recorded. Each employee had a field manual covering all aspects of the data collection procedure. On-site training sessions covered all field procedures. Training included working with the group of observers at each site to insure there was a mutual understanding and use of all coding categories (i.e., site specific definitions of all variables).

In cases where an observer was temporarily assigned to an unfamiliar site, an employee experienced at that site spent a day jointly collecting observation data with the newcomer to thoroughly orient the second employee to the unfamiliar site[6]. The project field manager spent several days collecting data concurrently with individual employees to check their reliability. Each employee's data was compared to that collected by the field supervisor, a rate of variance computed, and a conference was held with the employee to resolve any differences in observations.

In order to ensure proper rotation of each treatment as planned by site, time of day, day of week, and week of season, each employee was responsible for a journal specific to his/her observation team and sites. Prior to initiating actual observations in June, the entire rotation schedule for every treatment at every site was recorded in the appropriate journals by month and day for the whole data collection period through September. Employees were required to have these journals on hand at all times and to accurately follow the schedules. When administrative details in the park impacted the schedules, new

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6 This procedure was not followed at Panorama Point, which was part of the reason for the administration problem at that site discussed in the Data Limitations section of this report.

schedules were compiled for each relevant site based on the original systematic and randomization procedures. The new altered schedules were then recorded in the appropriate journals for the duration of the data collection period.

The employee journals were also to be used to record any observations relevant to the research questions or other issues pertinent to project administration. The journals offered insight into the nature of the impact problems and visitor behavior that was not addressed otherwise in the research design. Journal observations included references to visitors' comments on signs, obvious language problems, or interview refusals. The journals were also used to resolve questions during the coding procedures.

Limitations of the Data[7]

Changes in the research design to address the late implementation of the barrier treatments meant much less time was devoted to observation at the Panorama Point sign site than was originally scheduled in the research design. Further, signs were not constructed for a third site and were only available on a sporadic basis for observations at that site. Due to these complications, there was inadequate rotation of treatments at that site. The data are composed almost entirely of observations of the standard NPS sign. Given these problems, analysis of the data from Panorama Point for sign effectiveness is not possible. Therefore, the data are excluded from that analysis. These data can be used, however, to estimate overall rates of noncompliance at the site.

Barriers were not administered randomly over the summer season in the barrier experiment because of logistical complications involved in erecting all treatments on the sites in a timely manner. With removal from the analysis of the Alta Vista snow play data (collected only in the early summer with high rates of noncompliance due to the presence of snow), there is no significant difference in compliance by month. Thus the nonrandom administration of barriers by month of the data collection period was not judged to impact the results of the barrier experiment.

Due to inadequate rotation of the repeating signs under the humorous sign treatment, a test for novelty effect is not possible for that sign due to low cell counts.

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7 Analysis of several additional issues which relate to administration of the experiment or data analysis is considered in Appendix 5.

A novelty effect was found specific to the hybrid sign (Table 9), although there was no such effect found when all of the unique signs (new NPS, symbolic, hybrid, sanction, humorous) were collapsed into a single category, and compared to the control in a chi square table. Given that a novelty effect was found relative to that treatment, consideration of the impact on the aggregate data became an issue. The difference in the number of noncompliers between presence of the repeating signs and the single sign was only 11 subjects. Since this number of subjects actually involved is an extremely small proportion of the aggregate data base (0.074 percent of the sample, N = 14772, Table 2), the single hybrid sign data were not excluded from the aggregate data base used to assess sign effectiveness because the small number would not affect the results.

Observation data, in general, have inherent limitations in accuracy. Age categories are difficult to ascertain. Estimation of group size is sometimes difficult when several groups are simultaneously at the same site. Several categories of race or ethnic origin (Asian, white, black, Hispanic, and mixed party or other ethnic group) were recorded in the data in an attempt to understand behavior by race and to consider the issue of effectiveness of some treatments with minority and foreign visitors. Classification may not have been accurate when racial/ethnic differences were not obvious or when subjects were in mixed groups. Mixed groups were placed in the "other" category. Further, ethnic/racial categories do not establish whether the subject can actually read an English language sign. As a result,

the research design could not adequately address the issue of ethnic and language interactions in the effectiveness of symbolic and hybrid signs[8]. Interpretation of the data should reflect these inherent limitations to accuracy.

A large percentage of all noncompliance was committed by entire groups, rather than individuals within a group, a situation which might violate the a priori assumption of the chi square test of independence of the units of analysis (individuals). This situation would violate the assumption of independence only to the extent that individuals in a whole group of noncompliers deviated off-trail because other group members were also hiking off-trail (i.e. there is a group effect interacting with individual behavior). This issue is dealt with more fully in the technical appendix (Appendix 5) under the sections headed "Technical Notes". The reader is cautioned, however, that questions may be raised about the precise interpretation of the p values generated by the chi square tests.

The test for a potential novelty effect of unusual new signs consisted of only three exposures to the experimental signs. It was not practical to attempt more widespread distribution of the experimental signs. It is unclear whether this level of exposure is sufficient to produce a test for novelty effect. The potential direction of a novelty effect was indeterminant. Does repeated exposure to an unusual, novel sign cause an increase or a decrease in the effectiveness of an unusual sign type? Are these exposures sufficient to test both potential effects?

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8 The data do provide preliminary qualitative evidence of differential sign effectiveness by ethnic group membership.

Certain large parties of non-English speaking foreign visitors were removed from the data base as their noncompliant behavior was nonrandomly represented and would misrepresent the overall effectiveness of the relevant signs. This issue is reviewed more fully in Appendix 5.

RESULTS

Sign Experiment Results

There was a significant reduction in off-trail hiking at the Dead Horse and Lower Meadow sign sites with signs present (Table 1).[9] The average rate of noncompliance at the two sites with no sign present (i.e., control) was 6.9 percent, compared to an average 3.7 percent rate of noncompliance when the data are averaged across all treatments. The results of the sign experiment by treatment are presented in Table 2. The most effective signs (i.e., those having the lowest rate of noncompliance, enclosed in parentheses) were: (1) the threatened sanction sign (1.7 percent), (2) the new NPS sign (3.3 percent), (3) the humorous sign (3.4 percent), (4) the hybrid sign (3.6 percent), and (5) the symbolic sign (4.1 percent). The old standard NPS sign was the least effective sign (4.9 percent), and the stake was the least effective treatment (5.3 percent).

A possible approach to isolating the significant statistical relationships in a crosstabulation table is to do a step-wise analysis of the table referred to as a chi square partition. With a sufficiently large data base, one can either remove the least or the most effective treatments in an attempt to determine the most important treatment or set of treatments.

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9 To control for the effect of the uniformed presence, the data from the Lower Meadow site are only reported without the uniformed person present. The Panorama Point data are excluded due to the administrative problems associated with data collection and shortages of materials for rotation of the treatments at that site, as reported in the Data Limitations section of this paper.

First, a partition of the crosstabulation of the aggregate data base was initiated, removing the most effective treatments (i.e., removing the sanction sign, then the sanction and new NPS signs, then the sanction, new NPS, and humorous signs, etc.). When the old NPS sign was removed from the crosstabulation (Table 3), the significance disappears. Thus, all of the signs are more effective than the stake or the control (no sign), and the stake is no more effective than the control (no sign, Table 3). This approach does not, however, clearly establish the relative effectiveness of all of the remaining treatments.

Since the partitioning of most effective treatments did not differentiate between effective signs, a partition eliminating least effective treatments was initiated. Successive chi square tests were performed removing least effective treatments, and there was a significant difference between treatments even when only the sanction and new NPS signs were compared (Table 4).

To this point the analysis had established that: (1) the sanction was significantly more effective than any other treatment; (2) the stake had no effect on off-trail hiking; and (3) the relative effectiveness between all other treatments was not yet established.

In Table 5, a comparison of all of the other signs except the sanction sign (also without the stake or the control) was not significant. This does <u>not</u> mean that there is not a difference between all of these signs. For instance, the old NPS sign is substantially less effective than the new NPS sign. The new NPS sign reduces noncompliance by 33 percent in comparison to the old

NPS sign. This reduction is of considerable practical as well as statistical significance (Table 6).

The data establish that the signs significantly reduce off-trail hiking. The stake is no more effective than no sign (control). The most effective sign defined by the lowest rate of noncompliance was the threatened sanction sign. It was almost twice as effective as the next treatment, the new NPS sign (1.7 percent noncompliance compared to 3.3 percent noncompliance, respectively). The old NPS sign is clearly the least effective sign.

Table 1. Sign Status by Compliance Status - Dead Horse and Lower Meadow Sign Sites, with Uniform Absent - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
SIGN STATUS:			
All Signs	96.3% 89.1% 12633	3.7% 81.0% 486	100.0% 88.8% 13119
Control (no sign)	93.1% 10.9% 1539	6.9% 19.0% 114	100.0% 11.2% 1653
Column Totals	95.9% 100.0% 14172	4.1% 100.0% 600	100.0% 100.0% 14772

Missing Cases = 0
Chi-Square = 37.6 p = .0000
Phi = .05

1 C = Complier NC = Noncomplier

Table 2. Sign Text by Compliance Status - Dead Horse and Lower Meadow Sign Sites, with Uniform Absent

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
SIGN TEXT:			
Sanction	98.3% 13.8% 1957	1.7% 5.5% 33	100.0% 13.5% 1990
New NPS	96.7% 11.3% 1596	3.3% 9.2% 55	100.0% 11.2% 1651
Humorous	96.6% 11.3% 1607	3.4% 9.5% 57	100.0% 11.3% 1664
Hybrid	96.4% 14.8% 2095	3.6% 13.0% 78	100.0% 14.7% 2173
Symbolic	95.9% 15.2% 2155	4.1% 15.3% 92	100.0% 15.2% 2247
Old NPS	95.1% 13.0% 1837	4.9% 15.7% 94	100.0% 13.1% 1931
Stake	94.7% 9.8% 1386	5.3% 12.8% 77	100.0% 9.9% 1463
Control (no sign)	93.1% 10.9% 1539	6.9% 19.0% 114	100.0% 11.2% 1653
Column Totals	95.9% 100.0% 14172	4.1% 100.0% 600	100.0% 100.0% 14772

Missing Cases = 0
Chi-Square = 77.5 p = .0000
Cramer's V = .07

1 C = Complier NC = Noncomplier

Table 3. Sign Text by Compliance Status - Dead Horse and Lower Meadow Sign Sites, with Uniform Absent and All Effective Treatments Removed - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
SIGN TEXT:			
Stake	94.7% 47.4% 1386	5.3% 40.3% 77	100.0% 47.0% 1463
Control (no sign)	93.1% 52.6% 1539	6.9% 59.7% 114	100.0% 53.0% 1653
Column Totals	93.9% 100.0% 2925	6.1% 100.0% 191	100.0% 100.0% 3116

Missing Cases = 0
Chi-Square = 3.3 p = .0684
Phi = .03

1 C = Complier NC = Noncomplier

Table 4. Sign Text by Compliance Status - Dead Horse and Lower Meadow Sign Sites, with Uniform Absent, for Most Effective Treatments - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
SIGN TEXT:			
New NPS	96.7% 44.9% 1596	3.3% 62.5% 55	100.0% 45.3% 1651
Sanction	98.3% 55.1% 1957	1.7% 37.5% 33	100.0% 54.7% 1990
Column Totals	97.6% 100.0% 3553	2.4% 100.0% 88	100.0% 100.0% 3641

Missing Cases = 0
Chi-Square = 10.0 p = .0016
Phi = .05

1 C = Complier NC = Noncomplier

Table 5. Sign Text by Compliance Status - Dead Horse and Lower Meadow Sign Sites, with Uniform Absent, for Treatments with Mid-Range of Effectiveness - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
SIGN TEXT:			
New NPS	96.7% 17.2% 1596	3.3% 14.6% 55	100.0% 17.1% 1651
Symbolic	95.9% 23.2% 2155	4.1% 24.5% 92	100.0% 23.2% 2247
Hybrid	96.4% 22.6% 2095	3.6% 20.7% 78	100.0% 22.5% 2173
Old NPS	95.1% 19.8% 1837	4.9% 25.0% 94	100.0% 20.0% 1931
Humorous	96.6% 17.3% 1607	3.4% 15.2% 57	100.0% 17.2% 1664
Column Totals	96.1% 100.0% 9290	3.9% 100.0% 376	100.0% 100.0% 9666

Missing Cases = 0
Chi-Square = 8.1 p = .0896
Cramer's V = .03

1 C = Complier NC = Noncomplier

Table 6. Sign Text by Compliance Status - Dead Horse and Lower Meadow Sign Sites, with Uniform Absent, for New NPS and Old NPS Treatments - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
SIGN TEXT:			
New NPS	96.7% 46.5% 1596	3.3% 36.9% 55	100.0% 46.1% 1651
Old NPS	95.1% 53.5% 1837	4.9% 63.1% 94	100.0% 53.9% 1931
Column Totals	95.8% 100.0% 3433	4.2% 100.0% 149	100.0% 100.0% 3582

Missing Cases = 0
Chi-Square = 4.9 p = .0270
Cramer's V = .04

1 C = Complier NC = Noncomplier

Nested Treatment Results: Deterrent Effect of Uniformed Presence

There was a significant difference in compliance rates at the Lower Meadow site with the uniformed employee present and absent (Table 7). Noncompliance was only 0.6 percent with the uniformed NPS person at the site, compared to 2.5 percent when the uniformed NPS person was absent. Since the number of observations in this subset of the data was small, an additional crosstabulation was run to check for anomalous results due to large group behavior by exclusion of groups of greater than 14 visitors. The results were not significantly different.

Table 8 displays the data by treatment (collapsed categories) when the uniformed employee was present. There remains a significant difference between the most effective signs, the old NPS sign, and the control (no sign) although some cell counts are very small. This table is interpreted to mean that signs have an effect on off-trail hiking behavior even in the presence of a uniformed Park employee.

Test for the Potential Novelty Effect

A chi square test run of the aggregate data with all repeating or singular experimental sign exposures by compliance status was not significant. The analysis only contained data for those subjects exposed to the unusual experimental signs (new NPS, symbolic, hybrid, sanction, and humorous signs). As an added precaution due to the small number of observations, the analysis of the data was run again excluding parties of greater than 14 visitors, and this crosstabulation was also not significant. In general, there was no novelty effect observed in visitor behavior

(off-trail hiking) due to a single exposure to a unique sign. Therefore, all of the data from the Dead Horse site were included in the aggregate analysis of sign effectiveness without controlling for single or multiple exposures to experimental signs.

Further analysis of the data by specific signs revealed that there was no significant difference in compliance rates when the repeating signs were present or absent for the new NPS, symbolic, or sanction signs. There was a significant difference in compliance rates between single and repeated exposures to the hybrid sign (Table 9). There was a higher rate of noncompliance when the sign was present several times along the trail corridor. The relationship persists when controlling for party size. Thus, a novelty effect was observed for this sign. The difference in numbers of noncompliers between presence of the repeating signs and presence of a single hybrid sign was only 11 subjects.

Since the observed novelty effect is based on a very small number of observations of subject behavior, the caution concerning group behavior and interpretation of the chi square statistic is of considerable importance (see Appendix 5). This finding of a novelty effect specific to the hybrid sign should be considered tentative due to the fact that very small numbers of noncompliers are involved. Different <u>observed</u> behavior by only one or two groups would have changed the conclusions.

Table 7. Uniform Presence by Compliance Status - Lower Meadow Sign Site - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
Uniform Present	99.4% 33.0% 2522	0.6% 10.8% 16	100.0% 32.6% 2538
Uniform Absent	97.5% 66.1% 5123	2.5% 88.6% 132	100.0% 67.4% 5255
Column Totals	98.1% 100.0% 7645	1.9% 100.0% 148	100.0% 100.0% 7899

Missing Cases = 31.5
Chi-Square = 32.2 p = .0000
Phi = .065

1 C = Complier NC = Noncomplier

Table 8. Sign Text by Compliance Status - Lower Meadow Sign Site, with Uniform Present

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
SIGN TEXT:			
Effective Signs	99.7% 64.3% 1621	0.3% 31.3% 5	100.0% 64.1% 1626
Stake	99.3% 11.0% 278	0.7% 12.5 2	100.0% 11.0% 280
Old NPS	99.0% 11.9% 299	1.0% 18.8% 3	100.0% 11.9% 302
Control (no sign)	98.2% 12.8% 324	1.8% 37.5% 6	100.0% 13.0% 330
Column Totals	99.4% 100.0% 2522	.6% 100.0% 16	100.0% 100.0% 2538

Missing Cases = 0
Chi-Square = 10.80 p = .0128
Cramer's V = .065

1 C = Complier NC = Noncomplier

Table 9. Presence of Repeating Signs by Compliance Status - Dead Horse Sign Site for Hybrid Treatment - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
ADDITIONAL TREATMENTS:			
Repeating Signs Present	92.7% 40.4% 493	7.3% 58.2% 39	100.0% 41.4% 532
Repeating Signs Absent	96.3% 59.6% 726	3.7% 41.8% 28	100.0% 58.6% 754
Column Totals	94.8% 100.0% 1219	5.2% 100.0% 67	100.0% 100.0% 1286

Missing Cases = 0
Chi-Square = 7.5 p = .0060
Phi = .08

1 C = Complier NC = Noncomplier

Barrier Experiment Results

The barrier site experiment consisted of a study of the deterrent effect on visitor off-trail hiking of two types of physical barriers (rope, split rail) in comparison to a control (no barrier) at three sites in Paradise Meadows. The sites were: (1) Alta Vista in the early season with a large, informal snow play area, (2) Devil's Triangle - a photography vista in the lower meadow, and (3) Dead Horse Trail near a "climbing rock" (environmental cue).

The aggregate data from all barrier sites cannot be used in interpreting the results of the barrier experiment because the data from the Alta Vista snow play area contain a very high rate of noncompliance that skews the results. Since there was only one treatment at that site (rope) and a control, the rope treatment would appear less effective in the aggregate data than is actually the case due to the unusually high rate of noncompliance at that site when compared to the other barrier sites.

At the Alta Vista site (Table 10), the rope barrier significantly reduced the rate of noncompliance when compared to the control (20.7 percent and 30 percent noncompliance, respectively). Because the site is a snow play area, however, the rates of noncompliance remained very high.

The results from the other two sites were consistent with the Alta Vista data. At both sites, the rope reduced noncompliance in comparison to the control. At the Dead Horse site, there was virtually no deviation off-trail (0.2 percent) when the rope was present (Table 11). Observations of behavior at the split rail

fence treatment at Dead Horse recorded a 2.7 percent rate of noncompliance. These rates of noncompliance may be unusually low because the barrier was placed behind the environmental cue on the site (a climbing rock). Only those visitors passing beyond the rock away from the designated trail were classified as noncompliers. A much larger number of persons actually deviated off the trail at the site up to the rock (a distance of at least 20 feet). Due to the location of the barrier, these visitors were not classified as noncompliers. The location of the barrier was requested by the Park Resource Management staff to determine if it would contain those visitors already deviating off-trail. The area around the rock may eventually be officially designated as open to the public. Thus, there was concern as to whether barriers would deter visitors from further incursions into the meadow once they reached the rock.

Results from the Devil's Triangle site were similar, although the observed rates of noncompliance were higher (Table 12). The rope was the most effective treatment (noncompliance was 5.7 percent), followed by the split rail fence (7.3 percent), and the control (18.6 percent).[10]

The findings support the research hypothesis; the barriers reduced off-trail hiking in comparison to the control. Results were consistent between a photography vista (Devil's Triangle), a

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10 Since there was a very large increase in noncompliance rates between the control and the split rail treatment at the Devil's Triangle site, this raised the possibility that anomalous large parties were affecting the data. However, the results of the aggregate data from Devil's Triangle and Dead Horse (Table 13) with large parties in the data base did not change with the exclusion of large parties.

snow play area (Alta Vista), and on social trails with an environmental cue (Dead Horse climbing rock), although the rate of noncompliance remained high at the snow play area. The high rates of noncompliance at the snow play site suggest other social control techniques should be considered when snow is present. On average, ropes were over twice as effective as split rail fences in reducing noncompliance. Forty six percent less noncompliance was observed in the presence of the split rail fence in comparison to the control (no barriers) 1.0 - (4.990/9.190), Table 13.

Table 10. Barrier Type by Compliance Status - Alta Vista Site - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
BARRIER TYPE:			
Rope	79.3% 64.0% 1164	20.7% 51.7% 303	100.0% 61.0% 1467
Control	69.9% 36.0% 656	30.1% 48.3% 283	100.0% 39.0% 939
Column Totals	75.6% 100.0% 1820	24.4% 100.0% 586	100.0% 100.0% 2406

Missing Cases = 0
Chi-Square = 27.4 p = .0000
Phi = .11

1 C = Complier NC = Noncomplier

Table 11. Barrier Type by Compliance Status - Dead Horse Site - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
BARRIER TYPE:			
Rope	99.8% 25.1% 509	0.2% 2.1% 1	100.0% 24.6% 510
Split Rail	97.3% 43.8% 889	2.7% 53.2% 25	100.0% 44.0% 914
Control	96.8% 31.1% 631	3.2% 44.7% 21	100.0% 31.4% 652
Column Totals	97.7% 100.0% 2029	2.3% 100.0% 47	100.0% 100.0% 2076

Missing Cases = 0
Chi-Square = 13.5 p = .0012
Cramer's V = .08

1 C = Complier NC = Noncomplier

Table 12. Barrier Type by Compliance Status - Devil's Triangle Site - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
BARRIER TYPE:			
Rope	94.3% 18.2% 250	5.7% 9.9% 15	100.0% 17.4% 265
Split Rail	92.7% 57.8% 793	7.3% 40.8% 62	100.0% 56.1% 855
Control	81.4% 24.0% 329	18.6% 49.3% 75	100.0% 26.5% 404
Column Totals	90.0% 100.0% 1372	10.0% 100.0% 152	100.0% 100.0% 1524

Missing Cases = 0
Chi-Square = 45.8 p = .0000
Cramer's V = .17

1 C = Complier NC = Noncomplier

Table 13. Barrier Type by Compliance Status - Devil's Triangle and Dead Horse Sites - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
BARRIER TYPE:			
Rope	97.9% 22.3% 759	2.1% 8.0% 16	100.0% 21.5% 775
Split Rail	95.1% 49.5% 1682	4.9% 43.7% 87	100.0% 49.1% 1769
Control	90.9% 28.2% 960	9.1% 48.2% 96	100.0% 29.3% 1056
Column Totals	94.5% 100.0% 3401	5.5% 100.0% 199	100.0% 100.0% 3600

Missing Cases = 0
Chi-Square = 44.7 p = .0000
Cramer's V = .11

1 C = Complier NC = Noncomplier

Visitor Characteristics Relating to Noncompliance

The intention of the following analysis was to develop a description of differences between compliers and noncompliers that is complementary to the companion report from the 1987 Mt. Rainier project which reports the results of the mail survey (Johnson and Swearingen, 1988). Thus, only the results of analysis of the sign site data are generally reported, so the samples and results of analysis are similar between reports. Note, however, that the sample for the survey report did not include any visitors under age sixteen. Thus, the two analysis are not directly comparable.

When the data were analyzed extensively while controlling for the site by type of experiment (sign and barrier), the bivariate relationships reported herein between the various independent variables (e.g., age, ethnicity, proximity, etc.) and visitor behavior (compliance/noncompliance) were generally consistent between sites.

1) Age and Gender

There was a significant difference in rates of noncompliance by age/gender categories. Teens and kids (children of about grade school age) of both genders deviated off-trail more often than did adults or preschool children (Table 14). Analysis by age categories only (Table 15) revealed that teens and school age children (kids) were more likely to noncomply (noncompliance was 9 and 7 percent, respectively). Note, however, that adults accounted for 58 percent of all noncompliance.

2) Party Proximity

The majority of noncompliance (78 percent) occurs when other complying parties are present in the vicinity of the party under observation (Table 16). However, the presence of noncompliance is disproportionately associated with an increased probability of noncompliant behavior by others in the vicinity.[11] Only three percent of the parties were in the presence of other noncompliant parties, yet eleven percent of all noncompliance occurred in the vicinity of other noncompliant parties.

To isolate the important relationship in the original comparison (Table 16), a chi square partition was performed. First, a chi square test was performed collapsing the categories to noncompliant party present and all others/no party present (Table 17). The relationship between noncompliers and all others was significantly different (chi square = 65.07, $p \leq .0000$, and phi = .0673). When the comparison was then made of just other parties (of compliers) present and no parties present, the relationship was still significant (Table 18). However, the measure of association was much lower (phi = .0222) than in the previous comparison (Table 17). Thus, the most important relationship in the original table (Table 16) is the relationship between noncompliance and the presence of other noncomplying parties. The relationship between noncompliant party proximity and noncompliance of the observed

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11 Proximity which was deemed close enough to affect other parties in the vicinity was defined on a site specific basis. The criterion was that an approaching party could not reasonably fail to notice behavior of the other party already on the site if looking in the direction of the site. The distances involved were fairly small (30-50 feet).

party occurs when controlling for site at all experimental sites except the Dead Horse barrier site.

3) Party Size

When an analysis of variance (ANOVA) was run for party size by compliance for all of the experimental sites (sign & barrier) the results were significant (Table 19). The average complier party size was 4.3 persons; the average size of a party with some noncompliant members was 5.1 persons. These results are consistent with the findings of the 1987 survey data (Johnson and Swearingen, 1988), and the 1985 quasi-experiment (Johnson and Swearingen, 1986). However, when an analysis of variance of party size by compliance was run for the sign sites alone (Table 19); the results were not significant. The average compliant party size (100% compliance) was 4.7 persons, and the average size of parties with noncompliant members (i.e., some degree of noncompliance) was 5.1 persons.

Since this result is contrary to several previous and concurrent research efforts, it is difficult to reconcile the differences. Notably, the average party size of all other sources ranged from 3.7 to 4.3, whereas the average party size in the 1987 sign data alone was 4.7 visitors. This might indicate some degree of measurement error. The decision was made to exclude party size in the subsequent multivariate analysis of compliance because the analysis of the data when the party was the unit of analysis (see Technical Notes, Appendix 5) indicated that party size was not confounding the interpretation of the relative effectiveness of the signs.

4) Race/Ethnic Categories

Measurement of race/ethnicity was subject to some degree of error due to the crude measurement categories. As a result, the analysis of behavior by this visitor party characteristic was restricted to the three collapsed categories with the largest degree of accuracy (white, Asian, and all others). The comparison of race/ethnicity and compliance in the aggregate sign data is significant (Table 20); noncompliance by whites was three percent, and thirteen percent for both Asians and all others. Although the rates of noncompliance by all other races/ethnic categories were much higher than the noncompliance by whites, whites still accounted for nearly 69 percent of all noncompliance.

5) Summary of Bivariate Relationships

Noncompliant party proximity, age, and ethnicity were significantly related to visitor behavior. Since the measures of association are not directly comparable across tables of varying size, the decision was made to include these variables in a discriminant analysis to determine the relative importance of the different variables in predicting compliance. The discriminant analysis of the questionnaire data was run with only the data from visitors contacted at the Dead Horse and Lower Meadow sign experimental sites (Johnson and Swearingen, 1988). The reason for that decision was that this questionnaire data had the most statistically reliable sample group of compliers with which to compare to the sample of respondents who were noncompliers. Therefore, the discriminant analysis of the experiment data was run

with the comparable data from the Dead Horse and Lower Meadow sign sites only.

6) Discriminant Analysis - Noncomplier Characteristics

The bivariate analysis identified descriptive and situational variables significantly associated with visitor behavior (compliance/noncompliance). Because many of these variables may be related to each other, it is desirable to perform a multiple variable test to identify instances where the association between a variable and visitor behavior occurs because of, or partially because of, an association with another variable. The result of such an analysis is the most parsimonious explanation of the dependent variable (compliance/noncompliance) by the independent variables in the study.

A discriminant analysis was, therefore, performed using the previously cited descriptive variables (e.g., age, ethnicity, proximity, etc.) which were statistically related to off-trail hiking. This test identifies the set of variables that best predicts compliant and noncompliant behavior in these data. Given the frequency of off-trail hiking, the function derived from the discriminant analysis correctly classifies 96 percent of the cases (individuals) as compliers or noncompliers. Most of the ability of the discriminant function to classify the cases was provided by: (1) race/ethnic category of group, (2) age of subject, and (3) proximity of a noncompliant party. The rest of the variables provide very little to the predictive capability of the function.

Interpreting the meaning of the associations of the race/ethnic categorization with behavior is challenging. The most

logical explanation in that a large proportion of foreign visitors are included in the other than white categories - some of which are non-English speaking. The second variable to enter the function was presence of other noncomplying parties. The third variable was age of the visitor.[12]

12 Results of the survey component of the project found no association between age and off-trail hiking in a sample of visitors over 16 years of age (Johnson and Swearingen, 1988). That analysis had few people under age 20, and the present analysis is, therefore, the more reliable measure.

Table 14. Age and Gender Characteristics by Compliance Code - Dead Horse and Lower Meadows Sites, with Uniform Absent

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
AGE/GENDER CATEGORY:			
Adult Male	96.7% 40.3% 5710	3.3% 32.0% 192	100.0% 40.0% 5902
Adult Female	97.0% 35.8% 5069	3.0% 26.0% 156	100.0% 35.4% 5225
Teen Male	89.6% 3.1% 441	10.4% 8.5% 51	100.0% 3.3% 492
Teen Female	92.4% 3.2% 453	7.6% 6.2% 37	100.0% 3.3% 490
Kid Male	92.5% 7.8% 1105	7.5% 14.8% 89	100.0% 8.1% 1194
Kid Female	92.8% 5.1% 722	7.7% 9.3% 56	100.0% 5.3% 778
Preschool Male	97.0% 2.8% 390	3.0% 2.0% 12	100.0% 2.7% 402
Preschool Female	97.6% 2.0% 282	2.4% 1.2% 7	100.0% 2.0% 289
Column Totals	95.9% 100.0% 14172	4.1% 100.0% 600	100.0% 100.0% 14772

Missing Cases = 0
Chi-Square = 149.0 p = .0000 Cramer's V = .1004

1 C = Complier NC = Noncomplier

Table 15. Age Categories by Compliance Code - Dead Horse Lower Meadows Sites, with Uniform Absent - 1987 Paradise Meadows Sign Experiment

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
AGE AND GENDER:			
Adult	96.9% 76.1% 10779	3.1% 58.0% 348	100.0% 75.3% 11127
Teen	91.0% 6.3% 894	9.0% 14.7% 88	100.0% 6.6% 982
Kid	92.6% 12.9% 1827	7.4% 24.2% 145	100.0% 13.3% 1972
Preschool	97.3% 4.7% 672	2.7% 3.2% 19	100.0% 4.7% 691
Column Totals	95.9% 100.0% 14172	4.1% 100.0% 600	100.0% 100.0% 14772

Missing Cases = 0
Chi-Square = 143.29 p = .0000
Cramer's V = .0985

1 C = Complier NC = Noncomplier

Table 16. Proximity of Other Parties by Compliance Code - Dead Horse and Lower Meadows Sites, with Uniform Absent - 1987 Paradise Meadows Sign Experiment

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
PROXIMITY OF ANOTHER PARTY:			
NC Party Present	88.8% 3.1% 434	11.2% 9.2% 55	100.0% 3.3% 489
Other Party Present	96.0% 79.3% 11231	4.0% 78.3% 470	100.0% 79.2% 11701
No Party Present	97.1% 17.7% 2502	2.9% 12.5% 75	100.0% 17.5% 2577
Column Totals	95.9% 100.0% 14167	4.1% 100.0% 600	100.0% 100.0% 14767

Missing Cases = 5
Chi-Square = 73.60 p = .0000
Cramer's V = .0706

1 C = Complier NC = Noncomplier

Table 17. Proximity of Other Parties by Compliance Code (Collapsed Category) - Dead Horse and Lower Meadow Sites, with Uniform Absent - 1987 Paradise Meadows Sign Experiment

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
PROXIMITY OF ANOTHER PARTY:			
NC Party Present	88.8% 3.1% 434	11.2% 9.2% 55	100.0% 3.3% 489
Other or No Party Present	96.2% 96.9% 13733	3.8% 90.8% 545	100.0% 96.7% 14278
Column Totals	95.9% 100.0% 14167	4.1% 100.0% 600	100.0% 100.0% 14767

Missing Cases = 5
Chi-Square = 65.07 p = .0000
Phi = .0673

1 C = Complier NC = Noncomplier

Table 18. Proximity of Other Parties by Compliance Code (Noncompliant Parties Excluded) - Dead Horse and Lower Meadows Sites, with Uniform Absent - 1987 Paradise Meadows Sign Experiment

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
PROXIMITY OF ANOTHER PARTY:			
Other Party Present	96.0% 81.8% 11231	4.0% 86.2% 470	100.0% 82.0% 11701
No Party Present	97.1% 18.2% 2502	2.9% 13.8% 75	100.0% 18.0% 2577
Column Totals	96.2% 100.0% 13733	3.8% 100.0% 545	100.0% 100.0% 14278

Missing Cases = 494
Chi-Square = 6.74 p = .0094
Phi = .0222

1 C = Complier NC = Noncomplier

Table 19. Party Size by Compliance Code - 1987
Paradise Meadows Sign Experiment

All Experimental Data (Sign and Barrier Sites)

Sample	# of Cases	Mean Party Size
Entire Sample	25483	4.32
Compliers	23831	4.27
Noncompliers	1652	5.09

$F = 36.160$ $p \leq .000$

Sign Site Data (Dead Horse and Lower Meadows Sites, Uniform Absent)

Sample	# of Cases	Mean Party Size
Entire Sample	14772	4.71
Compliers	14172	4.69
Noncompliers	600	5.12

$F = 1.736$ $p \leq .188$

Table 20. Race/Ethnicity by Compliance Code - Dead Horse and Lower Meadows Sites, Uniform Absent - 1987 Paradise Meadows Sign Experiment

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
GROUP ETHNICITY:			
Asian	87.9% 5.5% 776	13.1% 19.5% 117	100.0% 6.0% 893
White	96.9% 91.2% 12924	3.1% 68.7% 412	100.0% 90.3% 13336
Others	86.8% 3.3% 467	13.2% 11.8% 71	100.0% 3.6% 538
Column Totals	95.9% 100.0% 14167	4.1% 100.0% 600	100.0% 100.0% 14767

Missing Cases = 5
Chi-Square = 334.75 p = .0000
Cramer's V = .1506

1 C = Complier NC = Noncomplier

Trailhead Interview Results

This section presents the results of the trailhead interview concerning visitor acceptance and perceived effectiveness of the audio trailhead message. The message was played through speakers at the trailhead written sign on the north side of the Paradise parking lot (Figure 2, p. 21). In addition to multiple choice questions on the interview site sheet (Appendix 4), additional open-ended comments were solicited on the form. However, the number of visitors who chose to write additional comments was extremely low (10-15 persons). Thus, these open-ended comments are not reported in this summary of the results of the survey.

Of those visitors contacted on the random interview days when the audio message was on, nearly 68 percent recalled hearing the audio message (Table 21). The subsequent tables contain the responses of only those persons who recalled hearing the message. The practical evaluation of the effectiveness of the audio message should include an awareness of the fact that 32.5 percent of the visitors did not recall hearing the message. Thus the measure of effectiveness of the media is attenuated to some degree by the number of people who did not recall exposure to the message.

One approach to determining the effectiveness of the media was to test visitor recall of the message content. As Table 22 and Table 23 illustrate, 10.6 and 13.6 percent of the subjects answered the message content questions incorrectly or did not remember the message. When this data is considered within the total sample (N = 759), 32.5 percent (247 subjects) did not recall hearing the message, and 13.7 percent (104 subjects) did not remember or

correctly recall the content (missed at least one of the content questions). Thus 46.2 percent [(247 + 104) / 759] of the visitors did not recall hearing the message or did not recall the content of the message.

Those persons who had correctly answered at least one of the content questions (N = 468) were included in the visitors' subjective evaluation of the perceived effectiveness of the media (Table 24). Of those visitors, 85 percent felt the message would affect their behavior, and 15 percent felt the message would not affect their behavior or were unsure. The number of visitors who felt the message would affect their behavior represents 52.2 percent of the total number of visitors contacted.[13] Several of the respondents to this question mentioned that the question was irrelevant to them because they were already planning to stay on the trail before they heard the sign.

Table 25 contains visitors' responses to a question designed to elicit their opinions of the more effective media (written or audio trailhead sign). A majority favored the audio sign (52 percent), and an additional 13 percent favored using both types of messages.

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13 The reader is cautioned that such a subjective attitude may be very poorly correlated with behavior (Ajzen and Fishbein, 1977; Triandis, 1971).

Table 21. Proportion of respondents who heard the recorded message. *

Value Label	Frequency	Percent
Yes	512	67.5
No	247	32.5
TOTAL	759	100.0

Valid Cases 759
Missing Cases 0

* Data in Table 21 are from Question 1. See Appendix 4.

Table 22. Proportion of hikers who heard the recorded message and correctly recalled its content. *

Value Label	Frequency	Percent
Correct	458	89.5
Incorrect	9	1.8
Don't Recall	45	8.8
TOTAL	512	100.0

Valid Cases 512
Missing Cases 0

* Data in Table 22 are from Question 2. See Appendix 4.

Table 23. Proportion of respondents who heard the message and recalled that it concerned park regulations. *

Value Label	Frequency	Percent
Correct	380	86.6
Incorrect	60	13.4
TOTAL	440	100.0

Valid Cases 440
Missing Cases 28

* Data in Table 23 are from Question 3. See Appendix 4.

NOTE: Persons who answered "Don't Recall" on Question 2 did not answer Questions 3-5 (Tables 22-25).

Table 24. Proportion of respondents who heard the message that believed it would influence their behavior. *

Value Label	Frequency	Percent
Yes	396	85.2
No	58	12.5
Don't Know	11	2.4
TOTAL	465	100.0

Valid Cases 465
Missing Cases 3

* Data in Table 24 are from Question 4. See appendix 4.

Table 25. Respondent's opinions concerning relative effectiveness of written and audio signs. *

Value Label	Frequency	Percent
Audio Sign	248	52.4
Written Sign	108	22.8
Both	61	12.9
Don't Know	56	2.4
TOTAL	473	100.0

Valid Cases 473
Missing Cases 5

* Data in Table 25 are from Question 5. See appendix 4.

NOTE: A total of 10 respondents who should not have responded on Question 5 (Table 25) did so. These persons answered "Don't Recall" on Question 2.

SUMMARY AND CONCLUSIONS

Sign Experiment Results

Trail side signs reduce noncompliance in comparison to a control (no sign), and different sign texts vary significantly in observed rates of noncompliance. The threatened sanction sign was significantly more effective than any other treatment in reducing off-trail hiking. The new NPS sign with an ethical appeal was the next most effective sign, but the rate of noncompliance nearly doubled in comparison with the threatened sanction sign. The old "Meadow Repairs" sign was the least effective sign. Off-trail hiking rates did not differ at the .05 level of significance among the control and the stake subsamples.

Novelty Effect of Unique Signs

On average, there does not appear to be a novelty effect related to the unfamiliar, experimental signs; they worked equally well as a deterrent to off-trail hiking in multiple or single exposures. However, there is some indication of a novelty effect specific to the hybrid sign. Not all signs in this group were adequately rotated, so these findings should be considered tentative. Further, it is unclear whether three exposures to an unusual sign represent a valid test of the possibility of a novelty effect for that sign.

Deterrent Effect of Uniformed Personnel

Noncompliance almost disappears in the presence of a uniformed NPS employee. However, signs still have a significant, although slight, deterrent effect on off-trail hiking in the presence of a uniformed person. These data suggest that off-trail hikers as a

group are not ignorant of agency expectation concerning (normative prohibitions against off-trail hiking). Visitor communications should reflect this knowledge.

This does not mean that off-trail hikers are motivated to act in defiance of the Park Service. It is possible that their behavior stems from a lack of understanding of the basis for the rules and the amount of impact their behavior causes in the meadow (ignorance of consequences). The fact that the ethical appeal of the new NPS sign worked well suggests these explanations may have some validity, a supposition partially supported by the survey results (Johnson and Swearingen, 1988).

Barrier Experiment Results

The rope barrier was more effective than the split rail fence. Both barriers significantly reduced off-trail hiking in comparison to the control. Although not directly compared to the signs in this study, rope barriers may not be more effective than threatened sanction signs in deterring off-trail hiking. The rope barrier reduced off-trail hiking at the Alta Vista snow play area, but noncompliance remained very high. Additional intervention measures would be desirable during the early season with snow present.

Noncompliance by Site

The rate of noncompliance at Panorama Point with the old standard NPS sign present was 6.1 percent. Since this treatment was the only one at that site with an adequate number of observations, an estimate was made of the rate of noncompliance at that site without a sign present. Using the change in the rate of noncompliance from the old NPS sign to the control (no sign) in the

aggregated data from the main sign experimental sites (Dead Horse and Lower Meadow), the estimated rate of noncompliance at Panorama Point without a sign present is 8.59%. (If one uses the main sites individually to estimate Panorama Point noncompliance, the rate of noncompliance would range from 7.72 to 15.68 percent.)

Using this estimate of noncompliance at the Panorama Point site, the average noncompliance with the control (no sign present) at the different sign sites would be: (1) Lower Meadow - 5.4%, (2) Dead Horse (middle meadow) - 6.9%, (3) Panorama Point (upper meadow) - 8.6%. These data present tentative evidence that there is a site effect related to off-trail hiking. The vegetative cover and quality of trail decrease, and the amount of visible human impact increases, as one ascends the meadow. The estimated proportion of visitors off-trail hiking also increases as one ascends the meadow. These data, therefore, offer support for the hypothesis that environmental cues such as amount of vegetative cover or visible human impact may play an important role in prompting noncompliant behavior. However, signs, especially the threatened sanction sign, reduce off-trail hiking (with some variance) across all sites despite environmental cues. More research on this subject is indicated.

Asian Noncompliance

Two Japanese tour groups (15 and 24 visitor groups) were excluded from the data base for the analysis of sign effectiveness (see Appendix 5). The group behavior pattern exhibited by Japanese groups suggested a need to clarify the nature of Japanese tour group behavior in a park setting. Other sites not part of the

study were also observed to sustain considerable off-trail use on the part of Asian families attempting to picnic in the meadow. Dr. George Kakiuchi of the University of Washington Geography Department, who specializes in East Asian studies, was consulted on the nature of picnicing among the Japanese and other Asian visitors (telephone interview, February 1, 1988).

It is important to note that the only notice a visitor has of a designated picnic area when approaching the Paradise Meadow on the highway from the Nisqually Entrance is a small symbolic picnic sign (an American style of picnic table). Yet according to Dr. Kakiuchi, there are few picnic tables in Japan's public recreation areas, and picnicing is almost always done while sitting on mats in the grass in any area that the group may find desirable. Because of their experiences in Japan's public parks, the Japanese visitors might frequently walk off trails to picnic in areas not designated for picnicing. Although some Japanese visitors might recognize the meaning of a "no picnicing" symbolic sign, Dr. Kakiuchi questioned the effectiveness of this deterrent. He also mentioned that the Japanese may not be as sensitive to human environmental impacts as are some other cultural groups (such as American park visitors, in general). Therefore, littering and off-trail hiking for photography or for picnicing are probably more common in Japan.

Dr. Kakiuchi also emphasized that there is a strong cultural tendency for Japanese people to act in groups. Thus, if one Japanese visitor walks off-trail, it would be predictable that the

entire group would also follow. This is particularly likely since there is little cultural inhibition against off-trail hiking.

His recommendation is that Japanese signs should be considered. Because of cultural differences in acceptable public park behavior, Japanese language pamphlets might be handed out at the entrance point mentioning the reasons for staying on the designated trails and other desired visitor behavior.

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APPENDIX 1

SIGN EXPERIMENT OBSERVATION SHEET

APPENDIX 2

PARADISE MEADOWS VISITOR SURVEY ON-SITE SHEET

APPENDIX 3

PARADISE MEADOW VISITOR SURVEY QUESTIONNAIRE

APPENDIX 4

TRAILHEAD AUDIO SIGN SURVEY

APPENDIX 5

ISSUES OF SAMPLING AND EXPERIMENT ADMINISTRATION RELATED TO DATA LIMITATIONS

Barrier Treatment Administration by Time of Day

To verify that the experimental treatments were rotated according to the research design, a chi square test of independence was performed under the null hypothesis of no differences in the frequencies of treatments across time of day intervals. In the case of the sign treatments (Lower Meadow and Dead Horse sites), there was a significant difference in the administration of the sign treatments over time. However, further analysis of this data revealed that off-trail hiking did not vary over time. It was, therefore, concluded that differential administration of signs was irrelevant to the research objectives.

A similar statistical test with the barrier data also resulted in rejection of the null hypothesis of no differences in the administration of barrier treatments across time of day intervals (Table 26). However, in this case, it was also found that compliance in the presence of the barriers varied by time (Table 27). Further analysis revealed that differences in the noncompliance rate by time of day were not significant for the Dead Horse barrier site, thus isolating the potential bias in the data for compliance by time of day to the Devil's Triangle site (Table 28).

At the Devil's Triangle site, noncompliance was low in the noon to 1:30 P.M. category (4.8 percent) and high in the late afternoon category (after 3 P.M., 13.1 percent). Analysis of treatments by time of day did not reveal an anomalous distribution of effective and ineffective treatments within these time categories that would explain the differences in noncompliance

rates. Controlling for barrier treatment revealed that there was not a significant difference in compliance rates by time of day for the rope treatment (although cell counts are very low, Table 29). There was a very high rate of noncompliance in the morning and a moderately high rate of noncompliance in the late afternoon (Table 30). Noncompliance under the control condition at Devil's Triangle (Table 31) increased substantially in the afternnon. Thus most of the increase in noncompliance occurred at the end of the day under the control condition (no barrier, Table 31). A check of the noncompliers at the site revealed that there was not an unusually large party involved that would skew the data.

Thus, analysis of barrier site treatment distribution by time of day intervals established that:

A) There is a difference in both time and compliance by barrier treatment in the main barrier site data. There is, however, no difference in compliance by time of day at the Dead Horse barrier site. Therefore, the differences in time of day by treatment at that site should not affect the conclusions of the barrier experiment. Given this situation, the potential problem is of concern only in the Devil's Triangle site data.

B) The difference in compliance by time of day is caused primarily by an increase in noncompliant behavior observed under the control condition at the Devil's Triangle barrier site in the late afternoon. A slight increase was also observed when the split rail barrier was present.

C) In summary, there was no significant difference in compliance by time of day during the administration of the rope treatment.

There is a moderate increase in noncompliance late in the day under the split rail condition. There is a substantial increase in noncompliance late in the day under the control condition but the cell counts are so small in the late afternoon that some of this difference could be due to sampling error. The researchers tentatively concluded therefore, that off-trail hiking rates varied by time at the Devil's Triangle site, except in the presence of an effective barrier such as the yellow rope.

Table 26. Time of Day by Barrier Type - Barrier Sites, Less Alta Vista - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	BARRIER TYPE Rope	Split Rail	Control	Row Totals
TIME OF DAY:				
9:00 am to 10:30 am	0.0% 0.0% 0	0.0% 0.0% 0	100.0% 1.4% 15	100.0% 0.4% 15
10:30 am to 12 Noon	18.6% 8.8% 68	36.3% 7.5% 133	45.1% 15.6% 165	100.0% 10.2% 366
12 Noon to 1:30 pm	27.2% 26.2% 203	38.5% 16.2% 287	34.2% 24.1% 255	100.0% 20.7% 745
1:30 pm to 3:00 pm	19.5% 34.7% 269	52.1% 40.6% 718	28.4% 37.1% 392	100.0% 38.3% 1379
3:00 pm to 5:00 pm	21.5% 30.3% 235	57.6% 35.7% 631	20.9% 21.7% 229	100.0% 30.4% 1095
Column Totals	21.5% 100.0% 775	49.1% 100.0% 1769	29.3% 100.0% 1056	100.0% 100.0% 3600

Missing Cases = 0
Chi-Square = 163.2 p = .0000
Cramer's V = .15

1 C = Complier NC = Noncomplier

Table 27. Time of Day by Compliance Status - Barrier Sites, Less Alta Vista - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
TIME OF DAY:			
9:00 am to 10:30 am	100.0% 0.4% 15	0.0% 0.0% 0	100.0% 0.4% 15
10:30 am to 12 Noon	95.1% 10.2% 348	4.9% 9.0% 18	100.0% 10.2% 366
12 Noon to 1:30 pm	96.6% 21.2% 720	3.4% 12.6% 25	100.0% 20.7% 745
1:30 pm to 3:00 pm	94.7% 38.4% 1306	5.3% 36.7% 73	100.0% 38.3% 1379
3:00 pm to 5:00 pm	92.4% 29.8% 1012	7.6% 41.7% 83	100.0% 30.4% 1095
Column Totals	94.5% 100.0% 3401	5.5% 100.0% 199	100.0% 100.0% 3600

Missing Cases = 0
Chi-Square = 16.8 p = .0021
Cramer's V = .07

1 C = Complier NC = Noncomplier

Table 28. Time of Day by Compliance Status - Devil's Triangle Barrier Site Only - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
TIME OF DAY:			
9:00 am to 10:30 am	100.0% .6% 8	0.0% 0.0% 0	100.0% 1.5% 8
10:30 am to 12 Noon	89.2% 7.2% 99	10.8% 7.9% 12	100.0% 7.3% 111
12 Noon to 1:30 pm	95.2% 18.7% 257	4.8% 8.6% 13	100.0% 17.7% 270
1:30 pm to 3:00 pm	90.6% 38.1% 523	9.4% 35.5% 54	100.0% 37.9% 577
3:00 pm to 5:00 pm	86.9% 35.3% 485	13.1% 48.0% 73	100.0% 36.6% 558
Column Totals	90.0% 100.0% 1372	10.0% 100.0% 152	100.0% 100.0% 1524

Missing Cases = 0
Chi-Square = 15.2 p = .0043
Cramer's V = .10

1 C = Complier NC = Noncomplier

Table 29. Time of Day by Compliance Status - Rope Barrier Only, for Devil's Triangle Barrier Site - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
TIME OF DAY:			
10:30 am to 12 Noon	90.9% 8.0% 20	9.1% 13.3% 2	100.0% 8.3% 22
12 Noon to 1:30 pm	100.0% 12.0% 30	0.0% 0.0% 0	100.0% 11.3% 30
1:30 pm to 3:00 pm	90.9% 32.0% 80	9.1% 53.3% 8	100.0% 33.2% 88
3:00 pm to 5:00 pm	96.0% 48.0% 120	4.0% 33.3% 5	100.0% 47.2% 125
Column Totals	94.3% 100.0% 250	5.7% 100.0% 15	100.0% 100.0% 265

Missing Cases = 0
Chi-Square = 4.9 p = .1816
Cramer's V = .14

1 C = Complier NC = Noncomplier

Table 30. Time of Day by Compliance Status - Split Rail Barrier Only, for Devil's Triangle Barrier Site - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
TIME OF DAY:			
10:30 am to 12 Noon	82.9% 3.7% 29	17.1% 9.7% 6	100.0% 4.1% 35
12 Noon to 1:30 pm	94.4% 16.9% 134	5.6% 12.9% 8	100.0% 16.6% 142
1:30 pm to 3:00 pm	94.6% 37.6% 298	5.4% 27.4% 17	100.0% 36.8% 315
3:00 pm to 5:00 pm	91.5% 41.9% 332	8.5% 50.0% 31	100.0% 42.5% 363
Column Totals	92.7% 100.0% 793	7.3% 100.0% 62	100.0% 100.0% 855

Missing Cases = 0
Chi-Square = 8.2 p = .0430
Cramer's V = .10

1 C = Complier NC = Noncomplier

Table 31. Time of Day by Compliance Status - Control Only, for Devil's Triangle Barrier Site - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
TIME OF DAY:			
9:00 am to 10:30 am	100.0% 2.4% 8	0.0% 0.0% 0	100.0% 2.0% 8
10:30 am to 12 Noon	92.6% 15.2% 50	7.4% 5.3% 4	100.0% 13.4% 54
12 Noon to 1:30 pm	94.9% 28.3% 93	5.1% 6.7% 5	100.0% 24.3% 98
1:30 pm to 3:00 pm	83.3% 44.1% 145	16.7% 38.7% 29	100.0% 43.1% 174
3:00 pm to 5:00 pm	47.1% 10.0% 33	52.9% 49.3% 37	100.0% 17.3% 70
Column Totals	81.4% 100.0% 329	18.6% 100.0% 75	100.0% 100.0% 404

Missing Cases = 0
Chi-Square = 72.9 p = .0000
Cramer's V = .42

1 C = Complier NC = Noncomplier

Tests for Observer Bias

To check for interobserver reliability, chi square tests for independence were performed predicting no differences in compliance rates between observers at the same sites. The null hypothesis was rejected for the Dead Horse site data only (Table 32). At the sign sites, one observation team had the primary responsibility for data collection per site, and others were present as substitutes according to the established work schedule. Thus, the data indicated an exceptionally low number of observations for two substitute observers. These were removed from the table (Table 33). Since the crosstabulation was still significant, a stepwise partition was initiated to isolate the primary effects in the statistical relationship. Even when only the primary observers are considered, there was still a significant difference in the observed rate of compliance by observer (Table 34). In this table, however, the low cell counts make chi square analysis questionable (see Item 9, Data Limits).

Analysis of compliance by sign text controlling for observer revealed that the primary team had a relatively even distribution of observations across all treatments (Tables 35 and 37), particularly when viewed in the aggregate. However, the substitute observer (with the lowest rate of observed noncompliance) had over one quarter of his observations with the most effective treatment (sanction sign, Table 36). Similarly, the other two substitute observers with an appreciable number of observations either had a skewed distribution of observations on the least effective treatments (Table 39) or cells with very small numbers (Table 40).

The data were then pooled to compare the substitute observers across a wider range of treatments with the primary observers (Table 40), and the significance in the relationship disappeared. Thus, it is concluded that observer bias is not affecting conclusions drawn from the data because the significance found in the analysis reflects a weighting of substitute observers on certain treatments.

Table 32. Observer by Compliance Status - Dead Horse Sign Site Only - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
OBSERVER:			
Observer 1	94.4% 46.2% 4184	5.6% 52.8% 247	100.0% 46.6% 4431
Observer 2	98.3% 12.5% 1133	1.7% 4.3% 20	100.0% 12.1% 1153
Observer 3	100.0% 0.0% 1	0.0% 0.0% 0	100.0% 0.0% 1
Observer 4	95.5% 35.7% 3235	4.5% 32.3% 151	100.0% 35.6% 3386
Observer 5	100.0% 0.0% 4	0.0% 0.0% 0	100.0% 0.0% 4
Observer 6	90.9% 4.3% 389	9.1% 8.3% 39	100.0% 4.5% 428
Observer 7	90.4% 1.1% 103	9.6% 2.4% 11	100.0% 1.2% 114
Column Totals	95.1% 100.0% 9049	4.9% 100.0% 468	100.0% 100.0% 9517

Missing Cases = 0
Chi-Square = 52.4 p = .0000
Cramer's V = .07

1 C = Complier NC = Noncomplier

Table 33. Observer by Compliance Status - Dead Horse Sign Site Only, Less Substitute Observers with Small Numbers of Observations - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
OBSERVER:			
Observer 1	94.4% 46.3% 4184	5.6% 52.8% 247	100.0% 46.6% 4431
Observer 2	98.3% 12.5% 1133	1.7% 4.3% 20	100.0% 12.1% 1153
Observer 4	95.5% 35.8% 3235	4.5% 32.3% 151	100.0% 35.6% 3386
Observer 6	90.9% 4.3% 389	9.1% 8.3% 39	100.0% 4.5% 428
Observer 7	90.4% 1.1% 103	9.6% 2.4% 11	100.0% 1.2% 114
Column Totals	95.1% 100.0% 9044	4.9% 100.0% 468	100.0% 100.0% 9512

Missing Cases = 0
Chi-Square = 52.1 p = .0000
Cramer's V = .07

1 C = Complier NC = Noncomplier

Table 34. Observer by Compliance Status - Dead Horse Sign Site Only, Primary Observers Only - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
OBSERVER:			
Observer 1	94.4% 56.4% 4184	5.6% 62.1% 247	100.0% 56.7% 4431
Observer 4	95.5% 43.6% 3235	4.5% 37.9% 151	100.0% 43.3% 3386
Column Totals	94.9% 100.0% 7419	5.1% 100.0% 398	100.0% 100.0% 7817

Missing Cases = 0
Chi-Square = 4.7 p = .0300
Phi = .03

1 C = Complier NC = Noncomplier

Table 35. Sign Text by Compliance Status - Dead Horse Sign Site Only, Observer Two Only

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
SIGN TEXT:			
New NPS	97.2% 15.0% 628	2.8% 7.3% 18	100.0% 14.6% 646
Symbolic	93.9% 19.0% 797	6.1% 21.1% 52	100.0% 19.2% 849
Hybrid	92.5% 17.9% 749	7.5% 24.7% 61	100.0% 18.3% 810
Stake	89.6% 7.4% 309	10.4% 14.6% 36	100.0% 7.8% 345
Sanction	97.5% 14.8% 618	2.5% 6.5% 16	100.0% 14.3% 634
Control (no sign)	92.4% 5.8% 244	7.6% 8.1% 20	100.0% 6.0% 264
Old NPS	93.0% 11.2% 467	7.0% 14.2% 35	100.0% 11.3% 502
Humorous	97.6% 8.9% 372	2.4% 3.6% 9	100.0% 8.6% 381
Column Totals	94.4% 100.0% 4184	5.6% 100.0% 247	100.0% 100.0% 4431

Missing Cases = 0
Chi-Square = 54.0 p = .0000
Cramer's V = .11

1 C = Complier NC = Noncomplier

Table 36. Sign Text by Compliance Status - Dead Horse Sign Site Only, Observer Four Only

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
SIGN TEXT:			
New NPS	100.0% 4.7% 53	0.0% 0.0% 0	100.0% 4.6% 53
Symbolic	100.0% 10.1% 114	0.0% 0.0% 0	100.0% 9.9% 114
Hybrid	98.8% 7.4% 84	1.2% 5.0% 1	100.0% 7.4% 85
Stake	99.0% 8.4% 95	1.0% 5.0% 1	100.0% 8.3% 96
Sanction	98.4% 27.2% 308	1.6% 25.0% 5	100.0% 27.1% 313
Control (no sign)	97.7% 15.1% 171	2.3% 20.0% 4	100.0% 15.2% 175
Old NPS	99.0% 17.9% 203	1.0% 10.0% 2	100.0% 17.8% 205
Humorous	93.8% 9.3% 105	6.3% 35.0% 7	100.0% 9.7% 112
Column Totals	98.3% 100.0% 1133	1.7% 100.0% 20	100.0% 100.0% 1153

Missing Cases = 0
Chi-Square = 17.8 p = .0129
Cramer's V = .12

1 C = Complier NC = Noncomplier

Table 37. Sign Text by Compliance Status - Dead Horse Sign Site Only, Observer Six Only

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
SIGN TEXT:			
New NPS	95.0% 7.6% 245	5.0% 8.6% 13	100.0% 7.6% 258
Symbolic	97.5% 12.0% 389	2.5% 6.6% 10	100.0% 11.8% 399
Hybrid	98.7% 11.9% 386	1.3% 3.3% 5	100.0% 11.5% 391
Stake	96.1% 18.1% 587	3.9% 15.9% 24	100.0% 18.0% 611
Sanction	100.0% 9.0% 292	0.3% 0.7% 1	100.0% 8.7% 293
Control (no sign)	91.0% 17.1% 554	9.0% 36.4% 55	100.0% 18.0% 609
Old NPS	92.8% 13.5% 436	7.2% 22.5% 34	100.0% 13.9% 470
Humorous	97.5% 10.7% 346	2.5% 6.0% 9	100.0% 10.5% 355
Column Totals	95.5% 100.0% 3235	4.5% 100.0% 151	100.0% 100.0% 3386

Missing Cases = 0
Chi-Square = 66.6 p = .0000
Cramer's V = .14

1 C = Complier NC = Noncomplier

Table 38. Sign Text by Compliance Status - Dead Horse Sign Site Only, Observer Seven Only

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
SIGN TEXT:			
New NPS	88.9% 10.3% 40	11.1% 12.8% 5	100.0% 10.5% 45
Symbolic	86.1% 27.0% 105	13.9% 43.6% 17	100.0% 28.5% 122
Stake	98.2% 13.9% 54	1.8% 2.6% 1	100.0% 12.9% 55
Sanction	100.0% 1.8% 7	0.0% 0.0% 0	100.0% 1.6% 7
Control (no sign)	75.0% 1.5% 6	25.0% 5.1% 2	100.0% 1.9% 8
Old NPS	97.2% 35.2% 137	2.8% 10.3% 4	100.0% 32.9% 141
Humorous	80.0% 10.3% 40	20.0% 25.6% 10	100.0% 11.7% 50
Column Totals	90.9% 100.0% 389	9.1% 100.0% 39	100.0% 100.0% 428

Missing Cases = 0
Chi-Square = 24.2 p = .0005
Cramer's V = .24

1 C = Complier NC = Noncomplier

Table 39. Sign Text by Compliance Status - Dead Horse Sign Site Only, Controlling by Observer Number Six

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
SIGN TEXT:			
Stake	100.0% 15.5% 16	0.0% 0.0% 0	100.0% 14.0% 16
Control (no sign)	93.1% 52.4% 54	6.9% 36.4% 4	100.0% 50.9% 58
Old NPS	82.5% 32.0% 33	17.5% 63.6% 7	100.0% 35.1% 40
Column Totals	90.4% 100.0% 103	9.6% 100.0% 11	100.0% 100.0% 114

Missing Cases = 0
Chi-Square = 5.0 p = .0804
Cramer's V = .21

1 C = Complier NC = Noncomplier

Table 40. Status of Observer by Compliance Status - Dead Horse Sign Site Only; - 1987 Paradise Meadows Sign Experiment.

Cells: Row Percent Col Percent Count	COMPLIANCE STATUS[1] C	 NC	Row Totals
STATUS OF OBSERVER:			
Substitute	95.9% 18.0% 1630	4.1% 15.0% 70	100.0% 17.9% 1700
Primary	94.9% 82.0% 7419	5.1% 85.0% 398	100.0% 82.1% 7817
Column Totals	95.1% 100.0% 9049	4.9% 100.0% 468	100.0% 100.0% 9517

Missing Cases = 0
Chi-Square = 2.6 p = .1050
Phi = .02

1 C = Complier NC = Noncomplier

Analysis of Whole Group Noncompliance

Fifty-eight percent of all noncompliance in the sign site data (N = 867) occurred by entire groups (more than one person) who deviated off-trail *en masse*; 42 percent of the noncompliance was committed by less than full groups (i.e., some group members did comply). The whole group noncompliance rate as a proportion of all noncompliers[14] at the Lower Meadow site was 67% (N = 98/147); the whole group rate of noncompliance at the Panorama Point site was 85% (N = 181/212); the whole group noncompliance rate at the Dead Horse site was 44% (N = 225/508). Given that the intent of the current analysis was to test hypotheses predicting only small differences between experimental treatments, and the unit of analysis was the individual, the effect of noncompliance by groups has a confounding effect on the interpretation of the results and in the use of inferential statistics where the unit of analysis is the individual.

From a practical standpoint, the problem can be illustrated by a hypothetical example. Suppose the observed noncompliance rate at an experimental site for sign X is six percent and for sign Y it is two percent. Assuming the sample was large enough, we would conclude that there was a statistically significant difference in the rate of noncompliance between the signs. However, if the observed difference in noncompliance was due to many individual

14 The whole group noncompliance rate was computed as the number of noncompliers who deviated off-trail with their entire group divided by the total number of noncompliers at a site. Two exceptions to this criteria were both Japanese tour groups included as whole group noncompliers when the actual deviation was by 14 of 15 visitors in one party and 23 of 24 visitors in the other party.

acts from a large number of parties for sign Y but was due to the behavior of only three complete parties that deviated off-trail as a unit when sign X was present, the inference that sign X was the less effective sign would be problematic. Specifically, the issue of group behavior presents a violation of the a priori assumption[15] that individuals behave independently. Without this assumption, the unit of analysis should not be the individual but rather groups. If this were the case the sample size would drop considerably and p values would be changed.

The problem is exacerbated in a data base with very small differences in variance of the dependent variable, as is the case with the cell counts of noncompliers by treatment. This is the case even though the total number of observations may include thousands of individuals.

If the sample contained a large number of parties of all sizes (i.e., an equal distribution of parties by size including many large parties across all treatments) analysis could proceed by individual and by group. A very detailed analysis of the data aggregated to the group level was undertaken. The results were supportive of the analysis of sign effectiveness at the individual level (see Technical Notes, this appendix).

Therefore, the p value generated by the chi square procedure must be interpreted with caution relative to the individual data. It is especially important to keep this caution in mind in

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15 Independence of the units of analysis (individuals) is required to interpret the p values which are generated by the chi square procedure to indicate the probability of obtaining the chi square statistic given the expected frequencies of the table cells of a crosstabulation.

identifying the importance of the relationship between two treatments of nearly equal effectiveness when their respective rates of noncompliance are very close and the cell counts are small. This situation also dictates that the proper analysis of the data is at the aggregate level where group behavior will have less impact on the interpretation of the results.

Large Party Behavior

There were only 282 subjects in parties of twenty or more visitors in the data base from the main sign sites (Dead Horse and Lower Meadow). Since large groups are clearly not very well represented in the data base, the anomalous behavior of a few large groups in the presence of a specific treatment would have considerable impact on the analysis of sign effectiveness. Thus, a detailed review of all noncompliers at all sites was undertaken.

This review revealed that two parties of a large size (15 and 24 persons) had deviated off-trail en masse in the presence of two English language signs. According to the research protocol, CPSU employees had approached the noncompliers for a preliminary interview to request participation in the questionnaire survey. As noted in the journals of the respective employees, these parties were both non-English speaking Japanese tour groups who declined to participate in the survey. There were no other large parties of Japanese noncompliers, and only one other unusually large Japanese tour group clearly identified in the data. Due to the fact that these visitor parties' behaviors were anomalous, and they were exposed to English signs which they could not understand, these parties were excluded from analysis of the data. This decision to exclude the two Japanese parties was made to avoid complicating interpretation of the results by increasing the rate of noncompliance on those treatments present when these parties deviated off-trail.

Technical Notes[16]

Two technical issues were raised during the analysis of the sign data when the unit of analysis was the individual. First, the noncompliant behavior of whole parties could be considered a violation of the assumption of independence of the unit of analysis (individuals) which is requisite for interpreting the p value derived from the calculation of the chi square statistic. Second, a regression plot of some potential predictor variables (e.g., Asian race, party size) indicated that some variables are skewed with respect to the dependent variable. The degree to which these variables might also be skewed on some sign treatments would confound interpretation of the effect of the treatment in question. It was feared this situation might violate the assumption of normal distribution of the dependent variable required for the use of standard multivariate regression.17 In order to ensure that these potential problems did not affect interpretation of the results of the experiment, the decision was made to perform additional analyses of the sign data at the group level.

The individual data were re-aggregated to the group level (i.e., the unit of analysis was the party), and additional analyses were first made of sign effectiveness and other predictor variables relative to party compliance using the chi square statistic. Thereafter, a multivariate analysis using a more powerful test

16 This section is a brief summary of additional technical analyses of the sign data that occurred after the draft report was completed. Since the further analyses indicated no change in the conclusions based on the results of the previously reported analyses, this section is only a brief summary of the work.

17 Technically speaking, the assumption in the normal multivariate regression model is normal distribution of the error term, not the dependent variable.

(logistic regression) was performed to consider sign effectiveness given the issue of lack of normal distribution of the dependent variable (error term).

The results of these analyses of the sign data at the party level support the conclusions of the original analysis of the individual data. These analyses indicate that regardless of the technical statistical problems associated with the unit of analysis and lack of normal distribution of the dependent variable, various approaches to the data analysis will yield similar conclusions:

1) The sanction sign is significantly more effective than all other treatments.

2) The new NPS, hybrid, and humorous signs are not significantly different from each other, but these treatments are significantly more effective than the other less effective treatments (old NPS, stake).

3) The symbolic sign is of transitional effectiveness from the cluster of effective signs to the group of ineffective treatments, depending on how one defines group noncompliance.

4) The ineffective treatments (stake, old NPS) are not significantly different from the control (no sign).

Due to the complexity and technical nature of the additional analyses of the party data, this report does not go into great detail concerning these procedures. The above results indicate that the party data analyses did not affect the conclusions of the previous analysis of the individual data. Many readers may wish to stop at this point in the discussion. However, for those readers interested in how the analyses of party data proceeded, a brief synopsis of the analyses follows. As full explication of the

further analyses would require another very detailed, completely separate report, persons interested in further explanations should consult the authors.

The party data were first analyzed using the chi square statistic. However, concerning <u>any</u> analysis of the party data, interpretation of what proportion of <u>group</u> behavior should be described as group noncompliance is an arbitrary decision (e.g., does a party engage in noncompliance when 50 percent or only 25 percent of it's members hike off-trail?). Thus, the analysis proceeded with successive different levels of party compliance proportion defined as group noncompliance. The results of these successive chi square tests were almost identical to the results of the previous chi square analyses when the individual was the unit of analysis. There were two ineffective treatments (stake, old NPS sign) not significantly different from the control (no sign). There was a middle range of effective signs which were not significantly different from each other (new NPS, humorous, and hybrid signs), but all were significantly different from (i.e., more effective than) the less effective treatments or the control. The symbolic sign was transitional in effectiveness between these two groups of treatments depending on the definition of party noncompliance. Finally, the sanction sign was significantly more effective than all other treatments.

Since the distribution of the dependent variable might be skewed relative to several predictor variables (Asian race, party size, proximity to other noncompliant parties), the a priori assumption of normal distribution of the dependent variable

required for interpretation of normal multiple regression analysis is violated. These other variables could also potentially interact with a specific sign treatment and affect the interpretation of the effectiveness of that sign. Examination of the data at the party level in a series of graphs (simple linear regressions) of party compliance proportion with party size indicated that there was indeed cause for more detailed statistical multivariate analysis of the data. Thus, an additional analysis of the party data was initiated which would allow simultaneous multivariate consideration of these potential interaction effects and treatments relative to a dependent variable (party behavior defined as a binary variable, compliance/noncompliance) without the assumption of a normal distribution of the dependent variable (error term).

The statistical model used in this analysis was logistic regression. Although the mechanics of the model are beyond the purpose of this paper, logistic regression compensates for the lack of normal distribution of the dependent variable while allowing simultaneous analysis of several treatments and potential interaction terms (Hunashek and Jackson, 1977). A step-wise series of logistic regressions controlling by treatment (selecting by treatment) was run to consider which additional predictor variables might be potential interaction effects affecting the interpretation of the effectiveness of a specific treatment in affecting party noncompliance. This analysis revealed that no significant correlates (predictors) of party noncompliance were distributed only on some treatments, but several significant predictor variables persisted across treatments (occurred in all step-wise

logistic regression models when controlling for treatment). These variables were Asian race, party size, proximity of another noncompliant party, and party size with noncompliant proximity (a potential two way interaction).

These potential interaction terms were then considered simultaneously in a final logistic regression model with all treatments. If the additional terms were interrelated to the treatments' effects, the model would indicate this interaction effect by treatment. However, no potential interaction terms were discovered. The results of this final model strongly supported conclusions of the original analysis, as all effective treatments stayed in the model even in the presence of other strong predictor (explanatory) variables (Asian race, presence of noncompliant parties, party size[18]). Further, the ineffective treatments (stake, old NPS sign) would be interpreted in this test as not being significantly different from the control[19].

A step-wise analysis was then undertaken to consider differences between effective signs. In this procedure, significant changes in the fit (predictive power) of the model with sequential consideration of each of several groups of signs would indicate whether the group of signs were equally effective (not significantly different from each other sign within the group) or significantly different. The clustering of signs with the fit (least likelihood ratio) nearest the fit of the model with

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18 The persistent significant effect of party size was of concern, but detailed analysis revealed that there was no significant variance in party size between treatments.

19 Strictly speaking, they offer no additional explanatory power to the equation predicting noncompliance.

individual treatments would be the most closely related groups of signs. This procedure demonstrated that the sanction sign was significantly more effective than all other treatments (i.e., it was a cluster of one treatment), and there was a cluster of similarly effective treatments (new NPS, humorous, hybrid). The symbolic sign was of transitional effectiveness as there was no significant change in the fit of the model whether this treatment was in the effective treatment cluster or the ineffective treatment cluster (old NPS sign, stake). This procedure confirmed that the groups of signs previously discussed in both the party and individual data analyses are the most parsimonious explanation of sign effectiveness.

A final step-wise analysis was undertaken to establish whether there was a significant difference between clusters of treatments established by the previous analysis. Successive logistic models were run with different potential ccombinations of clusters to establish which clusters significantly improved the fit of the model. Inclusion of the ineffective treatments (old NPS sign, stake) did not significantly improve the fit of the model. The predictive power of the middle range of effective treatments (new NPS, humorous, hybrid) was significant (i.e., there was a significant change in the fit of the model). The sanction sign was significantly different from the midddle range of effective treatments (again there was a significant change in the least likelihood ratio).

REFERENCES CITED

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APPENDIX 6

STATISTICS AND HYPOTHESIS TESTING

STATISTICS AND HYPOTHESIS TESTING[20]

Hypotheses and Hypotheses Testing

A hypothesis is a "tentatively held supposition about what is, how things change, or how things are interconnected" (Mueller, 1977). Research hypotheses state expected relationships between variables and are derived from theory and prior research. Such hypotheses may also be called substantive hypotheses. Before accepting empirical support for a substantive hypothesis, the scientist must be assured that the empirical data has not occurred by accident or chance because of sampling error -- in other words, that certain plausible rival explanations for the results such as sampling error or chance are invalid. A statistical testing procedure is designed to test the probability of the truth of the rival hypotheses.

In a statistical procedure, a hypothesis to be nullified (a null hypothesis) is constructed. This hypothesis is usually interpreted as predicting "no relationship", "no difference", etc., between the variables under study. Thus stated, the null hypothesis contradicts the substantive (research) hypothesis which is based upon actual expectations of the nature of relationship between variables. Rejecting the null hypothesis supports the substantive hypothesis; failing to reject the null hypothesis results in lack of support for the substantive hypothesis. Null

20 This section is a revision of a chapter that originally appeared in Johnson and Swearingen (1986b). Minor changes in the text have been made.

hypotheses are symbolized by (H_0); research or substantive hypotheses are symbolized by ($H_1 \ldots H_n$).

The null hypotheses are tested by examining sample probabilities assuming the truth of H_0 (i.e., that there is no relationship between the variables under study). If the obtained sample statistical value departs greatly from what would be expected if H_0 were true, then there is a high probability that H_0 is not true (i.e. the relationship between variables is not due to sampling error or chance alone). Therefore, given an outcome that would be extremely unlikely if the null hypothesis (H_0) were true, the more plausible conclusion is reached -- that it is false. The consideration of how rare an outcome must be to doubt the null hypothesis leads to a discussion of the level of significance. First, however, a brief explanation of the statistics most frequently used to test hypotheses in this work is presented.

Chi Square Test

The chi square statistic (X^2) is computed by comparing actual table frequencies in a crosstabulation[21] with the frequencies that would be expected if no relationship between the variables is present. The chi square statistic becomes larger as the differences between the expected and actual table frequencies increases. It is also directly proportional to the size of the sample under test. Small values of chi square are interpreted to indicate no relationship between the variables under study (i.e., statistical independence). A large value of chi square is

21 A crosstabulation is a table comparing values between two or more categorical (nominal, ordinal, or categorized interval) variables.

interpreted to indicate that some kind of relationship is present. In large samples, however, a large value of chi square is more common because chi square is directly proportional to sample size. Thus, a large chi square is not necessarily indicative of a substantively more important relationship between variables than a small X^2 value in a smaller sample.

Analysis of Variance

Analysis of variance ("F test") is used to test for differences among the means of more than two samples. (For only two samples, the "T test" for difference of means is equivalent.) The statistic is computed by a procedure which compares differences between sample means and the population mean. It can be used whenever testing for differences between categories of a variable (ex: age, size of party). Interpretation of an ANOVA (or T test) is based on the probability of obtaining that value for the statistic. A larger value of the statistic will lead to rejection of the null hypothesis.

Statistical Significance

To help ascertain the existence of a relationship between variables, the probability of obtaining the observed chi square value purely by chance is computed. If the probability of the obtained statistic's occurrence is low, and if the sample is random, then one can assume that a relationship exists between the variable in the population under study. Although arbitrary, it has become conventional in the social sciences to accept relationships that have a five percent probability, (.05) or less, of occurring by chance. Such relationships are said to be statistically

significant. The computed probability (p value) is referred to as the level of significance (e.g., $p \leq .005$). When a sample result is said to be statistically significant, the null hypothesis is rejected. However, the chi square value and its accompanying probability tell us nothing about the strength of association between the variables (i.e., the substantive importance of the observed relationship).

Strength of Association

Even though a crosstabulation produces a statistically significant chi square value, the relationship between two variables may be slight and perhaps of little substantive consequence, particularly when a large sample is under consideration. To aid in the interpretation of such results, a measure of the strength of association between the variables is provided. A measure of association indicates the extent to which the variables under study occur together. One measure used in this study is called Cramer's V, which varies from 0.0 (indicating no relationship) to 1.0 (indicating a perfect relationship).[22]

For example, imagine that the following data (indicating number of respondents) were obtained:

	High Pay	Low Pay	
Happy	50	0	50
Unhappy	0	50	50
	50	50	100 respondents

22 In some tables (tables with 2 variables of two values each) the statistic phi may be reported. Cramer's V and phi are exactly equal for a "2x2" table.

In this case, it can be easily seen that there is a perfect relationship between level of pay and happiness. (That is, all people who have high pay are happy, while all people with low pay are unhappy.) Cramer's V (and phi) would be 1.0.

However, such results are rarely obtained in the social sciences. More typically, we might have data such as the following two by two table:

	High Pay	Low Pay	
Happy	30	20	50
Unhappy	20	30	50
	50	50	100 respondents

These data would produce a statistically significant result and indicate that happiness is related to pay. However, not everyone who has high pay is happy, and not everyone who has low pay is unhappy. The Cramer's V (and phi) is .2.

In general in the social sciences, a Cramer's V of .5 or larger might be considered to indicate a strong relationship, a value of .20 to .49 is a moderate relationship and values under .20 a weak relationship. It must be carefully noted, however, that comparing Cramer's V values across tables of different dimensions (e.g., 2x2 with 3x2) cannot be done. (A two by two table has frequencies reported for two values of one variable corresponding to two values of another). Comparison is only meaningful when the table dimensions are identical.

To visualize the association of variables in a crosstabulation, one should carefully examine the percentages in the table cells. For example, in the data above it is easily seen that 60 percent of the high pay group are happy compared to 40 percent of the low pay group, a difference of 20 percent. Obviously, as these differences become greater, the strength of association increases. Comparing percentages in tables with more than two columns or rows becomes more difficult, and the measure of strength of association will become more valuable.

Discriminant Analysis

Whenever a series of bivariate comparisons indicates that several independent variables are statistically associated with the dependent variable (i.e., they "predict" the dependent variable), the question arises as to the relative importance of these variables. Many of these variables may also be interrelated to each other. Since the significant statistical relationships may be identified by comparisons in tables of different sizes (ex., 2x2 and 3x3 crosstabulations) or by different statistical tests (chi square, T test, ANOVA, etc.), it is not possible to simply compare measures of association to determine the relative importance of the predictor variables. Thus, it is desirable to identify those variables whose statistical association with the dependent variable is present because of this mutual association, and to identify the most importance statistical associations. The result of such a multivariate analysis is the most parsimonious explanation of the variables that predict the outcome of the dependent variable.

Discriminant analysis allows the researcher to identify differences between two groups with several variables considered simultaneously. The predictor variables are those identified in the bivariate statistical analyses as being significantly associated with the dependent variable. These variables will be called discriminating variables. Although the mathematical procedures involved are complex, discriminant analysis lends itself to classification procedures which are very intuitive. The results can be interpreted to indicate: (1) the set of variables in the analysis that best predicts the dependent variable; and (2) the proportion of cases that can be successfully classified (predicted status relative to the dependent variable) given the observed statistical associations. For readers familiar with regression analysis, two group discriminant analysis is closely related to multiple linear regression, where the two group variable is considered the dependent variable, and the predictor variables are the independent variables.

Logistic Regression

Similar to discriminant analysis, logistic regression allows multivariate analysis when the dependent variable is dichotomous (0 or 1). Logistic regression is similar to normal multiple regression but is used when the assumption of normal distribution of the dependent variable[23] is violated. The procedure allows multivariate comparisons by standardized (units free) coefficients that indicate the relative strength of the relationship of the various predictor variables to the dependent variable. These

23 Technically, the assumption is normal distribution of the error term.

coefficients are intuitively similar to the standardized coefficients in discriminant analysis or multiple regression.[24]

Substantive Importance

The preceding discussion briefly discusses statistical procedures for identifying certain features of scientific data. The reader is cautioned, however, that whether or not the obtained results are important from a practical or policy perspective depends in part on factors independent of the data. In some cases, a slight but significant association may be of little or no consequence. For example, it probably would be of little practical importance if it were found that 4% more males than females complied with low impact use guidelines. In the case of noncompliance to signs in a highly fragile physical environment, however, a slight difference in rates of sign noncompliance may double or triple the impact upon the resource. Consequently, a small difference in sign effectiveness may be of considerable practical importance.

24 The coefficients generated are actually the log of the odds ratio ((probability variable X) / (1 - probability X)).

1 The sign data were extensively analyzed at both the individual and the party level employing a variety of statistical procedures. Regardless of the approach, the results were nearly identical, and the recommendations are the same.

2 The employee, a female of small stature, was dressed in a Class A uniform with green jeans or shorts, an NPS short sleeve shirt, and a forest green NPS baseball cap. She did not wear the traditional Ranger uniform.

3 This section is a revised version of a review of the literature which is contained in the report on the pilot study of sign effectiveness conducted at Mt. Rainier in 1985 (Johnson and Swearingen, 1986).

4 Depreciative behavior is here defined as any normative violation which may impact the resource.

5 Those unfamiliar with statistics and hypothesis testing should refer to Appendix 6 prior to reading the research design and results sections of this paper.

6 This procedure was not followed at Panorama Point, which was part of the reason for the administration problem at that site discussed in the Data Limitations section of this report.

7 Analysis of several additional issues which relate to administration of the experiment or data analysis is considered in Appendix 5.

8 The data do provide preliminary qualitative evidence of differential sign effectiveness by ethnic group membership.

9 To control for the effect of the uniformed presence, the data from the Lower Meadow site are only reported without the uniformed person present. The Panorama Point data are excluded due to the administrative problems associated with data collection and shortages of materials for rotation of the treatments at that site, as reported in the Data Limitations section of this paper.

10 Since there was a very large increase in noncompliance rates between the control and the split rail treatment at the Devil's Triangle site, this raised the possibility that anomalous large parties were affecting the data. However, the results of the aggregate data from Devil's Triangle and Dead Horse (Table 13) with large parties in the data base did not change with the exclusion of large parties.

11 Proximity which was deemed close enough to affect other parties in the vicinity was defined on a site specific basis. The criterion was that an approaching party could not reasonably fail to notice behavior of the other party already on the site if looking in the direction of the site. The distances involved were fairly small (30-50 feet).

12 Results of the survey component of the project found no association between age and off-trail hiking in a sample of visitors over 16 years of age (Johnson and Swearingen, 1988). That analysis had few people under age 20, and the present analysis is, therefore, the more reliable measure.

13 The reader is cautioned that such a subjective attitude may be very poorly correlated with behavior (Ajzen and Fishbein, 1977; Triandis, 1971).

14 The whole group noncompliance rate was computed as the number of noncompliers who deviated off-trail with their entire group divided by the total number of noncompliers at a site. Two exceptions to this criteria were both Japanese tour groups included as whole group noncompliers when the actual deviation was by 14 of 15 visitors in one party and 23 of 24 visitors in the other party.

15 Independence of the units of analysis (individuals) is required to interpret the p values which are generated by the chi square procedure to indicate the probability of obtaining the chi square statistic given the expected frequencies of the table cells of a crosstabulation.

16 This section is a brief summary of additional technical analyses of the sign data that occurred after the draft report was completed. Since the further analyses indicated no change in the conclusions based on the results of the previously reported analyses, this section is only a brief summary of the work.

17 Technically speaking, the assumption in the normal multivariate regression model is normal distribution of the error term, not the dependent variable.

18 The persistent significant effect of party size was of concern, but detailed analysis revealed that there was no significant variance in party size between treatments.

19 Strictly speaking, they offer no additional explanatory power to the equation predicting noncompliance.

20 This section is a revision of a chapter that originally appeared in Johnson and Swearingen (1986b). Minor changes in the text have been made.

21 A crosstabulation is a table comparing values between two or more categorical (nominal, ordinal, or categorized interval) variables.

22 In some tables (tables with 2 variables of two values each) the statistic <u>phi</u> may be reported. Cramer's V and <u>phi</u> are exactly equal for a "2x2" table.

23 Technically, the assumption is normal distribution of the error term.

24 The coefficients generated are actually the log of the odds ratio ((probability variable X) / (1 - probability X)).