Information Quantity and Communication Effectiveness: Low-Impact Messages on Wilderness Trailside Bulletin Boards

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This study assessed the attention wilderness visitors gave to environmental messages encouraging low-impact practices posted on trailside bulletin boards at a national wilderness area, the ability of visitors to retain message content, and their ability to correctly identify agency-recommended practices. The number of posted messages was varied from two to eight, as well as whether there was a map posted beside the messages, to assess the effect of information quantity and a message attractant Hikers experienced a sign&ant increase in knowledge levels following exposure to messages, but there was evidence of information overload when numerous messages were posted. As the number of messages increased. total message attention increased, but the attention devoted to each message and the ability to retain message content declined. This finding helps explain why hikers exposed to all eight messages could not identify any more of the agency-recommended low-impact practices than those exposed to only two messages. Posting a map had no effect on message attention or message content retention.

Keywords attention, comprehension, information processing, low-impact knowledge, persuasive communication, retention, visitor education, wilderness management

Ecological and social impacts of recreation use continue to be major concerns of wilderness managers (Hendee, Stankey, & Lucas, 1990). To mitigate these impacts, managers have developed visitor education programs designed to persuade visitors to adopt low-impact practices. Most managers prefer this approach to more regulatory approaches.

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Despite the popularity of information and education, however, little is known about the effectiveness of low-impact persuasive message programs (Roggenbuck, 1992).

In choosing to use information as a means of encouraging low-impact behavior, managers have a multiplicity of media from which to select, such as brochures, newsletters, newspapers, talks, videos, slides, and trailside signs. Douchette & Cole (1993) reported that low-impact messages are posted on trailside signs and bulletin boards in 67% of wildernesses. Given the prevalence of trailside signs as a medium for communicating low-impact messages to visitors, surprisingly little is known about their effectiveness in recreational settings. Research at Rocky Mountain National Park (Fazio, 1979) and Shining Rock Wilderness (Stubbs, 1991) found no significant increase in low-impact knowledge among visitors exposed to messages on signs. In the Pecos Wilderness, Thorn (1995) found a small increase in knowledge among visitors who observed messages on signs, but these visitors discussed the content of messages with a researcher before their knowledge was evaluated. Finally, Swearingen and Johnson (1988) found that a trailhead sign was effective in reducing the number of people hiking off trails across meadows in Mount Rainier National Park.

Managers who post messages on trailside bulletin boards implicitly assume that visitors are willing to stop and read such messages, to process and recall the information contained in them, and to act in accordance with them. Managers need to be more concerned with issues such as the effect of sign design elements (e.g., the number of messages and the juxtaposition of competing kinds of information) and message design elements (e.g., type of message and quality of message) on the likelihood that visitors will receive and yield to the information that is presented.

This study was designed to address several of these issues. We (a) evaluated whether sign-based messages significantly increased visitors' knowledge about recommended low-impact practices, (b) explored relationships between attention to messages and retention of message content, and (c) assessed the influence of two sign design elements (number of messages and presence or absence of an attractor) on message attention and message retention. We have not attempted to assess the influence of trailside messages on behavioral change, although we recognize that this is the ultimate test of effectiveness. We did not assess the effect of repetitive exposure to messages; nor did we assess the influence of message type or quality, although we recognize that these variables explain much of the variation in sign effectiveness (Petty & Cacioppo, 1986; Swearingen & Johnson, 1988).

Theoretical Framework

The theoretical foundation for our research design is provided by McGuire's (1976, 1985) information-processing model. His theory is one of a number that emphasize the importance of detailed processing of message content by message recipients (Eagly & Chaiken, 1993)-an approach that has been termed the "central route to persuasion" (Petty & Cacioppo, 1986). McGuire's model assumes that reception of message content is a necessary mediator of persuasion-an assumption that is not universally accepted in the literature (Eagly & Chaiken, 1993). Although we recognize that there are other routes to persuasion, most trailside messages clearly are attempts to use the central route. Moreover, although reception may not always mediate persuasion, it seems more likely that visitors will change their behavior to conform to agency recommendations if they know what those recommendations are.

McGuire has proposed numerous versions of his model, with the number of steps varying between 2 and 12. Perhaps best known is his version that consists of 6 steps:

exposure, attention, comprehension, yielding, retention, and behavior. McGuire noted that the causal chain of processing steps is stochastic, and the failure of any single stage may cause the entire sequence to be broken and lead to an ineffective persuasive campaign. The probability of any one stage occurring is a function of the joint probability that all previous stages have occurred (Eagly & Chaiken, 1993).

McGuire's model posits that the persuasion process begins with presentation of a message or exposure of information to potential message recipients. Exposure occurs when one of the senses is activated by a stimulus. Message attention is the assignment of processing capacity to the incoming stimulus. Exposure does not necessarily lead to message attention, because recipients may choose to ignore the message. If recipients attend to the message, comprehension is the next step. Comprehension involves understanding the message content and storing message content in long-term memory, where it can be retained for later activation (Engel, Blackwell, & Miniard, 1993). At this stage, McGuire (1985) would conclude that the message has been received, and the information that has been seen has made more than a fleeting impression (Petty, McMichael, & Brannon, 1992).

The subsequent steps in McGuire's model pertain to recipients' yielding to messages that have been received or comprehended (Eagly & Chaiken, 1993). The recipient must first yield to, or accept, the content of the message that has been presented, attended to, and comprehended. The resultant changed attitude must be stored in memory or retained for later use, and, finally, recipients must behave in accordance with this changed attitude. Our study was confined to the steps in the model that result in message reception, although we recognize that yielding, retention, and behavior are critical to the ultimate success of a communication campaign.

McGuire's model has seldom been explicitly applied in the recreation literature. In the literature of social psychology and consumer behavior, the model has been used most often to organize studies of the influence of independent variables referred to as distal (Eagly and Chaiken, 1993) or context (source, message, channel, receiver and situational) factors (Ajzen, 1992) on the persuasion process. This organizational construct can allow for further interpretation of some of the recreation literature. For example, Petersen (1985) found that more wilderness visitors complied with a request that they register when the registration station was moved from the parking lot to a location a short distance up the trail; although other interpretations are possible, we suggest that this change in behavior (increased registration) resulted from increased attention to messages following manipulation of a situational variable. Attention to the registration station increased when it was removed from the distractions of the parking lot (preparing and organizing packs, other people, other information, etc.).

We emulated the approach of the social psychologists and consumer behaviorists and used the model's definitions of intermediate steps in the process of receiving and comprehending new low-impact information primarily as a means of structuring our study. This adoption allowed us to explore more fully how variation in two aspects of bulletin board design, the number of posted messages and the presence or absence of an attractor, influenced the reception of low-impact messages. We chose to study these two aspects of sign design because (a) they are important variables that wilderness managers should more consciously manipulate and (b) they address controversial concepts in the persuasive communication literature-information overload and attraction versus distraction.

Trailside bulletin boards are often cluttered with numerous messages with different designs and purposes. McGuire's information-processing model suggests that increasing the amount of information visitors are exposed to (by posting more messages on a bulletin

board) may result in increased attention and comprehension and, ultimately, the acquisition of more knowledge. Alternatively, information quantity can exceed both the motivation level and cognitive capacity required to process the information provided, resulting in reduced attention, reduced comprehension, and no increase in knowledge. Information overload, although a controversial issue (Jacoby, 1984), has been demonstrated in consumer research (Scammon, 1977). In a recreation setting, visitors may find cluttered signs unattractive and not attend to them, or they may allocate their limited time and processing capacity to a larger number of messages, thereby reducing per-message attention and comprehension.

The posting of different types of information on the same bulletin board may either increase or decrease attention to information. A locational map, for example, may be included within bulletin board design to attract visitors to the sign. Although this strategy may increase attention to posted low-impact messages, it is also possible that the use of an attractant may reduce attention if visitors are distracted by the map (Bither, 1972).

Hypotheses

Our initial research question was whether exposing visitors to low-impact messages posted on trailside signs would increase visitors' knowledge of low-impact practices recommended by management agencies. Consequently, we advanced Hypothesis 1 (Hl), that visitors exposed to low-impact messages posted on a sign should be able to correctly identify more suggested low-impact behaviors than those not exposed to a sign. If Hl were supported, we would invoke McGuire's model to better understand the linkages between steps in the process by which visitors receive and acquire new low-impact knowledge. Hypotheses 2 was that comprehension, operationalized as retention of message content pertaining to low-impact behaviors, would increase as attention to messages increased.

We also used McGuire's model as the basis for examining the influence of two sign design elements, number of posted messages and presence of an attractor, on steps in the process of receiving information and acquiring knowledge. We noted that exposure to more information could increase attention but that information overload could occur if visitors did not allocate the cognitive capacity required to adequately process the additional information. We hypothesized, therefore, that total attention to messages would increase as the number of messages on the bulletin board increased (Hypothesis 3 [H3]), but that attention per message would decrease as the number of messages increased (Hypothesis 4 [H4]). If H4 were supported, we would expect comprehension (retention of message content) also to decrease as the number of messages increased (Hypothesis 5 H5).

Finally, we considered the effect of an attractor, in this case a large-scale topographic location map. Such a map, because it provides useful information to visitors, may increase attention to adjacent messages; however, it may reduce attention by competing with the adjacent messages. We therefore also tested the null hypothesis (Hypothesis 6 [H6]), that attention to messages and message comprehension would not vary with the presence or absence of an attractor.

Method

These six hypotheses were evaluated with a field experiment. Subjects were visitors aged 18 years and older entering the Selway-Bitterroot Wilderness at the Big Creek trailhead during the period from June 21 to September 19, 1993. This trailhead is one of the more

frequently used accesses to the wilderness and is located about 40 mi. southwest of Missoula, Montana. The experimental design consisted of six treatments: (a) two messages and an area locational map, (b) four messages and a map, (c) six messages and a map, (d) eight messages and a map, (e) the map only, and (f) four messages without a map. The map was a large-scale (1:24,000) topographic map of the immediate vicinity.

The sampling design was a variation of random assignment of subjects to treatments. Treatments were randomly assigned to weeks of the hiking season because we could not randomly assign subjects to each treatment. Each treatment was in place for 2 nonconsecutive weeks.

Messages consisted of statements of U.S. Forest Service-recommended low-impact practices, based on research and experience about appropriate visitor behavior to reduce impacts (Hampton & Cole, 1988; Appendix 1). All messages were similar in design, length, and appearance and contained a line drawing relevant to the message, as well as text. Consequently, we considered message quality to be a constant among our treatments. No other messages were posted on the sign. Each message could be read in about 5 sec; however, a thoughtful reading would require longer. Messages and the map were posted on adjacent, connected 4-ft.-sq. sign panels, approximately 1.5 mi. from the trailhead. Previous research (Petersen, 1985) has suggested that such a location may be more effective in gaining visitor attention. Messages and map were positioned where they could easily be read by both hikers and riders on horseback.

Visitors were considered to have been exposed to messages if the messages were posted when they passed the bulletin board, We assessed attention in two ways: (a) whether visitors stopped and looked at the messages, and (b) how long they looked at the messages. Attention to messages was measured by observing subjects as recorded by a movie camera located a short distance away. The camera was activated by visitors crossing an infrared beam; it exposed a single frame every 4 set for the next 4 min. Attention in seconds was four times the number of frames in which visitors were judged to be looking at the bulletin board (standing still, body facing board, and head oriented at the height of messages or map). The bulletin board panels that displayed the map and the messages were oriented at different angles, allowing us to differentiate between time spent attending to low-impact messages and time spent attending to the map. One researcher made all attention evaluations. A total of 506 subjects were observed across all treatments.

Comprehension, as has frequently been done elsewhere (Eagly & Chaiken, 1993), was operationalized as retention of message content. Retention of message content was assessed with a quiz based on the eight low-impact messages used in the study (Appendix 2). Answers were considered correct if they corresponded to the messages posted on the bulletin board. Message retention was quantified as the proportion of questions about those messages to which the visitor was exposed (from two to eight questions, depending on the treatment) that were correctly answered.

We also used the quiz to assess what we refer to as knowledge of recommended low-impact practices, quantified as the proportion of correct responses to questions for all eight messages, regardless of how many messages the visitor was exposed to. This knowledge was the sum of prior knowledge and newly acquired knowledge, although only those visitors who were exposed to messages had the opportunity to acquire new knowledge. Our goal was to assess quantity of newly acquired knowledge. The retention measure was inadequate for this purpose because the amount of information visitors were asked to retain varied messages between treatments. It was therefore possible that visitors exposed to many messages could acquire more new knowledge than visitors exposed to few messages, despite retaining a smaller proportion of the new information they were

exposed to. Our approach to estimating newly acquired knowledge was as follows: Mean prior knowledge was assumed to be roughly equivalent between each of the treatment subpopulations. In support of this assumption, we found that wilderness experience, self-reported low-impact knowledge, and self-reported frequency of exposure to low-impact messages did not vary significantly between treatment subpopulations (chi-square, alpha= 0.05). Moreover, the mean low-impact knowledge score of the subpopulation that was not exposed to messages provided an estimate of this mean level of prior knowledge. Therefore, the difference in knowledge between those not exposed to messages and those exposed to messages provided an estimate of the quantity of newly acquired knowledge.

The quiz used to assess message retention and knowledge of recommended practices and questions pertaining to visitor characteristics were included on a questionnaire administered at the trailhead as visitors exited from their trips. Only visitors aged 18 and older, who had traveled as far as the bulletin board, and who entered and exited during the same treatment period were included in the sample. Five visitors refused. By recordings of time of contact, group size, equipment, and clothing colors, each completed questionnaire was related to a recorded film attention observation. The number and color of horses was usually adequate to identify horse groups. Group size, gender, and clothing characteristics were generally adequate to identify day hikers. Group size, gender, and pack color were adequate for overnight hikers. Questionnaires were administered for only about 8 hr per day,' 5 days per week. Of the 506 subjects for which film observations were made, 2 17 had corresponding questionnaire data.

Our experimental design assumed that subpopulations exposed to different treatments were equivalent in terms of visitor characteristics that might influence communication effectiveness, including prior knowledge of low-impact practices. We tested this assumption by (a) conducting bivariate analyses of relationships between visitor characteristics and attention, retention, and knowledge of recommended practices and (b) assessing variation between treatment subpopulations for visitor characteristics that explained variation in attention, retention, or knowledge of recommended practices. We used chi-square tests, t tests, analyses of variance, and regression analyses, depending on the scale of the dependent and independent variables. We found, for example, that attention, retention, and knowledge of day users were not different from those of overnight users; nor did the proportion of day users and overnight users vary between treatments. The only visitor characteristic that both varied between treatments and explained substantial variation in communication effectiveness was mode of travel. Consequently, we analyzed hikers and horse users separately.

Results

Visitor Characteristics, Knowledge, and Attention

Sixty-five percent of the 506 observed visitors were hikers; 35% were on horseback. Day users were more common than overnight visitors, particularly among horse users (Table 1). The average visitor was experienced in wilderness travel, with many previous wilderness visits. About one half of visitors indicated that they had frequently been exposed to low-impact information and that they were very knowledgeable about low-impact practices. The average correct score on the eight-item low-impact quiz was only 33%; however, hikers scored significantly higher (36%) than horse users (21%) ($p < .001$).

Fifty-five percent of all visitors attended to (stopped and looked at) messages on the bulletin board (Table 2), but this proportion was significantly higher for hikers (71%) than

Table 1
Characteristics of the sample of visitors

Characteristic	Hikers (*n* = 329)	Horse users (*n* = 177)
Overnight use (%)	43	27
Male (%)	67	69
College graduates (%)	48	45
Mean age (years)	35	41
Mean prior visits to Bitterroot canyons (#)	18	34
Mean prior visits to any wilderness (#)	28	40
Median wilderness visits per year (#)	4	7
"Experienced" in wilderness travel= (%)	78	81
"Very" knowledgeable about low-impact[a] (%)	56	49
"Frequently" had seen low-impact messages= (8)	48	47

[a]Self-reported.

for horse users (27%). If they stopped at the bulletin board, hikers and horse users were equally likely to look at the messages, but hikers gave the messages more attention (22 f 2 sec; Mean ± 95% confidence interval) than the horse users (14 ± 5 sec). Only 28% of hikers and 8% of horse users attended to messages for at least 5 sec per message; our estimate of the minimum attention needed to read the message.

Horse users were much less likely than hikers to look at the map, even among those who stopped at the bulletin board (Table 2). When the map was posted, 75% of hikers looked at it, compared with only 13% of horse users. Hikers also gave the map more attention (80 ± 9 sec) than horse users did (27 ± 19 sec).

One possible explanation for the low message attention (14 ± 5 sec) of the 27% of horse users who looked at the messages is that two of the messages were less relevant to them than to hikers. Because of the potential influence of message relevance, further analyses were confined to hikers.

Table 2
Attention to messages of hikers and horse users

Action	Hikers (*n* = 329)	Horse users (*n* = 177)	*P*
Stopped at bulletin board (%)	83	28	<.01[a]
Looked at messages on bulletin board (%)	71	27	<.01[a]
Looked at map on bulletin board (%)	75	13	<.0l[a]
Of those who stopped at bulletin board:			
looked at messages (%)	84	90	.34[a]
looked at map (%)	90	49	<.0l[a]
Mean attention of those who:			
looked at messages (seconds f 95% ci)	22+-2	14+-5	<.0l[b]
looked at maps (seconds + 95% ci)	80+-9	27+-19	<.0l[b]

[a]Significance determined by chi-square.
[b]Significance determined by t test

Table 3
Hiker knowledge of recommended low-impact practices in relation to number of messages posted

Low-impact quiz score	Number of Messages						
	0 (n = 28)	2 (n = 17)	4 (n = 29)	6 (n = 44)	8 (n = 21)	F	p
Average percent correct	16+-6a	35+-llb	42 +- 8b	41+-6b	42 +- 14b	0.4	0.76

Note. Significance determined by analysis of variance (Scheffe's multiple comparison test; alpha = .05). Values with the same letter following them are not significantly different.

Tests of Hypotheses

To evaluate Hl-that exposure to low-impact messages on bulletin boards would be positively associated with knowledge about these low-impact practices-we compared knowledge scores of hikers who were and were not exposed to the messages. The 111 hikers who had passed the bulletin boards when messages were posted (and completed a questionnaire) correctly answered 41 +- 3% of the eight low-impact questions, whereas the 28 hikers who had passed the bulletin board when no messages were posted (and completed a questionnaire) correctly answered only 16 +- 6% of the questions. This difference is statistically significant (one-tailed ***t*** test, ***p*** < .00l). On average, visitors exposed to messages could correctly identify three of the eight recommended practices. Visitors not exposed to the messages, who could only draw on prior knowledge, correctly identified just one of the practices on average.

This result confirms Hl and suggests that visitors exposed to low-impact messages on bulletin boards acquire new knowledge about recommended practices. The primary alternative explanation of this result is that hikers not exposed to messages had lower levels of knowledge before their visit than those who were exposed to messages. This explanation is highly unlikely given that treatments were randomly assigned to weeks. Moreover, no hiker characteristics (e.g., wilderness experience, self-reported low-impact knowledge, frequency of exposure to low-impact messages) varied significantly among treatments.

Interestingly, although hikers exposed to two messages scored significantly higher than those-exposed to no messages, hikers exposed to more than two messages did not score significantly higher than those exposed to two messages (Table 3). This finding suggests that visitors exposed to eight messages did not acquire any more new knowledge than those exposed to just two messages. Apparently, visitors' ability to acquire new information from a single exposure to trailside messages is limited, with a threshold of about two messages. Tests of the remaining hypotheses provide some possible explanations for this finding.

Hypothesis 2, that retention of message content would increase as attention to messages increased, was tested by Pearson's correlation. As support for H2, we found a significant positive correlation between message attention and message retention (***r*** = 0.51). In addition, hikers who looked at messages for at least 5 sec per message scored a mean of 67 +- 7% on the retention measure, whereas those who gave the messages less attention scored 40 +- 7%, a statistically significant difference (one-tailed ***t*** test, ***p*** <.000l).

We used two different measures of attention to test H3, that total attention to messages would increase as the number of messages increased. We used a chi-square test to

assess whether the proportion of hikers who looked at the messages varied as the number of posted messages varied. We used analysis of variance to assess whether the amount of time hikers spent reading messages varied with the number of posted messages. Both the proportion of hikers who looked at messages and the total time they spent attending to messages varied significantly with the number of posted messages (Table 4). As support for H3, we found that both the proportion of hikers who attended to messages and the length of time they attended to messages increased as the number of messages increased. However, the only statistically significant difference was between attention to two messages and attention to more than two messages.

Hypothesis 4, that attention per message would be inversely related to number of messages, was partially supported. When six or eight messages were posted, per-message attention was significantly less than when four messages were posted (Table 4). However, per-message attention when two messages were posted was not significantly different from per-message attention in any of the other treatments. The relationship between per-message attention and number of messages exhibited the form of an inverted U (quadratic term, $p = .04$)-a result also found in consumer research on the relationship between information quantity and decision effectiveness (Keller & Staelin, 1987).

Hypothesis 5, that retention of message content would be inversely related to number of messages, was supported. The ability of hikers to retain the information to which they were exposed declined linearly ($p = .01$) with number of messages, although the only statistically significant difference was between retention of two and eight messages (Table 4).

To test the final hypothesis (H6), that the presence of a locational map would have no effect on message attention or comprehension, we compared the treatment consisting of four messages and a map with the treatment consisting of just the same four messages.

Table 4

Hiker attention to messages and retention of message content in relation to number of posted messages

	Number of messages					
Action/characteristic	2	4	6	8	*F*	*P*
Attended to messages (%)[a]	53	70	80	85	na	.003
n	57	47	76	20		
Total attention to messages						
(sec +- 95% ci)[b]	9 +- 2a	23 +-_6b	25 +- 3b	26+-9b	10.8	<.001
n	30	33	61	17		
Per-message attention						
(sec +- 95% ci)[b]	4.5+0.8ab	5.7f1.4b	4.2&0.6a	3.3+-l.la	3.2	.02
n	30	33	61	17		
Message retention						
(% +- 95% ci)[c]	70+-19b	64+-13ab	49+-8ab	43+-18a	2.9	.04
n	10	20	37	9		

[a]Proportion of all visitors who looked at messages; chi-square test.

[b]Attention of just those visitors who looked at messages; ANOVA test. Values with the same letter following them are not significantly different (Scheffe's multiple comparisons test; a = 0.05).

[c]Retention quiz scores (% correct) of just those visitors who looked at messages; ANOVA and Scheffe's tests.

Table 5
Attention to messages and message content retention (comprehension) in relation to presence of map

Attention	Messages only	Messages and map	*p*
Mean attention to bulletin board (sec +- 95% ci)	17 +- 7 (36)	66 +- 14 (47)	<.01
Mean attention to messages of:			
all visitors (sec +- 95% ci)	17+-6 (36)	16+-6 (47)	.75
those who looked at messages (sec +- 95% ci)	24 +- 8 (26)	33 +- 7 (33)	.81
Mean message content retention of:			
all visitors (% + 95% ci)	53 +- 12 (24)	52+- 11 (29)	.88
those who looked at messages (% +- 95% ci)	64 +- 13 (16)	64 +- 12 (20)	.97

Note. Significance determined by t tests. Numbers in parentheses are n's

More hikers stopped at the bulletin board when both messages and a map were posted (89%) than when only messages were posted (72%)-a statistically significant difference (***p*** = .04, chi-square). However, the proportion of hikers who looked at the messages when a map was also posted (70%) was no higher than when only messages were posted (72%) (***p*** = .84, chi-square). Similarly, although the length of time visitors spent looking at the bulletin board was much greater when there was a map posted, the time spent looking at messages was no greater when there was a map (Table 5). Finally, retention of the content of posted messages was similar whether or not a map was posted (Table 5). Consequently, the null hypothesis cannot be rejected.

Discussion

McGuire's model of information processing provided a useful conceptual framework for identifying hypotheses and structuring our experiment. We suggest that it be used more often in the recreation literature pertaining to persuasive communication. We found that information overload can be a concern in recreation settings, but our attempt to evaluate attraction versus distraction was less successful. Our intervention neither attracted nor detracted attention from the target messages.

Our field experiment demonstrated that trailside signs and bulletin boards can be effective means of communicating low-impact information, at least for hikers. Most hikers stopped to look at messages when they were posted on the bulletin board, and those who were exposed to messages acquired new information about recommended low-impact practices. They were better able to identify agency-recommended practices after their trip than those who were not exposed to messages and who had to rely entirely on prior knowledge. It is not clear why our bulletin board messages were more effective than those used by Fazio (1979) and Stubbs (1991). Our results may be partly attributable to methodology, our ability to distinguish between visitors who attended to messages and those who did not. They may also reflect differences in sign design and placement, the quality of the messages posted; characteristics of visitors, or the instrument used to evaluate

knowledge and retention. Further research is needed to identify more specifically the conditions under which sign-based messages are effective.

The positive association we found between attention to messages and retention of message content suggests that inducing visitors to devote more attention to sign-based messages is one of the keys to increasing their effectiveness. Posting a topographic map was not an effective strategy for increasing attention to messages. The map attracted visitors to the bulletin board but not to the messages. If managers want to post maps for informational purposes, however, our results suggest that maps do not distract attention from adjacent messages. Additional research on other attractant strategies would be worthwhile. Perhaps attention to messages would have increased if we had used a more unique map with different information, attractants (e.g., photographs of local wildflowers) interspersed with the messages, or attractants (e.g., photographs of disturbed campsites) specifically related to the messages.

We found evidence that visitors can experience information overload when there are numerous messages on bulletin boards. As the number of messages increased, hikers allocated significantly more total attention to the messages but apparently not enough for them to process the increased information load adequately. As information quantity increased, attention per message and retention of message content both declined. The positive effects of exposure to more information were nullified by the negative effects of inadequate attention and retention of information. Consequently, visitors exposed to eight messages did not acquire any more new low-impact knowledge than those exposed to just two messages. This finding is consistent with consumer research that has also reported decreasing decision effectiveness ***once*** information quantity exceeds threshold levels (Keller & Staelin, 1987).

Our research found that few visitors were willing to spend more than 25 sec to read low-impact messages and that posting more than two messages had no positive effect on knowledge of recommended practices. If these findings are consistent in other areas, managers are faced with the challenge of selecting a few critical messages and designing them so that they can be adequately processed in a short time. Limited time should probably be reserved for messages designed either to (a) increase comprehension of critical practices that are poorly understood or (b) increase yielding and intention to act upon critical well-understood practices. For example, the pack-it-in, pack-it-out message may be so well known that its inclusion on a bulletin board has no effect on knowledge. If so, it may be best either to design a message with the goal of increasing commitment to packing it out or to replace that common message with one about a less well-known practice.

Only about one quarter of horse users stopped at the bulletin board and gave the messages any attention at all. This finding, along with the results of earlier research on the behavior of horse users at trailside registration stations (Lucas, 1983; Petersen, 1985). suggests that trailside signs are not an effective way of communicating low-impact behaviors to horse users. This is a cause for concern, given our finding that low-impact knowledge levels of horse users in the study were low and the general conclusion that the potential for biophysical impacts from packstock is high (McClaran & Cole, 1993). Finding other effective means of communicating low-impact behaviors to horse users seems to be an important priority for both managers and researchers. McGuire's model may prove useful in structuring experiments to evaluate the success of alternative communication media.

Further experimentation with alternative means of increasing the effectiveness of trailside bulletin boards is warranted, as is research that evaluates the relative effectiveness

of different media for different audiences. Finally, some research on effective messages and communication media must be practice-specific. For example, Stubbs (1991) found that trailhead messages had a significant effect on one behavior (use of stoves instead of fires), despite the intervention's not having a significant effect on knowledge that stoves are preferred. Our interpretation of this finding is that because even visitors who were not exposed to messages knew stoves were preferred, message reception was not a limiting factor prior to the intervention; the message could influence only whether visitors complied with a recommendation they knew and understood. In contrast, messages had no effect on another behavior (appropriate campsite selection), despite a significant increase in knowledge about appropriate places to camp. In this case, very few visitors knew about appropriate campsite selection prior to the intervention, so reception of information was a limiting factor. This finding suggests the need to understand, for specific recommended practices, whether reception of information is limiting behavior or whether the limiting factor is yielding to information that has already been received. Very different types of messages and communication media may be needed if the objective is to increase intention to act upon knowledge rather than simply to increase knowledge. If each attempt to communicate with visitors needs to be confined to only a few messages (as our results suggest), it is critically important to make certain that each message targets the most limiting stage in the persuasive communication process.

Our experiment was limited in a number of ways. We did not attempt to identify and measure the elaboration processes that other models of persuasive communication (e.g., Petty & Cacioppo, 1986) have suggested are important for long-term behavioral change. We did not attempt to measure long-term effects of messages (e.g., long-term retention), effects of repetitive exposure to messages, or effects on beliefs, attitudes, and behavioral intentions, the variables that other models (e.g., Fishbein & Ajzen, 1975) have suggested are the best predictors of behavioral change. Nor did we attempt to assess the effect of message quality on persuasive impact. Further research is needed on the effects of both message and sign design characteristics on elaborative processes, beliefs, attitudes, and behavioral intentions, as well as on the importance of repetitive exposure to messages.

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Appendix 1: Low-Impact Messages

1. Hikers, to minimize conflicts when meeting horses, please step off the downhill side of the trail, stand still, and speak softly until the horses pass.
2. Please dispose of human waste in a hole 6-8" deep and at least 200 from water and campsites. This helps avoid water pollution and the spree d of disease.
3. Please dispose of fish entrails (guts) by scattering them over a wide area. Do not throw them back into the water (they decompose slowly in cold water) or bury them (animals dig them up).
4. When hiking in areas without trails, spread out instead of walking single-file. This will minimize impact to fragile vegetation.
5. When camping in areas with obviously impacted campsites, (1) select a campsite that is already barren and (2) confine tents and activities to places that are already

barren. This will concentrate impact on places that are already disturbed and spate places that haven't been damaged.

6. To minimize impact on areas without well-developed campsites or trails; disperse your impact: (1) select a previously unused site for camping and (2) avoid repeat traffic over the same area.
7. When having a campfire where others have already been built, please use an existing fire ring. When breaking camp, destroy all existing fire rings by scattering the rocks and ashes over a wide area.
8. If you have a campfire where one has never been built before, do not use rocks to ring the fire. Use downed dead wood that is small enough to break by hand. Camouflage the fire scar when you leave.

Appendix 2: Examples from the Low-Impact Quiz (correct answer checked)

1. When hiking and encountering a horse party you should:

____ Step off to the uphill side of the trail
____ Move quickly past the horses
_x_ Speak softly until the horses pass
____ Once the horses have come to a stop, move quickly past them

2. When camping in obviously impacted areas you should:

____ Spread activities to places that have not been disturbed
____ Pitch your tent on a non-impacted site
____ Avoid sites that are heavily impacted
_x_ None of the above

3. When building a campfire where one has never been built before:

____ Build a new fire ring using rocks
____ Leave the fire ring you built for later use
_x_ Do not use rocks to ring the fire
____ Dig a pit for the fire