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Minimizing Visitor Impacts to Protected Areas:
The Efficacy of Low Impact Education Programs

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Abstract

Protected area managers, tourism providers, and other organizations commonly employ education programs to address visitation-related impairment of natural and cultural resources, social conditions, and neighboring communities. These programs have different names (Leave No Trace, Codes of Conduct, Environmental Guidelines for Tourists) but share common objectives: to sustain opportunities for high quality visitor experiences while avoiding or minimizing associated negative impacts to protected area resources, visitor experiences, and park neighbors. Theoretical and empirical research studies in the United States are reviewed to evaluate the efficacy of educational efforts that seek to encourage adoption of low impact behaviors. Findings reveal that most of the visitor education efforts evaluated did effectively alter visitor knowledge, behavior and/or resource and social conditions in the intended direction. These findings, including discussions of message content, delivery, audience characteristics and theoretical grounding, provide insights for improving the efficacy of future educational efforts.

Introduction

Tourism Impacts and Management Responses

Steadily expanding visitation to protected areas worldwide increasingly challenges land managers charged with balancing their dual mandates of resource protection and recreation provision. Visitors to protected areas inevitably leave an imprint, from vegetation trampling, trail erosion and degraded cultural resources to visitor crowding and recreation conflict. Sustaining pristine natural resource conditions while offering high quality recreational experiences are both primary goals for managers of protected areas. One group venturing off-trail or creating a new campsite may seem of little consequence, but the combined effects of repeated instances over many years leave a substantial and long-term mark on the land.

Research has shown that resource degradation is an inevitable consequence of recreational use even at low visitation levels (Hammitt & Cole, 1998; Leung & Marion, 2000). Social impacts related to the visitor's experience include crowding and recreation conflict that can lead to diminished satisfaction and to coping behaviors, such as activity substitution and the temporal or spatial displacement of visitors (Manning, 1999). Left unmanaged, these impacts can lead to unacceptable changes in resource or social conditions, such as the loss of sensitive or rare plants and animals, or declines in visitor satisfaction. These occurrences could precipitate a decline in tourism visitation and revenues or to carrying capacity-based reductions in use. Therefore, a principal challenge for protected area managers is to eliminate avoidable impacts, such as litter, tree damage or noisy/rude behavior, and minimize unavoidable impacts, such as trampled vegetation and wildlife disturbance.

Land managers most commonly address resource and social impacts through regulations, site management, and visitor education. Regulations include limitations on amounts or types of use, or visitor behavior (e.g., littering, building campfires). These actions directly curtail visitor freedoms, and aggressive enforcement will modify the behavior of all but the most ignorant or determined visitor (Peterson & Lime, 1979). However, regulation by rules or laws has a negative connotation to visitors due to their emphasis on what may not be done, and the potential for their enforcement with punitive actions. Regulations antagonize visitors rather than win their support. Enforcement is costly, which often limits efficacy. Site management actions, such as developing and hardening a recreation site or trail, are less direct but they are also costly and will permanently alter the natural setting and the nature of recreational experiences (Hendee & Dawson, 2002; Stankey & Schreyer, 1987). For example, adding bridges, pavement, and fencing to a trail improves resource protection but can transform the visitor experience from one that is primitive and intimate with nature to one that is more developed and separate from nature.

Visitor education programs recognize that most impacts are not from malicious acts, but result from insensitivity to the consequences of one's actions or a lack of knowledge regarding appropriate low-impact behaviors (Bradley, 1979). Education programs encourage visitors to consider the environmental and social consequences of their actions, promoting enhanced ethics and a self-directed modification of their personal behavior. Visitor education designed to persuade visitors to adopt low-impact practices is considered a more appropriate, light-handed and indirect management response to reduce resource impacts or improve visitor experiences (Manning, 1999; Roggenbuck, 1992). The objective of educational programs is not to "control" visitor behavior; rather, land managers seek to provide a cognitive basis to encourage appropriate low impact visitor behavior in recreation settings (Peterson & Lime, 1979). Visitors retain their

freedom of choice but information that considers the consequences of their actions guides their behavior.

Visitor education is also strongly favored by protected area visitors (Hendee & Dawson, 2002), who are generally very receptive to educational appeals due to their high educational levels and the great value they assign to protected areas. Hendee and Dawson (2002) note that educational programs can improve visitor experiences by building deeper appreciation for the areas they visit, including appropriate behavior, experiences, and values. Finally, effective educational programs can: 1) reduce per capita and cumulative resource and experiential impacts, 2) aid in keeping resource and social conditions within acceptable limits, 3) reduce the need for site management or regulatory actions such as use limits, and 4) provide a key component of sustainable tourism programs.

Leave No Trace and Other Educational Programs

In the United States, federal land management agencies initiated development of a public/private national Leave No Trace (LNT) program to provide a unified educational response to resource and experiential impacts. The program traces its conception to minimum impact camping messages developed by U.S. Forest Service wilderness managers in the 1970's (Marion and Reid 2001). Formal development of the current program began in 1990, with selection of the name "Leave No Trace" and formation of a partnership with the National Outdoor Leadership School to develop educational principles, materials, and training courses. The non-profit Leave No Trace, Inc. educational organization was formed in 1994 to further develop the program, partner with local, state and federal land managers and other organizations, and enlist support and involvement from manufacturers and outdoor retailers. The organization's mission is to promote and inspire responsible outdoor recreation through education, research and partnerships, with a focus on non-motorized recreation (http:/www.LNT.org). While the program had its origins in wilderness and backcountry settings, it has grown to include frontcountry (urban/suburban) environments and is widely applied in U.S. protected areas managed by federal, state, local and private entities. Its primary objective is to protect the quality of natural and cultural resources and recreational experiences by raising the awareness of visitors regarding the potential for negative impacts associated with their visits, and educating visitors in selecting the most appropriate and effective practices to avoid or minimize their impact.

The Leave No Trace Educational Review Committee, comprised of land managers, scientists and practitioners, develops, refines and approves practices and messaging to ensure validity and consistency. The committee routinely consults scientific research (e.g., Cole, 1989 and Hampton and Cole, 1995) to ensure that LNT practices are based on the best available research findings. The program has moved well beyond early lists of "do's and don'ts" in favor of messages that encourage visitors to consider environmental and use-related factors when selecting an LNT practice that is most likely to minimize impacts. LNT messages emphasize the development of judgment and context-specific decision-making rather than dogmatic adherence to rigid practices. For example, in popular areas visitors should travel single file down the middle of formal trails to concentrate trampling impacts on constructed and maintained treads. In less-visited pristine areas or for off-trail activities, visitors should spread out and travel on the most resistant surfaces available, such as snow, rock, non-vegetated substrates or dry grasses.

Information is disseminated through a Skills & Ethics booklet series, pamphlets, signs,

videos, and training courses. The non-profit guiding organization, the Leave No Trace Center for Outdoor Ethics, has 11 full-time staff and over 300 public and private partners. Participation and support by federal land management agencies remains strong but the program receives no federal funding. The Center's current annual budget of $1,084,000 consists of grants (35%), memberships (34%), in kind product and service contributions (17%), sales (9%) and other sources (5%).

Internationally, many other organizations employ educational strategies to address resource and cultural impacts resulting from nature-based recreation and tourism (UNEP, 1995). Members of the World Tourism Organization developed a Global Code of Ethics for Tourism in 1999 to help minimize the negative impacts of tourism on the environment and on cultural heritage (WTO, 2006). The Ecotourism Society (1993) has also published "Ecotourism Guidelines for Nature Tour Operators" that encourage and guide educational efforts aimed at preparing tourists to minimize their impacts while visiting sensitive environments and cultures. With an aim to improve the sustainability of nature-based tourism, many nature-based tourism programs have incorporated the delivery of low impact interpretive messages (Buckley, 1999; Mason, 1994; Weiler & Davis, 1993; Weiler & Ham, 2002). These educational efforts are generally called "Codes of Conduct" or "Environmental Guidelines for Tourists" and their use by public and private land managers and tourism providers has dramatically expanded in the past two decades (Eco-Tour, 2003 [http://www.eco-tour.org/information_en.html]; Mason & Mowforth, 1996; UNEP, 1995). The Leave No Trace program has also had some of its information translated into several different languages and has been adapted for use in other countries. Recently, Canada and Australia created formally affiliated LNT programs.

Educational Efficacy

Educational programs communicate low impact practices to millions of protected area visitors annually through a diverse array of literature, training activities, and public outreach messages. For example, Table 1 illustrates the prevalence of educational actions in U.S. national parks. Personal contacts, posters at visitor centers and trailheads, brochures, and videos are the most common methods used to communicate low impact messages. How effective are these programs in conveying low impact practices and ethics and do visitors who receive such messages retain the information or modify their behavior to reduce resource impacts or improve the experiences of other visitors? Which visitor education approaches are most effective?

In their review of international tourism codes of conduct, Mason and Mowforth (1996) conclude that: "there has been a clear lack of monitoring and evaluation of codes of conduct [and] the one issue that stands out above all others is the need for further investigation into the use, value, design, uptake and distribution of codes of conduct." This paper seeks to provide some answers to these questions by reviewing results from a growing body of research on the efficacy of visitor education efforts designed to reduce visitor impacts at protected areas. While this research focused on evaluating educational efficacy in the United States, searches of the international literature revealed very few studies. Indeed, there is little published research outside the U.S., even for the broader topic of evaluating the effectiveness of park-related interpretation. McArthur (1998) states that there has been little research undertaken in the international ecotourism industry to determine whether interpretation helps to develop visitor understanding and modify attitude or behavior. In a paper about interpretive evaluation in Australia, McLoughlin (1998) notes that "interpretation and education receive lowest priority for

funding and visitor research and evaluation rates almost not at all."

Visitor Education: What Is Possible?

The nature of a visitor's actions is a primary determinant of the potential for visitor education to be effective. Undesirable visitor actions may be classified as careless, unskilled, uninformed, unavoidable, and illegal (Hendee & Dawson, 2002). Careless actions are nuisance or thoughtless behaviors, such as picking wildflowers or littering, done without full consideration for their effect on the resource or other people. Unskilled actions are inappropriate behaviors that occur when visitors know what they should do, but lack the skills to do so (e.g., building a low-impact campfire). Uninformed actions result from visitors simply not having the adequate information to select a particular behavior. Visitors who feed wildlife or fell a tree for firewood without knowing that these practices violate regulations or recommended practices are examples. Unavoidable actions are behaviors that occur to some degree regardless of a visitor's knowledge or experience, such as vegetation trampling and soil compaction along a designated trail. Illegal actions are deliberate violations of laws or regulations, such as the theft of archeological artifacts.

Visitor education can only effectively address unskilled and uniformed actions, and to a lesser extent, careless actions, as these are more highly related to visitor knowledge and skill levels (Hendee & Dawson, 2002; Manning, 2003; Roggenbuck, 1992). Managers can target these undesirable actions by describing the nature and significance of ensuing impacts and persuading visitors of the need to learn and practice behaviors that avoid or minimize the impacts. There is a lower potential for effectively targeting unavoidable impacts, though this is possible if education successfully modifies behavior to minimize degradation or shifts recreation to times or places when these activities are less harmful (e.g., when soils are drier or to more resistant surfaces). Law enforcement actions are generally applied to address illegal actions, though more effective communication of regulations and laws, reasons for specific rules, and the environmental and social impacts of problem behaviors may alter opinions and encourage higher compliance (Roggenbuck, 1992).

Theoretical Basis for Visitor Education

Scientists seek to understand the mechanism by which visitor education alters an individual's behavior. Several conceptual approaches have been advanced and tested through research studies, including moral development, reasoned action/planned behavior, decision-making, and persuasion.

Moral Development

Theories of moral development formulated by Kohlberg (1976) and furthered by Gilligan (1982) have important implications for educating protected area visitors. These theories suggest that people progress through several stages of moral development that range from pre-conventional (characterized by fear of punishment), conventional (characterized by attention to the opinions of significant others and societal norms) and post-conventional (characterized by consideration for justice, fairness and self-respect) (Kohlberg, 1976).

Messages shaped by moral appeals ask recipients to alter their behavior to be more socially responsible. Christensen and Dustin (1989) suggested that managers communicate different

messages to target visitors at different levels of moral development. For example, visitors at pre-conventional moral levels would likely respond best to the threat of law enforcement actions or positive incentives while visitors at post-conventional levels would likely respond to rationales appealing to a sense of altruism and justice (e.g., what's best for society at large) (Manning, 1999). In contrast, visitors at conventional levels of morality need to be convinced that land managers, their family, peers and society as a whole condone certain actions in contrast to others.

Reasoned Action and Planned Behavior

These theories suggest that behavior depends on our intentions to behave in certain ways. Further, our behavioral intentions are derived from: 1) behavioral beliefs - our attitudes about the desirable or undesirable consequences of the behavior, 2) normative beliefs - perceived social pressures to engage in a particular behavior, and 3) control beliefs – a person's belief that he or she has the opportunity, knowledge, ability, skill and resources necessary to perform the behavior (Fishbein & Ajzen, 1975; Fishbein & Manfredo, 1992; Ham & Krumpe, 1996). Thus, educators must modify one or more of these three antecedents of behavioral intention to change a problem behavior. Effective interpretive messages must target and alter the problematic behavioral, normative or control beliefs that are most salient to the behavior in question. For example, education to reduce campfire impacts are enhanced when messages describe the personal advantages of stove use, the negative resource and aesthetic impacts of campfires, or the practices necessary to build and manage a low impact campfire.

Decision-Making

This theory examines the processes employed by visitors to choose the activities or actions they engage in and seeks to explain, understand, and/or predict these choices (Blichfeldt 2004). Ewing (1983) states that decision-making theory assumes that behaviors are the outcome of decisions between different courses of action, and that expected benefits accruing from the alternatives guide choices. For example, campers may choose to engage in high impact behaviors, like building a large campfire in a new location, due to the benefits of having a campfire (warmth and group camaraderie). If they are unaware of the environmental or social costs of building the campfire their decision-making cannot account for such "costs." Alternately, if campers are aware of bear activity in the area, a group may choose to carefully control food wastes and protect their food from wildlife to ensure their personal safety.

Persuasion

Two models of persuasion are pertinent to visitor education efforts: the central route to persuasion and the peripheral route to persuasion (Roggenbuck, 1992; Vande Kamp *et al.*, 1994). The Elaboration Likelihood Model (Petty *et al.,* 1992) provides a conceptual basis for these models. Protected area managers frequently base educational messages on the central route to persuasion, which relies on visitor attention, consideration and internalization of the message. This is an effective method of communication because the recipient processes information by drawing on prior experience and knowledge to evaluate the arguments presented in the message. Following careful consideration and internalization the resulting attitude is integrated into the receiver's belief structure, resulting in long-term behavioral change. Hence, the central route to persuasion is most appropriate when educational goals focus on instilling an enhanced environmental ethic, or when management issues are targeting unintentional deviant or depreciative behavior (Roggenbuck, 1992).

An information-processing model adapted from McGuire (1985) illustrates the application of this approach and provides a theoretical basis for programs that seek to influence behavior to avoid/reduce impacts in protected areas (Figure 1). Persuasion begins when a visitor sees or hears an educational message such as printed material (signs or publications) or a video. The visitor must attend to (process) the message and understand it (comprehension). Messages may be too complex for comprehension or may conflict with personal experiences or other information. A critical step, termed "yielding," occurs when visitors accept the content of the message and alter their attitude accordingly. The model further posits that visitors will later behave in accordance with the changed attitude if they retain the message and attitude in their memory. When all steps of the model are achieved, the persuasive message will be effective in precipitating low impact behavior that avoids or reduces the targeted impact (Figure 1).

The peripheral route to persuasion relies on the source of the message rather than the message itself. This approach is characterized by use of an authority figure (park ranger) or a well-known spokesperson (actor) to convey a message (Roggenbuck, 1992). Unfortunately, attitude change through the peripheral route may be short-term because it does not rely upon issue-relevant reasons for behavior. This method may be more effective in settings such as visitor centers where there are many competing or distracting educational messages, where audiences have a short attention span, or for visitors who are unable to process the content of the message or integrate an issue-relevant argument into their belief system (Roggenbuck & Manfredo, 1990). In particular, the peripheral route to persuasion may be more effective in education programs that target children (Hendricks, 1999; Roggenbuck & Manfredo, 1990).

The Efficacy of Visitor Education: Study Results

In this section, we highlight the results of studies that have assessed the effectiveness of low impact visitor education. We have grouped these in four categories based on the intent of the education: knowledge gain, behavioral change, redistributing visitors, and change in resource conditions. Within these, we also highlight studies that have assessed the effectiveness of different media in achieving education goals. Each study provides some additional insight into the effectiveness of visitor education programs and methods.

Knowledge Gain Following Education
Fazio (1979) developed some of the first tests of the effectiveness of education methods in improving visitor knowledge of low-impact camping techniques. His studies in Rocky Mountain National Park and the Selway-Bitterroot Wilderness evaluated the effectiveness of brochures, trailhead signs, slide shows, television programs and newspaper coverage in conveying low-impact messages to visitors. This work found that personal contact from an agency employee was the most effective method. Also effective was a visitor-activated slide show presentation with sound. Informational brochures were minimally effective while communication through the mass media (e.g., newspapers and television) was ineffective.

McAvoy and Hamborg (1984) assessed the effectiveness of a brochure on visitors' knowledge of regulations within the Boundary Waters Canoe Area Wilderness. The researchers found that sampled visitors had a high degree of knowledge of area regulations, suggesting that the brochure and the distribution method employed by the Forest Service were effective in raising visitors' knowledge of regulations.

Dowell and McCool (1986) evaluated three media (slide show, booklet and both together) to

teach Boy Scouts about wilderness ecology and Leave No Trace practices. Knowledge tests immediately following the education program and one month later demonstrated significant knowledge gains when compared to the control group. However, the three treatments did not vary significantly in their effectiveness in increasing knowledge. Behavioral intent did change to greater support for applying low-impact behaviors with no significant variation between educational treatments. However, decreases in behavioral intent scores for the later test suggest the need for continued LNT education over time. These results provide support for the beliefs and behavioral intent relationship suggested under the theory of planned behavior.

Stubbs (1991) examined the effectiveness of a wilderness trailhead sign on visitor knowledge, behavioral intent and actual behavior. Wilderness visitor's baseline knowledge of low-impact practices was low. This study found that communication of appropriate campsite selection and campfire behavior practices are difficult topics for visitors, perhaps due to the judgments involved or to inconsistent messages communicated by land managers over time. The trailhead sign was only slightly effective in increasing visitor knowledge levels, behavioral intent and behavior regarding campsite selection and campfire management. The complexity of the message (dispersed camping in low use pristine areas vs. established site camping in moderate to high use areas) and the difficulty of conveying that complexity through a trailhead sign suggest that visitors were unable to comprehend the message (Figure 1, Step 3).

Thorn (1995) evaluated the effect of trailhead signs and personal contact on visitor knowledge in the Pecos Wilderness of New Mexico. Educational messages effectively increased knowledge on campsite selection, campfire impacts and camping behaviors - areas identified as skill areas least understood by visitors in Stubbs' study. Thorn also found that more experienced backpackers were not significantly more knowledgeable about low-impact camping skills than less experienced visitors, suggesting that experience plays a minimal role in the understanding and practicing of low-impact camping skills. The majority of backpackers utilized some low-impact practices much of the time, such as cook stoves and proper disposal methods for human waste, litter and dishwater. However, decisions regarding toilet paper disposal and campsite selection were based less on low-impact principles. This study provided further evidence that knowledge of low-impact skills did affect visitor behavior in the intended direction.

Cole *et al.* (1997) evaluated the first three steps of McGuire's information-processing model of persuasion (Figure 1) in their investigation of the efficacy of trailhead bulletin boards in communicating low-impact messages to wilderness visitors. More hikers (71%) than horseback riders (27%) stopped to look at the bulletin boards (Attention - Figure 1, Step 2) and hikers spent more time (22 sec) than riders (14 sec). A low-impact knowledge quiz based on bulletin board messages assessed comprehension (Figure 1, Step 3) as retention of message content. Visitors exposed to the bulletin board messages correctly answered 41% of the questions, compared to 16% for the control group. Visitors who looked at messages for at least 5 sec per message scored a mean of 67%, whereas those who gave the messages less attention scored 40%, a statistically significant difference. Total message attention increased as the number of low impact messages increased (up to eight), but the attention devoted to each message and the ability to retain message content declined. Hikers exposed to three or more messages did not score significantly higher than hikers exposed to two messages, evidence of information overload. A follow-up study (Cole, 1998) found that written appeals for attention to the minimum impact messages improved average attention time.

The City of Boulder (Colorado) Open Space Program was the first to adopt a "frontcountry" Leave No Trace On Open Space program for visitors to urban/suburban parks and open spaces

(Jones 1999). The program was initiated through 1,700 trailhead contacts, wide distribution of brochures, signs, news releases, and interpretive programs. A subsequent survey of 633 Open Space visitors revealed that 51% of visitors had heard of the program, and of these, 52% answered at least four of five knowledge questions correctly, compared to 37% of those who had not heard of the program. Visitors were also asked about their intent to change behavior due to program messages. For those who knew of the program, 95% said they were very likely to practice the "trash your trash" principle, 90% to "leave it as you find it," 88% to "share the trail," 86% to "manage your dog," 79% to "stick to trail," and 78% to "pick up poop."

Newman *et al.* (2003) surveyed Appalachian Trail day and overnight hikers to test their general knowledge of Leave No Trace practices. The mean score for the 10-item quiz was 82%, indicating that most hikers are well informed about a variety of minimum impact practices. A similar study by Confer *et al.* (2000) revealed a significant discrepancy in LNT knowledge between hiking wilderness users and horse riders, gauged by the percentage of respondents who correctly answered at least 60% of the questions on a 12-item quiz. Sixty-two percent of hikers had passing scores compared to only 7% of horse users. The authors suggest the need to identify and target groups with low awareness or knowledge through offsite communications, such as user-group oriented magazines

Behavioral Change Following Education

Johnson and Swearingen (1992) assessed the effectiveness of different trailside signs in deterring off-trail hiking in Mt. Rainier National Park. Observation of hikers showed that the signs deterred off-trail hiking but different sign texts varied in their effectiveness. Of the signs evaluated, the threatened sanction message was the most effective, reducing off-trail hiking by 75%. Signs with an ethical appeal to stay on the trail to preserve the meadow, humorous appeals, and symbolic signs were moderately, but equally effective. These findings suggest that the pre-conventional moral appeal was the most effective technique for altering visitor behavior. Other messages representing higher moral appeal levels altered visitor behavior to a lesser degree. In contrast, Duncan and Martin (2002) specifically evaluated the effectiveness of sanction and interpretive written messages on visitor's intended behavior but found both types to be significantly but equally effective in comparison to a control group.

Martin (1992) compared the effects of three signs and a brochure in discouraging visitors from removing pumice from Mount St. Helens National Park. As with Johnson and Swearingen's study, all four approaches effectively reduced pumice theft, and the sign that threatened sanctions for theft was the most effective.

Interpretive messages that provide a rationale for recommended behavior are generally more effective than simple statements (Ham 1992). Kernan and Drogin (1995) evaluated the efficacy of interpretive verbal messages given to hikers at trailheads to stay on designated trails and reduce off-trail hiking. The minimum impact hiking messages included multiple reasons for complying with the request. Subsequent observations revealed that the majority of hikers who did not receive the message (64%) were non-compliers, significantly more than the percentage of hikers (42%) who received the message. The information-processing model of persuasion would suggest that including reasons for altering one's behavior would improve a visitor's acceptance of a message (Figure 1, Step 4, Yielding). Compliance was significantly lower for organized groups, larger groups, foreign visitors, and groups with younger children.

Gramann and Vander Stoep (1986) evaluated the effectiveness of three types of messages intended to reduce depreciative behavior at Shiloh National Military Park. The messages varied

in their use of rationales for appropriate behavior, including awareness of consequences, resource protection and incentives. Observation of subsequent depreciative behaviors found that all treatments were effective and that a simple message based on awareness of consequences (e.g., deterioration of artifacts due to inappropriate behavior) was the most effective. The majority of depreciative behavior was attributed to uninformed behavior.

Utilizing the theory of moral reasoning and normative theories, Widner and Roggenbuck (1999) assessed the effectiveness of three educational interventions on the theft of petrified wood in Petrified Forest National Park. To discourage the theft of petrified wood the interventions included an interpretive sign with text based on multiple behavior-change theories, a signed pledge by visitors to not take petrified wood, and a uniformed volunteer patrolling the site. Each of the three educational treatments significantly reduced wood theft. There were no significant differences between approaches, indicating that a good on-site interpretive sign can be as effective as an on-site uniformed volunteer in reducing depreciative behavior. The interpretive sign also significantly reduced wood theft compared with a previous sign that read, "Removal of petrified wood is prohibited."

Hockett (2000) evaluated the effectiveness of two different picnic table signs in reducing wildlife feeding by visitors in Shenandoah National Park. Both appeals were effective in reducing feeding behavior. A moral appeal was more effective than a fear appeal, likely because visitors discounted the threat of deer hurting them. Use of signs on picnic tables also acted as a timely primer to remind visitors of appropriate behavior while eating. Similar tests of moral and fear appeals in a study of mountain bicyclists' compliance with trail etiquette found mixed results depending on the target behavior and message source (Hendricks *et al.,* 2001). The efficacy of treatments also varied considerably; messages encouraging bikers to obey a speed limit were ineffective, while messages to protect a stream by using a bridge altered compliance from 17% for control observations to 59%.

Christensen and Cole (2000) used information from visitor surveys in eight wilderness areas to assess the effect of LNT information on the behaviors of wilderness visitors. Analyses of visitor's reported behavior revealed that campfire use had decreased substantially over 30 years since low impact camping educational programs began active promotion of camp stove use, and lakeshore camping had also decreased in response to educational messages promoting camping away from water. Most notably, visitor preferences and behaviors have changed in regards to campfire use. Visitors prefer cooking on camp stoves, as opposed to fires, when compared to visitor surveys from the 1970's. In contrast, visitors still prefer camping next to water, but over 80% are willing to be persuaded to camp away from water. Ecological reasons were found to be more compelling arguments than social reasons. The study concluded that LNT efforts have succeeded in altering visitor behavior, and to some extent, preferences.

Hendricks (1999) investigated the effects of persuasive communication sources and messages on the behavioral intentions of grade school students before and after presentation of low impact education role-playing performances. Post-test scores for behavioral intentions were significantly higher than pre-test scores for all factors investigated. However, scores for versions that employed an "asking" (questioning) message format (central route of persuasion) were lower than for a "telling" format (peripheral route of persuasion).

Daniels and Marion (2005) evaluated change in knowledge, ethics, and behavior of participants in two-day Trainer courses that teach Leave No Trace skills and ethics. This study employed pre- and post-course questionnaires and a follow-up survey four months after the course to evaluate long-term retention and, for those who had gone camping, reported camping

behaviors. Overall, more than half of the knowledge and behavior items, and half of the ethics items, showed significant improvement from pre-course measures to the follow-up. The authors found no correlation between change in knowledge and change in behavior and a significant correlation between change in ethics and change in behavior. This suggests that ethical appeals may be more important than information alone in promoting appropriate low impact behaviors. Based on McGuire's information-processing model (Figure 1), the knowledge portion of the LNT Trainer course addresses only exposure, attention and comprehension. The authors state that teaching LNT practices alone "may be ineffective unless the participants "yield" to the information." They conclude that ethical appeals, teaching participants "why" it is important to minimize their impact, is as important as "how" to minimize their impact.

Education to Redistribute Visitors

Lucas (1981) evaluated the effect of a brochure in redistributing visitor use to more lightly used wilderness campsites. The brochure influenced only one-third of the visitors, which Lucas attributed to its limited distribution, narrow focus, and presentation late in the decision process. He also speculated that visitors familiar with the area were less receptive to the information.

In contrast, Roggenbuck and Berrier (1981, 1982) distributed brochures intended to direct visitors away from a congested wilderness camping area to more lightly used sites. A comparison between the behavior of visitors exposed to the brochure versus those exposed to the brochure and a ranger contact revealed that both communication techniques were equally effective in dispersing camping activity; both dispersed camping activity to a greater degree than a control group.

In Rocky Mountain National Park, Huffman and Williams (1987) compared the effectiveness of a brochure and a computer program in redistributing visitor use to more lightly used backcountry sites. Both methods effectively redistributed visitors, but the computer was more effective in altering visitor travel and camping patterns. In Yellowstone National Park, Krumpe and Brown (1982) conducted a similar study using a trail selector information chart that described routes and destinations with different qualities. They found that descriptive information about the most heavily used trails helped redistribute visitors to lesser-used trails (37% vs. 14% for control groups).

These studies reveal that visitor use can be effectively redistributed through information and that some information distribution methods were more effective than others. We note that while redistributing use may effectively address visitor crowding or conflict, later recreation ecology studies have shown that the redistribution of visitors to more lightly used areas is generally not an appropriate management strategy for reducing resource impacts (Leung & Marion 2000).

Change in Resource Conditions Following Education

Interestingly, despite a thorough search, only two studies measuring changes in site conditions following educational efforts were located. A study by Oliver *et al.* (1985) gauged the efficacy of three educational methods in reducing tree damage and litter in a campground. The first approach was a brochure on low impact camping practices, the second employed the brochure plus a ranger contact, and the third used the brochure and ranger plus a request to report any destructive acts observed by campers to campground staff. All three educational treatments significantly reduced litter and tree damage, the personal contact treatments were more effective than the brochure alone. For example, observation revealed that the brochure reduced the percent of groups that damaged at least one tree from 39% on "control" weekends to 20%. The brochure plus personal

contact reduced this to 4%, but the damage rate rose to 10% when the addition of a request to report observed depreciative behavior. Similarly, almost 82% of groups on "control weekends left behind at least one piece of liter. The brochure reduced this percentage to 66%, and to 41% and 46% on brochure-plus-personal-contact and brochure-plus-personal-contact-plus-assistance weekends, respectively. Even the brochure distributed at the campground contact station reduced the average number of incidents of tree damage and pieces of litter per group by 50%. When a personal contact was added, depreciative acts dropped by 80%.

Jacobi (2003) evaluated the efficacy of trailside signs in discouraging visitors from building or altering rock cairns used to mark mountain trails. Every 5 days during 30-day control and treatment periods staff assessed the condition of 67 uniformly constructed cairns, reconstructing them when necessary. During the treatment period, signs placed at the ends and middle of the trail included a persuasive message asking visitors to not alter or build cairns. The message included a brief description of problems associated with this depreciative behavior and a rationale for the request. The signs increased the average percent of intact cairns from 64% to 81% and the average percent of cairns with added rocks decreased from 31% to 12%. Changes were statistically significant, though managers concluded that signs alone were insufficient in adequately resolving this perennial problem. Both of these studies indicate that education can alter the behavior of visitors to reduce impacts to resource conditions (Figure 1, Steps 6 & 7). Additional studies that evaluate the effectiveness of educational messages in reducing resource or social impacts are needed, particularly those that also fully evaluate the steps of the information-processing model of persuasion.

Discussion

What conclusions can we draw from these varied theoretical and empirical research studies evaluating the efficacy of visitor education in protected areas? There are some clear trends in spite of the wide variation in study design, theoretical basis, and issues studied. First, there is adequate evidence that most of the visitor education methods evaluated did affect visitor knowledge, attitudes, behavior, and/or resource conditions in the intended direction. Some efforts did not achieve their stated goals for various reasons, but the majority of educational efforts succeeded in altering visitor behavior. It is clear that visitor education can be an effective management strategy for addressing visitor impacts to protected area resources.

Many of the educational effectiveness evaluations focused on gains in visitor knowledge following exposure to educational messages. We note that visitors may not translate newly acquired knowledge into short- or long-term behavioral changes. In particular, we emphasize that very few studies have sought to evaluate the connection between altered behavior and actual changes in resource or social conditions and related indicators (see Figure 1). Only two studies investigated the efficacy of educational messages in improving resource conditions. This is a significant limitation of the current body of research on this topic. We were also able to locate only one study that evaluated the efficacy of training workshops or courses in conveying low impact practices and ethics. We do note, however, that several studies have documented successful educational efforts that altered visitor distribution patterns so we can assume that social conditions (e.g., crowding) can be effectively alleviated.

Most authors identify message content and delivery, audience characteristics, and theoretical grounding as important components related to education efficacy. These four topics frame the following discussion, followed by a discussion of additional factors that may limit the efficacy of

educational programs.

Message Content

 Message content is critical to message effectiveness. Oliver *et al.* (1985) found that simple, interesting and useful information was the most effective in reaching visitors. Douchette and Cole (1993) also concluded that messages should be clear and concise. Cole *et al.* (1997) found that messages on trailhead bulletin boards should be limited to a small number of topics to avoid information overload and that appeals can improve message attention. Clearly identifiable desirable and undesirable behaviors should be evident in the educational message (Gramann & Vander Stoepp, 1986). To assist in this goal, specific objectives need to guide education, suggesting that before any educational efforts are undertaken, land managers must agree on the message goals (Cole *et al.*, 1997; Douchette & Cole, 1993).

 Stubbs' (1991) findings suggested that consistency is critical to the message's effectiveness. The evolving nature of low-impact information was considered the primary reason for low knowledge levels among visitors. Respondents scored the lowest on questions pertaining to practices that have evolved the most over the years - campsite selection and campfires. Thorn (1995) reached similar conclusions in his study. Therefore, message consistency should be a goal for all protected area education efforts.

 Christensen and Cole (2000) and Hendricks *et al.*, (2001) found that visitors were more likely to be persuaded to alter their behavior for ecological than social reasons. This finding suggests that credible, convincing ecological rationales may be more effective than social rationales in convincing visitors to alter personal behaviors. The educational message's content should also be specific to a defined audience. Christensen and Cole (2000) and Confer *et al.* (2000) found that some user groups were less likely than others to practice low impact behavior. The researchers concluded that information would have to specifically target these groups to effectively address their specific resource and behavioral concerns. Messages should target issues and practices that are least understood by visitors.

Message Delivery

 The delivery of educational messages was also shown to play a key role in the messages' effectiveness. Consistently, these studies showed that messages should be well timed for maximum effectiveness. For example, in keeping with decision-making theory, information regarding planning a trip and campsite selection should be provided early in the planning process or prior to the visitor's arrival at the site (Lucas, 1981; Roggenbuck & Berrier, 1981; Douchette & Cole, 1993). When addressing issues such as feeding wildlife, education must occur near the moment of feeding, based on Hockett's (2000) findings. Visitors were less likely to feed deer if they received reminders and reinforcement at or as close as possible to the moment of potential feeding. This was also supported by the Widner and Roggenbuck study (1999) regarding message timing relative to theft of petrified wood. The timing of message delivery appears to play an important role in the effectiveness of visitor education. Future studies should apply decision-making theory to evaluate how different types of behaviors are affected by the timing of educational messages.

 Source credibility is another fundamental key to the success of any educational effort (Oliver *et al.,* 1985; Roggenbuck & Berrier, 1981). Consistent with the peripheral route to persuasion, Manfredo and Bright (1991) found that the degree of source credibility was strongly related to effectiveness of persuasion. Message consistency, critical to the effectiveness of a low-impact

education program, is also important to the credibility of the source. Fazio (1979) found examples where inconsistent messages were provided from the same source - the U.S. Forest Service. Sending mixed messages can undermine source credibility, suggesting that consistent messages based on well-defined objectives are needed.

A common question is whether personal contacts, signs, brochures or computers should be used to deliver messages to visitors. The answer remains unclear. Communication theories suggest that face-to-face communication has the greater potential for influence, in part due to non-verbal cues, including kinesics (messages sent by the body, including gestures, facial expression, and body movement), vocalics (paralinguistic cues such as volume, rate, and pitch), and the physical appearance of the communicator (Cicca et al. 2004). However, while some studies found that personal contacts were the most effective method of reaching visitors (Fazio, 1979; Oliver *et al.*, 1995), others found personal contacts no more effective than brochures (Roggenbuck & Berrier, 1981). Several studies have shown trail signs to be effective (Duncan & Martin, 2002; Jacobi, 2003; Johnson & Swearington, 1992; Martin, 1992; Thorn, 1995). Widner and Roggenbuck (1999) concluded that well-designed trailhead signs are as effective as a uniformed person in reducing depreciative behavior, while Stubbs (1991) found that trailhead signs could not communicate complex LNT information.

Brochures proved ineffective for some efforts (Lucas, 1981) but effective for others (Huffman & Williams, 1987; Martin, 1992; McAvoy & Hamborg, 1984; Oliver *et al.*, 1985; Roggenbuck & Berrier, 1981). Computers offer promise in providing self-directed information (Huffman & Williams, 1987), but have not been extensively tested. Clearly, large proportions of visitors must be exposed to the message for it to be effective (Lucas, 1981) and computers and the Internet offer an efficient method to achieve this goal. No studies have provided a definitive analysis of the relative efficacy of alternative media but several authors conclude that personal contacts are most effective, followed by audiovisual programs, brochures, and signs (Doucette & Cole, 1993; Manning, 2003). In general, message delivery with multiple methods is better than reliance on a single media.

Another potential consideration is the redundancy and repetition of educational messages. McAvoy and Hamborg (1984) found that long-term wilderness visitors had significantly higher knowledge levels of area regulations when compared to newcomers. Repetition of messages and area experience increases visitor knowledge, although this finding contrasts with those from two other studies (Manfredo & Bright, 1991; Fazio, 1979). Thorn (1995) also concluded that redundant messages are more effective, suggesting that managers should repeat their educational efforts to reach more visitors more often. Similarly, Hockett's (2000) findings that information should act as a primer to initiate action requires that messages be available, widespread and repetitious to maximize effectiveness.

Audience Characteristics

Audience awareness is another key element to effective public education (Fazio, 1979; Gramann & Vander Stoepp, 1986). Awareness of the audience's level of low-impact knowledge level and their recreation activity perspective allows an educator to target efforts to a specific group, regardless of the media used. Understanding an audience's needs and receptivity to low impact education allows for the selection of the best possible educational content and the communication of messages that resonate with different audiences.

For example, study findings suggest that an individual's experience is not always the best teacher (Thorn 1995). Fazio (1979) found that visitors who attributed their low-impact

knowledge to experience scored significantly lower on knowledge assessments. Visitors who had higher experience levels were also less likely to be persuaded by new information (Manfredo & Bright, 1991). Similarly, informal, word-of-mouth sources of information were found to be unreliable and potentially detrimental to low-impact knowledge (Manfredo & Bright, 1991). Messages targeting experienced visitors should therefore provide more convincing rationales and should try to logically refute common misconceptions. Christensen and Cole (2000) found that visitor characteristics are important considerations for the effectiveness of a low-impact educational message. User groups vary in their receptivity to low-impact messages. Awareness of audience receptivity allows educators to better target less receptive audiences through creative messages and delivery methods, such as peers or respected sources.

Ham and Krumpe (1996) emphasize the importance of designing educational messages that focus communication content on specific beliefs that are truly prominent, pertinent, and important to the target audience. Most educational messages contain only factual information concerning the behaviors that visitor should change. An improved understanding of the target audience regarding which of their beliefs truly influence how they behave can assist in selecting interpretive themes that resonate with the audience. They show how qualitative interviews with equestrians yielded relevant information used to construct belief-based messages that targeted their salient beliefs regarding advantages and rationales for adopting low-impact camping and stock handling practices.

Theoretically Grounded Messages and Delivery

An important consideration in the development and delivery of effective educational messages is the theoretical basis for educational efforts. Regardless of whether or not they are aware of it, land managers utilize these theoretical frameworks in their educational efforts. An improved understanding of the theoretical paradigms could help managers to develop more persuasive message content and delivery systems. Cole et al. (1997) illustrate this in their application and evaluation of McGuire's information-processing model of persuasion (Figure 1) to evaluate the efficacy of trailside bulletin boards. The extent of visitor attention to posted messages was significantly related to message retention. Hendricks (1999) concluded that the peripheral route to persuasion is more effective with children due to limitations in the information processing abilities of children.

Widner and Roggenbuck (1999) suggest that signs using multiple persuasive and moral techniques are more effective than those developed with no theoretical grounding. Messages designed to target visitors at multiple stages of moral development will be more effective than those with a single focus. Vande Kamp *et al.* (1994) recommend that a multifaceted approach be used to reduce noncompliant behavior, a concept easily extended to low-impact education efforts (Douchette & Cole, 1993). Of course, inadequate resources will often limit the number of approaches applied.

Limiting Factors

Low compliance with low impact practices is often attributed to lack of information but other factors may be responsible. Understanding these factors can help managers to address them and improve educational efficacy. Harding *et al*. (2000) cite four factors that could contribute to poor compliance. First, visitors may misinterpret certain environmental or social cues that are critical to identifying the need for choosing and applying a low-impact practice. For example, clear messages using the most effective media are needed to convey to visitors when they should

select an existing campsite (an impact containment strategy) versus a pristine site (a dispersal strategy). Second, visitors may not remember low-impact information or practices that they once knew. Repetitious and consistent messaging is needed to improve memory retention. Third, behavior is influenced by many factors, such as cognitive (what have I done in the past) and social-psychological (what would someone important to me do). Ethics can guide choice of behavior but different models of ethical decision-making exist. An improved theoretical basis to educational efforts can assist managers in constructing messages that are more effective and targeting of different visitor groups. And fourth, visitors must evaluate and gauge which behavior is most appropriate within the context of social and environmental factors. High-impact behavior may result from social pressure within a peer group. Alternately, a visitor who wants to be seen as environmentally conscious may behave one way when others are watching and another way when alone. Further, social considerations (preserving the solitude of another group) or physical limitations (fatigue, bad weather, and insufficient time) may outweigh ecological considerations (selecting a durable campsite). These issues point to the need to provide compelling rationales that resonate with target audiences, and to the need for clarifying the relative importance of different low impact practices.

Finally, we note that some authors have questioned the effectiveness of educational efforts, suggesting that such programs may only yield a temporary effect on a small percentage of visitors, that those who are reached and receptive are least likely to exhibit depreciative behaviors, that visitor attitudes are quite stable and resistant to educational programs, or that attitude change may not result in behavior change (McAvoy & Dustin, 1983). The findings presented in this paper directly refute some of these assertions but additional research is needed to more thoroughly understand overall program effectiveness. These authors conclude that direct management actions have become increasingly necessary to resolve problems of overuse, user conflict and depreciative behavior. They cite self-perception theory, which suggests that behavior causes attitudes, i.e., that visitors form attitudes and beliefs to support or justify their behavior. For example, a visitor may abstain from feeding wildlife when told that it is against park regulations, but over time the visitor may internalize their behavior and attribute it to the need to avoid harming wildlife by not feeding them human foods. Nonetheless, McAvoy and Dustin (1983) support education efforts, citing that they can assist visitors in internalizing the rationale for direct controls and influence the formation of appropriate attitudes and beliefs to govern subsequent behavior.

Methodological Challenges

Evaluating the effectiveness of low impact visitor education presents some formidable methodological challenges. We highlight these to inform scientists of the need to consider and address these difficulties when designing future studies. Isolating and assessing the effects of educational interventions generally require the use of experimental research designs with adequate control data for comparisons. Such experiments are more difficult to design and implement, and differences in visitor attributes between groups can still act to confound analyses. The characteristics assessed to evaluate education efficacy present additional challenges. It is possible to assess knowledge gain from an educational message by before-and-after visitor surveys but knowing the right low impact practice does not guarantee its use. Furthermore, while asking visitors to report on their behavior is straightforward, locating a sufficient number of participants after their recreational activity and obtaining truthful information about their behavior can be difficult. Actual behavior assessed with unobtrusive

observation is the most accurate method but such evaluations are time-consuming, can threaten the privacy of visitors, and may not be possible in some recreation settings. Assessments of long-term behavior change are particularly difficult, generally possible only through self-assessments rather than observation. Finally, for protected area managers, the real test of efficacy requires measuring improved environmental or social conditions or savings in maintenance costs (e.g., picking up litter, maintenance/restoration of trails and recreation sites).

Conclusion

Visitor education programs can be an important element, together with regulatory and site management efforts, toward ensuring the protection of protected areas and high quality recreational experiences. Protected area managers, tourism providers, visitors, and other stakeholders have traditionally favored education as an indirect and voluntary form of management that preserves visitor freedom and limits site development. But how effective are educational efforts; do they modify visitor behavior, protect natural and cultural resources, or reduce visitor crowding and conflicts? This paper assessed the efficacy of low impact visitor education based on a review of existing research in recreation settings. Most studies found that educational interventions were effective in increasing visitor knowledge and altering visitor behaviors. Some general conclusions were also suggested regarding the content and delivery of educational messages. Educators can apply these findings to improve the effectiveness of their educational efforts. Fewer conclusions were reached regarding whether education ultimately improves resource conditions or visitor experiences. These topics have received very little research, yet they are important topics for visitor education programs.

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Exposure Visitor is exposed to an educational message	→	Attention Visitor processes the message	→	Comprehension Message is understood	→	Yielding Visitor accepts the message and changes their attitude

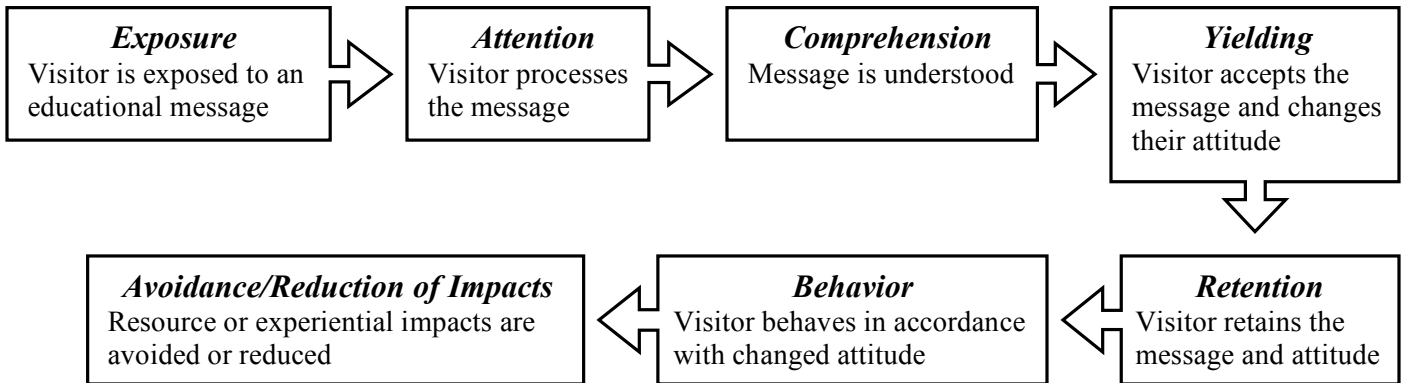| Avoidance/Reduction of Impacts Resource or experiential impacts are avoided or reduced	←	Behavior Visitor behaves in accordance with changed attitude	←	Retention Visitor retains the message and attitude

Figure 1. Information-processing model of persuasion and behavioral change. (Adapted from McGuire, 1985).

Table 1. Most common actions taken by U.S. National Park Service managers to educate visitors about minimum-impact backcountry use practices.

Visitor Education Action	Parks (%)
Park has a minimum-impact educational program	77
A "pack-it-in, pack-it-out" policy is emphasized to address littering	91
Park rangers are instructed to convey low-impact messages during visitor contacts	89
Visitors are instructed not to feed wildlife	74
Low-impact literature is displayed on bulletin boards at backcountry access points	67
Low-impact literature is available on request	64
Low-impact literature is displayed at visitor centers and ranger stations	63
Low-impact literature is provided or shown to most or all backcountry visitors	51

(From Marion *et al.*, 1993, results from a survey of U.S. National Park Service backcountry managers, N=93 parks)