ADVANCING THE SOCIAL SCIENCE OF LEAVE NO TRACE:
EXAMINING ATTITUDES, EFFICACY, INTENTIONS AND BEHAVIORS

A Dissertation in
Recreation, Park and Tourism Management &
Human Dimensions of Natural Resources and the Environment
by
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Submitted in Partial Fulfillment
of the Requirements
for the Degree of

Doctor of Philosophy

May 2017
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ABSTRACT

Leave No Trace is the most prevalent minimum-impact visitor education program used in parks and protected areas in the U.S. The overarching intent of the program is to educate outdoor enthusiasts about the nature of their recreation-related impact, and to teach techniques for minimizing impact, so they may make informed decisions about their recreation behaviors.

Visitor perceptions (i.e., attitudes, beliefs, awareness and knowledge) of Leave No Trace can lead to either appropriate or inappropriate behaviors, depending on understanding and perspective. Understanding visitor perceptions of Leave No Trace is critical to craft effective educational messages that work to reduce negative social and ecological impacts in parks and protected areas. While there has been steady progression in the social science contributions to Leave No Trace research, the literature base is still rather scant with many knowledge gaps and questions that merit further exploration. The studies included in this dissertation help to fill these gaps.

The purpose of this dissertation is to advance our understanding of the efficacy of Leave No Trace messaging and educational programs. This dissertation manuscript derives from three independent studies that were designed in direct collaboration with National Park Service and public land managers, as well as staff from the Leave No Trace Center for Outdoor Ethics. This innovative research agenda serves to inform empirically grounded responses to various outdoor recreation management challenges.

The first manuscript examines attitudes, knowledge, and perceptions of Leave No Trace-related bouldering practices, specifically comparing and contrasting indoor and outdoor learners, as well as levels of specialization. On-site survey data indicated that indoor learners and those of novice ability reported less knowledge of Leave No Trace and generally held attitudes and perceptions less congruent with Leave No Trace recommendations.
The second manuscript examines the influences of a youth-focused Leave No Trace educational program on participants’ attitudes, behaviors, and nature connectedness. The study employed an experimental, equivalent control-group design and included both survey and direct observation measures. Results indicated differences between control and treatment groups on attitude and behavior measures. Those who participated in the educational program reported positive attitude change above and beyond those in the control. They were also less likely to keep objects they found in nature.

The third study tested the effectiveness of a range of indirect and direct management approaches, including Leave No Trace messaging, to mitigate undesignated trail use on open space lands. The study applied a theory of planned behavior framework, utilized Leave No Trace messaging, and employed a method to pair survey and direct observation data. Results indicated the combined direct (barrier) and indirect (messaging) intervention was the most effective at mitigating undesignated trail use.
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ACKNOWLEDGEMENTS

They say it takes a village to raise a child… I think the same can be said about raising a PhD student. It truly takes a village. At least that was my experience anyway. So, to all of you who were part of this village (aka the village people), and the raising of Forrest Schwartz the PhD student – THANK YOU! I could not have done this without you all by my side. While there are far too many to mention here, I would like to take this opportunity to recognize in writing a few of the folks who helped to make this a successful adventure.

I owe a great amount of gratitude to Dr. Derrick Taff. I would not be where I am without you. A couple pages above, this document lists you as my ‘Dissertation advisor’, but you have been far more than that title subsumes. You have been a mentor, a role model, a coach, a guide, a teacher, a friend and an inspiration. You are a wonderful human being. This whole thing got started during a fateful mountain bike ride through the Scotia range. And look where we are now. Let’s go for a ride!

I would also like to give special thanks to Ben Lawhon and The Leave No Trace Center for Outdoor Ethics. This work would not have been possible without The Center’s support and Ben’s passion and enthusiasm for solid research. Ben, you’ve become a trusted colleague and friend – I look forward to working together into the future. And I would be remiss if I did not acknowledge Faith Overall at Leave No Trace for her data collection efforts in Rocky Mountain National Park. How many times did we hike that trail to Chaos Canyon together? Good times. Thank you.

I would like to thank Dave Pettebone and Scott Esser in Rocky Mountain NP, for supporting this work and helping to make the bouldering study possible. Special thanks goes to
Deonne VanderWoude and Megan Bowes with The City of Boulder Open Space and Mountain Parks for your above and beyond efforts in making the undesignated trail study a success. And thank you to Ellen Will and Matt Marsden with Shaver’s Creek Outdoor School.

Finally, I would not be here if it were not for the love and support from my mother, father, and brother. Peggy, Keith and Shane, I love you. This has been a journey full of twists and turns, of peaks and valleys, and tears of joy and tears of sorrow. At long last I have made it to the top of the climb…and I must say, the view is wonderful. Peace and love y’all.
Chapter 1

Introduction

The United States has a rich outdoors heritage that has established a legacy of parks and protected areas. These areas attract hundreds of millions of visitors per year. While we have developed a vast and diverse system of parks and forests over the course of U.S. history, early attitudes towards the natural environment were not always grounded in an appreciation for the natural world. Early views involved conquest and dominion over nature and later evolved to embrace such concepts as preservation, conservation, and wise use (Nash, 1982). Many of our first protected areas were created as a reactive measure in response to the rapid loss of natural areas due to urbanization, population growth, and westward expansion (Jensen, 1995). Slowly we have developed a stronger ethic of care for the environment and appreciation for the plants and animals with which we share this land.

The foundations of modern outdoor ethics emerged in the United States as a response to exponential increases in outdoor recreation. For example, the use of National Forest primitive areas tripled during the 1960s and 1970s, and between 1950 and 1970 recreation visits to National Park Service areas increased more than five-fold, from 33 million to 172 million (Marion & Reid, 2001). Moreover, between 1970 and 1985 the U.S. experienced a 4% annual increase in wilderness recreation (Stankey, Cole, Lucas, Peterson, & Frissell, 1985). These increases in outdoor recreation contributed to various ecological and social impacts, prompting land managers to develop new methods and approaches to public land management. Leave No Trace principles and ethics for outdoor recreation were developed in the late 1980s and formally adopted in the early 1990s as the prominent education approach used in parks and protected areas (Marion, 2014). The aim was to educate recreationists on the causes and effects of human induced natural
resource impacts, emphasizing a minimum-impact ethic, so they may make informed decisions regarding their recreation behavior.

In the years following the development of Leave No Trace and related minimum-impact recreation ethics, a substantial body of research has accumulated which has served to further our understanding of the efficacy of these practices. Recreation ecologists laid the foundation for much of the early minimum-impact research with particular focus on the ecological impacts related to recreation behaviors. The contributions of social science to this literature are growing, but still relatively scarce—especially regarding studies specific to Leave No Trace.

Now, some 20 years since the official establishment of Leave No Trace as the recognized authority in outdoor recreation ethics, we continue to struggle with the challenge of natural and social impacts in parks and protected areas. Is Leave No Trace working? If so, in what way(s) and in what context(s)? Is the message reaching those engaged in new and emerging forms of recreation? How are youth populations responding to Leave No Trace education? These are but some of the questions that social scientists, in collaboration with recreation ecologists, resource managers and others, have been working to answer as human population continues to increase, natural resource and environmental funding is on the decline, and demand for quality outdoor recreation continues to rise.

**Dissertation Purpose and Structure**

The purpose of this dissertation is to advance our understanding of the efficacy of Leave No Trace messaging and educational programs. It serves to strengthen the body of Leave No Trace social science literature and provide evidence-based knowledge upon which to build solutions to some of the complex issues associated with human dimensions of natural resource recreation. Three independent studies were conducted as a means to support these ends and are
presented within, as stand-alone manuscripts. Chapter one provides an introduction to the history, foundational concepts, and theoretical framework with which this dissertation is designed, followed by a presentation of the background and significance of each of the three studies in turn. The subsequent three chapters are standalone manuscripts that investigate the following: attitudes and perceptions of Leave No Trace among an emerging user group; the efficacy of Leave No Trace education for youth; the efficacy of Leave No Trace messaging to influence trail-use behavior. An overall summary of conclusions and management implications is provided in the fifth and final chapter.

Outdoor Recreation in the United States: A Commons Dilemma

In 1872 Yellowstone was established as the nation’s first National Park. This landmark event marked a shift in America’s perceptions, values, and attitudes about the management and use of our nation’s natural and scenic resources (Wellman, 1987). Writers such as Muir and Thoreau also exemplified this shift. They warned that the wilderness we once perceived as in the way, desolate, dark and dangerous was in danger of being lost for the sake of progress. And wilderness, they suggested, might in fact be a place where we can retreat to escape the ills of an ever-advancing urban landscape. There started a movement to, as Cronon (1996) suggests, protect these places from ourselves. Prior to this, the prevailing view was one of conquest and dominion over nature; the land was free for the taking – at any and all costs (Jensen, 1995).

In the next 100 years a number of federal acts would further symbolize the changing relationship between U.S. society and its vast natural resources (Nash, 1982). For example, in 1891 the Creation Act established the National Forest Reserves, which became the first federal system of reserved lands in the United States. The Transfer Act of 1905 transferred oversight of the Forest Reserves to what would become the United States Department of Agriculture Forest
Service (USFS). Forty-four years after Yellowstone was established, the National Park Service would be created by way of the Organic Act of 1916 to oversee the nation’s “crown jewels”. Each of these acts of legislation carried with them legally mandated prescriptions for how the land was to be managed (Jensen, 1995).

The decades following World War II included the introduction of significant recreation and environmental legislation that would provide further legal and philosophical direction for natural resource management (Jensen, 1995). In 1956 the Fish and Wildlife service was created. The Outdoor Recreation Resources Review Commission (ORRRC) was established by Congress in 1958 in response to fast-growing interest in outdoor recreation (Wellman, 1987). The ORRRC was charged with surveying the recreation needs of the public for the next 40 years and making recommendations for meeting those needs. Of great consequence to natural resource management was the Wilderness Act of 1964, which established the National Wilderness Preservation System (Scott, 2004). The Wilderness Act highlights legal precedent for the often-competing dual mandate of providing for resource protection, while also providing for a high quality visitor experience and opportunities for an unconfined recreation experience (Manning, 2011). These events were emblematic of increasing visitation to public lands experienced during this time, the recognition of the economic and social value associated with outdoor recreation, and the significant efforts being taken to preserve and protect these special places.

The 1960s and the decade that followed saw a dramatic increase in the popularity of outdoor recreation as hiking, camping, and backpacking became popular, and people ventured farther into the wild seeking physical challenge, solitude, and adventure (Hammitt, Cole, & Monz, 2015; Hampton & Cole, 2003). A growing economy, the proliferation of the automobile and an ever-increasing network of roads brought more and more people to experience the great outdoors. The use of National Forest primitive areas tripled during this time, and between 1950 and 1970 recreation visits to National Park Service areas increased more than five-fold, from 33
million to 172 million (Marion & Reid, 2001). The popularity of outdoor recreation in the 1960s and 1970s and the visitation trends that followed led to myriad impacts to the very resource people were working so hard to protect and enjoy.

The magnitude of recreation visitation was taking its toll on the natural environment, leading many to raise the issue of whether the parks and protected areas of the United States were being loved to death. Garrett Hardin’s 1968 treatise The Tragedy of the Commons was a beacon call, demanding attention be given to the damage being inflicted to the National Parks and other public commons. He wrote that population growth coupled with unlimited and unrestricted access to public lands has led to an erosion of the very values that visitors seek in these places. He suggested further that parks must cease to be treated as an infinite and self-sustaining resource or they will be of no value to anyone. He called for drastic changes to the management of public lands, including imposing strict visitation and access restrictions.

Managing the Human Dimension of Natural Resources

Today, managers of parks and protected areas continue to grapple with solutions for mitigating a tragedy in the commons. Faced with steady increases in recreation visitation and tasked with the often-competing dual mandates of resource protection and the provision of quality recreational opportunities, the responsibility of the protected area manager has become increasingly complex. It is well understood that visitors to protected areas inevitably leave an impact, whether in the form of vegetation trampling, trail erosion and degraded cultural resources, or visitor crowding and recreation conflict (Marion & Reid, 2007; Marion, Leung, Eagleston, & Burroughs, 2016). And because even nominal recreational use can cause an impact, and particularly since some impacts are cumulative over time, land managers must utilize a variety of strategies to minimize impacts (Hammitt et al., 2015).
In general, a primary objective of parks and protected area management is to strike a balance between satisfying public desires for recreational experiences without creating substantial irreversible losses of wildland resources (Hammitt et al., 2015). Land managers influence the “setting”, through their management approaches, in which a visitor’s experience takes place through decisions about recreational uses. In cases where visitor use is impactful, or has the potential to impact the ecological or social context of an area, managers may choose to engage in active management to accommodate recreation opportunities and mitigate associated impacts (Pettebone, 2013).

**Visitor Management**

Visitor use issues are typically addressed through the application of direct measures, indirect measures, or a combination of the two (G. W. Sharpe, Odegaard, & Sharpe, 1983). Direct measures are such management practices that act directly on visitor behavior and essentially involve the regulation and control of visitor actions (Manning, 2011). They are often referred to as “heavy-handed” or “hard” management approaches as they are meant to directly regulate and control the actions of visitors (Kuo, 2002). Regulation of behavior may take different forms, such as use limit policies, formalized rules with fines, permits, and physical barriers. These approaches offer little to no freedom of choice in the recreation experience, and thus tend to be viewed as less favorable by visitors (Manning, 2011).

Alternatively, rather than directly influencing behavior, indirect management approaches influence the decision factors upon which visitors base their decisions about appropriate behavior in recreation settings (Peterson & Lime, 1979). Visitor information and education programs, such as Leave No Trace, are commonly employed indirect management approaches. The most commonly applied principle in protected area management is that indirect actions be applied first,
with more direct management actions being applied as a last resort (Marion, 2016). Indirect management strategies have traditionally been the preferred approach to mitigating recreation-related resource impacts (Hammitt et al., 2015). These strategies tend to be less financially constraining, are perceived by visitors as unobtrusive, and are more in line with the experiential values associated with outdoor recreation (Marion et al., 2016; Park, Manning, & Marion, 2008; Reigner & Lawson, 2009).

**Understanding Behavior**

Understanding the reasons underlying problem recreation behaviors can inform managers of the most appropriate and effective approach for directing visitors to adopt behaviors more congruent with management objectives. Visitor education and information efforts are seen as having varying levels of effectiveness according to the nature of the behavior in question (Roggenbuck, 1992; Vander Stoep & Roggenbuck, 1996). Problem recreation behaviors can be classified into five basic types along a continuum: illegal, careless, unskilled, uninformed, and unavoidable actions (Manning, 2003). Each category is said to be influenced to varying levels based on management approach. Illegal and unavoidable actions are considered to be little influenced by indirect measures, such as messaging and education. In this case direct measures may be more effective. Alternatively, unskilled and uninformed actions are considered to be highly responsive to messaging/education, in which case a direct management approach might be too heavy-handed. By understanding where problem recreation behaviors lie on this continuum, managers are better positioned to craft strategies for addressing the underlying causes (McAvoy & Dustin, 1983).
Leave No Trace

While there was much to celebrate about the passing of the Wilderness Act, it certainly did not come without debate. This new notion of wilderness implied a place that would be preserved in perpetuity for the protection of the biological community, and as a pristine recreational resource. This sparked intense debate between the Forest Service and the wilderness advocacy community over whether wilderness recreationists should have unrestricted access to wilderness areas, or whether strict limitations should be established to protect wilderness as a biological preserve. These debates laid the groundwork for the rise of a modern minimum-impact ethic (Turner, 2002). One approach put forward by wilderness advocates involved a better-educated visitor. If people were informed of the consequences of their recreation behaviors and provided educational resources for developing requisite knowledge and skills congruent with a minimum-impact ethic, it might be possible, they suggested, to create a scenario of increased recreation and decreased impacts (Hampton & Cole, 1988; Petzoldt, 1974; Turner, 2002).

In the late 1960s and early 1970s, protected area land managers initially applied direct measures by way of regulations to address visitor impact problems (Hammitt et al., 2015). But with increasing awareness of the new minimum-impact approach, managers began to develop education programs to supplement regulations (Marion & Reid, 2001). Forest Service wilderness managers worked on an educational program in the mid-1970’s that placed Wilderness Information Specialists (WIS’s) at busy wilderness access points to provide information that included no-trace travel and camping tips (Marion & Reid, 2001). This program evolved in the early 1980’s into a more formal “No-trace” program that relied on a humanistic approach emphasizing the cultivation of new recreation ethics (Marion, 2014). The success of these programs led managers to emphasize the need for a more uniform and standardized educational program in order to reach more visitors. In 1987 the US Forest Service, National Park Service,
and Bureau of Land Management cooperatively developed a program called “Leave No Trace Land Ethics” (Marion & Reid, 2001).

By 1990 the clear need for visitor education, supported by increasing knowledge about visitor impacts from research prompted the US Forest Service (USFS) to enter an agreement with the National Outdoor Leadership School to develop hands-on minimum-impact ethics education through a science-based approach (Marion, 2014). Discussions led by the USFS began concerning the potential for a national program, based on the success of the Smokey Bear and Woodsy Owl campaigns (Marion & Reid, 2001). By 1993, Leave No Trace was formally adopted by the major federal land agencies including: The US Forest Service, Bureau of Land Management, Fish and Wildlife Service, and the National Park Service as their chief minimum-impact educational program (Marion & Reid, 2001). In 1994 the Leave No Trace Center for Outdoor Ethics (The Center) was established as a 501c(3) non-profit organization to take the lead on spreading the new minimum-impact ethic (Marion, 2014).

Leave No Trace has firmly established itself as the prominent minimum-impact visitor education program used in parks and protected areas in the U.S. (Marion, 2014). Intended to educate recreationists about the nature of their recreational impacts with the goal of resource protection, the Leave No Trace concept is based on the following seven principles:

1. Plan ahead and prepare
2. Travel and camp on durable surfaces
3. Dispose of waste properly
4. Minimize campfire impacts
5. Leave what you find
6. Be considerate of other visitors
7. Respect wildlife
Previous Minimum-Impact Information and Education Research

Much of the early research was initiated in response to observed resource impacts attributed to steadily increasing outdoor recreation patterns. With indirect management methods being adopted as the preferred method of directing visitor use, a number of minimum-impact information and education campaigns were developed and deployed (Marion & Reid, 2001). Social scientists and managers collaborated on research to examine the extent to which these programs were working to support management objectives. Much of this work focused on the efficacy of various persuasive communication strategies to increase knowledge and influence behavior change (Marion & Reid, 2007).

Some researchers (e.g. Manfredo & Bright, 1991; Ham, 2007; Winter et al., 2000; Borrie & Harding, 2002; Christensen & Dustin, 1989) have explored best practices for the design of messages based on persuasive communications theories and models, such as The Elaboration Likelihood Model (Cacioppo & Petty, 1984). Another line of research looked at knowledge of minimum impact practices. For example, Newman, Manning, Bacon, Graefe, and Kyle (2003) evaluated Appalachian Trail Hikers’ knowledge of minimum impact practices. While others examined knowledge gain following exposure to information and education (e.g. McAvoy & Hamborg, 1984; Stubbs, 1991; Thorn, 1995; Cole et al., 1997). Other studies examined the comparative efficacy of different message delivery mediums (e.g. brochures, personal ranger contact, magazines, trailhead signs and bulletin boards) in guiding visitors to practice minimum-impact behaviors. They addressed such actions as off-trail travel (Johnson & Swearingen, 1992; Kernan & Drogin, 1995; Winter, 2006), littering (Oliver, Roggenbuck, & Watson, 1985), campsite selection (Roggenbuck & Barrier, 1982), and theft of park resources (Ward & Roggenbuck, 2003; Widner & Roggenbuck, 2000).
In sum, these studies provided support for the efficacy of minimum-impact information and messaging strategies. Most previous research has provided evidence that visitor education and information programs improved knowledge of minimum-impact practices or positively influenced intentions and behaviors to comply with suggested actions (Marion & Reid, 2007). These studies informed the development of best practices for visitor education programs, including approaches to sign design, message content and delivery, and message placement. The diversity of theoretical and methodological approaches used in these studies provided a firm foundation upon which to build future studies.

The predominance of this early work, however, examined “minimum-impact” practices generally, as opposed to a specific focus on Leave No Trace. With Leave No Trace being the predominant minimum-impact education program used in parks and protected areas it is imperative that researchers continue to build a solid foundation of social science research in order to expand the reach, diversity, and efficacy of Leave No Trace programming.

**Previous Leave No Trace Research**

The contributions of social science research to our understanding of the efficacy of Leave No Trace programming are growing, but still relatively scarce. While there is a substantial body of literature on minimum-impact practices generally, the focus of this dissertation is on advancing the social science of Leave No Trace specifically. Accordingly, the following section provides an overview of the extant Leave No Trace literature.

One area that received early research attention was knowledge of Leave No Trace and sources of information. For example, one of the earlier published studies conducted by Confer and colleagues (2000) examined knowledge of Leave No Trace by subsets of magazine readership and recreation user groups. They found varying levels of Leave No Trace knowledge
by recreation user group (e.g. wilderness user, horse user, campground user) and magazine type (e.g. consumptive and non-consumptive outdoor recreation, environmental/conservation, equine sports, or general news). Wilderness users and non-consumptive readership groups scored the highest on a Leave No Trace knowledge quiz. They suggested Leave No Trace messaging and communications be targeted to reach consumptive and equine magazine readership.

Other studies have explored attitudes related to Leave No Trace. Vagias & Powell (2010) studied overnight backcountry visitors’ attitudes at three national parks. They found respondents to have generally positive perceptions of Leave No Trace as a program, though attitudes varied widely across samples and across specific behaviors. Their research provided insight regarding attitudes towards specific Leave No Trace behaviors that are less in line with recommendations. In a similar study, Taff and colleagues (2011) examined day-user attitudes and beliefs regarding Leave No Trace recommendations in Rocky Mountain National Park. Again, they identified specific instances where visitors held attitudes less in line with the Leave No Trace recommendation. A third study in this category involved a comparative analysis of overnight and day user Leave No Trace attitudes (see B. D. Taff, Newman, Vagias, & Lawhon, 2014). They found that, in general, there was little difference between the two groups as both had positive perceptions of Leave No Trace and held attitudes generally in line with Leave No Trace recommendations.

More recently researchers have incorporated predictive behavioral models (i.e. Theory of Planned Behavior) in effort to better understand the factors that contribute to the forming of intentions to practice Leave No Trace recommended practices. Lawhon and others (2013) utilized the Theory of Planned Behavior in their study of Rocky Mountain National Park visitors. They found perceived effectiveness to be the strongest predictor of behavioral intentions for Leave No Trace Behavior. In a similar study, Vagias and colleagues (2014) utilized the TPB to understand intentions for Leave No Trace behavior at Olympic and Glacier National Parks. Their results
suggested perceived difficulty and subjective norms to be the strongest predictors of behavioral intent.

Finally, other studies have examined the efficacy of Leave No Trace trainings and workshops, both for adults (see Daniels & Marion, 2005), and youth (see Miller, Shellman, Hill, Ramsing, & Lawhon, 2014). The Daniels & Marion (2005) study examined educational outcomes of 2-day Leave No Trace “Trainer” courses. They found significant knowledge and self-reported behavior changes in pre- and posttest measures, as well as in a four-month follow-up survey. Miller and colleagues (2014) measured educational outcomes associated with a one-day Leave No Trace training program for youth, finding significant gains in knowledge from pre- to posttest.

As the literature discussed above indicates, there has been a steady progression in the social science contributions to Leave No Trace research. That said, the literature base is still rather scant with many knowledge gaps and questions that merit further exploration. This dissertation helps to fill these gaps by: exploring topic areas that have been little-studied (e.g., youth and Leave No Trace); and by building upon research design issues researchers have identified as limitations in previous studies (e.g., conducting behavioral observations and pairing survey with observation data).

The next section provides a presentation of the theoretical underpinnings of this dissertation, and is followed by a discussion of the background and significance of the three research areas of this dissertation.

**Theoretical Foundation**

The Theory of Planned Behavior (TPB) (Ajzen, 1991) was used in this dissertation as the theoretical frame by which to examine underlying cognitive factors and attitude structures that
work to influence Leave No Trace behavior. Since its introduction to the literature, The TPB is recognized as one of the most frequently cited and influential models for the prediction of human behavior (Ajzen, 2011). It has been celebrated for its parsimonious nature and its relative ease of implementation, and in many cases it has quite good predictive ability across a variety of contexts and behaviors (Ajzen, 2011; Armitage & Christian, 2003; Armitage & Conner, 2001; Conner & Armitage, 1998).

At its root is the notion that behavioral intentions are the most proximate predictor of one’s actual behavior (Ajzen, 1991). Behavioral intentions are a function of salient information or beliefs about the likelihood that performing a particular behavior will lead to a specific outcome (Ajzen, 1991; Madden, Ellen, & Ajzen, 1992). It is assumed that intentions capture the motivational factors that influence a behavior – they are essentially indications of how hard people are willing to try, and how much of an effort they are willing to exert, in order to perform the behavior. As a general rule, the stronger the intention to engage in a behavior, the more likely should be its performance (Madden et al., 1992). Moreover, it has been found that when behaviors pose no serious problems of control, they can be predicted from behavioral intentions with considerable accuracy (Ajzen, 1991).

According to the TPB behavioral intention is a function of three antecedent constructs (Figure 1-1): attitudes toward a behavior, subjective norms, and perceived behavioral control. Attitude is the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question; subjective norm refers to the perceived social pressure to perform or not perform a behavior; and perceived behavioral control refers to the perceived ease or difficulty of performing the behavior (Ajzen, 1991). Behavioral intentions are a product of the weighted combination of the three constructs. The TPB suggests that the more favorable one’s attitude and subjective norm with respect to behavior, and the greater the perceived control, the stronger should be a person’s intention to perform the behavior in question (Beck & Ajzen, 1991).
The relative importance of attitude, subjective norms, and perceived behavioral control (PBC) in the prediction of intention is expected to vary across situations. For example, in situations where attitudes are strong, or where normative influences are powerful, PBC may be less predictive of intentions – the magnitude of the PBC-intention relationship is dependent upon the type of behavior and the nature of the situation (Armitage & Conner, 2001). Ajzen (1991) suggests that the addition of PBC becomes increasingly useful as volitional control over behavior decreases. In other words, in situations where prediction of behavior from intention is likely to be hindered by the level of actual (volitional) control, PBC should: 1) facilitate the implementation of behavioral intentions into action; and 2) predict behavior directly (Armitage & Christian, 2003; Armitage & Conner, 2001).

Underlying attitudes, subjective norms and perceived behavioral control are behavioral beliefs that are thought to be created or influenced through direct experiences and other outside sources in a particular decision context (Ajzen, 1991). People hold a great number of beliefs about any given behavior, but are said to have the ability to attend to only a few at any given moment, known as salient beliefs (Ajzen, 1991). The TPB relies on an expectancy-value model to specify the nature of the relations between salient beliefs and attitudes (Hrubes, Ajzen, & Daigle,
The expectancy-model posits that attitudes develop from the beliefs people hold about the object of the attitude. In other words, we form beliefs about an object by associating it with certain attributes (i.e. with other objects, characteristics, or events). Regarding attitudes towards behaviors, each belief links the behavior to a certain outcome, or some other attribute such as the cost incurred by performing the behavior. Since these attributes that come to be linked to behaviors are already valued as positive or negative, we simultaneously acquire an attitude toward the behavior (Ajzen, 1991).

The attitude, subjective norms, and perceived behavioral control constructs are the aggregates of these associated salient belief measures and reflect the relative strength and direction each contributes to the model. Behavioral beliefs are assumed to influence attitudes toward the behavior in question. The more one believes that by performing a certain behavior certain positive outcomes will result, and/or negative ones will be avoided, the more favorable the attitude toward the behavior (Ajzen & Fishbein, 1977). In contrast, if by performing a behavior negative outcomes result or positive ones are prevented, then the attitude will likely be negative (Bamberg, Ajzen, & Schmidt, 2010). Normative beliefs make up the underlying determinants of subjective norms. They are the product of an individual’s perception of the social pressures to perform or not perform a behavior, applied by important referent groups (e.g. persons, groups, or institutions) (Ajzen, 1991). Control beliefs provide the basis for perceptions of behavioral control. The more control one believes they have over a situation the more favorable their PBC, where alternatively if they feel little control over a situation their PBC is likely to be evaluated as low (Ajzen, 1991).
Theory of Planned Behavior in Leave No Trace Research

As mentioned above the TPB has been one of the most frequently cited and implemented theories of social psychology. It has been identified as an effective tool in the design and delivery of persuasive messages aimed at changing behavioral intent by targeting an individual’s beliefs and attitudes (Ham & Krumpe, 1996). Moreover, previous researchers who have utilized the TPB in studies of Leave No Trace (Lawhon et al., 2013; B. D. Taff et al., 2014; Vagias et al., 2014; Vagias & Powell, 2010), have suggested it as a valuable theoretical framework upon which to build future Leave No Trace education and information programs. Thus, following the logic of the theory, by gaining an understanding of the extent to which the TPB constructs influence one’s intentions to practice Leave No Trace behaviors, managers of public and protected areas will be better equipped to develop educational strategies that work to influence positive change in visitor behavior (Vagias et al., 2014). This dissertation builds on the work of previous researchers who have utilized the TPB in the context of minimum-impact and Leave No Trace outdoor recreation behavior (Lawhon et al., 2013; Reigner & Lawson, 2009; Vagias et al., 2014). Moreover, the variable relationships examined in this dissertation were framed within the context of the TPB to help identify those factors that exert influence over Leave No Trace behavior across three unique recreation contexts.

Three Focus Areas of this Dissertation

The purpose of this dissertation is to advance our understanding of the efficacy of Leave No Trace messaging and educational programs. The three independent studies that make up this dissertation were designed in direct collaboration with land managers and Leave No Trace directors to devise innovative research methods that serve to inform empirically-sound responses
to real-world problems. In this sense, each study was grounded in and guided by practical application. Additionally, in the interest of advancing the literature, the methodological approaches utilized were meticulously crafted based on critical review of the extant literature. The following section provides a discussion of the background and significance of each study in turn.

**Study One: Examining attitudes and perceptions of Leave No Trace among participants of a new and emerging outdoor activity: A study of bouldering and Leave No Trace**

Rock climbing in general is a growing sport among recreationists. The Outdoor Industry Association (2016) reports that over 11 million people participated in some form of rock climbing in 2016, a 40% increase since 2012. Various forms of outdoor rock climbing exist, including: traditional, sport, and ice climbing, mountaineering, and bouldering. The focus of this research is on the rapidly growing sport of bouldering exclusively. Bouldering is a recreational activity associated with climbing on small rock formations that are short enough in height that ropes and other climbing equipment are not used, given that heights of the climbing challenges rarely exceed 15-20 feet (5-7 meters). Instead of ropes for fall protection, boulderers rely on crash pads and fellow boulderers to act as spotters. Participation in bouldering has increased substantially over the past two decades. Of the 11 million estimated rock climbers in 2016, nearly two-thirds of those were considered to be boulderers and/or indoor gym climbers (The Outdoor Foundation, 2016).

The popularity of bouldering has been the low cost of entry, accessibility, and mainstream publicity (The Access Fund, 2006). Compared to other forms of climbing, the equipment needed for bouldering is a small investment. A person interested in bouldering can gain access to the sport by simply buying a pair of specialized rock climbing shoes. Additionally,
an increase in dedicated climbing gyms and fitness center climbing walls, the growth of youth climbing programs, indoor climbing competitions, and an increasing market of magazines, companies, products, and events have all contributed to bouldering’s growing popularity (The Access Fund, 2006). Indoor climbing is identified as the fastest sector of the climbing industry (Westley, 2016), evidenced by the steady growth of commercial climbing gyms in North America alone, which have increased from 353 in 2015 to 414 in 2016, and analysts predict continued growth (Gyms and Trends, 2017).

As bouldering continues to gain in popularity and participation, more climbing opportunities are being discovered within both public and private lands. It therefore becomes increasingly important that park and recreation managers be aware of the ecological and social impacts associated with bouldering. Rocky Mountain National Park (RMNP), for example, has experienced a significant increase in bouldering activity over the last decade. In 2011 a bouldering guidebook was published, increasing awareness and visitation to the park’s vast bouldering resources, uniquely set within the stunning yet fragile alpine wilderness found within RMNP. Officially designated as wilderness in 2009, RMNP contains high alpine peaks exceeding 12,000 feet and views of the Continental Divide that attract visitors from nearby urban cities and across the world (Pettebone, 2013). As a result, park managers are beginning to document the increase of bouldering and have raised questions of the associated environmental and social resource impacts.

Like all outdoor recreation activities, bouldering has the potential to cause ecological impacts, such as vegetation loss, soil erosion, and resource modification; social impacts, such as user conflicts, crowding, and increased anthropogenic noise; and aesthetic impacts associated with residual climbing chalk on boulders. Recreation-related impacts such as these are commonly addressed through indirect management approaches, such as Leave No Trace education programs and site/context specific visitor information and messaging campaigns (Manning, 2003).
However, while many parks and protected areas allow for bouldering on-site, there is a dearth of research on the environmental and social practices of boulderers and their Leave No Trace-related attitudes and behaviors.

The emergence of outdoor bouldering introduces a new pattern of recreation use in parks and protected areas (e.g. the use of crash pads and climbing chalk, accessing areas typically not visited by other recreationists), calling for a need to examine the extent to which commonly practiced outdoor bouldering behavior aligns with Leave No Trace recommended practices. To deliver effective messaging campaigns about acceptable bouldering behaviors, there is need to first identify common use patterns that may be less congruent with Leave No Trace recommendations. If appropriately implemented, bouldering specific Leave No Trace practices can reduce ecological and social impacts and improve visitor experiences by influencing behaviors.

**Study Two: Examining the efficacy of Leave No Trace education programs for youth: A study of the Leave No Trace Promoting Environmental Awareness in Kids (PEAK) program**

According to the 2010 United States Census more than 80% of the US population now lives in metropolitan areas. Additionally, a study commissioned by The Outdoor Foundation (The Outdoor Foundation, 2010) reports youth participation in outdoor recreation (defined as having taken part in one or more of 40 activities in the past year) in the U.S. has declined since 2006. Decreasing participation trends are seen in all age groups (6-12, 13-17, 18-24) and among both boys and girls. The rate of decline was greatest among 6- to 12-year-old girls, dropping from to 77% in 2006 to 58% in 2009.

Conversely, children’s use of media is at an all-time high. Rideout and colleagues (2010) report that in 2004, children spent an average of nearly 6 ½ (6:21) hours with media daily,
whereas children in 2009 spent an average of 7 ½ (7:38) hours with media daily. When multi-tasking is taken into account (time spent using more than one form of media at a time), children in 2009 packed a total of 10 hours and 45 minutes of media exposure each day into 7 ½ hours, an increase of almost 2.25 hours over 2004 levels (8 ½ hours). Furthermore, media use is typically an indoor activity, providing further challenge to getting children outside.

While it is well documented that decreased outdoor and nature-based activity is negatively impacting the mental and physical well-being of children, less is known of the relationship to environmental stewardship and pro-environmental behavior. Researchers have recently begun to explore the connection. In a longitudinal study (1976-2005) examining adolescents’ concern for the environment, Wray-Lake, Flanagan, and Osgood (2010) found that taking personal responsibility for the environment and conservation behavior has declined in adolescents over the past three decades. The researchers argue there has been a decline in knowledge regarding the scarcity of our natural resources stemming from a rise in consumerism and materialism in the U.S. Their research suggests this decline in knowledge about the environment has led to a decreased concern for the environment among youth (Wray-Lake, Flanagan, & Osgood, 2010).

Today’s youth will inevitably become national and global leaders with responsibility for environmental stewardship and sustainability, and trends in young people can serve as a barometer for social change (Wray-Lake et al., 2010). Significant life experiences in the childhood years have powerful influence to inform attitudes, values, and behaviors throughout life, especially those linked to issues of the environment. Early experiences in nature have been shown to be strong predictors of future environmental stewardship (Chawla & Cushing, 2007). Trends among youth showing decreases in time spent outdoors and decreases in environmental concern call for educational and programmatic interventions to promote environmental consciousness in youth (Wray-Lake et al., 2010).
Evidence supporting the importance of getting young people outside and engaging with the natural world is hard to ignore (see Louv, 2008). Considerable efforts by governmental and non-profit organizations are currently taking place, urging families, schools, towns, and communities to power down the electronic media and get their kids actively engaged in the out-of-doors. However, while getting children outside and experiencing natural environments is crucial to child development and fostering environmental stewardship, research shows that increased use of natural and recreational areas increases the probability of negative impacts on the environment (Marion, Leung, Eagleston & Burroughs, 2016; Hammitt, Cole & Monz, 2015; Marion & Reid, 2007). Therefore, it is essential that children learn basic low-impact skills necessary to help sustain the natural environment.

Recognizing the need to introduce young people to the outdoors while facilitating development of an environmental ethic of care, the Leave No Trace Center for Outdoor Ethics has developed a youth-focused program to promote environmental awareness and stewardship of the outdoors (Miller, Shellman, Ramsing & Lawhon, 2014). Developed in 2001, the Promoting Environmental Awareness in Kids (PEAK) program is used by outdoor educators around the world to teach children the skills necessary to make responsible decisions when recreating in the out-of-doors (Miller et al., 2014).

The PEAK program has been in existence for many years, though little is known as to the effectiveness of its message. Only one empirical study has been conducted to date, which measured changes in knowledge of Leave No Trace as a result of participation in PEAK (Miller et al., 2014). While their study suggests the PEAK program might increase Leave No Trace knowledge in the short-term, knowledge does not necessarily translate to behavior (see Hungerford & Volk, 1990; Hwang, 2000; Manning, 2003; Petty, McMichael, & Brannon, 1992), and more research needs to be conducted to understand the potential effectiveness of PEAK to influence subsequent Leave No Trace behavior. This study builds upon this line of research,
extending the focus to examine changes in attitudes and behavior as a result of program participation.

**Study Three: Examining the efficacy of combined Leave No Trace educational messaging and direct site management actions in reducing undesignated trail use in an urban-proximate open space context**

Recent trend data indicate that a continued increase in recreational use of public and protected areas nationwide, including open space, is likely to occur over the coming years (The Outdoor Foundation, 2013; USFS, 2010). Public land resources in urban-proximate locations, such as the 45,000-acre Open Space and Mountain Parks (OSMP) system in the City of Boulder, Colorado, may be especially susceptible to the impacts related to increased outdoor recreation visitation (Kyle & Graefe, 2007). Like many public land managing agencies OSMP is charged with the often-conflicting management directives of preservation of critical plant and animal habitat, and the provision of quality opportunities for passive recreation such as hiking, horseback riding, cycling, and fishing (City of Boulder, 2005). As the population across the frontrange of Colorado has steadily increased, it is now estimated that OSMP receives over 5 million recreational visits per year (Vaske, Shelby & Donnelly, 2009).

Striking a balance between recreational quality and ecological integrity is a perennial concern among public land managers. The development of a recreational infrastructure of trails and recreation sites that concentrate visitor use on hardened durable surfaces is a commonly employed approach to achieving this balance (Marion, Leung, Eagleston, & Burroughs, 2016). Of critical concern here is the notion that increased visitation often correlates to an increase in visitors traveling off of and away from sustainably developed recreational facilities, leading to the creation and proliferation of undesignated trails (Park, Manning, & Marion, 2008). Accordingly, a recent inventory of OSMP land-use designation identified approximately 147 miles of
designated trails across their system, and no less than 150 miles of undesignated trails
visitation increases, the extent of undesignated trail development is also likely to increase in the
absence of a plan for managing the recreational desires of visitors on the OSMP system.

Undesignated trails (e.g. social, visitor-created, unofficial or informal trails) are
identifiable pathways created and perpetuated by visitors outside of an area’s formally managed
trail system (Leung, Newburger, Jones, Kuhn, & Woiderski, 2011). These undesirable trail
segments are often products of heavy visitation coupled with diverse recreation interests and
motivations that draw visitors off of designated trails (Guo, Smith, Leung, Seekamp, & Moore,
2015). Because undesignated trails are not professionally designed, constructed or maintained
they can contribute substantially greater impacts to protected area resources than designated trails
(Wimpey & Marion, 2011). The proliferation of undesignated trail networks into protected
landscapes and habitats threatens ecological integrity, aesthetics, and visitor experiences (Leung
et al., 2011). Some off-trail travel is tolerated by the ecosystem; however, the amount of soil
compaction and erosion that is acceptable is weighed against the level of visitation at each site
(Kuo, 2002). While off-trail travel is not typically an illegal or sanctioned act on most public
lands, when experienced at high levels it represents a visitor behavior that works counter to
resource protection objectives, prompting the need for management interventions to mitigate the
problem behavior.

Problem recreation behaviors and visitor use issues are typically addressed through one
of two approaches: indirectly through visitor education such as Leave No Trace or directly
through enforcement or sanctions (Manning, 2003; Marion & Reid, 2007). Leave No Trace is the
most prevalent minimum-impact educational program in use in parks and protected areas in the
U.S. (Marion, 2014). The overarching intent of the program is to educate outdoor enthusiasts
about the nature of their recreation-related impact as well as teach them techniques for
minimizing impact (Harmon, 1997; Leave No Trace Center for Outdoor Ethics, 2016; Marion & Reid, 2007). The initial focus of Leave No Trace was on impacts in wilderness areas but has expanded to include other types of parks and protected areas. (Marion, 2014; Marion & Reid, 2001). Currently, Leave No Trace has a primary focus on frontcountry area visitors, and has created numerous educational resources addressing recreational pursuits common to these areas including day hiking, dog walking, biking, running, exercise, etc. (Leave No Trace Center for Outdoor Ethics, 2015; Marion, 2014). In 1998, OSMP was the first urban municipality to implement a frontcountry Leave No Trace program (Reid, 2000). As such, Leave No Trace education and information programs have historical precedent as an indirect management approach utilized on OSMP lands.

The OSMP Visitor Master Plan (VMP) provides “a framework for decisions that will ensure a continued high quality visitor experience, while at the same time ensuring that the lands are protected and preserved for future generations” (City of Boulder, 2005, p. ii). Importantly, the VMP mandates the development of a program to critically assess and manage undesignated trails on OSMP lands (City of Boulder, 2005). In order to effectively reduce use of undesignated trails, OSMP must have a better understanding of which types of closure treatments are most effective at ensuring visitor compliance with closures. Furthermore, an understanding of visitor motivations for using undesignated trails is paramount for implementing specific management actions (or combinations of actions) to reduce use of such trails. Thus, understanding the relationships between closure treatments and visitor behavior is critical for realizing lasting sustainability of OSMP lands. The purpose of this study is to investigate the efficacy of a range of management actions designed to mitigate the use of undesignated trails located within the OSMP system. Working in collaboration with OSMP managers we developed a quasi-experimental design to simulate an adaptive management process that applied a range of treatments in an effort to achieve the highest possible reduction in undesignated trail use.
References


http://doi.org/10.1080/01490409709512239.


Chapter 2

Examining attitudes and perceptions of Leave No Trace among participants of a new and emerging outdoor activity: A study of Bouldering and Leave No Trace

Title: Bouldering ethics from the gym to the crag: The influence of ability and origin of introduction on knowledge and attitudes toward Leave No Trace.

Target Journal: Journal of Outdoor Recreation Education and Leadership.

- Article Type: Research article
- Word Limit: 6,500 (Abstract < 250)

Proposed Authors: Schwartz, F., Taff, B. D., Lawhon, B., Pettebone, D., & D’Antonio, A.

Abstract: Participation in bouldering has increased substantially over the past two decades with indoor climbing and bouldering being identified as the fastest sector of the climbing industry. For many, their experience with bouldering begins in the gym and then progresses to climbing outdoors, which has led to questions of whether those who initially learn in a gym setting are making a responsible transition to the outdoors by adopting behaviors that protect and preserve ecological and social conditions, thus ensuring the future of outdoor bouldering access. This article reports on bouldering research conducted in Rocky Mountain National Park in the summer of 2015. The authors conducted an on-site visitor survey that examined attitudes, knowledge, and perceptions of Leave No Trace-related bouldering practices, specifically comparing and contrasting indoor and outdoor learners, as well as self-reported ability, across these measures. A total of n=227 boulderers completed the survey. The majority of the sample initially learned to boulder indoors. Indoor learners and those of novice ability reported less knowledge of Leave No Trace and generally held attitudes and perceptions less congruent with Leave No Trace
recommendations. The authors recommend continuing and expanding minimum-impact outdoor bouldering programs designed to educate boulderers making the transition from the gym to the crag in effort to support the long-term viability of outdoor bouldering on public and protected lands.

**Keywords:** Leave No Trace, bouldering, outdoor ethics, rock climbing

### Introduction

Rock climbing in general is a growing sport among recreationists. The Outdoor Industry Association (2016) reports that over 11 million people participated in some form of rock climbing in 2016, a 40% increase since 2012. Various forms of outdoor rock climbing exist, including: traditional, sport, and ice climbing, mountaineering, and bouldering. The focus of this research is on the rapidly growing sport of bouldering exclusively. Bouldering is defined as “the practice of climbing small rock formations or boulders that are short enough in height that ropes and gear are not necessary” (The Access Fund, 2006, p. 2). The route up a boulder is commonly referred to as a “boulder problem”, and rarely exceeds 15 to 20 feet in height. Bouldering falls are frequent, but short. And because ropes are not utilized in bouldering, relying on crash pads (mattress-like portable foam pads used to cushion falls) and fellow boulderers to act as “spotters” is common practice. In most other forms of climbing, climbers travel in pairs to ensure safety and increase speed. Conversely, boulderers most often climb in groups (typically 2 to 6) to ensure having enough spotters to climb safely (The Access Fund, 2006).

Participation in bouldering has increased substantially over the past two decades. Of the 11 million estimated rock climbers in 2016, nearly two-thirds of those were considered to be boulderers and/or indoor gym climbers (The Outdoor Foundation, 2016). Bouldering’s growing popularity has been attributed to the low cost of entry, accessibility, and mainstream publicity
Compared to other forms of climbing, the equipment needed for bouldering is a small investment. A person interested in bouldering can gain access to the sport by simply buying a pair of specialized rock climbing shoes. Additionally, an increase in dedicated climbing gyms and fitness center climbing walls, the growth of youth climbing programs, indoor climbing competitions, and an increasing market of magazines, companies, products, and events have all contributed to bouldering’s growing popularity (The Access Fund, 2006). Indoor climbing is identified as the fastest sector of the climbing industry (Westley, 2016), evidenced by the steady growth of commercial climbing gyms in North America alone, which have increased from 353 in 2015 to 414 in 2016, and analysts predict continued growth (Gyms and Trends, 2017).

Given the abundance of new climbing gym opportunities, for many, their experience with bouldering begins in these indoor facilities and then progresses to climbing outdoors. As bouldering continues to gain in popularity and participation, more outdoor climbing opportunities are being discovered within both public and private lands. Rocky Mountain National Park (RMNP), for example, has experienced a significant increase in bouldering activity over the last decade. In recent years it has become internationally recognized as an iconic bouldering destination, attracting climbers from across the globe. In 2011 a bouldering guidebook was published, increasing awareness and visitation to the park’s vast bouldering resources, uniquely set within the stunning yet fragile alpine, designated wilderness found within RMNP. As a result, park managers are beginning to document the increase of bouldering and have raised questions of the associated environmental and social resource impacts.

Thus, an important question that needs to be explored is whether those who are introduced to the sport in a gym setting are making a responsible transition to the outdoors by adopting behaviors that protect and preserve ecological and social conditions, thus ensuring the future of outdoor climbing access. To date, only one known study has examined rock climbers in
the context of where they learned to climb and its relation to minimum-impact attitudes (see Borrie & Harding, 2002). The small sample size \( (n = 40) \) of their study posed limitations on the reliability and generalizability of their results. Clearly more research is needed. Minimum-impact outdoor skills and ethics, such as those promoted through the Leave No Trace Center for Outdoor Ethics, are the most prevalent indirect management strategy promoted in parks and protected areas to mitigate adverse recreation-related ecological and social conditions (Marion, 2014). Understanding Leave No Trace-related attitudes and behaviors associated with bouldering is essential as park and recreation managers work to develop programs and policies to accommodate the rapidly expanding sport.

While many parks and protected areas allow for bouldering on-site, there is a dearth of research on the environmental and social practices of boulderers and their Leave No Trace-related attitudes and behaviors. In responding to this need, the authors worked in collaboration with RMNP managers on a study that aimed to establish baseline data on bouldering activity in the park, examining such factors as attitudes, perceptions, knowledge and awareness of Leave No Trace recommended practices (see Schwartz, Taff, Pettebone, & Lawhon, 2016). Because of the documented influx of boulderers transitioning from the gym to the outdoors a key area of interest to this study was the origin of introduction to bouldering (indoors or outdoors), and the role that learning context may play in the development of the aforementioned Leave No Trace-related outcomes. We were also interested in examining any additional influence related to bouldering ability. This article reports on the findings of this research. Our expectation is the insights gleaned from this research will inform the development of effective communication and education strategies that serve to support the long-term viability of outdoor bouldering on public and protected lands while protecting the often-fragile ecosystems that host the activity.
Rock Climbing and the Environment

Adverse environmental impacts as a result of outdoor recreation are practically unavoidable (Marion, Leung, Eagleston, & Burroughs, 2016). Necessarily, the occurrence of outdoor bouldering will be accompanied by its own set of social and natural resource impacts. However, because bouldering is a relatively new form of outdoor recreation and is expanding to areas of the natural landscape, often previously unexplored by other outdoor recreationists, little is known about the nature and extent of its impacts. To date, the bulk of research on the impacts of rock climbing have focused on roped forms of climbing.

We can look to the field of recreation ecology as the primary source for understanding the various environmental impacts attributed to rock climbing. Previous recreation ecology research has identified a number of climbing-related impacts, including, but not limited to: drilling for the placement of anchor bolts, use of gymnastics chalk (a drying agent to improve grip), creating holds by chipping or gluing, soil and vegetation disturbance near cliffs, the creation of social trails and tree damage (Monz, 2009). For example, in studies of roped rock climbing on cliff faces in Joshua Tree National Park, Camp & Knight (1998) found that as climbing use increased, plant cover at both the base of cliffs and on the cliff face decreased. They concluded that in order to mitigate plant loss caused by climbing, resource managers should control access to climbing.

In a similar study, McMillan & Larson (2002) analyzed cliffs of the Niagara Escarpment in Milton, Ontario. They found a significant decrease in population, richness, and diversity of plant species in more heavily climbed areas compared to unclimbed areas. Moreover, they found a decrease in the population of land snails near climbing areas. Their recommendation was for managers to ban future development of climbing routes and educate climbers on the cliffs’ unique
ecosystem. They stressed the need for increased communication and collaboration between climbers and managers.

While the studies discussed above have focused on the physical impacts to natural resources, others have looked at the human dimension in an effort to understand salient attitudes associated with environmental and social impacts. Monz (2009) investigated climbers’ attitudes towards impacts caused by roped climbing, finding that resource impacts resulting from climbing were considered to be “somewhat offensive” by climbers. Additionally, crowding was determined to be a significant concern, and most climbers reported neutral or oppositional attitudes towards climbing management. Monz (2009) stressed the importance for managers to understand climbers’ attitudes in an effort to craft effective educational programs.

Schuster, Thompson, & Hammitt (2001) reached a similar conclusion in their research on climbers’ attitudes towards climbing management. They used an on-site survey collected from 13 climbing areas in the United States to determine how climbers from different regions and disciplines view climbing management practices. The results suggest climbers feel as though: 1) managers don’t understand climbing, 2) climbers don’t understand management, and 3) climbers feel climbing is micromanaged. Evidence from these studies supports the need for increased communication and collaboration between climbers and land managers.

Visitor Education and Leave No Trace

Managers of parks and protected areas are charged with the difficult task of providing quality recreation opportunities while simultaneously protecting the health and integrity of the natural environment. Visitor use issues are generally addressed through two different approaches: directly through regulatory means such as enforcement or sanctions and indirectly through efforts such as visitor education (Hammitt, Cole, & Monz, 2015). Indirect management in the form of
education is frequently applied to minimize ecological and social impacts in protected area contexts (Hammitt et al., 2015). Leave No Trace is the prominent minimum-impact visitor education program used in parks and protected areas in the U.S. (Marion, 2014) with the end-goal of sustaining or improving resource and social conditions. Intended to educate recreationists about the nature of their recreational impacts with the goal of resource protection, the Leave No Trace concept is based on the following seven principles:

1. Plan ahead and prepare
2. Travel and camp on durable surfaces
3. Dispose of waste properly
4. Minimize campfire impacts
5. Leave what you find
6. Be considerate of other visitors
7. Respect wildlife

Leave No Trace was developed in the early 1990’s by the USDA Forest Service (USFS) in partnership with the National Outdoor Leadership School (NOLS) to encourage responsible outdoor ethics through a science-based approach. Leave No Trace has since been formally adopted by all major federal land agencies including: The US Forest Service, Bureau of Land Management, Fish and Wildlife Service, and the National Park Service as their chief minimum-impact educational program (Marion & Reid, 2001). In 1994, Leave No Trace was incorporated as a 501(c)3 nonprofit organization named ‘The Leave No Trace Center for Outdoor Ethics’, and continues to advance and grow the Leave No Trace program (Lawhon, Newman, Taff, & Vaske, 2013).

Over the years the principles of Leave No Trace have been adapted to address existing and emerging outdoor recreation use patterns. These adaptations have addressed specific activities, such as angling and llama packing; as well as recreation settings and contexts, such as
the Appalachian Trail, winter recreation, and international travel. The emergence of outdoor bouldering introduces a new pattern of recreation use in parks and protected areas (e.g. the use of crash pads and climbing chalk, accessing areas typically not visited by other recreationists), calling for a need to examine the extent to which commonly practiced outdoor bouldering behavior aligns with Leave No Trace recommended practices.

**Attitudes and Human Behavior**

As discussed above, managers of public recreation lands are often charged with the arduous task of managing visitor behavior. Educational efforts such as Leave No Trace are intended to increase understanding of minimum impact practices, and ultimately influence behavior change (Marion & Reid, 2007). Understanding the determinants of human behavior, then, becomes a critical element in the design of effective educational messaging. Early efforts to measure the effectiveness of various educational strategies focused on educational efficacy of the content (Marion & Reid, 2007). Though more recently, social scientists have expanded their understanding of the determinants of minimum-impact behaviors by exploring various antecedents of behavior such as attitudes, beliefs, values, perceptions, and knowledge (see Taff, Newman, Vagias, & Lawhon, 2014; Vagias, Powell, Moore, Dewayne, & Wright, 2014; Lawhon, et al., 2013; Vagias & Powell, 2010).

Previous research has established that attitudes often have a significant influence on a specific, discrete behavior (Ajzen, 2011; Ham & Krumpe, 1996; Heberlein, 2012). Attitudes are generally described as an individual’s evaluation of, and dispositional response to, a particular object, including behavior. Once an evaluation of an object has occurred, an associative attitude about that object can be retained in memory and influence future behavior (Ajzen & Fishbein, 2000; Fishbein & Ajzen, 2010). In theory, Leave No Trace behavior is thus influenced in part by
attitudes toward specific Leave No Trace guidelines and recommended practices. If attitudes directly influence behavior, and attitudes can be changed, then park managers may alter visitor behavior by specifically targeting the salient attitude that is determining human behavior (Ham & Krumpe, 1996). Understanding visitor attitudes related to Leave No Trace is critical in order to craft effective educational messages that have the potential to reduce depreciative behavior in parks and protected areas.

Researchers have recently begun to utilize behavioral theories to understand the influence of perceptions, and in particular attitudes, that aid in shaping the behavior of outdoor recreationists within the context of Leave No Trace specifically (see Lawhon et al., 2013; Schwartz et al., 2016; Taff et al., 2014; Taff, Newman, Bright, & Vagias, 2011; Vagias, Powell, & Moore, 2012; Vagias, et al., 2014). This is an important consideration in Leave No Trace-related research given the theoretical foundations that suggest attitudes significantly influence behavior (Ajzen, 1991; Heberlein, 2012).

In sum, visitor perceptions (i.e., visitor attitudes, beliefs and awareness) of Leave No Trace can lead to either appropriate or inappropriate behaviors, depending on understanding and perspective. Therefore, it is difficult to achieve management objectives without understanding visitor attitudes and behaviors, and in particular, perceptions of Leave No Trace. In order to deliver effective messaging campaigns about acceptable outdoor bouldering practices there is need to first identify common use patterns that may be less congruent with Leave No Trace recommendations. If appropriately implemented, bouldering-specific Leave No Trace practices can reduce ecological and social impacts and improve visitor experiences by influencing behaviors.
Recreation Specialization

While information and education programs such as Leave No Trace have been documented to hold influence over one’s knowledge, attitudes, and behaviors related to a specific activity, researchers have also suggested that the extent to which they are developed and applied is heavily influenced by one’s level of specialization in that activity (Scott, & Shafer, 2001). Bryan (1977) defines recreation specialization as “a continuum of behavior from the general to the particular, reflected by equipment and skills used in the sport and activity setting preferences” (p. 175). It is perceived as a continuum of skill with the activity from novice to expert, and entails a progression in behavior, attitudes, and preferences related to an individual’s level of specialization. Thus, in this study we use self-reported ability as an indicator of specialization. Specialization is described further by Scott & Shafer (2001) as “a focusing of behavior, the acquiring of skills and knowledge, and a tendency to become committed to the activity such that it becomes a central life interest” (p. 376).

The notion of recreation specialization has been used to understand how the motivations, preferences, attitudes, and behaviors of recreationists develop through progression in an activity (Donnelly, Vaske, & Graefe, 1986; Oh & Ditton, 2006). Researchers have noted a correlation between increased specialization and increases in environmentally responsible behaviors, values, and attitudes (Dyck, Schneider, & Thompson, 2003; Mullins, 2014; Oh & Ditton, 2008). Regarding the scope of this study, specialization theory advises the necessity to examine bouldering at different levels of ability within the sport. This is an important consideration for this research because it can provide further insight into areas where education and outreach efforts might be most pragmatic. That is, by understanding how, if at all, boulderers differ in their attitudes, knowledge and perceptions of Leave No Trace recommended practices depending on level of ability, educational efforts can be targeted to reach boulderers accordingly.
**Study Purpose**

As discussed above, bouldering is a rapidly growing recreational pursuit. And unlike more traditional outdoor-specific activities (e.g. hiking, angling, hunting, kayaking, backpacking), many people are learning to boulder in climbing gyms and later making the transition to the outdoors. This raises the question of whether those who are introduced to the sport in a gym setting are making a responsible transition to the outdoors by learning and adopting behaviors meant to protect and preserve ecological and social conditions. This study aims to provide an empirically grounded response to this question. Drawing on the literature reviewed earlier, the study is framed around the following research questions:

- **RQ1:** How do indoor learners compare to outdoor learners in regard to their attitudes towards bouldering-specific Leave No Trace recommended behaviors, perceptions of the Leave No Trace program in general, and knowledge of Leave No Trace?

The second research question is an extension of the first, extending the analysis of indoor and outdoor learners to include self-reported bouldering ability.

- **RQ2:** How do indoor learners compare to outdoor learners in regard to their attitudes towards bouldering-specific Leave No Trace recommended behaviors, perceptions of the Leave No Trace program in general, and knowledge of Leave No Trace, when accounting for self-reported bouldering ability?

**Methods**

This section describes the research design and methods applied in the development and implementation of the study. This study consisted of an on-site survey of boulderers at two locations in the Chaos Canyon area of the Bear Lake Corridor in RMNP.
Key Informant Interviews

To inform the development of the on-site methods and structure and content of the survey instrument, we first conducted semi-structured interviews (Bernard, 2013) with stakeholders, professionals, managers and others involved with bouldering activities in RMNP. The key informant interviews achieved three main goals: 1) to develop a general impression of the bouldering community at large, 2) to develop a general impression of those involved with bouldering activities at RMNP specifically, and 3) to aid in the development of the on-site survey instrument.

Interviews were conducted via telephone during January 2015, and were recorded upon receiving permission from the respondent. Key informants were identified through purposive and snowball sampling methods (Bernard, 2013). That is, we began by contacting a list of five known central figures in the local and national bouldering community. To generate a larger list of prospective informants we asked individuals in this initial group if they would be willing to recommend someone with substantial knowledge of the bouldering community, and RMNP specifically. A total of nine individuals participated in the interviews. These individuals included contextual experts such as a bouldering guidebook author, local climbing gym managers, a RMNP climbing ranger, staff at the Access Fund, and professional climbers that frequent the area. They provided expert knowledge essential to the design of the study, such as: peak bouldering hours in the park, which informed the sampling schedule; and bouldering specific behaviors considered ‘best practices’ (e.g. removing chalk tick marks from boulders), which were incorporated into questions on the survey instrument.
Survey Administration

The survey instrument was developed based on results of the key informant interviews and also includes Leave No Trace-related items that have been used in previous studies (see Lawhon et al., 2013; B. D. Taff et al., 2014; Vagias & Powell, 2010). Data was collected during July, 2015 at two areas within the Chaos Canyon area of the Bear Lake Corridor in RMNP: Emerald Lake and Lake Haiyaha, which have been identified by park managers and guidebooks as the most popular bouldering destinations within the park (McDonald, 2011). Emerald Lake and Lake Haiyaha are known in the international climbing community as premiere bouldering destinations due to the vast numbers of glacially deposited boulders and the serene natural environment. While, in general, fewer visitors access the Chaos Canyon than other parts of the park, dedicated boulderers are commonly found there and are diverse in style, ability, and origin (McDonald, 2011). The surveys were submitted and approved by the Federal Office of Management and Budget, and were administered in the field on paper and completed with pen or pencil. Survey length was two double-side pages and took approximately 8-10 minutes to complete.

Surveys were administered over a 21-day period from July 10-31, 2015 using a stratified sampling approach. Sampling was stratified by weekday and weekend at Chaos Canyon across 17 sampling periods, and at Emerald Lake through 15 sampling periods, each spanning from 10 a.m. to 5 p.m. All individuals and groups observed bouldering were approached using a standard introductory script and asked if they would be willing to participate in the study. Surveys were completed on-site and completed by a single individual over the age of 18. When parties of two or more were encountered, all individuals present aged 18 or older were invited to complete a survey. Each distinct/exclusive group or individual encountered was assigned a unique identifying number, which was recorded on the survey, allowing us to check for intragroup
homogeneity of survey responses. No significant similarities were found; thus all surveys were evaluated at the individual level. A total of 111 bouldering parties were approached for participation in the study and the overall response rate was 95% \( (n = 229) \). After cases with incomplete surveys were eliminated, the sample size analyzed was \( n = 227 \).

**Variable Measurement**

The data utilized for analysis in this report were part of a larger survey of bouldering in RMNP (see Schwartz et al., 2016). Based on attitude theory discussed previously, a subset of survey variables was selected for this research that examined: attitudes toward bouldering-specific Leave No Trace behaviors, global perceptions of Leave No Trace, and self-reported knowledge of Leave No Trace. Additional items focused upon respondents' experience use history, climbing background, and basic demographics (age, gender, place of residence).

Attitudes toward Leave No Trace behaviors were measured through 5 behavioral statements specific to bouldering (e.g. *Moving rocks, trees, or shrubs at the base of boulders to develop safer landing zones*), each of which corresponds to a recommended Leave No Trace practice. Respondents were asked to indicate how appropriate or inappropriate each behavior is for boulderers to engage in while at RMNP using a seven point Likert-type scale where 1 = Very Inappropriate and 7 = Very Appropriate. All of the provided statements are considered inappropriate behaviors under strict interpretation of Leave No Trace. Global perceptions (see Vagias & Powell, 2010) related to Leave No Trace as a program were assessed through three Likert-type items anchored from 1 = Strongly Disagree to 7 = Strongly Agree. These questions were located toward the end of the survey to eliminate potential bias associated with using the phrase “Leave No Trace” in any of the attitudinal batteries that preceded these items. Knowledge of Leave No Trace was measured by asking respondents to self-evaluate their level of knowledge
using a seven-point Likert-type scale anchored from 0 = No Knowledge to 6 = Expert. Basic demographic (e.g. age, gender, place of residence) and use history (e.g. years of previous experience, bouldering ability) questions were also included for sample description purposes.

Data Analysis

All data analysis was performed using IBM Statistical Package for the Social Sciences (SPSS) software, version 22. Univariate and bivariate descriptive statistics were conducted first to identify outliers and missing data. Independent samples t-tests were conducted to check for differences by survey location (i.e., Emerald Lake and Lake Haiyaha). No statistically significant differences were found, thus locations were combined and analyzed in aggregate.

To answer the first research question, we grouped and analyzed the data by location where respondents initially learned to boulder (indoor or outdoor). Descriptive statistics were used to create a basic demographic profile of respondents to gain a better understanding of the make-up of each group. Independent sample t-tests were utilized to examine differences between groups in their responses to the attitude, knowledge, and global perception statements. To answer the second research question we categorized respondents by self-reported bouldering ability (operationalized here as a proxy for specialization), and the origin of introduction to bouldering (indoor or outdoor). Bouldering ability was initially measured as a four-category variable (Beginner, Intermediate, Advanced, Expert), but because of analysis limitations related to small cell sizes was recoded to create a dichotomous variable (Novice or Advanced). Responses to these two items were then recoded to sort respondents into one of four categories: Indoor Novice, Indoor Advanced, Outdoor Novice, Outdoor Advanced. We then conducted analysis of variance (ANOVA) with Tukey’s post hoc tests to examine differences in responses across these categories. Analysis of covariance tests were run to check for confounding effects of Age and
*previous years of experience* on the attitudinal and knowledge items. No statistically significant relationships were found.

**Results**

**Sample characteristics**

The majority of respondents were male (72%), and overall ages ranged from 18 to 57 years with a mean age of 27.1 ($SD = 6.239$). More than 96% of the respondents were US residents, and approximately 65% resided in the state of Colorado. The majority (approximately 60%) of bouldering parties consisted of three or more people, and the overall mean group size was 3.2 ($SD = 1.658$). On average, respondents reported approximately seven years of previous bouldering experience ($M = 6.94, SD = 5.819$), and greater than 62% of the sample reported to be of advanced to expert bouldering ability (based on the commonly used “Hueco V-scale” bouldering route grading standards). When asked where they initially learned to climb, 67% of respondents reported to have learned indoors in a gym, while 33% learned outdoors.

To examine differences in attitudes, global perceptions and knowledge of Leave No Trace based on where respondents initially learned to climb (RQ1), we sorted cases into two groups: those who *learned indoors* in a gym ($n = 145$) and those who *learned outdoors* ($n = 73$). Nine people did not provide a response to the question, and were excluded from further analysis. These results are illustrated in Table 2-1. Those who learned to climb indoors were significantly younger than those who learned outdoors, with a mean age of 25.3 ($SD = 4.897$) for *indoor learners*, and 30.7 ($SD = 7.333$) for *outdoor learners* ($t = 6.471, p < .001$). *Indoor learners* reported significantly fewer years of previous bouldering experience – an average of 5.5 years compared to 9.9 years for *outdoor learners* ($t = 5.607, p < .001$). Differences were also identified
in self-reported knowledge of Leave No Trace. Results of independent samples $t$-tests indicated that *indoor learners* reported significantly less knowledge of Leave No Trace than did *outdoor learners*. The mean knowledge score for *indoor learners* was 4.02, whereas *outdoor learners* averaged 4.44 ($t = 3.027, p < .01$).

### Table 2-1. Descriptive and $t$-test statistics reported by where respondents learned to climb.

<table>
<thead>
<tr>
<th></th>
<th>Where initially learned to climb</th>
<th></th>
<th></th>
<th>$t$</th>
<th>$p$</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>N</td>
<td>Indoors</td>
<td>Mean</td>
<td>SD</td>
<td>Outdoors</td>
</tr>
<tr>
<td>Distribution of cases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>217</td>
<td>25.3</td>
<td>4.897</td>
<td></td>
<td>30.7</td>
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<tr>
<td>Years of previous bouldering experience</td>
<td>220</td>
<td>5.5</td>
<td>3.740</td>
<td></td>
<td>9.9</td>
</tr>
<tr>
<td>Knowledge of Leave No Trace practices$^1$</td>
<td>197</td>
<td>4.02</td>
<td>.913</td>
<td></td>
<td>4.44</td>
</tr>
<tr>
<td>Attitudes$^2$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Playing music through external speakers</td>
<td>217</td>
<td>2.53</td>
<td>1.369</td>
<td></td>
<td>2.16</td>
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<tr>
<td>Stashing crash pads for later use</td>
<td>220</td>
<td>3.01</td>
<td>1.564</td>
<td></td>
<td>2.60</td>
</tr>
<tr>
<td>Moving rocks, trees, or shrubs at the base of a boulder to develop a safer landing zone</td>
<td>218</td>
<td>3.95</td>
<td>1.708</td>
<td></td>
<td>3.51</td>
</tr>
<tr>
<td>Leaving tick marks when done bouldering</td>
<td>217</td>
<td>2.98</td>
<td>1.523</td>
<td></td>
<td>2.81</td>
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<tr>
<td>Placing gear and crash pads on vegetation</td>
<td>219</td>
<td>3.28</td>
<td>1.496</td>
<td></td>
<td>3.00</td>
</tr>
<tr>
<td>Global Perceptions and Behavior Change$^3$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leave No Trace is time consuming</td>
<td>217</td>
<td>2.97</td>
<td>1.658</td>
<td></td>
<td>2.69</td>
</tr>
<tr>
<td>Leave No Trace limits my freedom in the outdoors</td>
<td>217</td>
<td>2.14</td>
<td>1.294</td>
<td></td>
<td>1.82</td>
</tr>
<tr>
<td>If informed that my actions in the Park damaged the environment, I would change my behavior</td>
<td>217</td>
<td>6.43</td>
<td>.815</td>
<td></td>
<td>6.11</td>
</tr>
</tbody>
</table>

1 Scale: 0= None to 6= Expert  
2 Scale: 1= Very Inappropriate to 7= Very Appropriate  
3 Scale: 1= Strongly Disagree to 7= Strongly Agree

Comparisons of mean scores revealed additional response differences between the two groups. *Indoor learners* consistently reported attitudes less in line with recommended Leave No Trace-related practices when compared to *outdoor learners*. For example, behaviors such as *Playing music through external speakers; Stashing crash pads for later use; and Moving rocks, trees, or shrubs to develop safer landing zones* are considered inappropriate behaviors by strictly
interpreted Leave No Trace-based practices. However, *indoor learners* evaluated these items more favorably than did *outdoor learners*, an indication of attitudes that are less congruent with Leave No Trace recommendations.

Respondents were asked about their perceptions of Leave No Trace as a program by indicating their level of agreement with a series of items. *Indoor learners* tended to report less favorable perceptions of Leave No Trace than did *outdoor learners*. For example, *indoor learners* were more likely than *outdoor learners* to agree that *Practicing Leave No Trace is time consuming*, and that *Leave No Trace limits my freedom in the outdoors*. These results suggest that *indoor learners* hold a stronger perception that Leave No Trace is constraining and limiting to their outdoor recreation experiences. Interestingly, when responding to the statement, *If informed that my behaviors damaged the environment I would change my behavior*, *outdoor learners* were significantly less likely to agree (*M* = 6.11) than were *indoor learners* (*M* = 6.44, *t* = 2.502, *p* < .05), suggesting a greater willingness for behavioral change among *indoor learners*.

Next, we assigned respondents to one of four categories based on the where they learned to boulder (*indoor* or *outdoor*) and their self-reported bouldering ability (*novice* or *advanced*). Categories included: *Indoor novice*, *Indoor advanced*, *Outdoor novice*, and *Outdoor advanced*. Categories were mutually exclusive, meaning that each respondent could be assigned to only one category. One-way between-subjects ANOVAs were used to evaluate whether there were differences in attitudes, global perceptions, and self-reported knowledge of Leave No Trace across the four respondent categories (Table 2). Age and years of previous experience differed significantly across categories. *Indoor novices* tend to be younger (*M* = 25.0 years) and have fewer years of experience (*M* = 3.4 years). The data show a general trend of increasing age and previous years of experience as the categories progress to *Indoor advanced* and *Outdoor novice*. Those in the *Outdoor advanced* category were the oldest (*M* = 32 years) and most experienced (*M* = 12 years).
Table 2-2. Analysis of variance: Grouping by where respondents initially learned to climb by self-reported bouldering ability.

<table>
<thead>
<tr>
<th>Category*</th>
<th>n</th>
<th>Indoor Novice</th>
<th>Indoor Advanced</th>
<th>Outdoor Novice</th>
<th>Outdoor Advanced</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution of cases</td>
<td>217</td>
<td>53</td>
<td>92</td>
<td>28</td>
<td>44</td>
<td></td>
<td></td>
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<tr>
<td>Group characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>214</td>
<td>25.0&lt;sup&gt;a&lt;/sup&gt;</td>
<td>5.413</td>
<td>25.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.669</td>
<td>29.1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>5.334</td>
</tr>
<tr>
<td>Years of previous bouldering experience</td>
<td>215</td>
<td>3.4&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.021</td>
<td>6.6&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.663</td>
<td>6.3&lt;sup&gt;b&lt;/sup&gt;</td>
<td>4.821</td>
</tr>
<tr>
<td>Knowledge of Leave No Trace practices&lt;sup&gt;1&lt;/sup&gt;</td>
<td>194</td>
<td>3.83&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.781</td>
<td>4.11&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>.970</td>
<td>4.20&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>.913</td>
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<tr>
<td>Attitudes&lt;sup&gt;2&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Playing music through external speakers</td>
<td>219</td>
<td>2.75</td>
<td>1.399</td>
<td>2.47</td>
<td>1.353</td>
<td>2.36</td>
<td>1.615</td>
</tr>
<tr>
<td>Stashing crash pads for later use</td>
<td>220</td>
<td>3.04</td>
<td>1.480</td>
<td>3.02</td>
<td>1.617</td>
<td>2.75</td>
<td>1.578</td>
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<tr>
<td>Moving rocks, trees, or shrubs at the base of a boulder to develop a safer landing zone</td>
<td>218</td>
<td>4.04</td>
<td>1.786</td>
<td>3.93</td>
<td>1.685</td>
<td>3.96</td>
<td>1.675</td>
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<tr>
<td>Leaving tick marks when done bouldering</td>
<td>217</td>
<td>3.49&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.527</td>
<td>2.69&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>1.458</td>
<td>3.19&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>1.520</td>
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<tr>
<td>Placing gear and crash pads on vegetation</td>
<td>219</td>
<td>3.45</td>
<td>1.539</td>
<td>3.22</td>
<td>1.482</td>
<td>3.21</td>
<td>1.449</td>
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<td>Global Perceptions and Behavior Change&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Leave No Trace is time consuming</td>
<td>217</td>
<td>3.10</td>
<td>1.640</td>
<td>2.90</td>
<td>1.664</td>
<td>2.67</td>
<td>1.641</td>
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<tr>
<td>Leave No Trace limits my freedom in the outdoors</td>
<td>217</td>
<td>2.24</td>
<td>1.365</td>
<td>2.10</td>
<td>1.267</td>
<td>1.70</td>
<td>.775</td>
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<tr>
<td>If informed that my actions in the Park damaged the environment, I would change my behavior</td>
<td>217</td>
<td>6.55</td>
<td>.783</td>
<td>6.37</td>
<td>.835</td>
<td>6.04</td>
<td>1.255</td>
</tr>
</tbody>
</table>

<sup>1</sup> Scale: 0=None to 6=Expert  
<sup>2</sup> Scale: 1=Very Inappropriate to 7=Very Appropriate  
<sup>3</sup> Scale: 1=Strongly Disagree to 7=Strongly Agree  
* Superscripts represent significantly different groups (Tukey posthoc)
Of particular interest are the findings related to self-reported knowledge of Leave No Trace. The results of the ANOVA examining mean differences in knowledge scores between the groups, was statistically significant \((F = 5.021, \ p < .01)\). Those who learned to boulder indoors fell on the lower end of the knowledge scale, with *Indoor novices* reporting the least knowledge \((M = 3.83)\), followed by those in the *Indoor advanced* category \((M = 4.11)\). On the upper end are those who learned to boulder outdoors. *Outdoor novices* fell just below those in the *Outdoor advanced* category with mean scores of 4.20 and 4.59 respectively. The line chart shown in Figure 1 illustrates these differences. These findings support the notion that those who learn to boulder indoors tend to enter the sport, and eventually the outdoors, with significantly less self-perceived knowledge of Leave No Trace recommended practices.

![Mean Leave No Trace knowledge scores by respondent group segmentation.](image)

Means for the attitude and perception measures showed variation across categories. While not all comparisons yielded statistically significant results, there are general patterns that emerge in the data. In general, *Indoor novices* showed a tendency to hold attitudes and
perceptions that were less congruent with Leave No Trace-related practices compared to the other categories. Alternatively, those in the Outdoor advanced category tend to report attitudes and perceptions most in line with Leave No Trace-related recommendations. Taken together, these results seem to indicate that, when compared to those who learned to boulder outdoors, indoor learners tend to have attitudes and perceptions less in line with minimum-impact recommendations, and report less knowledge of Leave No Trace. Moreover, level of specialization also appears to play a role, as mean scores generally trend in a positive direction across indoor and outdoor learners when accounting for self-reported bouldering ability.

**Discussion and Management Implications**

The purpose of this research was to examine the extent to which boulderers differ with regard to their attitudes, perceptions and knowledge of Leave No Trace recommended practices when accounting for where they initially learned to boulder, as well as their level of bouldering ability. The segmentation analysis was successful in identifying differences in attitudes, perceptions, and knowledge across respondent groups, thus highlighting specific areas where the focus of future education and outreach efforts might be most expedient.

In general, those who learned to climb indoors in a gym and reported novice levels of bouldering ability, were less knowledgeable of Leave No Trace, and reported attitudes and behaviors less in line with minimum-impact bouldering recommendations. They also expressed a stronger perception that Leave No Trace recommended practices are time consuming and limiting to their freedom in the outdoors. These results suggest that increased educational efforts should be targeted towards those who are new to the sport and are learning in an indoor setting.

Results suggest that for most boulderers, their experience with the sport begins in the gym and then progresses to climbing outdoors. Thus, in order to ensure the protection of the often
fragile natural environments that host the activity, it is essential that they enter the outdoor setting with requisite knowledge and skills of Leave No Trace recommended practices in general, and those related to bouldering specifically. These findings suggest that opportunities exist to deliver Leave No Trace-related minimum-impact bouldering information in the climbing gym setting, as well as other introductory-level instructional classes and workshops. With proactive interest to engage boulderers in the management process, there is potential to develop specific minimum-impact practices associated with the activity. Research such as this provides insight to effective communication approaches to engage and educate this group in order to develop best messaging practices.

Nearly 70% of respondents in this study indicated they first learned to climb indoors in a gym. Furthermore, significant knowledge and attitudinal differences were found based on where one learned to climb. This research confirms the priority to enhance education and outreach efforts within the climbing gym industry. Recreation managers should continue with, and expand upon, collaborative partnerships with external agencies and constituent groups in outreach and education efforts.

These findings also provide information that can be used to develop a “standard” set of minimum-impact bouldering principles and ethics, which currently does not exist. The Leave No Trace Center for Outdoor Ethics along with other advocacy groups (e.g. The Access Fund) are currently in the process of developing these messages and materials (B. Lawhon, personal communication, May 26, 2016), and will employ these results to craft effective messaging strategies. It is essential that messages be clear, concise, and consistent to ensure uniform adoption across various information outlets. Once developed, these principles should be disseminated widely across outlets and mediums (e.g. websites, brochures, equipment, indoor and outdoor bouldering areas, etc.).
In effort to reinforce minimum-impact messages and appropriate behaviors, managers should continue with, and expand upon, on-site education and messaging efforts via signage, website, and direct ranger or volunteer contact. For example, volunteer teams of “climbing stewards” could be employed to model minimum-impact practices and actively engage boulderers in conversations about best practices in the field. This is a strategy that RMNP implemented in 2015. Based on the high agreement of respondents about their willingness to change behaviors if they knew they were causing impacts, particularly among indoor learners of novice ability, messaging that contains a notion of shared responsibility for resource protection might prove effective. Websites could be updated with more prominent focus on bouldering activities and recommendations for minimum-impact bouldering practices for the particular location. Interpretive signage could be installed at key trailheads that include information for boulderers, as well as information for other visitors about the practice of bouldering in the area. This could serve the dual function of providing site-specific information for boulderers, while informing other visitors could help mitigate inter-group user conflicts.

Limitations and Future Research

While these data provide empirical evidence of the relationship between the context where one learns to boulder and the attitudes, knowledge, and perceptions they associate with Leave No Trace, there are limitations research implications that should be noted. First, the study was conducted at one park in the United States, and thus the generalizability of the results may be limited. Future research such as this should be conducted at various national and international locations to capture a more representative sample of the bouldering population. A related limitation is that our sample included only people who were actively bouldering outdoors. That is, we did not administer the survey in the climbing gym setting. It is possible that respondents
therefore already had previous exposure to outdoor bouldering norms and expectations, perhaps through park informational materials or other climbers, which may have skewed the results. We recommend extending this research into the climbing gym setting in effort to collect data from indoor learners who have not yet transitioned to the outdoors. Finally, we suggest that after focused minimum-impact bouldering education programs be implemented, future research be conducted that examines the efficacy of such efforts, as well as examining the influence of site-specific education efforts (such as in Rocky Mountain National Park) on ecological impacts.

**Conclusion**

It is essential that recreation managers work in collaboration with emerging user-groups, such as boulderers, in order to develop management strategies that promote the protection of resources while maintaining quality recreational opportunities. The findings from this study may help inform the development and implementation of such strategies. This study identified significant differences in attitudes toward, and knowledge of, Leave No Trace practices depending on whether one initially learned to boulder indoors in a gym or in an outdoor setting. Significant differences were also identified by level of specialization in bouldering. These findings confirm and provide support for continued and expanded efforts for collaborative work among the gym climbing industry, public land agencies, and bouldering interest and advocacy groups in the development and delivery of minimum-impact bouldering information and educational resources.

**References**


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Chapter 3

Study Two: Examining the efficacy of Leave No Trace education programs for youth: A study of the Leave No Trace Promoting Environmental Awareness in Kids (PEAK) program

Title: Will they leave what they find? The efficacy of a Leave No Trace education program for youth.


- Article Type: Research article
- Word Limit: 3,500 (Abstract < 100)

Proposed Authors: Schwartz, F., Taff, B. D., Lawhon, B., Hodge, C. & Will, E.

Abstract: The authors explored the influences of a youth-focused Leave No Trace educational program on participants’ attitudes, behaviors, and nature connectedness. The study employed an experimental, equivalent control-group design and included survey and direct observation measures. Pre- and post-test surveys provided self-report measures of attitudes and nature connectedness, while direct observations examined participants’ behavior toward keeping or leaving objects found in nature. Participants who received the PEAK educational program reported positive attitude changes above and beyond participants who did not receive the program, and left found objects more often than those in the control group.

Keywords: Leave No Trace, environmental education, attitudes, youth
Introduction

Decreased outdoor and nature-based activity is negatively related to mental and physical well-being among youth (Louv, 2008). Less is known about the relationship youth have to environmental stewardship and environmentally responsible behavior. Researchers have recently begun to explore this relationship. For example, in a study spanning 1976 to 2005, Wray-Lake, Flanagan, and Osgood (2010) found that taking personal responsibility for the environment and conservation behavior has declined in adolescents. They argue there has been a decline in knowledge regarding the scarcity of natural resources stemming from a rise in consumerism and materialism in the U.S., and suggest this decline in knowledge has led to a decreased concern for the environment among youth (Wray-Lake et al., 2010).

Today’s youth will inevitably become national and global leaders with responsibility for environmental stewardship and sustainability, and trends among young people can serve as a barometer for social change (Wray-Lake et al., 2010). Significant life experiences in the childhood years have powerful influence to inform attitudes, values, and behaviors throughout life, especially those related to issues of the environment (Chawla, 1998). And these early experiences in nature have been shown to be strong predictors of future environmental stewardship (Chawla & Cushing, 2007). Adolescents’ reduced time spent outdoors and environmental concern call for educational and programmatic interventions to promote environmental consciousness among this rising generation (Wray-Lake et al., 2010). Environmental education interventions are one way to develop greater environmental consciousness and outdoor activity among youth.
Youth and Environmental Education

In her review, Davis (2009) identified three areas of inquiry regarding youth and environmental education (EE) research: (a) youth’s relationships with nature (education in the environment), (b) youth understandings of environmental topics (education about the environment), and (c) youth and environmental behaviors (education for the environment). Generally, literature around education in and about the environment suggests that young people who participate in EE programs develop a greater connection to nature and an increased knowledge of the environment and natural processes (e.g. Barratt Hacking, Barratt, & Scott, 2007; Wells & Lekies, 2006). Davis (2009) suggested studies involving youth and education for the environment are still needed. Where such studies do exist, researchers have typically utilized self-report measures of behavior, or behavioral intent, as surrogates for actual behavior (e.g. participation in home recycling programs). Studies utilizing actual behavioral observations are practically non-existent in the EE literature (Camargo & Shavelson, 2009).

While getting children outside and experiencing natural environments is a critical step in fostering environmental stewardship, research shows that increased use of natural and recreational areas increases the probability of negative impacts on the environment (Mari, Leung, Eagleston, & Burroughs, 2016). Thus, it is essential that children not only be provided opportunities to engage in EE programs, but also taught basic minimum-impact outdoor skills necessary for the long-term health of the natural environment.

Leave No Trace: Promoting Educational Awareness in Kids

Recognizing the need for youth education in minimum-impact outdoor skills, The Leave No Trace Center for Outdoor Ethics developed the Promoting Environmental Awareness in Kids
(PEAK) program to teach children about the environment and how to recreate responsibly in the out-of-doors (LNT, n.d.). However, little is known as to the effectiveness of the PEAK program. One study measured the effect of the PEAK program on children’s knowledge of Leave No Trace principles following participation in a one-day program (see Miller, Shellman, Hill, Ramsing, & Lawhon, 2014). The authors noted a significant increase in knowledge scores between pre- and post-test; however, knowledge does not necessarily translate to behavior change (Hungerford & Volk, 1990; Hwang, 2000; Manning, 2003; Petty, McMichael, & Brannon, 1992), and this is particularly true of Leave No Trace-related behaviors (Vagias & Powell, 2010). Therefore, more research needs to be conducted to understand the effect of PEAK on attitudes and behavior.

Previous research has established that attitudes influence behaviors (Ajzen, 2001; Fishbein & Manfredo, 1992; Ham & Krumpe, 1996; Heberlein, 2012). Accordingly, Leave No Trace behavior is influenced in part by attitudes toward specific Leave No Trace guidelines and recommended practices. Understanding the influence of PEAK education on attitudes related to Leave No Trace is essential for the development of educational programs that foster positive attitude and behavior change. Thus, the purpose of this study was to measure the influence of a PEAK educational program on the attitudes and behaviors of youth participants using an experimental, equivalent control-group design that included survey and direct observation measures.
Methods

Site and Sample

The research was conducted in Pennsylvania, U.S.A., at an outdoor school (ODS) program for fifth and sixth grade students. ODS is a four-day, three-night residential environmental education program that uses nature-based experiential learning techniques to teach about the interrelatedness of humans and the natural environment. Participants consisted of primarily fifth grade students from participating schools in three counties surrounding the ODS location.

Data for this study were collected during the six-week spring 2016 ODS season, from March 29 - May 13, 2016. Students spend four days at ODS (Tuesday morning through Friday). A typical day involves a combination of outdoor lessons, free time activities, cabin time, meals and campfire activities. For the outdoor lessons students are randomly assigned to “learning groups” of 10 to 12 students. While much of the ODS curriculum is built around environmental and nature-based themes and topics there is currently no explicit discussion of Leave No Trace or other similar outdoor ethics concepts, thus creating a baseline control condition.

All spring 2016 ODS students ($N = 360$) were eligible for participation. Upon Institutional Review Board (IRB) approval, a letter describing the study and a parental consent form were included with the ODS registration forms. Parental consent was provided for 357 children (99%).

1 Due to word count limitations of the targeted journal for this manuscript, an abbreviated methods discussion is presented here. Detailed study methods are provided in Appendix E.
Educational Intervention

The intervention was a single 30-minute educational module from the Leave No Trace PEAK program titled “Unlocking the Past” focused on the Leave What You Find Principle (LWYF). LWYF teaches the importance of leaving artifacts and other natural objects behind for future visitors to enjoy. It stresses leaving places in their natural state so as to preserve the ecological, cultural, and historical value of the place. This principle was selected because: (1) the prescribed behavior is observable at the individual level (e.g. whether someone removes a fossil from a rock outcrop), and (2) it involves the highest level of ethically grounded decision-making compared to the other principles.

Students were randomly assigned to learning groups, and learning groups were randomly assigned to treatment or control conditions. Learning groups selected to receive the treatment participated in the PEAK educational module on the first day (Tuesday) of ODS during a three-hour nature walk that includes a combination of games, teambuilding activities, and educational components. Control groups participated in the same nature walk program without the PEAK module.

Survey Instrument

Pre- and post-test surveys measured attitudes toward the LWYF Principle. Respondents indicated the extent to which they agreed or disagreed with a series of behavior-related statements regarding the appropriateness of keeping things found in nature (e.g., *It is wrong to collect fossils*). Responses used a five-point Likert Scale ranging from one ("strongly disagree") to five ("strongly agree"). Thus, respondents who agreed that keeping objects they find in nature was acceptable would have attitudes less aligned with the LWYF Principle.
Post-test survey items, presentation order, and design were identical to pre-test surveys, with the addition of two items examining nature connectedness as related to found objects. Taking home natural objects found during an outdoor experience is often cited as a reminder of the event, like a souvenir (Ward & Roggenbuck, 2003; Taff et al., 2014). To explore this concept, we asked respondents to evaluate: (1) the importance they attributed to keeping found objects, and (2) the extent to which keeping a natural object might foster connections with nature. These items were not included on the pre-survey to avoid biasing participant behaviors during the observation phase of data collection (Schwarz, 1999). Pre-test surveys were administered on the first day of ODS. Post-test surveys were administered on the last day of ODS. After removing incomplete and unmatched surveys, 346 matched-pair surveys were collected ($n_{control} = 153$; $n_{treatment} = 193$). Females represented 54% of the sample.

**Field Experiment and Behavior Observation**

The behavior of interest was whether students decided to keep a unique object they discovered during an ODS activity. We devised a field experiment that created opportunities for students to find arrowheads, fossils, or pyrite in a seemingly natural and authentic context. These three objects are known to occur in the geographical region, and are considered collector’s items. Therefore, the discovery of one of these objects would create a novel nature-based experience requiring students to navigate a moral/ethical dilemma of what to do with the found object.

The field experiment and behavior observations were conducted during the second and third days (i.e., not on the nature walk day) of ODS. During an interactive lesson at one of three previously identified sites, students engaged in digging and sifting through soil layers and taking note of what they found to better understand soil. Researchers prepared the sites in advance by burying the objects of interest within a dig plot. Objects were buried to be easily found during the
activity, while also appearing to be naturally occurring. Each dig site consisted of three individual 14-inch dig plots, spaced approximately eight to ten feet apart. One object was buried within each dig plot. For consistency, plot one always contained an arrowhead, and plots two and three the fossil and piece of pyrite respectively. Learning groups of 10 to 12 students were randomly assigned to one of the three dig sites, and then groups of three to four students were randomly assigned to dig plots. Two researchers worked independently at each dig site, noting the type and number of objects found and kept.

A total of 48 learning groups participated under control conditions and 54 learning groups participated in the educational treatment. An initial variable of interest during the observations was whether or not the pre-buried object of interest was found during the activity. For objects that were discovered, we then recorded whether the object was kept or left at the dig site. Objects were evenly distributed across conditions and groups.

**Results**

**Attitudes toward Leave What You Find Behaviors**

Overall, results of paired samples t-tests suggest the treatment group held attitudes more in line with the LWYF Principle than did the control group (Table 3-1). That is, while the data indicate positive shifts in attitudes from pre- to post-test for both groups, those in the treatment group showed a tendency to report post-test scores in greater agreement with LWYF than those in the control group. For some behaviors both groups reported significant changes in attitudes to better align with LWYF. For example, attitudes toward picking flowers in nature (Item 1) significantly improved in both groups, with both becoming less supportive of the behavior at the time of post-test. The same is true for Item 6 regarding collecting rocks.
Table 3.1. Comparison of attitude measures by treatment group: paired and independent samples t-tests.

<table>
<thead>
<tr>
<th>When visiting nature…</th>
<th>Control</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>1. It is OK to pick flowers.</td>
<td>Mean 2.73</td>
<td>2.16***</td>
</tr>
<tr>
<td></td>
<td>N 146</td>
<td>146</td>
</tr>
<tr>
<td></td>
<td>SD 1.288</td>
<td>1.083</td>
</tr>
<tr>
<td>2. It is wrong to pick up natural objects even if you put them back where you found them.</td>
<td>Mean 3.08</td>
<td>2.67**</td>
</tr>
<tr>
<td></td>
<td>N 146</td>
<td>146</td>
</tr>
<tr>
<td></td>
<td>SD 1.329</td>
<td>1.249</td>
</tr>
<tr>
<td>3. It is OK to collect live animals.</td>
<td>Mean 2.94</td>
<td>2.93</td>
</tr>
<tr>
<td></td>
<td>N 141</td>
<td>141</td>
</tr>
<tr>
<td></td>
<td>SD .845</td>
<td>.848</td>
</tr>
<tr>
<td>4. It is wrong to collect fossils.</td>
<td>Mean 2.27</td>
<td>2.00*</td>
</tr>
<tr>
<td></td>
<td>N 147</td>
<td>147</td>
</tr>
<tr>
<td></td>
<td>SD 1.366</td>
<td>1.398</td>
</tr>
<tr>
<td>5. It is OK to collect insects.</td>
<td>Mean 2.57</td>
<td>2.85*</td>
</tr>
<tr>
<td></td>
<td>N 143</td>
<td>143</td>
</tr>
<tr>
<td></td>
<td>SD 1.302</td>
<td>1.251</td>
</tr>
<tr>
<td>6. It is wrong to collect rocks.</td>
<td>Mean 2.37</td>
<td>2.18</td>
</tr>
<tr>
<td></td>
<td>N 139</td>
<td>139</td>
</tr>
<tr>
<td></td>
<td>SD 1.342</td>
<td>1.309</td>
</tr>
<tr>
<td>7. It is OK to keep arrowheads.</td>
<td>Mean 2.62</td>
<td>3.07***</td>
</tr>
<tr>
<td></td>
<td>N 138</td>
<td>138</td>
</tr>
<tr>
<td></td>
<td>SD 1.363</td>
<td>1.461</td>
</tr>
<tr>
<td>8. It is OK to collect animal bones or antlers.</td>
<td>Mean 3.76</td>
<td>3.58</td>
</tr>
<tr>
<td></td>
<td>N 139</td>
<td>139</td>
</tr>
<tr>
<td></td>
<td>SD 1.172</td>
<td>1.285</td>
</tr>
<tr>
<td>9. It is best to look but don’t touch the things you find</td>
<td>Mean 3.46</td>
<td>3.45</td>
</tr>
<tr>
<td></td>
<td>N 145</td>
<td>145</td>
</tr>
<tr>
<td></td>
<td>SD 1.236</td>
<td>1.252</td>
</tr>
<tr>
<td>10. It is OK to pick up things as long as you leave them where you found them.</td>
<td>Mean 4.23</td>
<td>4.27</td>
</tr>
<tr>
<td></td>
<td>N 146</td>
<td>146</td>
</tr>
<tr>
<td></td>
<td>SD 1.127</td>
<td>1.039</td>
</tr>
<tr>
<td>11. It is important to leave nature as you find it so others may enjoy it.</td>
<td>Mean 2.85</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N 146</td>
<td>151</td>
</tr>
<tr>
<td></td>
<td>SD 1.269</td>
<td></td>
</tr>
<tr>
<td>12. Bringing a natural object home from nature is important to me.</td>
<td>Mean 3.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N 146</td>
<td>152</td>
</tr>
<tr>
<td></td>
<td>SD 1.385</td>
<td></td>
</tr>
</tbody>
</table>

Note: asterisks indicate statistically significant differences between pre- and post-test scores based on paired samples t-tests, where *p < .05; ** p < .01; *** p < .001

1 These items were only included in the post-test survey instrument.

2 Indicates statistically significant difference in mean post-test scores between control and treatment groups.
Alternatively, significant changes in attitudes toward the keeping of arrowheads (Item 7) were less in line with the LWYF Principle for both the control and treatment groups, indicating participants became more supportive of the behavior from pre- to post-test. The changes for the control group participants were greater than those in the treatment: a mean change of .45 and .23 respectively. Comparisons of mean post-test scores indicated that those in the treatment group ($M = 2.56, SD = 1.353$) had a greater tendency to evaluate this behavior as negative, while the mean score for the control group ($M = 3.07, SD = 1.461$) is just above the midpoint on the scale indicating more favorable attitudes toward keeping arrowheads.

When examining attitudes toward more general LWYF behaviors (Table 3-1), the control and treatment groups reported a high level of agreement with item 11 at both pre- and post-test. Results from Item 10 indicate that treatment group participants reported significant attitudinal shifts, becoming more likely to agree with the statement. Those in the control reported no changes in attitude toward this behavior.

Overall, while not all item comparisons revealed significant differences, general trends in the data suggest that those who participated in the treatment left the ODS program with more positive attitudes toward LWYF than did those in the control.

**Nature Connectedness**

Items 12 and 13 addressed nature connectedness (Table 3-1). Results indicate significant differences between control and treatment groups on both items. Participants in the treatment group were significantly less likely to agree with item 11 ($M = 2.85, SD = 1.269$) than control participants ($M = 2.20, SD = 1.148$), and item 12 ($M = 2.73, SD = 1.348$; and $M = 3.05, SD = 1.385$) respectively, indicating greater alignment with LWYF. These results suggest participating
in the LWYF educational program led participants to associate less importance with keeping natural objects as a way to feel more connected to nature.

**Behavioral Observations**

**Rate of object discovery.** The control group found the object 41 times out of 48 discovery opportunities (85%) (Table 3-2). Pyrite had the greatest likelihood of being found (94%) followed by arrowheads (88%) and fossils (75%). Treatment groups found 40 objects out of 54 opportunities (74%). Pyrite was found 100% of the time, followed by fossils (72%) and arrowheads (50%). Thus, differences in LWYF behaviors were based upon a nearly identical number of objects found (e.g., $n_{control} = 41$; $n_{treatment} = 40$).

**Rate of object removal.** Participants in control groups removed 29 of 41 found objects (71%) (Table 3-2). Arrowheads were most likely to be kept (86%), followed by pyrite (67%), and fossils (58%). Participants in treatment groups removed 24 of 40 found objects at a rate of 11% less (60%). Arrowheads were most likely to be kept (78%), followed by pyrite (67%), and fossils (39%).
Table 3-2. Relationship between objects of interest and number of objects found and kept.

<table>
<thead>
<tr>
<th>Object</th>
<th>Control</th>
<th>Treatment</th>
<th>Condition</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total N</td>
<td>Found</td>
<td>Kept</td>
<td>Total N</td>
</tr>
<tr>
<td>N</td>
<td>16</td>
<td>14</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>Arrowhead</td>
<td>% within Arrowhead</td>
<td>87.5%</td>
<td>85.7%</td>
<td>50.0%</td>
</tr>
<tr>
<td>% within Condition</td>
<td>34.1%</td>
<td>41.4%</td>
<td>22.5%</td>
<td>29.2%</td>
</tr>
<tr>
<td>N</td>
<td>16</td>
<td>12</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>Fossil</td>
<td>% within Fossil</td>
<td>75.0%</td>
<td>58.3%</td>
<td>72.2%</td>
</tr>
<tr>
<td>% within Condition</td>
<td>29.3%</td>
<td>24.1%</td>
<td>32.5%</td>
<td>20.8%</td>
</tr>
<tr>
<td>N</td>
<td>16</td>
<td>15</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>Pyrite</td>
<td>% within Pyrite</td>
<td>93.8%</td>
<td>66.7%</td>
<td>100.0%</td>
</tr>
<tr>
<td>% within Condition</td>
<td>36.6%</td>
<td>34.5%</td>
<td>45.0%</td>
<td>50.0%</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>41</td>
<td>29</td>
<td>54</td>
</tr>
<tr>
<td>% within Object</td>
<td>85.4%</td>
<td>70.7%</td>
<td>74.1%</td>
<td>60.0%</td>
</tr>
<tr>
<td>% within Condition</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Discussion and Implications

Youth are spending less time outdoors—a trend linked to decreased environmental concern, knowledge, and stewardship. Scholars have called for effective educational interventions to promote environmental consciousness in youth (see Louv, 2008; The Outdoor Foundation, 2010; Wray-Lake et al., 2010). The present research responded to this call by investigating the influence and efficacy of a Leave No Trace educational program on the attitudes and behaviors of youth participants.

While both control and treatment groups reported attitudes generally in line with LWYF at pre-test, treatment group participants reported attitudes in greater alignment with LWYF after the intervention. Individuals with positive attitudes toward a behavior are more likely to then perform that behavior (Ajzen, 1991; 2011). Therefore, the positive attitudes reported by participants from the treatment group suggest they may subsequently behave in a manner more consistent with the LWYF Principle. However, self-report attitudinal measures are not always accurate and must be interpreted with caution (Camargo & Shavelson, 2009).
The behavioral data reported in this study address that limitation. Supporting the attitude-behavior thesis, we found that treatment group participants removed objects found in nature 11% less frequently (60% removal rate) than control groups (71% removal rate). While we expected lower removal rates overall, the novelty of finding an arrowhead, fossil, or pyrite is different than finding common objects such as acorns or wildflowers. Therefore, the uniqueness of the find might explain the relatively high object removal rate. Overall, however, treatment group participants left objects in place at a higher rate than did the control group participants.

Even though objects were kept more often than not, the majority of participants across both groups indicated that taking home an object they find in nature was not an important part of the experience. LWYF program participants, however, were significantly more likely to evaluate the behavior as unimportant, and the majority disagreed further that bringing natural objects home helped them feel connected to nature. A common critique of the Leave No Trace program is that it discourages human interactions with the natural world, where one should not pick up or interact with things they find (Simon & Alagona, 2009). These results provide evidence to the contrary, suggesting that participating in the LWYF educational program led participants to associate less importance with the keeping of natural objects, which could be further indication they will be less inclined to keep found natural objects in the future.

The fact that significant differences in attitudes and behavior were present after only a 30-minute program that broadly covered the LWYF concept, it stands to reason that a more intensive (e.g., longer, more elaborate) outdoor ethics curriculum might have even greater positive influence on outdoor behaviors. Further research is needed to better understand the extent to which outdoor ethics education might influence environmentally responsible recreation behaviors in youth.

The results of this research are intended to provide guidance for the development of future Leave No Trace programs for youth. They also provide further support for the value and
importance of outdoor and environmental education programs for youth. Though limited research of this kind has been conducted, most of which has been hypothetical and attitudinal rather than behavioral and experimental, there have been no such studies of this kind related to youth and Leave No Trace to date. As such, this study provides a unique addition to the scientific and professional literature on parks and protected areas, and the limited body of literature on alternative management practices for reducing outdoor recreation-related impacts in parks and protected areas. Additionally, the study helps to fill a gap in the youth environmental education literature concerned with the effectiveness of programs designed to educate for the environment.

At a time when outdoor activity and environmental concern among youth is trending downward, it is essential that we continue our efforts, through both research and practice, to get children outside and interacting with the natural environment. Today’s youth will be the leaders of tomorrow, responsible for the health of the natural environment. This research supports the notion that Leave No Trace education for youth can make a positive impact on attitudes and behaviors for the environment.

References


http://doi.org/10.1080/13504620701581539

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http://doi.org/10.1080/00958964.1990.10753743


Chapter 4

Study Three: Examining the efficacy of combined Leave No Trace educational messaging and direct site management actions in reducing undesignated trail use in an urban-proximate open space context

Title: Please stay on designated trails: An application of the Theory of Planned Behavior to understand Leave No Trace attitudes and behaviors in the context of recreational trail use

Target Journal: Environment & Behavior.

- Article Type: Research article
- Word Limit: 25-40 pages (Abstract <150)

Proposed Authors: Schwartz, F., Taff, B. D., Lawhon, B., VanderWoude, D.

Abstract. The use and creation of undesignated trails can lead to erosion, vegetation damage, unsafe trail conditions, and impacts to local wildlife. The mitigation of undesignated trail use is typically addressed indirectly through visitor education such as Leave No Trace, or directly through closures or sanctions. Researchers collaborated with City of Boulder Open Space and Mountain Parks (OSMP) staff to develop a quasi-experimental field study that examined the effectiveness of indirect (messaging) and direct (barriers) management approaches to mitigating undesignated trail use. The study applied a theory of planned behavior framework, utilized Leave No Trace messaging, and employed a method to pair survey and direct observation data. A total of 2,232 visitor parties were observed, and 225 surveys were collected. The combined direct (barrier) and indirect (messaging) intervention was the most effective at mitigating undesignated trail use. Implications for management and future research are discussed.

Keywords: Leave No Trace, Theory of Planned Behavior, visitor education, visitor use management, informal trails
Introduction

Recent trend data indicate that a continued increase in recreational use of public and protected areas nationwide, including open space, is likely to occur over the coming years (The Outdoor Foundation, 2013; USFS, 2010). Research has shown that increasing visitation often leads to increased impacts to soils, vegetation, wildlife and other visitors (Hammit, Cole, & Monz, 2015). Public land resources in urban-proximate locations, such as the 45,000 acre Open Space and Mountain Parks (OSMP) system in the City of Boulder Colorado, may be especially susceptible to the impacts related to increased outdoor recreation visitation (Kyle & Graefe, 2007). Like many public land managing agencies OSMP is charged with the often-conflicting management directives of preservation of critical plant and animal habitat, and the provision of quality opportunities for passive recreation such as hiking, horseback riding, cycling, and fishing (City of Boulder, 2005). As the population across the frontrange of Colorado has steadily increased, it is now estimated that OSMP receives over 5 million recreational visits per year (Vaske, Shelby & Donnelly, 2009).

Striking a balance between recreational quality and ecological integrity is a perennial concern among public land managers. The development of a recreational infrastructure of trails and recreation sites that concentrate visitor use on hardened durable surfaces is a commonly employed approach to achieving this balance (Marion, Leung, Eagleston, & Burroughs, 2016). Of critical concern here is the notion that increased visitation often correlates to an increase in visitors traveling off of and away from sustainably developed recreational facilities, leading to the creation and proliferation of undesignated trails (Park, Manning, & Marion, 2008). Accordingly, a recent inventory of OSMP land-use designation identified approximately 147 miles of designated trails across their system, and no less than 150 miles of undesignated trails (VanderWoude, Lezberg, & Cseke, 2015). VanderWoude and colleagues (2015) suggest that if
visitation increases, the extent of undesignated trail development is also likely to increase in the absence of a plan for managing the recreational desires of visitors on the OSMP system.

The OSMP Visitor Master Plan (VMP) provides “a framework for decisions that will ensure a continued high quality visitor experience, while at the same time ensuring that the lands are protected and preserved for future generations” (City of Boulder, 2005, p. ii). Importantly, the VMP mandated the development of a program to critically assess and manage undesignated trails on OSMP lands (City of Boulder, 2005). In order to effectively reduce use of undesignated trails, OSMP must have a better understanding of which types of trail management approaches are most effective at ensuring visitor compliance (i.e., adhering to closures and staying on designated trails). Furthermore, an understanding of the underlying reasons (e.g. intentional or unintentional) why visitors use undesignated trails is paramount for implementing specific management actions (or combinations of actions) to reduce use of such trails. Thus, understanding the relationships between management interventions and visitor behavior is critical for realizing lasting sustainability of OSMP lands. The purpose of this study is to investigate the efficacy of a range of management actions designed to mitigate the use of undesignated trails located within the OSMP system. Working in collaboration with OSMP managers, we developed a quasi-experimental field study that applied a range of treatments in an effort to achieve the highest possible reduction in undesignated trail use.

Review of the Literature

Undesignated trails (e.g. social, visitor-created, unofficial or informal trails) are identifiable pathways created and perpetuated by visitors outside of an area’s formally managed trail system (Leung, Newburger, Jones, Kuhn, & Woiderski, 2011). These undesirable trail segments are often products of heavy visitation coupled with diverse recreation interests and
motivations that draw visitors off of designated trails (Guo, Smith, Leung, Seekamp, & Moore, 2015). Because undesignated trails are not professionally designed, constructed or maintained they can contribute substantially greater impacts to protected area resources than designated trails (Wimpey & Marion, 2011; Marion & Wimpey, 2017). The proliferation of undesignated trail networks into protected landscapes and habitats threatens ecological integrity, aesthetics, and visitor experiences (Leung et al., 2011). Some off-trail travel is tolerated by the ecosystem; however, the amount of soil compaction and erosion that is acceptable is weighed against the level of visitation at each site (Kuo, 2002). Off-trail travel is not typically an illegal or sanctioned act on most public lands. However, when experienced at high levels it represents a visitor behavior that conflicts with resource protection objectives, prompting the need for management interventions to mitigate the problem behavior.

Problem recreation behaviors and visitor use issues are typically addressed through one of two approaches: indirectly through visitor education such as Leave No Trace or directly through enforcement, closures, or sanctions (Manning, 2003; Marion & Reid, 2007). Indirect management strategies have traditionally been the preferred approach to mitigating recreation-related resource impacts (Hammitt et al., 2015), as they tend to be less financially constraining, are perceived by visitors as less obtrusive, and are more in line with the experiential values associated with outdoor recreation (Marion et al., 2016; Park, Manning, & Marion, 2008; Reigner & Lawson, 2009).

Leave No Trace is the most prevalent minimum-impact educational program in use in parks and protected areas in the U.S. (Marion, 2014). The overarching intent of the program is to educate outdoor enthusiasts about the nature of their recreation-related impact as well as teach them techniques for minimizing impact (Harmon, 1997; Leave No Trace Center for Outdoor Ethics, 2016; Marion & Reid, 2007). The initial focus of Leave No Trace was on impacts in wilderness areas but has expanded to include other types of parks and protected areas. (Marion,
2014; Marion & Reid, 2001). Currently, Leave No Trace has a primary focus on frontcountry area visitors, and has created numerous educational resources addressing recreational pursuits common to these areas including day hiking, dog walking, biking, running, exercise, etc. (Leave No Trace Center for Outdoor Ethics, 2015; Marion, 2014). In 1998, OSMP was the first urban municipality to implement a frontcountry Leave No Trace program (Reid, 2000). As such, Leave No Trace education and information programs have historical precedent as an indirect management approach utilized on OSMP lands.

The extent to which indirect management strategies, such as Leave No Trace, are effective in achieving management objectives varies depending on a number of factors, such as: target resource impacts, recreation settings and contexts, characteristics and circumstances of the message, and visitor experiences and behaviors to which they are applied (Reigner & Lawson, 2009). In the case of recreational trail use, much of the research has focused largely on the use of persuasive messaging techniques (see Cialdini, 2003; Winter, Sagarin, Rhoads, Barrett, & Cialdini, 2000) to direct visitors onto designated trails and away from undesignated, or informal, trail networks (Bradford & McIntyre, 2007; Kidd et al., 2015; Park et al., 2008). Injunctive prescriptive messages (i.e., positively worded messages informing visitors of behaviors that align with management objectives) with an appeal to ecological concerns are suggested as the most effective approaches when enforceable laws or regulations do not exist (Bradford & McIntyre, 2007; Johnson & Swearingen, 1992; Winter et al., 2000; Winter, Cialdini, Bator, & Rhoads, 1998). With the exception of Habitat Conservation Areas, off-trail travel is not an illegal activity on OSMP lands, therefore education and information which utilizes a prescriptive and ecologically-grounded plea might be most effective in this setting. Moreover, Manfredo and Bright (1991) found that messages are most influential when originating from a trusted source. Others have suggested messages be clear and concise, and delivered early in a visitor’s planning process (Cole, Hammond, & McCool, 1997; Doucette & Cole, 1993; Ham & Krumpke, 1996).
Messages that stimulate personal responsibility and relevance (Knapp & Forist, 2014), are linked specifically to the target behavior (Widner & Roggenbuck, 2000), and are contextually specific (Vagias & Powell, 2010) have also proven efficacious.

Additionally, the location of messages has been identified as an important factor in their influence over visitor behavior. Strategies that target visitor behavior at or near the location where a given behavior is desired have been more successful than those placed at a general location (Hockett & Hall, 2007; McCool & Cole, 2000; Widner & Roggenbuck, 2000). For example, Bradford and McIntyre (2007) found that signs placed directly at undesignated trail intersections were significantly more effective at reducing undesignated trail use than were signs placed at an information kiosk at the area entry-point.

Finally, visitor education and information efforts are seen as having varying levels of effectiveness according to the nature of the behavior in question (Roggenbuck, 1992; Vander Stoep & Roggenbuck, 1996). Problem recreation behaviors can be classified into five basic types along a continuum: illegal, careless, unskilled, uninformed, and unavoidable actions (Manning, 2003). Each category is said to be influenced by visitor education and information to varying levels. On the two ends of the continuum, illegal and unavoidable actions are considered to be little influenced, whereas careless, unskilled, and uninformed actions are considered to be more amenable to education and information (Park et al., 2008). Regarding undesignated trail use it is important to understand, for example, whether recreationists travel off designated trails knowingly with intent, or if they end up off trail accidentally due to inadequate signage or some other reason. By understanding where off-trail behaviors lay on this continuum, managers are better informed to craft strategies for addressing the underlying causes.

However, as the continuum of behavior described above suggests, a routinely applied indirect management strategy may not always be the most effective approach (McAvoy & Dustin, 1983; Cole, 1995), particularly in areas that receive moderate to high use (Marion et al., 2016).
Direct approaches can efficiently alter visitor behavior, but need to be weighed against public perceptions, as these strategies tend to be perceived negatively and opposed by visitors (McCool & Christensen, 1996). McAvoy & Dustin (1983) write that direct approaches should be implemented in conjunction with indirect measures to best influence the formation of appropriate attitudes to govern subsequent behavior. This highlights the need to consider the efficacy of a range of management interventions - from indirect to direct - in developing strategies to alter visitor behavior.

**Theoretical Framework**

The Theory of Planned Behavior (TPB) was used in this research as a theoretical frame by which to examine underlying cognitive factors and attitude structures that contribute to trail use behavior. Since its introduction to the literature, the TPB is recognized as one of the most frequently cited and influential models for the prediction of human behavior (Ajzen, 2011). It has been celebrated for its parsimonious nature and its relative ease of implementation, and in many cases it has quite good predictive ability across a variety of contexts and behaviors (Ajzen, 2011; McEchan, Conner, Taylor, & Lawton, 2011; Armitage & Christian, 2003; Armitage & Conner, 2001; Sutton, 1998). At its root is the notion that behavioral intentions - sometimes also considered as motivations (Ajzen, 1991) - are the most proximate predictor of one’s actual behavior. It is assumed that intentions capture the motivational factors that influence a behavior – they are essentially indications of how hard people are willing to try, and how much of an effort they are willing to exert, in order to perform the behavior. As a general rule, the stronger the intention to engage in a behavior, the more likely should be its performance (Madden, Ellen, & Ajzen, 1992). The strength of one’s behavioral intent, then, is posited to be a product of three unique antecedent constructs (Fig. 1): Attitudes towards the behavior, subjective norm
assessments, and perceived behavioral control. The strength of each construct is understood to be determined by an individual’s underlying belief structures.

The TPB can be used to articulate persuasive messages aimed at changing behavioral intent by targeting an individual’s beliefs and attitudes (Ham & Krumpe, 1996). Thus, following the logic of the theory, by gaining an understanding of the extent to which the TPB constructs influence one’s behavioral intentions, managers of public and protected areas will be better equipped to develop educational strategies that work to influence positive change in visitor behavior (Vagias, Powell, Moore, & Wright, 2014). Drawing on the work of previous researchers who have utilized the TPB in the context of minimum-impact outdoor recreation behavior (Lawhon, Newman, Taff, & Vaske, 2013; Reignier & Lawson, 2009; Vagias et al., 2014), the present study utilized an extended version of the TPB to help identify those variables that exert influence over one’s behavior in the context of recreational trail use.

**Study Purpose**

Visitor education and information campaigns have often proven to be successful means for achieving management objectives. The extant literature provides a valuable contribution to

![Figure 4-1: Hypothesized TPB relationships (Ajzen, 1991).](image)
our understanding of the efficacy of these efforts, though a number of knowledge gaps still exist. For example, the predominance of research has been conducted in wilderness or backcountry settings, thus less is known of the efficacy in urban-proximate frontcountry settings. Moreover, little research has measured the effectiveness of a range of management approaches – from indirect to direct – in influencing visitor behavior. Additionally, the majority of previous research has examined minimum-impact messaging generally, as opposed to Leave No Trace specifically. Finally, when researchers have been able to collect observational and survey data they have often lacked the ability to pair the data sources - a commonly mentioned suggestion for future research focused on visitor behavior in parks and protected areas. This study was designed to fill some of these gaps.

Thus, the objectives of this study were to 1) apply a range of direct and indirect site management interventions, and use unobtrusive visitor observation and survey methods to assess the effectiveness of each of the interventions in mitigating undesignated trail use on OSMP lands; and 2) to pair observed OSMP trail users’ response to treatments/control with survey data from those same observed individuals or parties for comparative analysis of observed behavior and reported behavior. This article reports on the results of this study, focusing on the following research questions:

1. Which management strategy (intervention) is most effective in mitigating undesignated trail-use?
2. To what extent do the Theory of Planned Behavior constructs work to explain behavioral intentions to travel only on designated trails?
3. To what extent do the Theory of Planned Behavior constructs work to explain actual trail use behavior?
Methods

Research Design

This study involved a quasi-experimental design in which we devised a field experiment to determine the effectiveness of a range of educational and site management actions aimed at mitigating the use of undesignated trails on OSMP lands. Data was collected through both direct visitor observation and visitor surveys. Data collection methods allowed for the pairing of observation and survey data, which facilitated a more robust understanding of the efficacy of the various educational messages and site management strategies. The study was approved by the first author’s institutional ethics review board, and all participants provided informed consent during participation.

Site Selection

A total of 20 undesignated trail intersections were selected for inclusion in the study. The sites were selected by OSMP managers using a systematic randomized sampling process designed to provide a representative sample of system wide trail characteristics. Using GIS software and spsurvey in the statistical software R, the initial population of 1,542 points (trail intersections) was pared down to 870 after excluding those located at intersections that included: 1) roads; 2) facility access paths; 3) driveways; 4) cattle trails not used as visitor trails; and 5) climbing access. An oversample of 40 sites was drawn from the population of 870. Next, during field evaluations, 13 of the initial sites were rejected for logistical reasons and replaced with the next 13 oversamples that met the study site criteria. The final sample of 20 sites included 16 “high” volume sites and 4 “low” volume sites, which was determined to be representative of the system based on the approximate distribution of these categories in the sample frame.
Management actions examined in the study

In addition to a control condition, which represented no management action, the four treatments under study included two different signs containing informational messages (i.e., indirect management strategies), a wooden barrier (i.e., direct management strategy), and a wooden barrier combined with an informational message (i.e., paired direct and indirect management strategy). The signs containing informational messages were developed based on recommendations of previous research reviewed above, and were designed and printed by the OSMP contracted sign manufacturer. As such, they were of the same size and color as other official OSMP signage, included OSMP and Leave No Trace logos (i.e. originated from official and trusted sources), and contained clear and concise language. The wooden barriers were also of the same design used across the OSMP system.

The management conditions under examination consisted of the following:

- Control condition: No sign or barrier treatments in place;
- Treatment 1: Trailside sign with message #1 - “Stay on designated trails: Even when wet and muddy, to protect trailside plants and minimize erosion. This is not a designated trail” (Figure 4-2);
- Treatment 2: Trailside sign with message #2. “To protect OSMP lands: Please stay on designated trails. This is not a designated trail” (Figure 4-3);
- Treatment 3: Physical barrier (buck and rail style fencing) constructed of logs commonly used in the OSMP system (Figure 4-4);
- Treatment 4: Same physical barrier used in Treatment 3 combined with sign from Treatment 2 affixed to the center (Figure 4-5).
Each of the five conditions was tested at 20 randomly selected locations (undesignated trail junctions) in June 2015. Stratified sampling took place in June and July of 2015. Control days, in which no treatments were in place, were also included in the sampling stratification scheme. Sampling was divided to ensure a representative sample of visitors across treatment type (and control), location, day of the week, and sampling period. Sampling periods consisted of three-hour blocks, dividing the day as follows: early morning (6:30 a.m. - 9:30 a.m.); late morning (10:00 a.m. - 1:00 p.m.); early afternoon (1:00 a.m. - 4:00 p.m.); and late afternoon (4:30 p.m. - 7:30 p.m.).
Content of Messages.

A visitor elicitation study was conducted to inform our decision as to which messages might be most influential in this particular location and context. Applying elicitation study methods used in other park-based communications research (Curtis, Ham, & Weiler, 2010; Downs & Hausenblas, 2005; Sutton et al., 2003), in October 2014, the authors approached OSMP visitors and asked them to complete a one-page survey about the potential messages. The survey included nine messages that were crafted based upon recommendations reported in the persuasive communications literature (see Cialdini et al., 2006; Hockett & Hall, 2007; Widner & Roggenbuck, 2000; Winter, 2006). Ultimately respondents evaluated two components of each message: 1) the persuasiveness of the message; and 2) the likelihood that the message would influence the visitor to stay on designated OSMP trails. The two statements that were indicated as being the most influential were selected for use in the study: 1) “Stay on designated trails: Even when wet and muddy, to protect trailside plants and minimize erosion. This is Not a Designated Trail” (Treatment 2); and 2) “To Protect OSMP Lands: Please Stay on Designated Trails. This is Not a Designated Trail” (Treatment 3). Message 1 was the highest rated of the two and was therefore also selected as the message to be used in Treatment 4.

Treatments 1 and 2 (trailside signs) were affixed to portable bases called “little buddies” - a 4x4 post connected to a metal stand (see Figure 4-6). These were transported to the study location by the researchers and put in place at the start of a sampling shift. They were then removed at the end of the shift. Treatments 3 and 4 (barriers) were installed by OSMP staff prior to the start of a sampling period and removed immediately following. No treatments were left in place for more than 24 hours in an effort to minimize any habituation or bias that might be associated with extended exposure to a specific treatment.
Survey Administration

On-site visitor intercept surveys were administered in tandem with observations on 15 randomly selected sampling days. During these “paired” sampling days, field researchers worked in teams of three, which consisted of an observer and two survey administrators (one on the DT and another on the UT) (see Figure 4-7). Survey administrators were positioned in a location out of sight of the trail junction, and typically 50-100 yards away. Distancing survey administrators from the trail junction not only served to keep them out of sight but also created a time and distance gap between intervention and researcher contact so that visitors were less likely to associate the survey with the experimental site management aspects of the study. In other words, we did not want visitors to perceive that their being approached for a survey was associated with the treatment in place or because of their behavior or actions at the trail intersection. Two-way radios were used to communicate visitor party pairing identifiers and pairing identification
numbers between observers and survey administrators. Thus, every visitor party who was recruited to participate in the survey had an associated set of observed behavior characteristics/attributes.

Visitors were recruited to participate in the survey according to the following parameters:

- Every visitor party who was traveling on the UT was approached.

- On treatment days (days when one of the four interventions was in place) every DT user who passed by the trail junction AND interacted with the study intervention was approached. DT users who had no interaction with an intervention were not approached. An interaction was defined as obvious and meaningful engagement (operationalized as three seconds or more of attention) with the intervention.

- On control days (days when no intervention was in place) the sampling frame included every third visitor party who passed the trail junction traveling on the DT. Because there

Figure 4-7: Field research diagram
was no treatment in place, the sampling parameters defined for treatment days (i.e. an interaction with study intervention) did not apply. Thus, we decided to approach every third visitor party as a systematic randomization strategy. If this individual/party refused, the survey administrator approached every subsequent party until a survey was accepted. Once a survey was administered, they reverted back to every third DT user.

**Behavioral observations**

Unobtrusive visitor observation was used to collect behavioral data at the 20 research sites. Observers positioned themselves in a location out of sight (as possible) of the trail intersection so as to not influence visitor behavior. On “observation only” days, a single observer recorded observations for every individual or visitor party that passed the sample point capturing the specifics of their behavior as it pertains to study objectives (i.e. whether the visitor was traveling on the DT or UT). A visitor party was considered as any recreation group that, in the best judgment of the observer, was intentionally traveling together. During “paired” sampling days (when surveys were also being administered), the field crew included two survey administrators, in which case the observers also noted visitor characteristics such as the color of lead person’s bottoms and shoes to ensure that observation ID numbers could be accurately paired with survey ID numbers. No personally identifiable markers were captured by observers.

**Survey Instrument**

The survey instrument was developed through a collaborative, iterative review process between the research team and OSMP staff. The instrument was framed within the context of the Theory of Planned Behavior (Ajzen, 1991) and developed to incorporate established
natural resource-based human dimensions questions, including established Leave No Trace-focused questions that have been used in numerous peer-reviewed studies (Lawhon et al., 2013; Taff, Newman, Vagias, & Lawhon, 2014; Vagias et al., 2014), questions regarding trail behaviors and perceptions of intervention treatments (Park et al., 2008), and questions about visitor use preference, history, and basic demographic information. In the early development of the survey instrument, it was pretested with 30 undergraduate students; and was subsequently field-tested with visitors on OSMP properties in May 2015. Pretesting allowed respondents to inform researchers of potentially confusing wording and layout issues.

Variable Measurement

The primary independent variables of interest in the survey were framed within the context of the TPB framework (Ajzen, 1991). The specific items and question wording were adapted from previous Leave No Trace research (Lawhon et al., 2013; Taff et al., 2014; Vagias & Powell, 2010), and reworded minimally to reflect behaviors specific to recreational trail travel. TPB constructs examined in the survey included: attitudes toward Leave No Trace trail use practices (how appropriate or inappropriate practices are perceived), perceived effectiveness of Leave No Trace practices, subjective norms, and perceived behavioral control (perceived difficulty) of Leave No Trace practices. The dependent variables were behavioral intent, measured through self-report in the survey, and actual behavior, which was measured through direct observation. The following sections discuss the measurement strategy for each construct.
Attitudes toward the behavior

In this study we were interested in examining respondent attitudes toward Leave No Trace recommended trail-use behaviors. Specifically, we measured perceived appropriateness, or inappropriateness, of the behaviors. Respondents were asked to evaluate six trail-use behaviors using a seven-point Likert-type scale, anchored from 1 = Very Inappropriate to 7 = Very Appropriate (Table 4-1). The statements as written are considered inappropriate behaviors under strict interpretation of Leave No Trace. The responses categories were reverse-coded during analysis to match the directionality of the other constructs used in the TPB model (i.e. Greater mean scores suggest responses more in line with Leave No Trace, whereas lower scores indicate less congruence). The six items were combined to create a summated rating scale (Vaske, 2008). The items had an internal consistency of $a = .95$. 
Table 4-1. Descriptive statistics and reliability analysis for TPB items and latent constructs.

<table>
<thead>
<tr>
<th>Construct and Items</th>
<th>Scale Mean/Item Mean</th>
<th>α if item deleted</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude toward behavior¹</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traveling off a designated trail to experience the natural environment</td>
<td>4.97 1.711</td>
<td>.877</td>
<td></td>
</tr>
<tr>
<td>Traveling around muddy spots on a designated trail</td>
<td>4.43 1.633</td>
<td>.917</td>
<td></td>
</tr>
<tr>
<td>Traveling off a designated trail to explore</td>
<td>4.87 1.741</td>
<td>.868</td>
<td></td>
</tr>
<tr>
<td>Traveling off a designated trail to take photos</td>
<td>4.81 1.661</td>
<td>.876</td>
<td></td>
</tr>
<tr>
<td>Traveling off a designated trail to get away from crowds on the trail</td>
<td>5.13 1.600</td>
<td>.879</td>
<td></td>
</tr>
<tr>
<td>Traveling off a designated trail because there is an alternative established path</td>
<td>4.17 1.917</td>
<td>.911</td>
<td></td>
</tr>
</tbody>
</table>

¹Items measured using a seven-point scale (1=Very Appropriate to 7=Very Inappropriate)

**Perceived effectiveness**

The effectiveness construct examined respondent perceptions regarding the extent to which practicing Leave No Trace trail-use behaviors work to reduce negative environmental impacts on OSMP lands. While the notion of perceived effectiveness is not included in the TPB model as originally conceptualized, Ajzen (1991) writes that the possibility of adding additional predictor variables to the model was explicitly left open. The addition of perceived effectiveness measures has proven to be an important explanatory variable in previous research. For example, in a study of water conservation behavior Lam (2006) found “subjective effectiveness” of water saving solutions, in addition to core TPB constructs, to significantly improve the explanatory power of their predictive model. Additionally, in a study examining factors that influence behavioral intentions for practicing Leave No Trace, Lawhon and colleagues (2013) found perceived effectiveness to be the strongest predictor of future Leave No Trace behavioral intent. They noted further that the concept of perceived effectiveness is important because it is possible
that behaviors perceived as ineffective are less likely to be practiced than those perceived as highly effective.

In this study, perceived effectiveness was assessed through four behavior statements asking respondents to indicate the extent to which each behavior reduces negative impacts (e.g. *Traveling in the middle of a designated trail, even when wet or muddy*), while visiting OSMP (Table 4-2). These items were rated on a seven-point Likert-type scale anchored from 1 = Never Effective to 7 = Effective Every Time. These four items were combined to create an *effectiveness* index. Cronbach’s alpha for this index was adequate (*α* = .66).

Table 4-2. Descriptive statistics and reliability analysis for perceived effectiveness construct

<table>
<thead>
<tr>
<th>Construct and Items</th>
<th>Scale Mean/ Item Mean</th>
<th>α if item deleted</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived effectiveness¹</td>
<td>Scale <em>M</em> = 5.28 Mean SD</td>
<td>--</td>
<td>.661</td>
</tr>
<tr>
<td>Staying on a designated trail</td>
<td>5.55 1.35 2</td>
<td>.516</td>
<td></td>
</tr>
<tr>
<td>Traveling in the middle of a designated trail, even when wet or muddy</td>
<td>4.98 1.50 6</td>
<td>.569</td>
<td></td>
</tr>
<tr>
<td>Traveling on a designated trail, even when passing other visitors</td>
<td>5.24 1.40 3</td>
<td>.483</td>
<td></td>
</tr>
<tr>
<td>Staying off a designated trail when conditions are wet and muddy</td>
<td>4.86 1.68 2</td>
<td>.773</td>
<td></td>
</tr>
</tbody>
</table>

¹Items measured using a seven-point scale (1=Never effective to 7=Effective Every Time)

*Perceived behavioral control (Perceived difficulty)*

Perceived behavioral control (PBC) refers to an individual’s perceived control over performing a specific behavior (Ajzen, 2002). PBC is understood to be a multi-dimensional construct - an amalgamation of both perceived control and perceived difficulty (Trafimow, Sheeran, Conner, & Finlay, 2002). *Perceived control* refers to the extent to which a behavior is considered to be under one’s complete voluntarily control, whereas *perceived difficulty* is the extent to which the behavior is considered to be easy or difficult to perform. Following the
recommendations of previous Leave No Trace research (Lawhon et al., 2013; Vagias et al., 2014), this study draws on the latter dimension, examining respondents’ perceived physical ease or difficulty of performing various Leave No Trace trail-use behaviors. PBC was evaluated through six behavioral statements asking respondents to indicate how difficult each would be for them to do while visiting OSMP (Table 4-3). These items were rated on a seven-point Likert-type scale anchored from 1 = Very Difficult to 7 = Very Easy. The Cronbach’s alpha for the PBC index was .89, indicating good reliability among measures.

Table 4-3. Descriptive statistics and reliability analysis for PBC construct

<table>
<thead>
<tr>
<th>Construct and Items</th>
<th>Scale Mean/Item Mean</th>
<th>α if item deleted</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived behavioral control – Perceived difficulty</td>
<td>Scale $M = 5.44$</td>
<td>--</td>
<td>.88</td>
</tr>
<tr>
<td>Mean SD</td>
<td>5.71 1.500</td>
<td></td>
<td>.876</td>
</tr>
<tr>
<td>Staying on a designated trail</td>
<td>5.11 1.500</td>
<td></td>
<td>.890</td>
</tr>
<tr>
<td>Traveling in the middle of a designated trail, even when wet or muddy</td>
<td>4.99 1.608</td>
<td></td>
<td>.868</td>
</tr>
<tr>
<td>Traveling on a designated trail, even when passing other visitors</td>
<td>5.46 1.505</td>
<td></td>
<td>.856</td>
</tr>
<tr>
<td>Traveling on a designated trail, even when you have previously traveled on an undesignated trail in the area</td>
<td>5.38 1.450</td>
<td></td>
<td>.854</td>
</tr>
<tr>
<td>Traveling on a designated trail, even when an undesignated trail is available in the area</td>
<td>5.57 1.304</td>
<td></td>
<td>.867</td>
</tr>
<tr>
<td>Traveling on a designated trail, even when you have observed another visitor traveling on an undesignated trail</td>
<td>5.54 1.480</td>
<td></td>
<td>.854</td>
</tr>
</tbody>
</table>

1. Items measured using a seven-point scale (1=Very Difficult to 7=Very Easy)

Subjective norms

The influence of subjective norms was measured through seven items that asked respondents to indicate the extent of their motivation to comply with social and personal pressures. Respondents were provided a list of reasons why visitors might be influenced to use only designated trails, and asked to indicate how important each of the reasons would be for them
to travel only on designated trails while visiting OSMP in the future (Table 4-4). Items were rated on a seven-point Likert-type scale where 1 = Not at all important and 7 = Extremely Important.

Normative items examined subjective evaluations of local rules and Leave No Trace recommendations, personal norms, and perceived social norms. All seven items were combined to create a subjective norms index. Cronbach’s alpha for internal consistency was .91, indicating good reliability among measures.

Table 4-4. Descriptive statistics and reliability analysis for subjective norms construct

<table>
<thead>
<tr>
<th>Construct and Items</th>
<th>Scale Mean/Item Mean</th>
<th>α if item deleted</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjective norms</td>
<td>Scale M = 4.92</td>
<td>--</td>
<td>.91</td>
</tr>
<tr>
<td>Because visitors are encouraged to stay on designated trails</td>
<td>5.25</td>
<td>.895</td>
<td></td>
</tr>
<tr>
<td>To not damage the soils and vegetation</td>
<td>6.02</td>
<td>.907</td>
<td></td>
</tr>
<tr>
<td>To not break the rules</td>
<td>4.59</td>
<td>.895</td>
<td></td>
</tr>
<tr>
<td>Because I do not want anyone to see me travel off designated trails</td>
<td>3.91</td>
<td>.906</td>
<td></td>
</tr>
<tr>
<td>Because it is unfair for me to travel off designated trails while many other visitors do not</td>
<td>4.48</td>
<td>.896</td>
<td></td>
</tr>
<tr>
<td>Because Leave No Trace promotes traveling on designated trails</td>
<td>5.41</td>
<td>.900</td>
<td></td>
</tr>
<tr>
<td>Because I feel better about myself by not traveling off designated trails</td>
<td>4.76</td>
<td>.894</td>
<td></td>
</tr>
</tbody>
</table>

1 Items measured using a seven-point scale (1=Not at all Important to 7=Extremely Important)

Behavioral intentions

A core tenet of the theory of planned behavior is that behavioral intentions are the most proximal predictor of actual behavior. It is assumed that intentions capture those motivational factors that influence a behavior (Ajzen & Driver, 1992). In this study, behavioral intent was measured by asking respondents their likelihood of engaging in specific behaviors (Table 4-5).
This block of items included the same behaviors as listed in the PBC scale, though this time the phrase preceding the scale was “How likely are you to do this in the future?” The response format was a seven-point Likert-type scale anchored from 1=Very Unlikely to 7=Extremely Likely. Cronbach’s alpha for the behavioral intent index was .90, indicating good internal consistency.

Table 4-5. Descriptive statistics and reliability analysis for behavioral intent construct

<table>
<thead>
<tr>
<th>Construct and Items</th>
<th>Scale Mean/ Item Mean</th>
<th>α if item deleted</th>
<th>α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavioral Intent†</td>
<td>Scale M = 5.70</td>
<td>--</td>
<td>.90</td>
</tr>
<tr>
<td>Staying on a designated trail</td>
<td>Mean 5.94 SD 1.21</td>
<td>7</td>
<td>.884</td>
</tr>
<tr>
<td>Traveling in the middle of a designated trail, even when wet or muddy</td>
<td>5.46 Mean 1.37 SD 5</td>
<td></td>
<td>.909</td>
</tr>
<tr>
<td>Traveling on a designated trail, even when passing other visitors</td>
<td>5.78 Mean 1.25 SD 1</td>
<td></td>
<td>.888</td>
</tr>
<tr>
<td>Traveling on a designated trail, even when you have previously traveled on an undesignated trail in the area</td>
<td>5.59 Mean 1.39 SD 0</td>
<td></td>
<td>.875</td>
</tr>
<tr>
<td>Traveling on a designated trail, even when an undesignated trail is available in the area</td>
<td>5.66 Mean 1.20 SD 7</td>
<td></td>
<td>.879</td>
</tr>
<tr>
<td>Traveling on a designated trail, even when you have observed another visitor traveling on an undesignated trail</td>
<td>5.76 Mean 1.21 SD 7</td>
<td></td>
<td>.884</td>
</tr>
</tbody>
</table>

† Items measured using a seven-point scale (1=Extremely Unlikely to 7=Extremely Likely)

Data Analysis

All data analysis was performed using IBM Statistical Package for the Social Sciences (SPSS) software, version 22. Survey and observation data were initially entered into an Excel spreadsheet and then imported into an SPSS database for analysis. Univariate and bivariate descriptive statistics were conducted first to identify outliers and missing data. Surveys that were less than 75% complete were deleted from the dataset. Only matched data were used in the analysis. That is, cases that included both survey and observation data. Next, the survey and observation data were analyzed as discussed below to examine several research questions.
First, we utilized chi-square analysis to examine the difference in treatment effectiveness. Further post-hoc analyses using Fisher’s exact tests with continuity correction and phi coefficients for effect size were utilized to examine statistical significance of each treatment compared to control conditions. Next, we examined the extent to which an extended version of the TPB would account for intentions to travel only on the designated trails (RQ2). As such, all independent variables described previously were entered into a multiple correlation regression path model to explore which variables serve as predictors of behavioral intent. In answering RQ3, we tested the influence of the same independent variables as in the previous on actual behavior, which was measured as a dichotomous (yes or no) dependent variable. Thus, due to the dichotomous nature of the dependent variable, logistic regression procedures were utilized in this analysis. Logistic regression is a recommended statistical technique for predicting the probability that an event will or will not occur and identifying the variables useful in making the prediction (Vaske, 2008). Results of a logistic regression will provide insight as to how well the constructs operationalized in the TPB model predict actual behavior.

Results

Sample characteristics

A total of 147 respondents completed a survey, for a total response rate of 68%. Upon removal of incomplete surveys and cases that involved missing data necessary for paired data analysis, a total of 101 cases were included in the analyses reported here. Of these, 44 (44%) were observed using undesignated trails, and the other 57 (56%) were designated trail users. A total of 2,232 visitor parties were observed during the study, the majority of those were walking/hiking (68%) and traveling alone (58%).
**RQ1: Which management strategy (interventions) is most effective in mitigating the use of undesignated trails?**

Observation data indicate that Treatment 4 (combined physical barrier and educational message) was the most effective at mitigating UT use (Table 4-6). This method was approximately 97% effective at directing visitors to proceed onto the DT rather than traveling on the UT. This treatment was followed in effectiveness by the physical barrier (Treatment 3), which was 94% effective, and Treatment 2, which was also 94% effective. Further post-hoc analysis revealed that only Treatment 4 produced a statistically significant reduction in UT use compared to control conditions ($x^2=6.506, p < .05$).

Table 4-6. Treatment effectiveness

<table>
<thead>
<tr>
<th></th>
<th>Treatment 1: Ed Message 1</th>
<th>Treatment 2: Ed Message 2</th>
<th>Treatment 3: Barrier</th>
<th>Treatment 4: Barrier and Ed Message 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>349</td>
<td>337</td>
<td>261</td>
<td>220</td>
</tr>
<tr>
<td>Designated trail use rates</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample size</td>
<td>349</td>
<td>337</td>
<td>261</td>
<td>220</td>
</tr>
<tr>
<td>Designated trail use rates</td>
<td>91.4% $^a$</td>
<td>90.8% $^a$</td>
<td>93.9% $^a$</td>
<td>94.2% $^a$</td>
</tr>
<tr>
<td>$^a, ^b$ Rates with different superscripts are significantly different compared to control conditions ($p&lt;.05$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RQ2: What is the influence of attitude, perceived effectiveness, subjective norms, and PBC on self-reported behavioral intent?**

Results of the multiple regression path analysis indicated that attitudes, perceived effectiveness, perceived behavioral control, and subjective norms have a significant and positive linear relationship with behavioral intent (Figure 4-8). That is, those who hold favorable attitudes towards Leave No Trace behaviors, positive perceptions of the effectiveness of such behaviors, perceive the behaviors as easy to perform, and are positively motivated by subjective norms, were more likely to report intentions to use designated trails. These variables account for
approximately 50% of the variance in behavioral intent ($F (4, 73) = 17.007, p < .001$). PBC held the strongest influence over behavioral intentions ($\beta = .325$), followed by subjective norms ($\beta = .245$).

To answer the third research question, we examined the same independent (predictor) variables as in Model 1 above in a logistic regression model (Figure 4-9). In this analysis, behavior was used as the dependent (outcome) variable, which was coded and operationalized as a binary, where 0 = respondents who made a decision to use an undesignated trail, and 1 = those who decided to travel on the designated trail.

**RQ3: What is the influence of attitude, perceived effectiveness, subjective norms, and PBC on actual (observed) behavior?**

Figure 4-8. TPB Model 1: Multiple regression predicting behavioral intent
Results indicate the predictor variables in the model account for approximately 10% (Cox & Snell $R^2 = .096$) of the variance in trail use behavior. The Cox & Snell $R^2$ provides an approximation of the proportion of the variance in the dependent variable that is accounted for by the independent variable - a logistic analogy to the $R^2$ (coefficient of determination) in a linear regression (Vaske, 2008). The relatively small Cox & Snell coefficient suggests that behavior in this analysis is little explained by the TPB constructs operationalized in the study. Additionally, the model correctly classified 84% of designated trail users, but only 47% of undesignated trial users, correctly classifying 68% of cases overall. In other words, the classification of undesignated trail users would have been more accurate if researchers had simply flipped a coin. This lends further evidence that the TPB constructs were not reliable predictors of actual behavior.

Moreover, the initial model indicates that of the predictor variables in the model, only PBC is significantly related to the variance in behavior ($Wald = 4.999$, $p < .05$). Attitudes, subjective norms, and perceived effectiveness did not contribute significantly to the explanatory
ability of the model and were dropped in subsequent model iterations. The final model suggests PBC to be the single best predictor of actual behavior (Wald = 7.505, p < .01). In other words, the extent to which behaviors are perceived to be completely within one’s volitional control appears to be the most important factor influencing behavior.

**Discussion**

The purpose of this research was to examine the effectiveness of a range of management interventions to minimize the use of undesignated trails. One of the strengths of this study was the consistent observation methodology, which enabled the researchers to document visitor behaviors and ultimately provided highly accurate data regarding treatment efficacy. Using the Theory of Planned Behavior as a theoretical framework we identified factors most likely to predict behavioral intentions for trail use. By pairing observation data with survey data we were able to carry the analysis of those predictors one step further and determine the extent to which they hold in the prediction of actual behavior.

Observation data indicated the majority of visitors were traveling on DTs, as approximately 10% were observed traveling on UTs. Though this is a comparatively small percentage of overall trail use, previous research suggests that a small number of visitors can create visible and lasting impacts to ecological systems (see Marion et al., 2016), such as the proliferation of the numerous UTs (i.e., the ~150 miles of UTs) on the OSMP system.

We found a relationship between the management treatments utilized in this study and a decrease in the use of undesignated trails, though the level of effectiveness depended on the type of treatment in place. While the results of Treatment 1 (“Stay on designated trails: Even when wet and muddy, to protect trailside plants and minimize erosion. This is Not a Designated Trail”) suggested that it was slightly less effective than control conditions; all other treatments reduced
use of UTs. However, chi-square post-hoc analyses comparing treatment to control conditions reveal that only Treatment 4 (combined barrier and education message) produced a statistically significant reduction in UT use from control conditions.

While these results indicate that among the treatments utilized in the study only Treatment 4 produced a statistically significant reduction in UT use compared to control conditions, they should be interpreted with caution from an applied management perspective. That is, a statistically significant relationship may not necessarily translate to one of practical significance (Vaske, 2008). In terms of practical application, it may not be physically, aesthetically, or economically practical to treat every UT intersection with a combination barrier and educational sign. Therefore, Treatment 2 should not be eliminated as a plausible management option based solely upon the statistically significant test result associated with Treatment 4. In cases where UT use is high or very high Treatment 4 may be warranted. But in other contexts that see relatively low levels of UT use a more minimalist approach (i.e. Treatment 2) may be justified. Ultimately, these results suggest that a range of UT management options exist, each with different levels of effectiveness, which provide managers a set of alternative approaches for use in the mitigation of UT use depending on resources, management objective, and context.

The use of the TPB framework provided valuable insight to the cognitive factors that influence ones intended trail-use on OSMP lands. We found that attitudes (regarding the appropriateness and effectiveness of behaviors), subjective norms, perceived behavioral control, were all determinants of behavioral intentions. Perceived behavioral control (perceived difficulty) and subjective norms were the strongest individual predictors. Overall this model explained approximately 50% of the variance in intentions to travel on designated trails.

These findings are comparable to the findings of other studies using the TPB to understand minimum-impact Leave No Trace behaviors. For example, Vagias and others (2014) found PBC to be the primary predictor of behavioral intent for Leave No Trace practices in
Olympic National Park. While at Glacier National Park he found that PBC and subjective norms worked to influence intentions. Lawhon and colleagues (2013) found perceived effectiveness to be the strongest predictor of intentions for Leave No Trace behavior in Rocky Mountain National Park. Finally, Reigner & Lawson (2009) used the TPB to understand off-trail behavior in the context of exploring the pools of `Ohe`o in Haleakalā National Park. They found that normative beliefs hold the strongest influence over intentions to explore the pools. Taken together the results of these studies seem to suggest that the formation of behavioral intentions in an outdoor recreation context varies, among other things, by location, the specific behavior in question, and site-specific features such as minimum-impact information and educational messaging. In other words, there is no perfect formula for predicting intentions across all situations; therefore, it behooves managers to support site-specific research as one approach to developing strategies for mitigating problem recreation behaviors.

While understanding behavioral intentions does well to inform the development of management interventions, intentions do not always directly correlate to subsequent behaviors. The observation methods developed in this study allowed us to examine the contrasts between self-reported intentions and actual behavior. In comparing the results of the linear and logistic regression models in terms of the predictive ability of the independent variables, we found the prediction of actual behavior to be less accurate than the prediction of behavior intentions. These results suggest there is a fairly substantial disconnect between what visitors said they would do and what they actually did.

This result could be interpreted in several ways. One possible explanation is related to social desirability in self-report data. In other words, in the presence of a researcher respondents might have provided responses to the survey based on what they thought was the appropriate response regarding trail behavior. However, their trail use decision was not influenced by researcher presence, as they were not aware of the field observations being conducted.
Another possible explanation is that respondents did in fact have strong intentions to travel only on designated trails as suggested by their survey responses, but the introduction of other intervening factors, perhaps beyond their control, had stronger influence over their eventual behavior. As suggested by both regression models, PBC (operationalized as perceived difficulty) was the most salient factor influencing one’s trail use behavior. That is, in cases when the use of a DT was perceived as difficult or under less control of the visitor, the likelihood of DT use was significantly lower. For example, if a visitor was unaware of the difference between a UT and a DT, perhaps due to inadequate trail demarcation, the decision about which trail to use was likely perceived as a difficult decision. Further cross-examination of survey and observation data provided some clarity to this notion.

More than 40% of survey respondents indicated they were unaware of UTs in the OSMP trail system. This aligned with paired survey and observation data, as nearly 50% of visitors who were observed and surveyed while traveling on a UT reported that they ‘always’ use DTs, suggesting that these visitors did not know they were in fact traveling on a UT. Furthermore, UT respondents were significantly more likely to report not knowing if they traveled off a DT. Observed behavior paired with survey responses showed that almost half of UT users reported they had not traveled off trail, and approximately 20% of UT users were unsure if they had traveled off the DT. While being unaware may account for a substantial amount of the UT use on OSMP lands, a considerably smaller number of UT users indicated that they had seen management signs than DT users. Thus, this suggests a small segment of individuals — as also noted through observation data — will use UTs despite management interventions.

Open-ended comments on the survey provide additional insight into the difficulty of traveling exclusively on designated trails, as multiple respondents suggested there is a need to better clarify which existing OSMP trails are UTs and DTs. For example, one respondent wrote, “Often it is difficult to tell where exactly designated trails exist because of so many social trails.”
Another stated, “When trails have extreme braiding or social trails it is hard to know designated trails.” A third respondent added, “I don't know if I should stay on trail when wet/muddy, and if walking in the middle of trail is best - signage would be good if that's what is right.”

Taken together, these results point to the need for management actions designed to make it easier for visitors to differentiate between UTs and DTs. We recommend the use of consistent dissemination of information, signage, and management interventions throughout the trail system that signify which trails are DTs. For example, existing infrastructure on UTs, such as block steps, water bars, or small signs indicating no mountain biking may confuse visitors, as those are typically visual cues that indicate a managed (designated) trail segment. Thus, eliminating existing infrastructure on current UTs, coupled with the implementation of Treatment 4 (i.e., educational message and barrier) from this study could enhance mitigation efforts. Given the high visitor use of OSMP, it is important to consider wide-scale implementation of those management actions that are most effective in order to improve compliance by the majority of visitors, and in particular those existing UT users.

An additional finding worth note is that, according to survey results, visitors to OSMP largely believe that recreation behaviors have the potential to cause both ecological and social impact, and the majority of respondents indicated they would change their behaviors if they learned their actions were damaging the environment. Of the list of potential activities provided for reducing negative impacts in OSMP, Adhering to messages on posted signage was reported to be the most effective, followed by Staying on a designated trail. Furthermore, Adhering to messages on posted signage was reported to be the easiest of the behaviors to perform. Aligning with the message in treatments 1 and 4 (“Stay on designated trails: Even when wet and muddy, to protect trailside plants and minimize erosion. This is Not a Designated Trail”), the majority of respondents indicated that the most important reason for only using DTs was To not damage soils and vegetation. Based on these findings, it is recommended to consider the use of attributional-
based messages in the design of future information and education campaigns. While attribution theory was not directly applied or tested in this study, previous research suggests attributional messaging to be a particularly effective approach to visitor messaging.

Attribution theory posits that people often interpret their behavior in terms of its cause, and these attributions play a central role in human behavior (Kelley & Michela, 1980). Previous studies (Alessa, Bennett, & Kliskey, 2003; Bradford & McIntyre, 2007) have found that personal attribution is inversely related to depreciative behaviors. That is, the more visitors believed their behavior had the potential to cause resource degradation, the less likely they were to engage in depreciative behavior. Interestingly, Bradford and McIntyre (2007) found that recreationists typically do not view themselves as the cause of impacts – they tend to attribute impacts to the behaviors of others. Thus, the use of messages informing visitors their personal recreation behaviors cause, or have the potential to cause, social and ecological resource degradation on OSMP lands is warranted.

**Limitations and Future Research**

With regard to methodological considerations and future research, this study demonstrated the strength in pairing self-reported survey data with actual behavioral observations. As noted, self-reported behaviors do not always align with the actions visitors take in the environment. Thus, when feasible, future studies should consider pairing visitor surveys and observations. While it is important to consider systematic approaches to understanding visitor use, further examination of the most effective treatment in this study, set-up long-term in high UT use locations could yield greater understanding of the influence of paired indirect and direct management actions on UT use. For example, if the entire DT trail system and associated UT junctions within a predetermined area were treated with the barrier and educational signage over a
period of two years for instance, researchers and managers could monitor visitor attitudes and behavior change with the methods used in this study. Furthermore, expanding the study over a multi-year period could afford the opportunity to measure ecological change (e.g., vegetation regrowth) resulting from treatment application.

Observers used their best judgment when determining if a particular trail user had an interaction with a treatment or control. While it was generally easy to detect “no treatment interaction” and “stop and read,” it was more challenging to determine if a trail user should have been categorized as “pass and read.” Consistent treatment placement (i.e., 5-10 feet from the point of entry onto an undesignated trail) was established to minimize error, and accurately determine visitor intention.

Every effort was made to provide a robust, evenly distributed stratified sample, given the vast number of strata, the limited time span of this study, and the available resources. However, there are limitations that should be noted. For example, this sampling effort took place over 25 days, during a 30-day (one-month) period. Visitation patterns and behaviors may have been subject to weather or other environmental factors beyond our control. Additionally, each of the 20 sites received all five of the treatments, however, a.m./p.m. and weekday/weekend stratification was not evenly distributed, given the one-month sampling period. Finally, this study only incorporated 20 randomly selected sites, and other OSMP undesignated trail sites may produce alternative visitor behaviors and associated perceptions.

Although this study attempted to represent system-wide use, some of the sampling sites selected for this study receive relatively low visitation, which is not ideal for a visitor survey. Thus, this is a trade-off. For instance, while the total N could have been increased if the research had taken place at consistently busier OSMP locations, the results would not have represented the entire system, as this study attempted to do. Additionally, due to some of the selected sampling sites, the survey sample size is small compared to the large number of visitors observed as part of
this study. This can partially be attributed to the purposeful sampling approach whereas only individuals that interacted with a treatment were asked to complete a survey. Finally, it should be noted that some visitors may have felt and acted upon social desirability (i.e., provide responses that they think coincide with the survey administrator’s viewpoints) (Vaske, 2008); however, staff were trained extensively to minimize any bias.

**Conclusion**

Through a rigorous quasi-experimental design, this study examined the effectiveness of indirect and direct management approaches for reducing the use of undesignated trails on OSMP lands. The management actions applied in this research, particularly the educational message paired with a physical barrier, can effectively influence behavior and significantly reduce UT usage from baseline control conditions. Furthermore, the data provide empirical evidence regarding a range of UT management options, each with different levels of effectiveness, which provides managers a set of alternative approaches for mitigating the use of UTs on the OSMP system. OSMP staff can utilize the data provided by this research, combined with known practical constraints (i.e. human or financial resources, site characteristics, aesthetics, etc.) to make informed decisions about the most appropriate approach to mitigating the use of undesignated trails on OSMP lands.

While limited research of this kind has been done in national parks and wilderness settings, most of which has been hypothetical and attitudinal rather than behavioral and experimental (Johnson & Swearingen, 1992; see Park et al., 2008), we are aware of no such studies of this kind that have been conducted on open space lands to date. As such, this multi-method, quasi-experimental study is a unique addition to the scientific and professional literature on parks and protected areas, and adds to the minimal body of literature on alternative
management practices for reducing visitor impacts in parks and protected areas. Studies such as this, in an open space context, may be particularly useful for both informing educational efforts and management actions that can be implemented by managers as they work to reduce recreation-related impacts.

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Chapter 5

Conclusions and Implications

The purpose of this dissertation is to advance our understanding of the efficacy of Leave No Trace messaging and educational programs. It serves to strengthen the body of Leave No Trace social science literature and provide evidence-based knowledge upon which to build solutions to some of the complex issues associated with human dimensions of natural resource recreation. This was achieved through three independent studies. The first study examined attitudes and perceptions of Leave No Trace among an emerging user group. The second study measured the efficacy of a Leave No Trace education program for youth. The third study tested the effectiveness of a range of management interventions, including Leave No Trace messaging, to influence trail-use behavior. This final chapter provides a summary of the key findings and management implications related to study research questions, followed by a discussion of limitations and recommendations for future research.

Study One: Examining attitudes and perceptions of Leave No Trace among participants of a new and emerging outdoor activity: A study of bouldering and Leave No Trace.

Bouldering is a rapidly growing recreational pursuit. And unlike more traditional outdoor-specific activities (e.g. hiking, angling, hunting, kayaking, backpacking), many people are learning to boulder in climbing gyms and later making the transition to the outdoors. This raises the question of whether those who are introduced to the sport in a gym setting are making a responsible transition to the outdoors by learning and adopting behaviors meant to protect and
preserve ecological and social conditions. This study aimed to provide an empirically grounded response to this question.

**RQ1:** How do indoor learners compare to outdoor learners in regard to their attitudes towards bouldering-specific Leave No Trace recommended behaviors, perceptions of the Leave No Trace program in general, and knowledge of Leave No Trace?

**Key Findings**

Nearly 70% of respondents in this study reported they first learned to climb indoors in a gym. When compared to those who learned to boulder outdoors, indoor learners tend to have attitudes and perceptions less in line with minimum-impact recommendations, and report less knowledge of Leave No Trace.

**Management Implications**

These results confirm the priority to enhance education and outreach efforts within the climbing gym industry. They further highlight the importance of providing Leave No Trace-related minimum-impact bouldering information and other introductory-level instructional classes and workshops in the climbing gym setting. Recreation managers should continue with, and expand upon, collaborative partnerships with external agencies and constituent groups in outreach and education efforts.
RQ2: How do indoor learners compare to outdoor learners in regard to their attitudes towards bouldering-specific Leave No Trace recommended behaviors, perceptions of the Leave No Trace program in general, and knowledge of Leave No Trace, when accounting for level of specialization?

**Key Findings**

Those who learned to boulder indoors fell on the lower end of the self-reported knowledge measure, with *Indoor novices* reporting the least knowledge, followed by those in the *Indoor advanced* category. On the upper end are those who learned to boulder outdoors. *Outdoor novices* fell just below those in the *Outdoor advanced* category. *Indoor novices* showed a tendency to hold attitudes and perceptions that were less congruent with Leave No Trace-related practices compared to the other categories. Alternatively, those in the *Outdoor advanced* category tend to report attitudes and perceptions most in line with Leave No Trace-related recommendations.

Taken together, these results indicate that, when compared to those who learned to boulder *outdoors*, *indoor learners* tend to have attitudes and perceptions less in line with minimum-impact recommendations, and report less knowledge of Leave No Trace. Moreover, level of specialization also appears to play a role, as mean scores generally trend in a positive direction across *indoor* and *outdoor learners* when accounting for self-reported bouldering ability.

**Management Implications**

Educational efforts should be targeted towards those who are new to the sport and are learning in an indoor setting. These findings also provide information that can be used to develop a standard set of minimum-impact bouldering principles and ethics, which currently does not
exist. In an effort to reinforce minimum-impact messages and appropriate behaviors, managers should continue with, and expand upon, on-site education and messaging efforts via signage, website, and direct ranger or volunteer contact.

**Limitations and Future Research**

This study was conducted at one park in the United States, and thus the generalizability of the results may be limited. Future research such as this should be conducted at various national and international locations to capture a more representative sample of the bouldering population. Relatedly, the sample included only people who were actively bouldering outdoors. It is possible that respondents therefore already had previous exposure to outdoor bouldering norms and expectations, perhaps through park informational materials or other climbers, which may have skewed the results. Future research should extend into the climbing gym setting in an effort to collect data from indoor learners who have not yet transitioned to the outdoors. Researchers might also consider in-depth interview or longitudinal study of people who begin bouldering indoors and then adapt more favorable LNT attitudes and behaviors to find intervening points. Finally, after focused minimum-impact bouldering education programs are implemented, future research should be conducted that examines the efficacy of such efforts, as well as examining the influence of site-specific education efforts (such as in Rocky Mountain National Park) on ecological impacts.
Study Two: Examining the efficacy of Leave No Trace education programs for youth: A study of the Leave No Trace Promoting Environmental Awareness in Kids (PEAK) program

The Promoting Environmental Awareness in Kids (PEAK) Principles and associated educational curriculum were first developed in 2001 by the Leave No Trace Center for Outdoor Ethics to teach young people the skills necessary to make responsible decisions when recreating in the outdoors. While the program has been in existence for many years, little is known as to the effectiveness of its message. The purpose of this study is to gain understanding of the efficacy of a PEAK educational module to influence attitudes and behaviors in a manner more congruent with commonly accepted Leave No Trace Principles and practices. Specifically, the research examined the efficacy of a 30-minute PEAK lesson designed to teach practices related to the Leave What You Find Principle.

RQ1: How does participation in the PEAK educational module influence attitudes toward the Leave What You Find Principle?

Key Findings

The PEAK educational module (i.e., the treatment) was effective at influencing attitudes in a direction more in line with the Leave What You Find Principle. Those in the treatment group showed a tendency to report post-test scores in greater agreement with the Leave What You Find Principle than those in the control group. Overall, the data suggest that those who participated in the treatment left the ODS program with more positive attitudes toward Leave What You Find than did those in the control.
Management Implications

Results suggest that a brief educational lesson such as the one used for this study, can positively influence attitudes. Therefore, the positive attitudes reported by participants from the treatment group suggests they may subsequently behave in a manner more consistent with the Leave What You Find Principle.

RQ2: Are there differences between treatment and control groups in the extent to which keeping found natural objects influences nature connectedness?

Key Findings

Compared to the control group, Leave What You Find program participants were significantly less likely to agree that taking home natural objects would make them feel more connected to nature. Moreover, those in the treatment group were significantly more likely to indicate that taking home an object they find in nature was not an important part of the experience, indicating greater alignment with LWYF.

Management Implications

These results suggest participating in the Leave What You Find educational program led participants to associate less importance with keeping natural objects as a way to feel more connected to nature. Because keeping objects is reported to be an unimportant factor in the development of nature connectedness, PEAK participants may be more likely to leave what they find, yet still place high value on the nature experience as a whole. In other words, ‘leaving what you find’ does not appear to detract from one’s nature connectedness.
R3: Are there behavioral differences between treatment and control groups regarding found natural objects?

**Key Findings**

The PEAK educational module was effective at reducing the frequency at which participants kept found objects of interest during the field experiment. Participants in control groups removed 29 of 41 found objects (71%), while participants in treatment groups removed 24 of 40 found objects (60%). Arrowheads were most likely to be kept, followed by pyrite, and fossils respectively.

**Management Implications**

The educational module utilized in the study was a 30-minute program that broadly covered the Leave What You Find concept. There was no mention of the specific study objects in the curriculum. Therefore, it appears students were able to connect general concepts and principles learned during the program to more specific behaviors related to natural found objects. The fact that significant differences in attitudes and behavior were present after only a 30-minute program, it stands to reason that a more intensive (e.g., longer, more elaborate) outdoor ethics curriculum might have even greater positive influence on outdoor behaviors.

**Limitations and Future Research**

Several limitations to this study and implications for future research are worth note. Importantly, participants in the treatment group had only brief exposure to Leave No Trace (30 minutes) curricula, and were introduced to just one of the seven Principles. Research indicates
that, for adults, more exposure to Leave No Trace leads to greater reported adoption and application of Leave No Trace recommendations (See Bromley, Marion, & Hall, 2013; Daniels & Marion, 2005). Therefore, future research with youth should examine educational programs that are longer in length and that include broader coverage of Leave No Trace Principles. Additionally, the study examined behaviors related to highly desirable found objects, which could have contributed to the high rate of taking objects. Future studies might consider the use of more common artifacts.

Because of concerns about participant anonymity observations were conducted at the group level, whereas surveys were administered at the individual level. Therefore, we were not able to directly correlate individual survey data with individual behavior. Rather, survey data were grouped by condition and compared to trends in observed group behavior. As a result, we cannot be sure about the influence of group pressure or social norms on behavior (i.e. would individuals act differently when alone as opposed to in a group setting?). Future studies should consider methods that allow for individual level behavior analysis that can be matched with individual level self-report data. Relatedly, follow-up interviews with participants exploring the reasoning behind their behavior are also suggested. Both of these elements would provide more accurate measures of attitude-behavior consistency and greater insight into factors influencing decision-making.

While this study does suggest that attitudes and behaviors were at least partially influenced by the Leave What You Find educational module in the short-term, it is necessarily limited in the extent to which it can suggest attitude and behavioral changes hold over time. The educational treatment was delivered just one day prior to the behavioral observation and post-test attitudinal measures were evaluated just three days following program participation. A longitudinal design that included follow-up measures at extended time intervals (e.g. three months or six months, or significantly later in life) is recommended.
The generalizability of results might also be limited as this study took place at one site in one geographic region, and with predominantly fifth-grade participants. The extent to which these results hold across settings and samples should be applied conservatively. This line of research should be expanded on a larger scale to include participants in different geographic regions and a variety of age groups.

A final possible limitation is that because this study took place at an environmental education camp, there may have been overlap in general themes and concepts covered generally by ODS and the educational treatment. This might have masked the influence of the Leave What You Find module on program participants. In other words, while the ODS curriculum was not specific to Leave What You Find, it did focus on a variety of skills and concepts related to humans and the environment, concepts which are also at the core of Leave No Trace outdoor ethics. On some measures, control group participants reported significant attitudinal change from pre- to post-test, which might be attributed to the ODS curriculum, thus the results may be conflated by outside variables, such as the ODS curriculum. Because of this, future research should be conducted with populations not engaged with EE curriculum, and/or include multiple comparison groups.

**Study Three: Examining the efficacy of combined Leave No Trace educational messaging and direct site management actions in reducing undesignated trail use in an urban-proximate open space context**

The City of Boulder Open Space and Mountain Parks (OSMP) manages approximately 45,000 acres of land in and around the City of Boulder, Colorado, which offers protection of critical habitat for plant and animals and opportunities for passive recreation such as hiking, horseback riding and cycling. The use and creation of undesignated trails is a specific area of concern on the OSMP system. Across OSMP lands there are 147 miles of designated trails and
over 150 miles of undesignated trails (VanderWoude, Lezberg, & Cseke, 2015). To effectively reduce use of undesignated trails, OSMP must have a better understanding of which types of closure treatments are most effective at ensuring visitor compliance with closures. Furthermore, an understanding of visitor intentions for using undesignated trails is paramount for implementing specific management actions (or combinations of actions) to reduce use of such trails. The purpose of this study was to investigate the efficacy of a range of management actions designed to mitigate the use of undesignated trails located within the OSMP system.

**RQ1: Which management strategy (intervention) is most effective in mitigating undesignated trail-use?**

**Key Findings**

The management intervention that included a combined physical barrier and educational message was the most effective at mitigating undesignated trail (UT) use. This method was approximately 97% effective at directing visitors to proceed onto the designated trail (DT) rather than traveling on the UT. This treatment was followed in effectiveness by a standalone physical barrier, which was 94% effective, and an educational message, which was also 94% effective. Further post-hoc analysis revealed that only the combined physical barrier and educational message produced a statistically significant reduction in UT use compared to control conditions.

**Management Implications**

The results presented here suggest a range of UT management options exist, each with different levels of effectiveness, which provide managers a set of alternative approaches for mitigating the use of UTs on the OSMP system. OSMP staff can utilize the data provided by this
research, combined with known practical constraints (i.e. human or financial resources, site characteristics, aesthetics, etc.) to make informed decisions about the most appropriate approach to mitigating the use of undesignated trails on OSMP lands. In terms of practical application, it may not be physically, aesthetically, or economically practical to treat every UT intersection with a combination barrier and educational sign (the most effective intervention). In cases where UT use is high or very high this approach may be warranted. But in other contexts that see relatively low levels of UT use a more minimalist approach, such as trailside educational messages, may be justified.

RQ2: To what extent do the Theory of Planned Behavior constructs work to explain behavioral intentions to travel only on designated trails?

**Key Findings**

Attitudes, perceived effectiveness, perceived behavioral control, and subjective norms have a significant and positive linear relationship with behavioral intent. These variables account for approximately 50% of the variance in intentions to travel only on designated trails. Perceived behavioral control held the strongest influence, followed by subjective norms.

**Management Implications**

These results point to the need to initiate management plans that make it easier for visitors to differentiate between UTs and DTs. We recommend the use of consistent dissemination of information, signage, and management interventions throughout the trail system that signify which trails are DTs. For example, existing infrastructure on UTs, such as block steps, water bars, or small signs indicating no mountain biking may confuse visitors, as those are
typically visual cues that indicate a managed (designated) trail segment. Thus, eliminating existing infrastructure on current UTs, coupled with the implementation of a combined barrier and educational message intervention could enhance mitigation efforts.

**RQ3: To what extent do the Theory of Planned Behavior constructs work to explain actual trail use behavior?**

**Key Findings**

The TPB constructs account for approximately 10% (Cox & Snell R2 = .096) of the variance in trail use behavior. This suggests that behavior in this sample is little explained by the TPB constructs operationalized in the study. Additionally, the model correctly classified 84% of designated trail users, but only 47% of undesigned trial users, correctly classifying 68% of cases overall. Attitudes, subjective norms, and perceived effectiveness did not contribute significantly to the explanatory ability of the model. As such, the model suggests PBC to be the single best predictor of actual behavior. That is, the extent to which behaviors are perceived to be completely within one’s volitional control appears to be the most important factor influencing behavior.

**Management Implications**

While understanding behavioral intentions does well to inform the development of management interventions, intentions do not always directly correlate to subsequent behaviors. In this study, the prediction of actual behavior was far less accurate than the prediction of behavior intentions. These results suggest there is a fairly substantial disconnect between what visitors said they would do and what they actually did. Because of this identified inaccuracy between self-
report (survey) data and behavioral (observed) data, we suggest researchers utilize measures of actual behavior whenever possible, rather than relying solely on self-report data.

**Limitations and Future Research**

Every effort was made to provide a robust, evenly distributed stratified sample, given the vast number of strata, the limited time span of this study, and the available resources. However, there are limitations that should be noted. For example, this sampling effort took place over 25 days, during a 30-day (one-month) period. Visitation patterns and behaviors may have been subject to weather or other environmental factors beyond our control. Additionally, each of the 20 sites was examined under all intervention and control conditions; however, a.m./p.m. and weekday/weekend stratification was not evenly distributed, given the one-month sampling period. Moreover, this study only incorporated 20 randomly selected sites, and other OSMP undesignated trail sites may produce alternative visitor behaviors and associated perceptions.

Longitudinal research using the most effective intervention used in this study set-up in high UT use locations could yield greater understanding of the influence of paired indirect and direct management actions on UT use. For example, if the entire DT trail system and associated UT junctions within a predetermined area were treated with the barrier and educational signage over a period of two years for instance, researchers and managers could monitor visitor attitudes and behavior change with the methods used in this study. Additionally, expanding the study over a multi-year period could afford the opportunity to measure ecological change (e.g., vegetation regrowth) resulting from treatment application.

Finally, this study demonstrated the strength in pairing self-reported survey data with actual behavioral observations. As noted, self-reported behavioral intentions do not always align
with the actions visitors take in the environment. Thus, when feasible, future studies should consider pairing visitor surveys and observations.

**Reflections on the Theory of Planned Behavior: Limitations, extensions, and directions for future Leave No Trace Research**

While the TPB has become one of the most influential models used in the understanding of human behavior, it is not without limitations. The studies described in this dissertation were framed largely within the context of the TPB, largely focusing on attitude-behavior relationships. In reflecting on my experience using the TPB as a theoretical frame for Leave No Trace research, I would like to discuss three primary limitations that have implications for future Leave No Trace research: 1) the broad range (or inconsistency) in explained variance when comparing across multiple studies; 2) that perceived behavioral might be a confounded construct – as it doesn’t differentiate between internal and external controllability; and 3) the lack of attention to personal, or moral norms.

Regarding inconsistencies in predictive ability, a review by Sutton (1998) cites that the TPB ranges in its explanation of variance in behavioral intent from about 20-50% (with the majority of studies in the 40-50% range), and explained variance in actual behavior was found to be anywhere from 19-38%. The model presented in Chapter 4 of this dissertation resulted in approximately 50% of the explained variance in behavioral intent, which is at the upper end of the studies in Sutton’s review. However, the model’s ability to predict actual behavior was on the lower end, at approximately 10%. In interpreting the significance and implications of results such as these it is important that we make a distinction between prediction and explanation. If we operate under the assumption that 100% prediction of human behavior is the ultimate goal (which is theoretically and statistically impossible), then these predictive outcomes are not so great.
However, often times our interest is more about explaining behavior – we look to uncover trends and potential causal relationships that can guide interventions, educational practices, or future research. My research has been most interested in explanations of human behavior. Thus, the ability to explain 40-50% of the variance in Leave No Trace related behavior is highly beneficial.

Second, the perceived behavioral control construct has been frequently scrutinized for its broad measure of controllability (Kraft, Rise, Sutton, & Røysamb, 2005). Some have argued that it is unclear whether PBC measures factors of internal control, or factors outside of one’s control (Ajzen, 2002). The inability to discriminate between the two aspects of behavioral control limits the extent to which implications can be suggested for practitioners. For example, if one were utilizing the TPB to inform the development of educational strategies, it would be important to know if people felt they had no volitional control over a behavior due to internal or external reasons. This is an important concept to discern for Leave No Trace research.

In addressing this, Ajzen did conclude that there might in fact be two distinct concepts underpinning PBC (Ajzen, 2002). He suggested a hierarchical structure exists where self-efficacy (internal locus) and controllability (external locus) can be distinguished and measured separately, which in their aggregate, form a global measure of perceived behavioral control as initially conceptualized. He offered that measures of internal locus of control are best operationalized in the TPB by eliciting responses to questions about one’s perceived difficulty of performing a behavior. Thus, I suggest that future research on Leave No Trace operationalizes PBC as perceived difficulty (very easy to very difficult) of performing a behavior. This will aid in understanding the level of internal control an individual perceives in their ability to perform Leave No Trace recommended practices.

A third limitation of the TPB is its lack of attention to personal or moral norms. Ajzen has suggested that moral norms should be largely accounted for in the behavioral attitude construct. Nevertheless, he has also acknowledged that when the behavior under question has an
ethical or moral aspect to it, the inclusion of measures designed specifically to tap moral norms could add to the utility of the TPB. I will discuss extension of the TPB to include moral norms in further detail below.

Extensions to the Theory of Planned Behavior in Future Leave No Trace Research

In light of the limitations to the TPB discussed above, researchers working to advance the social science of Leave No Trace might consider applying the following theoretical extensions and additions to future Leave No Trace investigations. First, an area that has received little attention is the extent to which people attribute recreation impacts to their own behavior. In other words, recreation scholars and land managers see ecological and social impacts and attribute them to the visitor, but do the visitors believe they are personally contributing to the issues? Moreover, do they feel a personal responsibility to contribute to the solutions? Meta-analyses of the environmentally responsible behavior (ERB) literature conducted by Hines, Hungerford, & Tomera (1987) and replicated by Bamberg & Möser (2007) both found, in addition to the commonly explored constructs in the TPB, that personal responsibility, awareness of the issue, attribution of cause, and personal norms were among the strongest predictors of ERB. But little has been explored as to whether recreationists perceive their actions to contribute the impacts Leave No Trace is employed to mitigate.

Attribution theory suggests that people often interpret their behavior in terms of its cause, and these attributions play a central role in human behavior (Kelley & Michela, 1980). However, recreationists are often unwilling to view themselves as the cause of the impact (Bradford & McIntyre, 2007). Lynn & Brown (2003) found that when asked about their contribution to recreation impacts, the majority of hikers indicated their behavior contributes “not at all to minimally.” Other studies have found that personal attribution is inversely related to depreciative
behaviors (Alessa, Bennett, & Kliskey, 2003). That is, the more visitors believed their behavior had the potential to cause resource degradation, the less likely they were to engage in deprecative behavior. Finally, Bradford (2007) found that the use of an attribution message was twice as effective as a plea message in reducing off-trail hiking. Taken together, these studies suggest personal attribution to be an area worthy of further study as related specifically to Leave No Trace recommended behaviors.

Closely related to the notion of attribution is Shalom Schwartz’s (1968) norm activation model (NAM). Personal norms form the core of the NAM. According to Schwartz, personal norms are experienced as feelings of moral obligation, not as intentions. The NAM hypothesizes that moral norms are activated by two distinct factors: 1) ascription of consequences, and 2) ascription of responsibility. The model follows a linear mediation structure where ascription of consequences (awareness) contributes to one’s ascription of responsibility, which in turn activates the moral norm, thus resulting in decision to engage or not engage in a particular behavior. Ajzen (1991) has suggested that when certain behaviors are in question, the inclusion of moral norms could add to the TPB, while Conner and colleagues (1998) argued that when the behavior is of moral or ethical dimension moral norms should work in parallel with attitudes, subjective norms, and PBC. Additionally, Onwezen and others (2013) found that when the NAM was included into the TPB it added an additional 17% of explained variance in global measures of environmentally responsible behavior. We know very little about the extent to which recreationists see their behavior as contributing to impacts, or if they feel responsible for contributing to the solutions. Exploring dimensions of personal attribution and moral norms are important additions to Leave No Trace research moving forward.
Setting Forth a Leave No Trace Research Agenda

The studies in this dissertation are meant to advance our understanding of the efficacy of Leave No Trace messaging and educational programs. It is my hope that research will continue to forward this line of inquiry in continued efforts to advance the social science of Leave No Trace. While the studies in this dissertation help to fill a number of gaps in the literature, there are still myriad opportunities for the continued advancement of Leave No Trace research. In the following sections, I will highlight knowledge gaps that merit research attention and outline four priority areas for future Leave No Trace research.

Knowledge Gaps

First, there is relatively little known about the relationship between Leave No Trace education/information interventions and changes in resource conditions. In other words, how does the deployment of a Leave No Trace focused visitor education program translate to on the ground resource conditions? There is evidence that recreationists have generally positive attitudes towards Leave No Trace and report fairly high levels of intent to perform recommended practices (Lawhon, Newman, Taff, & Vaske, 2013; F. Schwartz, Taff, Pettebone, & Lawhon, 2016; Taff, Newman, Vagias, & Lawhon, 2014; Vagias & Powell, 2010). Studies also show information and messaging can be effective at changing visitor behavior patterns (Johnson & Swearingen, 1992; Ward & Roggenbuck, 2003). But we have yet to fully explore how these behavior changes interact to with the ecological resource conditions.

Second, the empirical evidence on the efficacy of Leave No Trace training courses is deficient. Education that occurs off-site, or before a visitor engages in outdoor recreation, is understood to be more effective and lasting than on-site messaging approaches (Daniels &
Marion, 2005). The extant research on this aspect of Leave No Trace is scant, and admittedly limited due to research design and methods (Daniels & Marion, 2005).

Third, the influence of personal moral norms on Leave No Trace behavior has not been explored, in addition to whether Leave No Trace education might work to form new personal moral norms. Finally, there is very little understanding of the cross-cultural or cross-national applicability of Leave No Trace outdoor ethics. In a rapidly diversifying country and globalizing world, it will be essential for the continued relevance of Leave No Trace to understand how outdoor ethics are perceived and understood in a diverse cultural and international landscape.

Based on the gaps in the literature discussed above, I propose four research priorities for the advancement of Leave No Trace Outdoor Ethics. They are meant to set forth a robust transdisciplinary research agenda that serves to empirically document essential components of Leave No Trace information and education programs.

A Proposed Leave No Trace Research Agenda

The following section will provide an overview of proposed priority areas for future Leave No Trace research. These priority areas are by no means an exhaustive list, nor are they listed in hierarchical order of importance.

Priority Research Areas

1. Coupled human and natural systems research
2. Program evaluation: Efficacy and outcomes
   a. Youth programs
   b. Training courses and workshops
3. Exploring the influence of moral norms on behavior
4. Cross-cultural/Cross-national applicability

Priority Area 1: Coupled human and natural systems research: Leave No Trace and changes in ecological conditions

It has been well documented, the extent to which outdoor recreation behaviors can result in myriad environmental impacts (Marion, 2016; Marion, Leung, Eagleston, & Burroughs, 2016). There is increasing evidence that time spent outdoors provides countless physical and psychological health benefits (Louv, 2008). For health reasons alone, it is essential to continue efforts to get people outside. It is equally important this be done in a way that supports the ecological integrity of natural places. Leave No Trace is positioned as a means to this end.

This research priority proposes a coupled human and natural systems approach to investigating the relationship between Leave No Trace educational strategies and on the ground ecological conditions. A coupled human and natural systems approach calls for an integrated scientific framework that endeavors to understand the reciprocal interactions that link humans to natural systems. This unique approach to Leave No Trace research will engage strategic partnerships with recreation ecologists resulting in cutting edge and innovative research methods.

- Research questions include:
  - What is the relationship between the implementation of a Leave No Trace visitor education program and changes in ecological conditions?
  - What is the spatial effect? What is the temporal effect?
Priority Area 2a: Evaluating the efficacy and outcomes of Leave No Trace youth programs

Significant life experiences in the childhood years have powerful influence to inform attitudes, values, and behaviors throughout life, especially regarding issues related to the environment. Early experiences in nature have shown to be strong predictors of future environmental stewardship (Chawla, 1988). Trends among youth showing decreases in time spent outdoors and decreases in environmental concern call for educational and programmatic interventions to promote environmental consciousness in youth.

The Leave No Trace PEAK (Promoting Educational Awareness in Kids) program is a kid-friendly curriculum designed to promote environmental awareness and stewardship of the outdoors. While the program has been in existence for many years, little is known as to the effectiveness of its message. In addition to the study presented in this dissertation, only one other empirical study has been conducted (Miller, Shellman, Hill, Ramsing, & Lawhon, 2014). Moreover, The Leave No Trace Center has recently developed a camp-based youth curriculum that has not yet been put into practice or researched.

- Research questions include:
  - Camp curriculum:
    - What are participant attitudes and perceptions of the program?
    - What are the knowledge outcomes (both short and long-term)?
    - Do program goals align with outcomes?
    - What is the relationship between program participation and environmental consciousness?
  - PEAK and Teen programs:
    - What is the effect of program participation on knowledge acquisition?
    - What are they learning and how lasting are the effects?
To what does participation modify subsequent outdoor behavior?

Priority Area 2b: Evaluating the efficacy and outcomes of workshops and courses

The Center for Leave No Trace Outdoor Ethics provides training programs for thousands of people every year. These trainings include online awareness courses, 2-day trainer programs, and extensive 5-day Master Educator “train the trainer” programs. Previous research on these programs has found general increases in knowledge, and self-reported changes in “ethics.” These studies provide a strong foundation from which to continue empirical documentation of educational outcomes. The researchers have noted several limitations in their work, which they admit limits the generalizability and validity of the results. Improvements to study design, data collection methods, and construct measurement will enhance the validity of this line of inquiry.

An extension of this work was forwarded by Giuseffi (2011) in her master’s thesis. A common critique of Leave No Trace ethics as that they are perceived as something that begins and ends upon entry and exit of the outdoor recreation experience. However, there is no empirical evidence to confirm or deny this claim. There is validity in this critical view, however, as an outdoor ethic that transcends the outdoor recreation context is one that will contribute to the overall environmental health and well-being. Giuseffi’s study attempted to examine this concept. Again, a number of methodological factors admittedly limited her work. This is an important theme of research that needs to be refined and expanded.

- Research questions include:
  - How well are programs meeting their intended outcomes?
  - What is the relationship between LNT Training and general environmentally responsible behavior in a day-to-day context?
  - To what extent does the LNT message transfer to day-to-day ERB
Priority Area 3: Determining the influence of moral norms on Leave No Trace recommended behavior

According to Schwartz’s (1968) norm activation model (NAM), personal norms, or moral norms, are experienced as feelings of moral obligation, not as intentions. Moral norms are expected to guide our judgment and activation of behavioral intentions when the behavior in question has some moral or ethical dimension. The NAM hypothesizes that moral norms become activated by two distinct factors: 1) ascription of consequences (AC), and 2) ascription of responsibility (AR). Based on this premise, awareness of the problem and its causes is expected to activate an ascription of responsibility (a person can decide to take personal responsibility for the problem and the solution, or they may choose to defer to someone else or some other thing). From there a moral norm is activated which guides the subsequent behavior.

Previous research has found that moral norms contributed significantly to environmentally responsible behavior, and were also found to account for the emergence of new moral norms (Heberlein, 1977). In an integrated Theory of Planned Behavior model, Onwezen and colleagues (2013) found that moral norms significantly improved the predictive ability of the model contributing an additional 17% of the variance in global ERB. Moral norms have yet to be explored in Leave No Trace behavior research and the findings from previous studies suggest they could contribute significantly to our understanding of Leave No Trace behaviors. Moreover, understanding the relationship between Leave No Trace education and its influence on emerging, or new, moral norms related to outdoor environmental ethics could work to support the notion that Leave No Trace ethics transcends beyond the outdoor recreation context.

- Research questions include:
  - To what extent are people aware that their behavior contributes to resource degradation?
To what extent do people feel a responsibility or obligation to help minimize recreation impacts by modifying their behavior?

Do the moral norms contribute to our understanding of behavioral intentions and behaviors?

Priority Area 4: Cross-cultural/Cross-national applications

Leave No Trace began as a uniquely American concept, based on American cultural norms, values, and ideals. However, our population demographic is changing and with that comes new interpretations of cultural norms, values, ideals, and perhaps outdoor ethics. Moreover, Leave No Trace is gaining the attention of other countries as an approach to visitor education in parks and protected areas (Taff, personal communication, 2016). Leave No Trace has worked in over 80 countries, and has partner organizations in at least four other countries. Leave No Trace is becoming a globally embraced concept.

But to what extent does an ethic derived from American conservation ideals transfer to other cultures and countries? In a discussion of their research in India, Seeneri (2013) suggested that while many countries are beginning to adopt Leave No Trace principles, there is question about the cross cultural transfer of Western ideals and ethics. Leave No Trace directly applied may or may not be appropriate and may face social and cultural obstacles. This will be an essential line of research as Leave No Trace continues to be recognized as an international leader in outdoor ethics education

- Research questions include:

  - To what extent does Leave No Trace transfer across cultures in the United States? How is it perceived and accepted?
  - How is Leave No Trace perceived by non-US cultures and nations?
For countries that are interested in adopting Leave No Trace ethics, how can research facilitate the appropriate changes in message and curriculum?

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http://doi.org/10.1016/S0169-2046(02)00202-5


http://doi.org/10.1016/j.joep.2013.07.005


Appendix A

Rocky Mountain National Park Bouldering Survey

ROCKY MOUNTAIN NATIONAL PARK VISITOR STUDY

1. How many years have you been bouldering? (write in number) ______

2. How many years have you been bouldering at Rocky Mountain National Park? (write in number) ______

3. In what year did you first visit Rocky Mountain National Park? (write in the year) ______

4. Approximately how many days a year do you boulder outside? (check one)
   □ <10 days/year □ 11-20 days/year □ 21-30 days/year □ 31-40 days/year □ 41-50 days/year □ >50 days/year

5. Approximately how many days a year do you boulder at Rocky Mountain National Park? (check one)
   □ <10 days/year □ 11-20 days/year □ 21-30 days/year □ 31-40 days/year □ 41-50 days/year □ >50 days/year

6. Approximately how many days a year do you boulder indoors in a gym? (check one)
   □ <10 days/year □ 11-20 days/year □ 21-30 days/year □ 31-40 days/year □ 41-50 days/year □ >50 days/year

7. What category best describes your overall ability as a climber? (check one)
   □ Beginner (V0-V2) □ Intermediate (V3-V5) □ Advanced (V6-V8) □ Expert (V10-V15)

8. What type of climber are you predominately? (check one)
   □ Roped (Sport, Traditional, etc.) □ Un-rope (Lead Climber)

9. Where did you learn to climb? (check one)
   □ Indoors at a rock gym □ Outdoors

10. Who taught you to climb? (check one)
    □ Family members (informally) □ Friends (informally)
    □ Climbing club (informally) □ Took a course from University/College (formal instruction)
    □ Took a course from outfitter/guide (formal instruction) □ Other

11. In general, where do you most prefer to boulder? (regardless of season, weather, availability of climbing partners) (check one)
    □ Gyms □ Frontcountry (road-side crags, easy/short approaches) □ Backcountry (i.e. remote areas, long approaches)

12. Which bouldering area in Rocky Mountain National Park do you typically spend most of your time? (check one)
    □ Chaos Canyon □ Wild Basin □ Endo Valley □ Emerald Lake □ Hyland □ Other

13. What specific bouldering problem did you spend the most time on TODAY? (write in response)

14. When bouldering in Rocky Mountain National Park, please indicate the level of Appropriateness of the following activities. (Circle the number of your response for each statement)

   a. Playing music through external speakers
      1 2 3 4 5 6 7
   b. Stashing crash pads near bouldering problems for later use
      1 2 3 4 5 6 7
   c. Moving rocks, trees, or shrubs at the base of a boulder to develop a safer landing zone
      1 2 3 4 5 6 7
   d. Leaving tick marks when done bouldering
      1 2 3 4 5 6 7
   e. Traveling off designated trails to access boulders
      1 2 3 4 5 6 7
   f. Dropping food on the ground to provide wildlife a food source
      1 2 3 4 5 6 7
   g. Scheduling a visit during times of high use
      1 2 3 4 5 6 7
   h. Moving rocks, trees, or shrubs at the base of a boulder for better/easier access
      1 2 3 4 5 6 7
   i. Placing gear and crash pads on vegetation (grasses, trees, shrubs, moss, etc.)
      1 2 3 4 5 6 7
   j. Keeping a single item like a rock, plant, stick, or feather as a souvenir
      1 2 3 4 5 6 7
   k. Traveling side by side in a group on existing trails
      1 2 3 4 5 6 7
   l. Removing/cleaning lichen, moss, or plants from a boulder to establish a new route
      1 2 3 4 5 6 7
   m. Spreading out gear and crash pads to establish a "basecamp" while at the crag
      1 2 3 4 5 6 7
15. Please indicate how EFFECTIVE the following activities would be at reducing negative impacts while bouldering in Rocky Mountain National Park. (Circle the number of your response for each statement)

<table>
<thead>
<tr>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Preparing for all types of weather, hazards, or emergencies before I get on the trail</td>
</tr>
<tr>
<td>b. Scheduling a visit to avoid times of high use</td>
</tr>
<tr>
<td>c. Staying on designated or established trails</td>
</tr>
<tr>
<td>d. Walking single file in the middle of the trail, even when wet or muddy</td>
</tr>
<tr>
<td>e. Carrying out all litter, even crumbs, peels, or cores</td>
</tr>
<tr>
<td>f. Leaving all natural objects in the area, including rocks, plants, sticks, or feathers</td>
</tr>
<tr>
<td>g. Avoiding approaching, feeding, or following wildlife</td>
</tr>
<tr>
<td>h. Taking breaks away from the trail and other visitors</td>
</tr>
<tr>
<td>i. Keeping the footprint of gear and crash pads to a minimum while at the crag</td>
</tr>
<tr>
<td>j. Playing music at a level that only you, or your immediate group can hear it</td>
</tr>
<tr>
<td>k. Carrying crash pads out of the park each time you exit</td>
</tr>
<tr>
<td>l. Leaving existing rocks, trees, or shrubs intact at the base of boulder problems</td>
</tr>
<tr>
<td>m. Removing tick marks when done bouldering</td>
</tr>
<tr>
<td>n. Leaving existing lichen, moss, or plants intact at boulder problems</td>
</tr>
<tr>
<td>o. Placing gear and crash pads on durable surfaces</td>
</tr>
<tr>
<td>p. Depositing solid human waste in “cat holes”, away from water, bouldering areas, and trails</td>
</tr>
</tbody>
</table>

16. The same activities are listed below. Regardless of how effective you think each of the following activities are, please indicate how DIFFICULT you think each of the following activities would be for you to do while bouldering in Rocky Mountain National Park. (Circle the number of your response for each statement)

<table>
<thead>
<tr>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Preparing for all types of weather, hazards, or emergencies before I get on the trail</td>
</tr>
<tr>
<td>b. Scheduling a visit to avoid times of high use</td>
</tr>
<tr>
<td>c. Staying on designated or established trails</td>
</tr>
<tr>
<td>d. Walking single file in the middle of the trail, even when wet or muddy</td>
</tr>
<tr>
<td>e. Carrying out all litter, even crumbs, peels, or cores</td>
</tr>
<tr>
<td>f. Leaving all natural objects in the area, including rocks, plants, sticks, or feathers</td>
</tr>
<tr>
<td>g. Avoiding approaching, feeding, or following wildlife</td>
</tr>
<tr>
<td>h. Taking breaks away from the trail and other visitors</td>
</tr>
<tr>
<td>i. Keeping the footprint of gear and crash pads to a minimum while at the crag</td>
</tr>
<tr>
<td>j. Playing music at a level that only you, or your immediate group can hear it</td>
</tr>
<tr>
<td>k. Carrying crash pads out of the park each time you exit</td>
</tr>
<tr>
<td>l. Leaving existing rocks, trees, or shrubs intact at the base of boulder problems</td>
</tr>
<tr>
<td>m. Removing tick marks when done bouldering</td>
</tr>
<tr>
<td>n. Leaving existing lichen, moss, or plants intact at boulder problems</td>
</tr>
<tr>
<td>o. Placing gear and crash pads on durable surfaces</td>
</tr>
<tr>
<td>p. Depositing solid human waste in “cat holes”, away from water, bouldering areas, and trails</td>
</tr>
</tbody>
</table>
17. The same activities are listed below.
PART 1: In COLUMN A tell us if YOU DO each activity by circling
Never, Sometimes, or Always.
PART 2: In COLUMN B, please indicate how LIKELY you are to do
the activity in the future by circling the number of your response
for each statement. (please circle only one number)

<table>
<thead>
<tr>
<th>Activities</th>
<th>Do You Do This Now?</th>
<th>COLUMN B</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Preparing for all types of weather, hazards, or emergencies</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>b. Scheduling a visit to avoid times of high use</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>c. Staying on designated or established trails</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>d. Walking single file in the middle of the trail, even when wet or muddy</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>e. Carrying out litter, even crumbs, peels, or cores</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>f. Leaving all natural objects in the area, including rocks, plants,</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>g. Avoiding approaching, feeding, or following wildlife</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>h. Taking breaks away from the trail and other visitors</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>i. Keeping the footprint of gear and crash pads to a minimum while</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>j. Playing music at a level that only you, or your immediate group can</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>k. Carrying crash pads out of the park each time you exit</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>l. Leaving existing rocks, trees, or shrubs intact at the base of</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>m. Removing tick marks when done bouldering</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>n. Leaving existing lichen, moss, or plants intact at boulder problems</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>o. Planting gear on durable surfaces</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>p. Depositing solid human waste in “cat holes”, away from water,</td>
<td>Never</td>
<td>1</td>
</tr>
<tr>
<td>18. How much of a problem do you think each of the following issues are</td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Park. (Circle the number of your response for each statement)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Vegetation loss at the base of boulders</td>
<td>1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>b. Excessive chalk and tick marks on boulders</td>
<td>1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>c. Moving rocks, trees, or shrubs at the base of boulders to develop</td>
<td>1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>d. Hearing music being played through external speakers</td>
<td>1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>e. Stashing crash pads for later use</td>
<td>1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>f. The presence of human waste near trails or bouldering sites</td>
<td>1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>g. The presence of trash at bouldering sites</td>
<td>1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>h. Excessive social trails leading to bouldering sites</td>
<td>1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>i. Crowding at bouldering sites</td>
<td>1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>j. Park visitors stopping me to ask what my crash pad is used for</td>
<td>1 2 3 4</td>
<td></td>
</tr>
</tbody>
</table>

15. Are you familiar with outdoor bouldering ethics? (please check one)
☐ No    ☐ Yes
If yes, how/where were you introduced to outdoor bouldering ethics? (write in response below)
20. How would you describe your current level of knowledge of “Leave No Trace” practices? (circle one number)

<table>
<thead>
<tr>
<th>No Knowledge</th>
<th>Very Limited</th>
<th>Limited</th>
<th>Average</th>
<th>Above Average</th>
<th>Extensive</th>
<th>Expert</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

21. Please indicate how strongly you DISAGREE or AGREE with the following statements. (Circle the number of your response for each statement)

<table>
<thead>
<tr>
<th>Statement</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practicing “Leave No Trace” is time consuming</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practicing “Leave No Trace” limits my freedom in the outdoors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Practicing “Leave No Trace” protects the environment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is important that all visitors practice “Leave No Trace”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>It is important that park regulations require all visitors to practice “Leave No Trace”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I insist that “Leave No Trace” practices are followed by all members of my group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I practice “Leave No Trace” because the people I recreate with believe it is important</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>If informed that my actions in the Park damaged the environment, I would change my behavior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rocky Mountain National Park means a lot to me</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I enjoy bouldering in Rocky Mountain National Park more than any other place</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I feel no commitment to Rocky Mountain National Park</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am very attached to Rocky Mountain National Park</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bouldering in Rocky Mountain National Park is more important to me than bouldering in any other place</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

22. How did the number of people you saw bouldering during your visit compare with what you expected? (check one)

- A lot less than what you expected
- A little less than what you expected
- About what you expected
- A lot more than what you expected
- You did not have any expectations

23. How crowded did you feel while bouldering at Rocky Mountain National Park today? (circle one number)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all crowded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slightly crowded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderately crowded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very crowded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extremely crowded</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

24. How did the number of other boulderers you encountered affect your overall experience today? (circle one number)

<table>
<thead>
<tr>
<th>Added greatly</th>
<th>Added somewhat</th>
<th>Had no effect</th>
<th>Detracted somewhat</th>
<th>Detracted greatly</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

25. Did you move to a different crag/boulder based on the number of people you encountered? (check one) □ No □ Yes

26. What did you like LEAST about your bouldering experience at Rocky Mountain National Park today? (write in answer)

27. What did you like MOST about your bouldering experience at Rocky Mountain National Park today? (write in answer)

28. What is your gender? (check one) □ Female □ Male

29. What is your age? (write in number of years): _________

30. Do you live in the United States? (check one and fill in):

- Yes - What is your zip code? ___________  □ No - In what country do you live? _________________

Rocky Mountain National Park and Pennsylvania State University thank you for your assistance.

<table>
<thead>
<tr>
<th>Office Use Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey #:</td>
</tr>
<tr>
<td>Date:</td>
</tr>
<tr>
<td>Time:</td>
</tr>
<tr>
<td>Initials:</td>
</tr>
<tr>
<td>Location: EL LH WB</td>
</tr>
</tbody>
</table>
Appendix B

Outdoor School PEAK Pre-Survey

Your Initials: __________ What is the number on the back of your wood cookie? _____

PLEASE READ THESE INSTRUCTIONS CAREFULLY BEFORE BEGINNING THE SURVEY

This survey will ask you about your feelings about nature and things you will learn at Outdoor School.

For this section, think about the next time you will be in nature. Each survey item will describe an action you might do in nature. We would like to know how likely you are to do the action. You will have five choices to choose how true that statement is for you. Your choices range from (1) Strongly Disagree to (5) Strongly Agree. The higher the number you circle, the more likely you are to do the action.

<table>
<thead>
<tr>
<th>The next time I am in nature...</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. If I find flowers I like I will pick them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. If I find an interesting rock I will keep it.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. I will pick up things I am interested in, but leave them where I found them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. If I find an animal bone or antler I will take it with me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. If I find an arrowhead I will keep it.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. I will pick up things I am interested in and take them with me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. If I find a fossil I will keep it.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. I will only look at natural objects and not touch them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. If I find a fossil I will leave it where I found it.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. I will leave natural objects as I found them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

This section is about things people do in nature. We would like to know how you feel about these things. Each survey item is a statement. You will have five choices to choose how much you agree or disagree with the statement. Your choices range from (1) Strongly Disagree to (5) Strongly Agree. The higher the number you circle, the more you agree with the statement.

<table>
<thead>
<tr>
<th>When visiting nature...</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. It is OK to pick flowers.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. It is wrong to pick up natural objects even if you put them back where you found them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. It is OK to collect live animals.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. It is wrong to collect fossils.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. It is OK to collect insects.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. It is wrong to collect rocks.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. It is OK to keep arrowheads.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. It is OK to collect animal bones or antlers.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. It is best to look but don’t touch the things you find.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. It is OK to pick up things as long as you leave them where you found them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. It is important to leave nature as you find it so others may enjoy it.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
Appendix C

Outdoor School PEAK Post-Survey

Your initials: ______ I am a: Boy ___ Girl ___ What is the number on the back of your wood cookie? ______

PLEASE READ THESE INSTRUCTIONS CAREFULLY BEFORE BEGINNING THE SURVEY

This survey will ask you about your feelings about nature and things you will learn at Outdoor School.

For this section, think about the next time you will be in nature. Each survey item will describe an action you might do in nature. We would like to know how likely you are to do the action. You will have five choices to choose how true that statement is for you. Your choices range from (1) Strongly Disagree to (5) Strongly Agree. The higher the number you circle, the more likely you are to do the action.

<table>
<thead>
<tr>
<th>The next time I am in nature...</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. If I find flowers I like I will pick them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. If I find an interesting rock I will keep it.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. I will pick up things I am interested in, but leave them where I found them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. If I find an animal bone or antler I will take it with me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. If I find an arrowhead I will keep it.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. I will pick up things I am interested in and take them with me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. If I find a fossil I will keep it.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. I will only look at natural objects and not touch them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. If I find a fossil I will leave it where I found it.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. I will leave natural objects as I found them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

This section is about things people do in nature. We would like to know how you feel about these things. Each survey item is a statement. You will have five choices to choose how much you agree or disagree with the statement. Your choices range from (1) Strongly Disagree to (5) Strongly Agree. The higher the number you circle, the more you agree with the statement.

<table>
<thead>
<tr>
<th>When visiting nature...</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. It is OK to pick flowers.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. It is wrong to pick up natural objects even if you put them back where you found them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. It is OK to collect live animals.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. It is wrong to collect fossils.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. It is OK to collect insects.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. It is wrong to collect rocks.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. It is OK to keep arrowheads.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. It is OK to collect animal bones or antlers.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. It is best to look but don't touch the things you find.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. It is OK to pick up things as long as you leave them where you found them.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. It is important to leave nature as you find it so others may enjoy it.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>12. Bringing a natural object home from nature is important to me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. I feel more connected to nature if I bring a natural object I find home with me (such as a rock, feather, or shell).</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Learning Group Leader: ____________
Appendix D

Open Space and Mountain Parks Visitor Survey

**City of Boulder Open Space and Mountain Parks (OSMP) Visitor Survey**

1. What is your **PRIMARY ACTIVITY today**? (Select only one)
   - [ ] Hiking/Walking
   - [ ] Walking dog(s)
   - [ ] Climbing/Bouldering
   - [ ] Horseback Riding
   - [ ] Running
   - [ ] Biking
   - **Other:________**

2. How many dogs did **YOU** bring today (please **do not** include dogs another person in your group brought)? (Select only one)
   - [ ] 0
   - [ ] 1
   - [ ] 2
   - [ ] 3
   - [ ] 4
   - [ ] 5
   - [ ] 6

3. How many times have you visited this section of trail **in the past 12 months**? (Select only one)
   - [ ] Today is my first visit
   - [ ] 1 – 12 Visits
   - [ ] 13 – 48 Visits
   - [ ] 49 – 144 Visits
   - [ ] 145 – 240 Visits
   - [ ] > 240 Visits

4. Are you aware that some trails in City of Boulder OSMP are “**undesignated**” or not official trails?
   - [ ] Yes
   - [ ] No

5. To what extent do you believe that **human recreation behaviors** have the potential to cause **NEGATIVE IMPACT**, a) **Ecologically**, and b) **Socially** in City of Boulder OSMP? (Select only one answer per item)

<table>
<thead>
<tr>
<th>Type of impact as a result of human recreation behaviors...</th>
<th>No Impact At All</th>
<th>Moderate Impact</th>
<th>Extensive Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Ecological</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>b. Social/Experience</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

6. Please indicate how **INAPPROPRIATE** or **APPROPRIATE** you think each of the following activities is for a visitor to do in City of Boulder OSMP. (Select only one answer per item)

<table>
<thead>
<tr>
<th>Activities</th>
<th>Very Inappropriate</th>
<th>Neutral</th>
<th>Very Appropriate</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Traveling off a designated trail to experience the natural environment</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Traveling around muddy spots on a designated trail</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Traveling off a designated trail to explore</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Traveling off a designated trail to take photos</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Traveling off a designated trail to get away from crowds on the trail</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Traveling off a designated trail because there is an alternative established path</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. Please indicate how **EFFECTIVE** the following activities would be at reducing **NEGATIVE IMPACTS** in City of Boulder OSMP. (Select only one answer per item)

<table>
<thead>
<tr>
<th>Activities</th>
<th>Never Effective</th>
<th>Sometimes Effective</th>
<th>Effective Every Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Staying on a designated trail</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Traveling in the middle of a designated trail, even when wet or muddy</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Traveling on a designated trail, even when passing other visitors</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Staying off a designated trail when conditions are wet and muddy</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Adhering to messages on posted signage</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8. Please indicate how **DIFFICULT** you think each of the following activities would be for you to do in City of Boulder OSMP. (Select only one answer per item)

<table>
<thead>
<tr>
<th>Activities</th>
<th>Very Difficult</th>
<th>Neutral</th>
<th>Very Easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Staying on a designated trail</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>b. Traveling in the middle of a designated trail, even when wet or muddy</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>c. Traveling on a designated trail, even when passing other visitors</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>d. Traveling on a designated trail, even when you have previously traveled on an undesignated trail in the area</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>e. Traveling on a designated trail, even when an undesignated trail is available in the area</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>f. Traveling on a designated trail, even when you have observed another visitor traveling on an undesignated trail</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>g. Adhering to messages on posted signage</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

9. In Column A, tell us if you **CURRENTLY DO** each activity by circling *Never, Sometimes, Always*. In Column B, please indicate how **likely** you are to do the activity in the **FUTURE**. (Select only one answer per item, in both Column A, and B)

<table>
<thead>
<tr>
<th>Activities</th>
<th>Column A</th>
<th>Column B</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Staying on a designated trail</td>
<td>Never</td>
<td>Sometimes</td>
</tr>
<tr>
<td>b. Traveling in the middle of a designated trail, even when wet or muddy</td>
<td>Never</td>
<td>Sometimes</td>
</tr>
<tr>
<td>c. Traveling on a designated trail, even when passing other visitors</td>
<td>Never</td>
<td>Sometimes</td>
</tr>
<tr>
<td>d. Traveling on a designated trail, even when you have previously traveled on an undesignated trail in the area</td>
<td>Never</td>
<td>Sometimes</td>
</tr>
<tr>
<td>e. Traveling on a designated trail, even when an undesignated trail is available in the area</td>
<td>Never</td>
<td>Sometimes</td>
</tr>
<tr>
<td>f. Traveling on a designated trail, even when you have observed another visitor traveling on an undesignated trail</td>
<td>Never</td>
<td>Sometimes</td>
</tr>
<tr>
<td>g. Adhering to messages on posted signage</td>
<td>Never</td>
<td>Sometimes</td>
</tr>
</tbody>
</table>

10. Did you **travel off a designated trail** during your visit today? □ Yes □ No □ Don’t Know/Unsure

11. Indicate whether or not any of the following **reasons for traveling off the designated trail(s)** applied to your visit today. (Select only one answer per item)

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Does Not Apply Because (Only) Traveled On Designated Trail</th>
<th>Applies to Me</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. I didn’t know that traveling off the designated trail could damage soils and vegetation</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>b. I didn’t know that it was recommended to stay on the designated trail</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>c. I didn’t mean to travel off the designated trail (it was an accident)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
12. Please indicate how IMPORTANT these reasons would be for you to travel only on designated trails in the FUTURE. (Select only one answer per item)

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Not Relevant</th>
<th>Not At All Important</th>
<th>Moderately Important</th>
<th>Extremely Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. To improve my outdoor experience on OSMP lands</td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>b. Because visitors are encouraged to stay on designated trails</td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>c. To not damage the soils and vegetation</td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>d. To not break the rules</td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>e. Because I do not want anyone to see me travel off designated trails</td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>f. Because it is unfair for me to travel off designated trails while many other visitors do not</td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>g. Because I have no reason to travel off designated trails</td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>h. Because Leave No Trace promotes traveling on designated trails</td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>i. Because I feel better about myself by not traveling off designated trails</td>
<td></td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

13. Did you notice the following on this trail today? (Check all that apply)
   - Informational signage to keep visitors on designated trails
   - Fence or barrier to keep visitors on designated trails
   - Combination of informational signage and fence or barrier to keep visitors on designated trails

14. Please RANK the following in order (1st, 2nd, and 3rd), indicating which would be most effective in keeping you off an undesigned trail. (1st = Most Effective; 3rd = Least Effective)
   - Informational signage
   - Fence or barrier
   - Combination of informational signage and fence or barrier

15. How many people, including yourself, were part of your group today? ________________

16. Do you live in the United States?
   - Yes — If Yes, a.) do you live within Boulder City limits, and b.) what is your zip code?
     a.) Yes, Boulder City limits
     b.) Zip code: ______________________
   - No (What country do you live in? __________________________)
17. Please indicate how strongly you AGREE or DISAGREE with the following statements. (Select only one answer per item)

<table>
<thead>
<tr>
<th>Statements</th>
<th>Strongly Disagree</th>
<th>Neither Agree or Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. If I learned my actions in OSMP damaged the environment, I would change my behavior</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Practicing &quot;Leave No Trace&quot; does not reduce the environmental harm caused by travel in OSMP</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Practicing &quot;Leave No Trace&quot; takes too much time</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Practicing &quot;Leave No Trace&quot; effectively protects the environment so that future generations may enjoy it</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18. How IMPORTANT were each of the following reasons for your visit to City of Boulder OSMP today? (Select only one answer per item)

<table>
<thead>
<tr>
<th>Reasons</th>
<th>Not Relevant</th>
<th>Not At All Important</th>
<th>Moderately Important</th>
<th>Extremely Important</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Physical fitness</td>
<td>0</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Physical rest</td>
<td>0</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Psychological health</td>
<td>0</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Psychological rest</td>
<td>0</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Escape personal/social pressures</td>
<td>0</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Enjoying nature</td>
<td>0</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. Learning</td>
<td>0</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Family/friend togetherness</td>
<td>0</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Solitude</td>
<td>0</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

19. Is there anything else you would like us to know? If so, please provide additional feedback below:


Thank you for your participation.
Appendix E

PEAK Study Detailed Methods

Site and Sample

Data was collected during all six weeks of Penn State University’s Shaver’s Creek Environmental Center’s Outdoor School, in the spring of 2016. Outdoor School (ODS) is a four-day, three-night residential environmental education program that uses nature-based experiential learning techniques to teach about the interrelatedness of the natural and built environments (Andrejewski, 2011). ODS takes place in the heart of the Allegheny Mountains, at the edge of a Pennsylvania State Forest area, several miles from Penn State University’s main campus. The ODS experience is available to all upper-elementary students (primarily fifth grade) of participating schools in Centre, Huntingdon, Mifflin, and surrounding counties in central Pennsylvania. Thus, the location and diverse population of participants made ODS an ideal program to facilitate this study.

Each ODS season (fall and spring) includes five to seven four-day sessions with approximately 75-100 students participating each session. Students arrive on Tuesday morning and share a cabin with six to eight peers and a counselor (typically a Penn State undergraduate student) until their departure on Friday. A typical day involves a combination of outdoor lessons, free time, structured activities, cabin time, meals, and campfire activities. For the outdoor lessons, students are assigned to learning groups of 10 to 12 students, which are comprised of different individuals than their cabin groups, in effort to maximize interactions and minimize clique formation. ODS staffing generally involves two positions: cabin counselors and learning group leaders (LGLs). Cabin counselors are typically first-year staff and are primarily responsible for supervising cabin groups, whereas LGLs are more experienced staff with primary responsibilities
that include lesson planning and curriculum delivery. While much of the ODS curriculum is built around environmental and nature-based themes and topics, there is currently no explicit discussion of Leave No Trace or other similar outdoor ethics concepts. Furthermore, PEAK has never been utilized at ODS. Therefore, ODS provides a true controlled environment for this study.

All ODS students for the spring 2016 season were eligible for participation in the study. A letter describing the study and a parental consent form was included with the standard registration forms students receive for ODS. Following recommendations of the Penn State University Institutional Review Board, students were asked if they wished to participate in the study, and their parent or guardian was asked to complete and return a consent form for his or her child’s participation. A total of 357 out of 360 ODS students returned signed consent forms (99%). Parents or guardians were also asked if the research team had permission to contact the study participant after the study, should an opportunity arise to conduct a longitudinal study. A total of 258 provided permission to contact them for future study.

Students were randomly assigned to treatment and control groups based on learning groups. In other words, the treatment was randomized at the learning group level as opposed to the individual level. Learning groups selected to receive the treatment participated in a 30-minute PEAK-based educational module in addition to regularly scheduled activities, and those in the control participated in the typical ODS schedule of activities for that instructional period which had no PEAK-based education. A discussion of the educational treatment is provided below.

**Educational Treatment**

The educational treatment under examination in this study was a single module from the Leave No Trace PEAK program, and the broader contextual aspects of if or how Leave No Trace
connects youth to nature. This study focused exclusively on the Leave No Trace Principle, Leave What You Find. Leave What You Find teaches the importance of leaving artifacts, cultural objects, and other natural items behind for future visitors to enjoy. This Principle was selected because: 1) the prescribed behavior is observable at the individual level (i.e., whether or not someone removes a fossil from a streambed), and 2) it is considered to involve the highest level of ethically grounded decision-making as compared to the other Leave No Trace Principles.

The educational treatment utilized in this study was a 30-minute PEAK module titled *Unlocking the Past*, designed specifically to teach the Leave What You Find Principle. The learning groups randomly selected to receive the treatment participated in the module on the first day of ODS during the discovery walk activity. Discovery walk is a three-hour nature walk that includes a combination of name games, teambuilding activities, natural history facts, and a map and compass lesson. The discovery walk is a routine part of ODS, and has been for decades.

The PEAK module was led by ODS learning group leaders (LGLs) during the discovery walk. To ensure consistency in how the module was administered over the 6-week period, six LGLs were trained and assigned exclusively to lead the treatment groups. The training detailed the goals and objectives of the *Unlocking the Past* activity, provided step-by-step activity instructions, and allowed opportunities to practice facilitating the activity. Conformance to the activity instructions was stressed so as to ensure uniform application of the module across all LGLs and the six weeks of ODS. A rotating schedule was devised for the six LGLs who were assigned to the treatment groups so that each week three of the six were present. This also further stratified the manner in which the treatment was delivered across the entire data collection effort.
Data Collection

Survey Methods

The survey instrument for this study was designed to measure attitudes and reported behavioral intentions related to the Leave What You Find Principle and its specific recommendations. Attitudes toward a specific behavior have been shown to correlate highly with the individual’s performance of the behavior (Heberlein, 2012). Those with positive attitudes toward a behavior are more likely to perform the behavior than those with negative attitudes. Behavioral intentions are considered to be the most proximal determinant of behavior. In social science research, self-report measures of behavioral intentions are commonly used as surrogates for actual behavior. The extent to which someone intends to perform a behavior tends to be a fairly accurate predictor of actual behavior (Ajzen, 1991). Thus, as one component of this study, we examined the theoretical linkage to actual behavior, by measuring both attitudes and behavioral intent toward Leave What You Find-based practices.

Pre- and post-test surveys were utilized to explore changes in the attitudes and behavioral intentions of study participants. Assessing attitudes and intentions at both pre- and post-test allowed for measurement of changes in these domains as a result of participation in ODS generally, as well as any additive influence of the PEAK module specifically. This also allowed for the exploration of the effects of attitude on behavior, and the relationship between behavioral intent and actual behavior. Pre-test surveys were administered within an hour or two after students arrived to ODS on the first day of any given session. Post-test surveys were administered on the last day of every four-day session, before students departed. Survey instruments are included in Appendices C and D.
**Item Measurement**

Attitudes were measured through a battery of items that examined perceived appropriateness of various behaviors related to Leave What You Find recommended practices. Respondents were provided the following instructions: “This section is about things people do in nature. We would like to know how you feel about these things. Each survey item is a statement. You will have five choices to choose how much you agree or disagree with the statement.” Study participants were then presented 11 Likert-type statements anchored from 1 = Strongly Disagree to 5 = Strongly Agree, that describe behaviors people might do while in nature (e.g. picking flowers, collecting fossils). Some statements were positively worded (e.g. *It is OK to pick flowers*) and others were negatively worded (e.g. *It is wrong to collect fossils*). The Principle of Leave What You Find stresses the importance of leaving places in their natural state so as to protect the natural, cultural, and historical record of the place. Thus, by these standards, study participants who reported attitudes more in favor of keeping objects they find in nature would be considered to possess attitudes less in line with the Leave What You Find Principles.

Behavioral intent was measured similarly, using a battery of 10 Likert-type statements applying the same scale as used with the attitudinal battery, where 1 = Strongly Disagree and 5 = Strongly Agree. For this series of questions respondent were given the following instructions: “For this section, think about the next time you will be in nature. Each survey item will describe an action you might do in nature. We would like to know how likely you are to do the action. You will have five choices to choose how true that statement is for you.” Some items were worded to agree with Leave No Trace Principles (e.g. *I will pick up things I am interested in, but leave the where I found them*) and others were worded in disagreement (e.g. *If I find a fossil I will keep it*).
Post-test surveys were identical to the pre-test in terms of item presentation order and overall design, but two items were added to the attitudinal battery of questions that dealt with the level of importance attributed to keeping found objects, and the extent to which keeping a natural object might foster nature connectedness. Taking home natural objects found during an outdoor/nature experience is often cited as an important reminder of the event – a sort of souvenir or memento of the experience (Ward & Roggenbuck, 2003; Taff et al., 2014). The two items were: *Bringing a natural object home from nature is important to me,* and *I feel more connected to nature if I bring a natural object I find home with me (such as a rock, feather, or shell).* These items were left off of the pre-test survey for concern that introducing the notion of taking objects home could produce a biasing effect related to the actual behaviors of interest during the observation phase of data collection. Participants were also asked to indicate their gender on the post-test instrument.

In both the pre- and post-survey, the battery of items regarding intentions were presented first, followed by the attitude assessment, to reduce potential biasing effects of question order. For example, if respondents were first asked to indicate their perceived appropriateness of a behavior, it is possible this appraisal would then influence their honesty in responding to the intention statements. By presenting intention statements first it is believed respondents would be more inclined to provide responses based on a consideration of their typical, or past behavior, as opposed to attitudinal evaluations of right or wrong that may have been primed by the attitudinal statements.

The survey instrument went through multiple rounds of review and revision before being finalized and administered to study participants. It the initial review it was circulated to researchers with prior knowledge and experience conducting survey research. Reviewers were asked to evaluate the survey items based on the extent to which they appear to measure the intended construct or behavior. They were also asked to identify items that may not be easily
understood by fifth-grade readers. A first round of revisions was made based on reviewer comments. Next, we distributed the survey to colleagues with children of equivalent age to the study sample, and asked their children to review the survey for readability, and note items that are unclear or confusing. A second round of revision were made based on these comments. Finally, the survey was administered to a fifth-grade classroom in Lyons, Colorado, for final evaluation. At this stage the survey was deemed appropriate for readers at the fifth-grade level and approved for use in the study.

Observation Methods

To gain further insight regarding the relationship between the *PEAK* curriculum and actual behavior, participant observation data collection methods were utilized to measure actual behaviors. Survey data were then paired with observational measures. Such data collection methods allow for robust exploration and analysis of reported behavior with actual (observed) behavior.

The purpose of the observational data collection was two-fold: 1) it served to provide accurate, reliable, and quantifiable information regarding behaviors of interest; and 2) it allowed the ability to triangulate, or validate, and compare trends and patterns that may have emerged from the survey data. The following questions regarding observational variable relationships were examined:

- To what extent does the type of object relate to whether or not it was found during the activity, and subsequently kept or left on site?
- What role does gender play in regard to keeping found objects and the type of object kept? Is there a difference males and females in regard to the likelihood of keeping objects?
• Was an adult asked for permission to keep the found object? And if so, what role did that play in whether or not the object was kept?

• What is the relationship between asking an adult about keeping found objects and further discussion among the group (i.e. Did the asking of an adult for permission to keep the found object lead students to engage in further discussion?)?

• Is there a relationship between the occurrence of group discussion about keeping found objects and whether or not the object was kept?

• Does the level of group engagement with the found object relate to whether or not the object was kept?

• Does the content of discussions regarding the appropriateness of keeping objects differ between control and treatment groups?

**Observation Site Description**

Behavioral observations were made on either the second or third day of ODS during the soil cycle lesson. The variation in when learning groups took part in the soil cycle lesson was the result of overall learning group logistics (e.g., space for groups to engage with the soils lesson and have enough room to interact with potential objects found, without biasing nearby groups).

The soil cycle lesson teaches students about the role and process of soil and nutrient cycles. During the interactive lesson students are engaged in digging and sifting through soil layers, taking note of what they find, to better understand soil composition and the role of nutrients and soil-dwelling living things. During most weeks, three learning groups would participate in the soil cycle lesson on Wednesday morning, and three would participate on Thursday morning. Week four was a shortened week due to scheduling needs of that particular school, in which case all
participants took part in the soil cycle lesson on Wednesday. As a result, all observations happened on that day: three groups in the morning and the remaining three in the afternoon.

The primary behavior of interest during the activity was whether or not ODS students decided to keep a unique natural or cultural object found during the soil cycle activity. Ahead of the soil cycles lesson, researchers set up dig sites by burying the objects of interest within the dig plot boundary, which was designated by a 14” loop of red rope.

Objects used in this portion of the study were unique natural or cultural items found in central Pennsylvania, including: 1) Native American-style arrow heads (hand-carved from real stone, but not authentic pieces), 2) authentic trilobite fossils, 3) pieces of pyrite or (fool’s gold). Objects were placed in a consistent manner where they could easily be found during the lesson, while also appearing to be naturally occurring.
Each dig plot was pre-set to contain one object of interest. For consistency, the arrowhead was always placed in dig plot 1, fossil in dig plot 2, and pyrite in dig plot 3. During the site set-up plots were pre-dug to loosen the soil.

Preparation of study dig plots

Objects were then buried in the center of the dig plot approximately 1-2 inches below the surface.
Next, the surface was made to look untouched ("naturalized") by replacing any soil that had been removed and covering the area with leaf litter and other natural debris.
Finally, the red loops and numbered orange cones were staked in place.

The soil cycle ‘dig sites’ were located in a dense patch of forest, primarily Eastern Hemlock, and were approximately a 10-minute walk from the main camp. Dig sites were pre-selected and spaced approximately 50-100 yards apart to provide adequate distance from other groups so as to not influence behavior among groups.
Dig site showing spacing between groups, and researchers conducting observations (standing)

Groups could not easily hear or see members of another group. Each dig site accommodated one learning group of 10-12 students and consisted of three individual dig plots, identified by the orange cones seen in.

Dig site set-up showing spacing between individual dig plots
Two to four students were accompanied by one ODS counselor at each dig plot for the duration of the soil cycle lesson. The soil cycle lesson typically lasted approximately 30-45 minutes. Dig plots were spaced 8-10 feet apart, which allowed enough space for each group to work independently with minimal distraction from adjacent groups. This spacing also allowed researchers to effectively and accurately observe each plot (Figure 9). All LGLs and ODS counselors were instructed to avoid any guidance regarding how a group responded to an object. If a student or group asked a LGL or counselor what they should do with the object, the pre-determined and practiced response was “what do you think you should do”?

Observers collecting behavioral data at dig site

Each dig plot boundary was designated by a loop of red rope that measured approximately 14” in diameter. Students were instructed to dig only within the boundary of the red loop. Each loop was affixed to the ground with four stakes. Orange cones numbered one through three were placed at each dig plot so observers could reference the appropriate plot number when recording notes.
**Participant Observation Procedures**

To collect behavioral data, trained research assistants joined learning groups as participant observers (Bernard, 2013). Participant observers were of the same age (Penn State undergraduate students) as ODS counselors and participated in learning group activities in the same manner as ODS counselors. Thus, it is unlikely students perceived them as anything but ODS counselors.

Participant observers were undergraduate students enrolled in a Foundations of Research Methods course at Penn State University. The lead researchers worked with the methods professor to develop a course assignment that involved conducting observations for this study. In advance of the data collection, researchers visited the class on two separate occasions to discuss the project and provide an orientation and training on study-specific observation methods. During the training students were guided through a mock soil cycle lesson in which they observed the activity, and took notes using the same form they would use in the field. Approximately 80 students assisted with observation data collection over the course of six weeks. Two additional undergraduate students were hired to work as research assistants. They assisted with site set-up and served as additional participant observers.

During observation data collection sessions, one of the lead researchers and research assistants would meet student observers at the study site to provide a site orientation and final run-through of the observation methods. An observation session typically consisted of six student observers – allowing for two observers per dig site. Trained research staff were also on-site, and participated in the observation sessions to ensure inter-rater reliability among observers.

During the soil cycle activity, student observers were instructed to capture observations independently, i.e. they were instructed not to discuss observations with their classmates or trained researchers during the observation session. Observers noted the number of objects found,
whether the objects were kept, gender of student who kept the object, whether an adult was consulted for permission to keep a found object, whether discussion took place about the appropriateness of keeping objects, and a brief summary of discussion content (e.g. mention of concepts learned from the PEAK module). An additional variable captured the level of group engagement with study objects. With this item we were interested in the extent to which finding a study object contributed to group engagement with the activity. That is, when a study object was found, we wanted to know if participants expressed ‘high’, ‘medium’, or ‘low’ levels of engagement with the object. The observer data collection form is included in Appendix E, which includes details on how observational variables were operationalized during data collection.

The lead researcher rotated through the three dig sites to provide support, answer questions, and generally provide supervision of the data collection procedures. The research assistants most often filled in as observers when less than six student observers were available, or became a third observer when all students were present. At the end of the activity, observers would compare observation sheets to check for consistency or missed data points, and update the data forms as necessary. At that point, the lead researcher and research assistants would make note of dig plots where items had not been found, or where objects were placed back in the soil, and ultimately retrieve items to ensure additional objects would not be present in any dig plot for the next set of ODS learning groups.

Data Analysis

All data analyses were performed using IBM Statistical Package for the Social Sciences (SPSS) software, Version 22. Survey and observation data were initially entered into an Excel spreadsheet and then imported into an SPSS database for analysis. Univariate and bivariate descriptive statistics were conducted first to identify outliers and missing data. Missing data was
coded as 999 and responses that were unclear or illegible were coded with 888. Surveys that did not include both a pre- and post-test survey were removed from the dataset. Independent samples t-tests were conducted against pre-test scores to check for statistical differences between control and treatment groups. No statistically significant differences were found - indicative of effective randomization of participants into study groups - and thus the treatment and control groups were considered to be statistically equivalent at the start of the study.

Subsequently, paired samples t-tests were utilized to examine differences in means from pre- to post-test (for potential attitude and behavioral intention changes) for both the control and treatment groups. Mean change from pre- to post-test was calculated for each survey item, and these scores were used in independent samples t-tests to check for significant differences between control and treatment in regard to the amount of change from pre- to post-test. Observation data were coded as nominal/categorical variables (i.e., “yes” or “no”; “low”, “med”, or “high”). Therefore tabular analyses with chi-square tests of statistical significance were utilized in the analysis of these data.
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